SHAHEED BENAZIR BHUTTO UNIVERSITY
SHERINGAL, DIR UPPER (KP)



COMPLETE WORKING PAPER

M.Phil. ZOOLOGY

DEPARTMENT OF BASIC AND APPLIEDZOOLOGY

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WORKING PAPER (MPhil)
10th BOARD OF STUDIES MEETING
DEPARTMENT OF BASIC AND APPLIED ZOOLOGY
SHAHEED BENAZIR BHUTTO UNIVERSITY-SHERINGAL

APPROVAL OF COURSES FOR M.PHIL IN ZOOLOGY PROGROM

Following courses were unanimously approved by the board.

Course Category	Course Code	Course Title	Cr. Hrs.	Semester
Compulsory	ZOO-711	Advanced Techniques in Zoological Science	3(1+2)	I/II
Compulsory	ZOO-712	Research Design and Biostatistics	3(2+1)	I/II
Uni. Option	ZOO-713	Advanced Physiology	3(3+0)	I/II
Uni. Option	ZOO-714	Advances in Helminthology	3(3+0)	I/II
Uni. Option	ZOO-715	Medical Parasitology	3(3+0)	I/II
Uni. Option	ZOO-716	Research Methodology	3(3+0)	I/II
Uni. Option	ZOO-717	Apiculture	3(3+0)	I/II
Uni. Option	ZOO-718	Applied Entomology	3(3+0)	I/II
Uni. Option	ZOO-719	Applied Parasitology	3(3+0)	I/II
Uni. Option	ZOO-720	Fish Nutrition and Health	3(3+0)	I/II
Uni. Option	ZOO-721	Fish Parasitology	3(3+0)	I/II
Uni. Option	ZOO-722	Fish Requirements	3(3+0)	I/II
Uni. Option	ZOO-723	Medical Entomology	3(3+0)	I/II
Uni. Option	ZOO-724	Wildlife Conservation & Management	3(3+0)	I/II
Uni. Option	ZOO-725	Wildlife of Pakistan	3(3+0)	I/II
Uni. Option	ZOO-726	Advances in Protozoology	3(3+0)	I/II
Uni. Option	ZOO-727	Avian Haemosporidians Parasites	3(3+0)	I/II
Uni. Option	ZOO-728	Advance Mammalogy	3(3+0)	I/II
Uni. Option	ZOO-729	Advance Ornithology	3(3+0)	I/II
Uni. Option	ZOO-730	Hematology	3(3+0)	I/II
Uni. Option	ZOO-731	Herpetology	3(3+0)	I/II
Compulsory		Fehm-e- Quran I	1	I /II
Compulsory		Fehm-e- Quran II	1	I/II
Compulsory		Research and Thesis	6	III & IV
Total Credits=32				

DETAIL COURSE CONTENT OF MPhil PROGRAM

Semester 1			
Course Category	**Course Code**	**Course Title**	**Credits**
Compulsory	ZOO-711	Advanced Techniques in Zoological Science	3(1+2)
Uni. Option		Elective-I	3(3+0)
Uni. Option		Elective-II	3(3+0)
Uni. Option		Elective-III	3(3+0)
Compulsory		Fehm-e-Quran I	01
Total Credits			13

Semester 2			
Course Category	**Course Code**	**Course Title**	**Credits**
Compulsory	ZOO-712	Research Design and Biostatistics	3(2+1)
Uni. Option		Elective-I	3(3+0)
Uni. Option		Elective-II	3(3+0)
Uni. Option		Elective-III	3(3+0)
Compulsory		Fehm-e-Quran II	01
Total Credits			13

Semester 2			
Course Category	**Course Code**	**Course Title**	**Credits**
Research		Thesis	6
Total Credits			6

Compulsory	**ZOO-711**	**Advanced Techniques in Zoological Science**	**3(1+2)**

Course Objectives:

1. To provide advanced knowledge of modern techniques used in zoological research across molecular, cellular, physiological, ecological, and computational domains.
2. To train students in laboratory and field methodologies essential for contemporary zoological investigations.
3. To develop skills in analyzing, interpreting, and presenting zoological data using advanced analytical and imaging tools.

Course Learning Outcomes (CLOs)

After completing this course, students will be able to:

1. Explain the principles and applications of advanced modern techniques used in zoological sciences.

2. Demonstrate competence in laboratory-based molecular, cellular, and imaging techniques.
3. Apply ecological, behavioral, and field-based research methods for zoological data collection.
4. Analyze molecular, phylogenetic, and ecological datasets using advanced statistical and computational tools.

Course Outline

1. Introduction to Advanced Zoological Techniques
a. Overview of modern zoological research methodologies
b. Integration of molecular, ecological, and physiological approaches
c. Laboratory and field safety, quality control, and ethical guidelines
2. Microscopy, Imaging & Histological Techniques
a. Light, fluorescent, confocal, and electron microscopy
b. Histological preparations: fixation, staining, sectioning
c. Immunohistochemistry and imaging analysis software
3. Molecular and Genetic Techniques
a. DNA/RNA extraction and quantification
b. PCR, qPCR, and gel electrophoresis
c. DNA barcoding and molecular identification of species
d. Next-generation sequencing (NGS): principles and applications
4. Protein and Cellular Analysis
a. Protein extraction and quantification assays (Bradford/Lowry)
b. Western blotting and ELISA
c. Flow cytometry and cell sorting
5. Bioinformatics and Computational Zoology
a. Sequence alignment, phylogenetic analysis, and genomics
b. Use of databases: NCBI, BOLD, UniProt
c. Introduction to R/Python for zoological data analysis
6. Ecological, Behavioral, and Field Techniques
a. Mark–recapture methods, transect sampling, camera trapping
b. Behavioral observation techniques, ethograms, automated tracking
c. Remote sensing, GIS mapping, and species distribution modeling
7. Physiological and Biochemical Techniques
a. Respirometry and metabolic rate measurement
b. Electrophysiology basics
c. Hormonal and biochemical assays

Practical

1. Use of compound, fluorescence, and digital microscopy.
2. Preparation of histological slides (fixation, staining, imaging).
3. DNA/RNA extraction from animal tissues.
4. PCR amplification and gel electrophoresis.
5. qPCR for gene expression profiling.
6. Protein extraction, quantification, and Western blotting.
7. ELISA for pathogen or hormone detection.

8. Running basic phylogenetic analyses using MEGA / IQ-TREE.
9. Sequence alignment and barcode-based species identification.
10. Field sampling methods: traps, nets, and ecological surveys.
11. Behavioral data collection and software-based movement analysis.
12. GIS mapping and species distribution modeling exercises.
13. Respirometry/metabolic rate measurement.
14. Data analysis using R/Python: statistics, visualization.

Recommended Books and References

1. Alberts, B. et al. (2015). *Molecular Biology of the Cell*. Garland Science.
2. Sambrook, J., & Russell, D. (2001). *Molecular Cloning: A Laboratory Manual*. Cold Spring Harbor Laboratory Press.
3. Krebs, C. J. (2014). *Ecology: The Experimental Analysis of Distribution and Abundance*. Pearson.
4. Prosser, C. L. (1991). *Comparative Animal Physiology*. Wiley-Liss.
5. Sutherland, W. J. (2006). *Ecological Census Techniques: A Handbook*. Cambridge University Press.

Compulsory	**ZOO-712**	**Research Design and Biostatistics**	**3(2-1)**

Course Objectives:

1. Understand advanced concepts of research methodology relevant to zoological sciences, including ecological, molecular, physiological, and behavioral research.
2. Apply advanced biostatistical techniques for data analysis in experimental and field-based zoological research.
3. Use statistical software (SPSS/R/Excel) for data analysis and visualization.

Course Learning Outcomes (CLOs)

After completing this course, students will be able to:

1. Explain advanced concepts of research methodologies used in zoology.
2. Select appropriate experimental or field research design for zoological investigations.
3. Perform descriptive, inferential, and advanced biostatistical analyses.

Course Outline

1. Foundation of Research

a. Philosophy of science, research paradigms
b. Research ethics and animal care guidelines (IACUC/ethical review)
c. Identifying research problems in zoology
d. Hypothesis building

2. Research Design in Zoology

a. Experimental vs. observational studies
b. Field-based research (population studies, wildlife monitoring, biodiversity assessments)
c. Laboratory research designs (behavior, physiology, morphology, molecular studies)
d. Longitudinal vs cross-sectional designs

e. Controls, randomization, replication, pseudo replication

3. Sampling & Data Collection

a. Sampling methods in field biology: transects, quadrats, mark–recapture, camera trapping
b. Sample size estimation, power analysis
c. Measurement scales and data types

4. Biostatistics

a. Descriptive statistics
b. Probability distributions (normal, Poisson, binomial)
c. Inferential statistics
    - t-test, ANOVA, MANOVA
    - Chi-square tests
    - Correlation & regression
    - Non-parametric tests (Mann–Whitney, Kruskal–Wallis)
d. Multivariate analyses (PCA, cluster analysis) – *introductory*
e. Survival analysis (for wildlife studies) – *introductory*

5. Scientific Writing & Communication

a. Writing research proposals and theses
b. Referencing styles (APA, Chicago, Harvard)
c. Preparing tables, graphs, and figures
d. Using plagiarism-check tools
e. Peer-review process

Practical

1. Data entry, coding, and cleaning
2. Use of statistical software: **SPSS, R, Excel**
3. Running analyses:
    - Descriptive statistics
    - t-test, ANOVA, chi-square
    - Correlation & regression
    - Non-parametric tests
4. Producing graphs, charts, and summary tables
5. Interpretation and reporting of statistical outputs

Recommended Books and References

1. **Research Methodology: Methods and Techniques** – C. R. Kothari & Gaurav Garg. **4th Edition (2019)**, New Age International Publishers, New Delhi, India.
2. **Experimental Design and Data Analysis for Biologists** – Graeme P. Quinn & Michael J. Keough. **2nd Edition (2002)**, Cambridge University Press, Cambridge, UK.
3. **Biostatistical Analysis** – Jerrold H. Zar.**5th Edition (2010)**, Pearson Education, Upper Saddle River, USA.
4. **Discovering Statistics Using SPSS** – Andy Field. **5th Edition (2018)**, SAGE Publications Ltd., London, UK.
5. **Ecological Census Techniques: A Handbook** – William J. Sutherland. **2nd Edition (2006)**, Cambridge University Press, Cambridge, UK.

6. **A Short Guide to Writing About Biology** – Jan A. Pechenik.**9th Edition (2019)**, Pearson Education, USA.

Uni. Option	ZOO-713	Advanced Physiology	3(3+0)

Course Objectives:

1. Teach basic and advanced assisted reproductive techniques in animals and humans.
2. Train students in semen evaluation cryopreservation IVF and embryo technologies.
3. Develop skills to diagnose infertility and apply ART for breeding and conservation.

Course Learning Outcomes (CLOs)

1. Explain key ART methods including IVF and embryo transfer.
2. Perform semen evaluation cryopreservation and basic lab procedures.
3. Identify infertility causes and apply ART for animal improvement and conservation.

Course Outline:

1. **Assisted Reproductive techniques:** an overview
2. **Semen Collection & Evaluation:**

a. Semen collection methods
b. Initial assessment: Appearance, volume & concentration
c. Sperm motility: Computer Aided Sperm Analysis
d. Sperm Morphology
e. Acrosome status
f. Chromatin integrity

3. **Semen cryopreservation:**

a. Properties of Semen Extenders
b. The cryopreservation technique
c. Application in farm animals & endangered species and humans.

4. **Artificial insemination:**

a. Introduction and history of Artificial insemination
b. Artificial insemination procedures

5. **Estrus synchronization**
6. **In vitro fertilization (IVF) and in vitro embryo production (IVEP):**

a. IVEP & Transfer for genetic improvement of farm animals
b. IVF and ICSI for treatment of infertility in human

7. **Superovulation and Embryos transfer**
8. **Assisted Reproductive techniques for conservation of endangered species:**

a. Sperm cryobanking
b. Embryo freezing

9. **Causes of sterility in domestic animals:**

a. Infertility in Male
b. Infertility in female
c. Sperm sexing for sex pre-selection
d. Contraception

Text and Reference Books

1. **Andrology: Male Reproductive Health and Dysfunction** – Eberhard Nieschlag, Hermann M. Behre & Susan Nieschlag.**4th Edition (2019),** Springer, Berlin,Germany / New York, USA.
2. **Knobil and Neill's Physiology of Reproduction** – Tony M. Plant & Anthony J. Zeleznik (Editors).**4th Edition (2015)**, Academic Press (Elsevier), Springer imprint, USA.
3. **Reproduction in Farm Animals** – E. S. E. Hafez & B. Hafez. **8th Edition (2013),** Wiley-Blackwell, New York, USA.
4. **Applied Animal Reproduction** – H. J. Bearden, J. W. Fuquay & S. T. Willard.**6th Edition (2004)**, Pearson Prentice Hall, Upper Saddle River, USA.

Uni. Option	**ZOO-714**	**Advances in Helminthology**	**3(3+0)**

Course Objectives

1. To provide an evolutionary and biological understanding of host–parasite relationships in helminths.
2. To familiarize students with epidemiology, pathology, immunology, and diagnosis of major human helminth infections.
3. To introduce modern approaches for control, chemotherapy, immunodiagnosis, and genetic aspects of helminth infections.
4. To develop analytical skills for interpreting epidemiological and immunological data related to helminth diseases.

Course Learning Outcomes (CLOs)

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

1. Explain host–parasite interactions, adaptation, and host specificity in helminths.
2. Describe the epidemiology, ultrastructure, chemical composition, and pathogenesis of major human helminth parasites.
3. Explain host immune responses and antigenic characteristics of pathogenic helminths.
4. Discuss diagnostic, immunodiagnostic, chemotherapeutic, and genetic control strategies for helminth infections.

Course Contents

Evolutionary perspectives of host parasite relationship, helminths adaptation, Host specify in helminths, Epidemiology of some helminth infection of human origin with emphasis on Ascariasis, Trichuriasis, Enterobiasis, Dracunculiasis, Taeniasis, Hymenolepiasis, Echinococcosis, Fascioliasis. Genetic variation in helminth and their epidemiological importance. Ultra-structure, chemical composition and pathogenesis of helminth parasites. Host response to helminth infection, antigen of pathogenic helminth, diagnosis of helminth infection. Immunodiagnosis and radiation in the control of helminth infection, chemotherapy and genetic

control of immunity to helminth parasites. Examination of stool specimens for different helminth eggs/segments. Helminth eggs recovery through different techniques, Kato-Katz, Direct smear methods and concentration procedures, Recovery of Enterobius vermicularis and Taenia spp eggs through cellophane tape Swab, Methods for estimation of worm burden (stoll-egg counting technique, Kato-Katz techniques), Methods for investigation of intestinal helminthes (Knott concentration technique and membrane filtration technique for micro-filaria)

Books Recommended

1. **Foundations of Parasitology** – Larry S. Roberts, John Janovy Jr., Gerald D. Schmidt.**9th Edition (2013)**, McGraw-Hill Education, USA.
2. **Medical Parasitology** – C. K. Jayaram Paniker.**8th Edition (2018)**, Jaypee Brothers Medical Publishers, New Delhi, India.
3. **Human Parasitology** – Burton J. Bogitsh, Clint E. Carter, Thomas N. Oeltmann.**5th Edition (2019)**, Academic Press (Elsevier), USA.
4. **Parasitic Diseases** – Dickson D. Despommier, Robert W. Gwadz, Peter J. Hotez, Serap Aksoy.7**th Edition (2022)**, Springer, USA.

Uni. Option	**ZOO-715**	**Medical Parasitology**	**3(3+0)**

Course Objectives

1. To provide students with a comprehensive understanding of **host-parasite interactions**, ranging from symbiosis to parasitism, and the biological, immunological, and pathophysiological aspects of major parasitic diseases.
2. To develop knowledge of the **immunology and molecular mechanisms** involved in protozoan and to develop knowledge of the **immunology and molecular mechanisms** involved in protozoan and helminth infections, including cytokine responses and host defense mechanisms.
3. To introduce the clinical, epidemiological, and public health significance of **protozoan and helminth infections**, with emphasis on disease spectra, pathology, and immune responses.

Learning Outcomes

By the end of the course, students will be able to:

1. **Explain the life cycles, pathology, and immunopathology** of medically important protozoan and helminth parasites, including malaria, leishmaniasis, schistosomiasis, filariasis, and nematodiasis.
2. **Analyze host-parasite interactions and immunological mechanisms**, including cytokine responses, eosinophilia, and molecular interactions at the cellular level.

3. **Apply knowledge to assess disease impact**, interpret clinical and epidemiological data, and understand the significance of parasitic infections in public health and disease management.

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.

Books Recommended

1. **Foundations of Parasitology** – Larry S. Roberts & John Janovy Jr.**8th Edition (2009)**, McGraw-Hill, Boston, USA.
2. **Animal Agents and Vectors of Human Diseases** – P. C. Beaver & R. C. Jung. **5th Edition (1985)**, Lea & Febiger, Philadelphia, USA.
3. **Hunter's Tropical Medicine and Emerging Infectious Diseases** – Edited by G. T. Strickland.**9th Edition (2013)**, Elsevier Saunders, Philadelphia, USA.
4. **Immunobiology: The Immune System in Health and Disease** – Charles A.Janeway Jr., Paul Travers, Mark Walport & Mark J. Shlomchik.**8th Edition (2012)**, Garland Science, New York, USA.

Uni. Option	**ZOO-716**	**Research Methodology**	**3(3+0)**

Course Objectives:

1. Teach the basic steps of research from topic selection to data analysis and writing.
2. Develop skills in research design sampling statistics and use of software tools.
3. Train students to write scientific reports follow ethics and prepare proposals.

Course Learning Outcomes (CLOs)

1. Explain key concepts of research methods research design and literature review.
2. Collect analyze and present data using statistical tests and software tools.
3. Write research proposals reports and theses using proper referencing and ethics.

Course Contents:

1. Introduction:

a. Objectives of Research
b. Motivations

2. Research Process:

a. Research methods vs. research methodology

b. Scientific method
c. Types of research
d. General steps involved in research
e. Problems of research in Pakistan

3. Topic Selection:

a. Problem identification for research
b. Criteria and evaluation

4. Literature Review:

a. Importance and sources
b. Referencing and citation and bibliography
c. Plagiarism

5. Research Design:

a. Parts
b. Important features
c. Important concepts in research design

6. Aims and Objectives:

a. Research objectives
b. Qualities of research objectives

7. Material and Methods:

a. Bioethics
b. Sampling, sampling designs
c. Data collection and data analysis
d. Sampling requirements
e. Scales of measurement
f. Error of measurement and its sources

8. Data Analysis:

a. Processing
b. Statistics in research
c. Hypothesis testing
d. t-tests and ANOVA

9. Statistical Software:

a. SPSS
b. SAS
c. SATA
d. Python and R etc.

10. Data Presentation:

a. Tabulation
b. Graphical presentation
c. Presentation software

11. Scientific Writing:

a. Difference between thesis/report/synopsis/research proposal
b. Parts of synopsis/project proposal, parts of thesis/report

12. Reference management software:

a. Endnote
b. Reference Manager
c. Mendeley etc.

13. Budgeting:

a. Cost estimates for a research project

b. Funding sources e.g. USAID, HEC, MOST, HED, PMRC, WWF, PSF etc.

Recommended Books:

1. **Practical Research: Planning and Design** – Paul D. Leedy & Jeanne Ellis Ormrod. **8th Edition (2005)**, Pearson Education, Upper Saddle River, USA.
2. **Research Design: Qualitative, Quantitative, and Mixed Methods Approaches** – John W. Creswell. **5th Edition (2018)**, SAGE Publications, Thousand Oaks, California, USA.
3. **Approaches to Qualitative Research: A Reader on Theory and Practice** – Sharlene N. Hesse-Biber & Patricia Leavy. **2nd Edition (2010)**, Oxford University Press, New York, USA.
4. **Research Methodology: Methods and Techniques** – J. A. Khan. **2nd Edition (2006)**, APH Publishing Corporation, New Delhi, India.
5. **Research Methodology: Methods and Techniques** – C. R. Kothari & Gaurav Garg. **4th Edition (2019)**, New Age International Publishers, New Delhi, India.
6. **Research Methodology: A Step-by-Step Guide for Beginners** – Ranjit Kumar. **5th Edition (2019)**, SAGE Publications, London, UK.

Uni. Option	**ZOO-717**	**Apiculture**	**3(3+0)**

Course Objectives

1. To provide students with a thorough understanding of **bee biology, behavior, and the apiculture industry**, including the economic and ecological importance of bees.
2. To develop practical skills in **beekeeping management**, including hive preparation, seasonal colony management, queen rearing, pest and disease control, and honey extraction.
3. To introduce students to the **production, properties, and utilization of honey and other bee products**, emphasizing their value in pollination and as a commercial enterprise.

Learning Outcomes

By the end of the course, students will be able to:

1. **Explain the biology, behavior, and classification of bees**, identify bee species, and understand their role in pollination and the apiculture industry.
2. **Perform practical beekeeping tasks**, including colony inspection, hive preparation, seasonal management, queen rearing, pest and disease management, and honey extraction.
3. **Assess and utilize bee products**, including honey, wax, propolis, and royal jelly, understanding their properties, storage, and commercial value in beekeeping

Course Outline:

Introduction, importance, scope of apiculture industry, bee species and their biology, morphology, behavior and products, bee flora their distribution and flowering time; beekeeping equipments, seasonal management, uniting, dividing and preparation for shifting colonies; bee

stings, queen rearing and swarming; pest and diseases of bees and their management; honey extraction; factors affecting honey yield; importance of bees in pollination; honey, its properties and uses; granulation, fermentation and storage of honey, uses of other bee products; beekeeping as an enterprise. Demonstration of bee colonies. Observation of colonies and different casts. Beekeeping equipment. Preparation of frames and comb foundation for their hives. Colony inspection; visit to apiaries.

Recommended Books:

1. Ahmad, R. Latest Edi. A Guide to Bee Keeping in Pakistan. Extension Book.
2. Devillers, J., Phame, M. and Delegue, M. Latest Edi. Honey Bees.
3. Goodwin, R.N. and Van Eaton, C. Latest Edi. Elimination of American Foulbrood without the use of Drugs. A Practical Manual for Bee Keepers. National Bee Keepers Association of New Zealand, Napier, New Zealand.
4. Hooper, T. Latest Edi. Guide to Bees and Honey. BAS Printers Ltd. Hampshir, U.K

Uni. Option	**ZOO-718**	**Applied Entomology**	**3(3+0)**

Course Objectives

1. To provide students with a comprehensive understanding of the **biology, ecology, and economic importance of insects**, including their life histories and damage patterns on crops, stored products, and households.
2. To equip students with knowledge of **principles and methods of insect control**, including cultural, biological, chemical, mechanical, reproductive, legislative, and biotechnological approaches, along with the fundamentals of Integrated Pest Management (IPM).
3. To develop practical skills in **identification, collection, and management of insect pests**, as well as techniques for apiculture, sericulture, and lac-culture.

Learning Outcomes

By the end of the course, students will be able to:

1. **Identify and describe** major insect pests of crops, fruits, vegetables, stored grains, and households, including their life cycles, modes of damage, and economic significance.
2. **Apply and evaluate** appropriate pest control methods, including chemical, biological, cultural, mechanical, and IPM strategies, and safely handle and use insecticides and application equipment.
3. **Demonstrate practical skills** in collecting, identifying, and documenting insect pests, as well as implementing techniques in apiculture, sericulture, and lac-culture for commercial and research purposes.

Course Outline:

Introduction; causes of success and economic importance of insects; principles and methods of insect control i.e. cultural, biological, physical, mechanical, reproductive, legislative, chemical and bio-technological control; introduction to IPM; insecticides, their classification, formulations and application equipment; identification, life histories, mode of damage and control of important insect pests of various crops, fruits, vegetables, stored grains, household, termites and

locust; introduction to entomological industries: apiculture, sericulture and lac-culture. Collection, identification and mode of damage of insect pests of various crops, Fruits, Vegetables, Stored grains and household, Insecticide formulations, their dilutions and safe handling; Use of application equipments, instructions for apiculture, sericulture and lac-culture.

Recommended Books:

1. **Agricultural Pests of Southeast Asia and Their Management** – A. S. Atwal & H. S. Dhaliwal. **Latest Edition (2010)**, Kalyani Publishers, Ludhiana, India.
2. **Introduction to General and Applied Entomology** – V. B. Awastheir. **Latest Edition (1997)**, Scientific Publishers, Jodhpur, India.
3. **The Insect: Beneficial and Harmful Aspects** – P. A. Duncton. **Latest Edition (2004)**, Kalyani Publishers, Ludhiana, India.
4. **The Insects: An Outline of Entomology** – P. J. Gullan & P. S. Cranston. **4th Edition (2010)**, Wiley-Blackwell; A John Wiley & Sons, Ltd. Publication, UK.
5. **Applied Entomology** – M. K. Lohar. **Latest Edition (2015)**, Department of Entomology, Sindh Agriculture University Tandojam, Sindh, Pakistan.
6. **Pesticide Application Methods** – G. A. Mathews. **3rd Edition (2008)**, John Wiley & Sons, Inc., New York, USA.
7. **Entomology and Pest Management** – L. P. Pedigo & E. R. Marlin. **6th Edition (2014)**, Pearson Education, Inc., Upper Saddle River, New Jersey, USA.
8. **Fundamentals of Applied Entomology** – E. R. Pfadt. **Latest Edition (1994)**, The Macmillan Company, New York, USA.
9. **Entomology: Principles and Practices** – D. H. Robinson. **Latest Edition (2005)**, Agro-Bios, India.
10. **Applied Entomology** – H. A. Shah & M. A. Saleem. **Latest Edition (2013)**, Izhar Bottom of Form

Uni. Option	**ZOO-719**	**Applied Parasitology**	**3(3+0)**

Course Objectives:

1. Teach methods for collection processing preservation and identification of parasites.
2. Develop understanding of chemotherapeutic agents vaccines and parasite resistance.
3. Train students in modern techniques including tissue culture cryopreservation and genetic approaches in parasite control.

Course Learning Outcomes (CLOs)

1. Identify parasites and apply techniques for recovery preservation and drug-resistance assessment.

2. Explain modes of action of antiparasitic drugs vaccine development and parasite resistance.
3. Perform basic laboratory techniques such as culture PCR preservation and antigen-based approaches in parasitology.

Course Outline:

1. **Chemicals and reagents used in preservation of parasitic materials:**
a. Collection, processing and identification of parasites
b. Recovery of parasite eggs, oocysts and larvae from faecal specimens
c. Determination of parasite resistance to pesticidal chemicals and chemotherapeutic drugs.
2. **Control and Vaccine Development Against Parasitic Infections:**
3. **Chemotherapeutic agents used against parasitic infections:**
a. e.g, anthelmintics, insecticides etc.
b. The mode of action of chemotherapeutic agents
c. The mechanisms of parasite resistance to drugs.
4. **Methods of Vaccine Development:**
a. Various approaches will be discussed for example: Helminths use of 3 types of antigens viz: Irradiation-attenuated live helminths
b. Somatic extracts of helminthes
c. Metabolic or excretory/secretory (E/S) antigens produced by the in vitro culture of helminths.
d. Genetic engineering. the application of genetically engineered vaccines will be discussed. Cultivation of Parasites tissue culture techniques, cryopreservation

Recommended Books:

1. **Parasitology & Vector Biology** – William Charles Marquardt, Richard S. Demaree Jr. & Robert Burton Grieve. **2nd Edition (2015)**, Academic Press (Elsevier), USA.
2. **Introduction to Parasitology** – A. C. Chandler & C. P. Read. **13th Edition (2015)**, Wiley-Blackwell (Toppan), New York, USA.
3. **Insect Transgenesis: Methods and Applications** – A. M. Handler & A. A. James (Editors). **Latest Edition** , CRC Press, Boca Raton, FL, USA.
4. **PCR Technology: Principles and Applications for DNA Amplification** – Henry Erlich (Editor). **Latest Edition** , W. H. Freeman & Company, New York, USA

Uni. Option	**ZOO-720**	**Fish Nutrition and Health**	**3(3+0)**

Course Objectives:

1. Teach principles of fish nutrition digestion energy use and nutrient requirements.
2. Develop understanding of fish feeds feed formulation feed additives anti-nutritional factors and toxic agents.
3. Train students in rationing feed evaluation proximate analysis and quality control in aquafeed production.

Course Learning Outcomes (CLOs)

1. Describe nutrients digestion bioenergetics and types of fish feeds.
2. Identify feed additives anti-nutritional factors toxins and nutritional disorders in fish.
3. Calculate feed conversion ratio SGR perform proximate analysis and evaluate feed quality in aquaculture.

Course Outlines:

1. Introduction:
a. Introduction to nutrients (macronutrients and micronutrients) and their importance
b. Carbohydrates, lipids, protein, amino acids, vitamins, minerals, carotenoids
c. Nutritional energetic
d. Digestion process in fish
e. Energy partitioning
f. Bioenergetics model
g. Methods of digestibility determination
h. Factors affecting digestibility
i. Nutrient digestibility.

2. Types of fish feed:
a. Natural and artificial
b. Production of live feed
c. Classification of fish feed on the basis of nutrient composition and texture

3. Feed Additives and anti-nutritional factors:
a. Introduction to feed additives
b. Other dietary components (water, fiber, hormones, antibiotics, pigments, pellet binders, stimulants)
c. Anti-nutritional factors, types of anti-nutrients and their sources

4. Introduction to toxic agents and anti-oxidants:
a. Toxic agents
b. Non-nutrient diet components
c. Antioxidants in compounded feeds

5. Nutritional disorders:
a. Nutritional fish diseases
b. Nutrients and immune response
c. Feed rancidity

6. Feed Rationing and Frequency:
a. Feeding ratio
b. Feeding frequency
c. Feed conversion ratio
d. Feed digestibility
e. Pre-biotics and pro-biotics

7. Novel diets for aquaculture:
a. Encapsulated diets, medicinal diets and experimental diets

8. Aqua feed industry:
a. Introduction
b. Economics of feed production and feeding
c. Quality control in fish feed manufacturing
d. Feed regulations.

Recommended Books:

1. **Fish Nutrition** – John E. Halver. **3rd Edition (2002)**, Academic Press (Elsevier), Boston, USA.
2. **Nutrition and Feeding of Fish** – T. Lovell. **2nd Edition (2006)**, Springer Science + Business Media, USA.
3. **Aquaculture: An Introductory Text** – R. R. Stickney. **2nd Edition (2000)**, CABI Publishing, London, UK.
4. **Aquaculture** – B. N. Pandey, S. Deshpande & P. N. Pandey. **Latest Edition (2010)**, APH Publishing Corporation, New Delhi, India.
5. **Aquaculture Nutrition and Biochemistry** – J. S. Ojha. **Latest Edition (2015)**, Geeta Somani Agrotech Publishing Academy, Udaipur, India.
6. **Aquaculture Science** – R. O. Parker. **Latest Edition (2003)**, Delmar Learning, London, UK.
7. **Fish Nutrition** – J. E. Halver & R. W. Hardy. **3rd Edition (2002)**, Academic Press, Boston, USA.
8. Handbook on Ingredients for Aquaculture Feeds – J. W. Hertrampf, F. P. Pascual & S. L. Ong. 1st Edition (1997), Kluwer Academic Publishers, Netherlands.
9. Nutrient Dynamics in Freshwater Fish Culture System – C. B. T. Rajagopalsamy & V. Ramadhas. Latest Edition (2008), Daya Publishing House, Delhi, India

Uni. Option	**ZOO-721**	**Fish Parasitology**	**3(3+0)**

Course Objectives:

1. Provide basic knowledge of fish parasites their diversity life cycles and host relationships.
2. Develop skills for identification diagnosis treatment and control of fish parasitic infections.
3. Build understanding of medically important parasites and their impact on fish health and aquaculture.

Course Learning Outcomes (CLOs)

1. Identify major ecto and endoparasites of fish and describe their life cycles.
2. Diagnose parasitic diseases through physical examination and laboratory methods.
3. Apply treatment prevention and control measures for fish parasites in aquaculture settings**.**

Course Outlines:

1. Introduction to fish parasitology:

a. Host and parasite
b. Types of hosts and parasite
c. Ectoparasite and endoparasite concepts
d. Overview and Adaptation
e. Association of parasites

f. Symbiosis, commensalism, mutualism, and parasitism

2. Fish parasites:

a. Classes of fish parasites
b. Ecto-parasites
c. Endo-parasite
d. Identification of parasitic problems
e. Methods of diagnosis, physical examination
f. Pathogenesis
g. Life cycles and treatment methods of following parasites
h. Protozoa
i. Monogenean trematodes
j. Degenean trematodes
k. Nematodes
l. Cestodes
m. Crustaceans
n. Leeches.

3. Medically important parasites:

a. The medically important parasites
b. Protection and the treatment of fish parasites

4. a. Identification of parasites
b. Life cycles of parasites
c. Isolation of fish parasites from host Treatment methods
d. Prevention and control measures

Recommended Books:

1. **Fish Parasites: Pathobiology and Protection** – Patrick T. K. Woo & Kurt Buchmann. **1st Edition (2012)**, CABI Publishers, Wallingford, UK.
2. **Safety and Quality Issues in Fish Processing** – H. A. Bremner. **1st Edition (2002)**, Woodhead Publishing Limited, Cambridge, England.
3. **An Introduction to Practical Methods in Fish Parasitology** – Kurt Buchmann. **1st Edition (2012)**, CABI Publishers, Wallingford, UK.
4. **Fish Disease: An Introduction** – J. Bresciani, E. Ariel, K. Pedersen & I. H. Dalsgaard. **1st Edition (2010)**, CABI Publishers, Wallingford, UK.

Uni. Option	**ZOO-722**	**Fish Requirements**	**3(3+0)**

Course Objectives:

1. Teach principles of fish nutrition digestion energy use and nutrient requirements.
2. Develop understanding of fish feeds feed formulation feed additives anti-nutritional factors and toxic agents.
3. Train students in rationing feed evaluation proximate analysis and quality control in aquafeed production.

Course Learning Outcomes (CLOs)

1. Describe nutrients digestion bioenergetics and types of fish feeds.
2. Identify feed additives anti-nutritional factors toxins and nutritional disorders in fish.
3. Calculate feed conversion ratio SGR perform proximate analysis and evaluate feed quality in aquaculture.

Course Outlines:

1. Introduction to fish nutrition
2. Digestion and absorption of nutrients
3. Feeding types and anatomy
4. Energy, protein, lipids, carbohydrate, mineral and vitamin requirements of fish
5. Factors affecting nutrient requirements of fish
6. Energy losses and partitioning in fish
7. The role of other dietary components viz. water, fiber, hormones, antibiotics, antioxidants, pigments, pellet binders and feeding stimulants
8. Anti-nutrients and toxins
9. Forms and size of feed, feeding rates and feeding practices for different fish species
10. Special purpose feeding
11. Feed calculations, feed requirements and feed conversion ratios
12. Feed ration and frequency, judging feeding response of cultured species, methods of feeding

Recommended Books:

1. Fitzsimmons, K., R.S.N. Janjua and M. Ashraf, Latest Edi. Aquaculture Handbook—Fish Farming and Nutrition in Pakistan.
2. John Halver. Latest Edi. Fish Nutrition, ELSEVIER.
3. Lovell, T., Latest Edi. Nutrition and Feeding of Fish. Latest Edi. Springer Science, USA
4. Hepher, B., Latest Edi. Nutrition of Pond Fishes. Cambridge University Press, UK.
5. Halver, J.E., Ronald, W.H. and Daniel, M.H. Latest Edi. Fish Nutrition (4thed.). Academic Press, N. York.
6. Pillay, T.V.R. Latest Edi. Aquaculture: Principles and Practices. Fishing News Books, London.
7. N.C.R., Latest Edi. Nutrient Requirements of Fish. National Academy Press, Washington D.C.

Uni. Option	**ZOO-723**	**Medical Entomology**	**3(3+0)**

Course Objectives:

1. Teach identification biology and medical importance of arthropods affecting human and animal health.
2. Explain diseases pests toxins venoms and allergic reactions caused by medically important arthropods.
3. Train students in collection diagnosis management and control strategies for vectors and pests.

Course Learning Outcomes (CLOs)

1. Identify major medically important arthropods describe their life cycles and explain their public health impact.
2. Diagnose arthropod-borne problems including toxins venoms food contamination and allergic reactions.
3. Apply field sampling methods and recommend appropriate control and management strategies for vectors and pests.

Course Outline:

1. **General Introduction of arthropods of Medical Importance**
2. **Problems caused**
3. **Arthropods borne**
4. **Food Contaminants**
5. **Toxins and Venoms**
6. **Defense secretions and allergens**
7. **Introduction, lifecycle, medical importance and management strategies of:**
   a. Mosquitoes
   b. Sandflies
   c. Horse flies
   d. Tsetse fly
   e. Fleas
   f. Lice
   g. Bed bugs
   h. Cockroaches
   i. Houseflies
   j. Black flies
   k. Beetles
   l. Butterflies and Moths
   m. Bees and Wasps
   n. Scorpions
   o. Spiders
   p. Ticks
   q. Mites

Recommended Books:

1. Medical Entomology for Students – Mike W. Service. 5th Edition (2012), Cambridge University Press, Cambridge, UK.
2. Medical and Veterinary Entomology – G. R. Mullen & L. A. Durden. 3rd Edition (2019), Academic Press, San Diego, CA, USA.
3. Veterinary Entomology: Livestock & Companion Animals – R. E. Williams. Latest Edition (2009), CRC Press, Boca Raton, FL, USA.
4. Biology of Disease Vectors – W. C. Marquardt. 2nd Edition (1996), Elsevier Academic Press, Amsterdam, Netherlands.

5. Medical Entomology: Textbook of Public Health and Veterinary – B. Aldridge. Latest Edition (2004), Chapman and Hall, London, UK.
6. Medical Entomology: A Handbook of Medically Important Insects & Other Arthropods – Tyagi. Latest Edition (2003), Scientific Publishers, Jodhpur, India.
7. Medical Entomology: A Textbook on Public Health and Veterinary Problems Caused by Arthropods – F. B. Eldridge & J. D. Edman. Latest Edition (2000), Kluwer Academic Publishers, Dordrecht, Netherlands.
8. Medical and Veterinary Entomology – D. S. Kettle. 2nd Edition (1995), CAB International, Wallingford, UK.
9. Insects and Hygiene – J. R. Busvine. 3rd Edition (1980), Chapman and Hall, London, UK.

Uni. Option	**ZOO-724**	**Wildlife Conservation and Management**	**3(3+0)**

Course Objectives:

1. Teach identification distribution status and values of major wildlife of Pakistan.
2. Explain conservation problems laws protected areas threatened species and management strategies.
3. Build skills in applying modern wildlife conservation techniques and understanding national and international conservation systems.

Course Learning Outcomes (CLOs)

1. Identify key wildlife groups of Pakistan and explain their distribution status and conservation needs.
2. Describe conservation issues laws agencies protected areas and threatened species categories.
3. Apply basic wildlife management and pollution-control techniques and evaluate conservation measures

Course Outline:

1. Wildlife of Pakistan:
a. Introduction
b. Important Definitions
c. Identification
d. Distribution
e. Status
f. Wildlife values
g. Conservation and Management (population estimate technology) of fishes, amphibians, reptiles, birds and mammals of major importance in Pakistan
2. Objectives of wildlife conservation
3. Problems in wildlife conservation
4. Wildlife rules and regulations in Pakistan:
a. Principles of Reintroduction
b. IUCN categories of Wildlife

c. Zoo rules

5. **National and International agencies involved in conservation and management of wildlife:**

a. National Organizations
b. International Organizations

6. **Protected Areas in Pakistan:**

a. Sanctuaries
b. Game Reserves
c. National Parks

7. **Threatened species of Pakistan:**

a. Vulnerable
b. Endangered
c. Critically Endangered

8. **Modern Techniques for Control of Environmental Pollution in Wildlife Areas**
9. **Endangered Species Causes and Measures for the Conservation**
10. **International Conventions**
11. **Visit to National Parks, Wildlife Sanctuaries, Game Reserves**

Recommended Books:

1. **Conservation of Wildlife Populations** – S. Mills. 3rd Edition (2025), Oxford University Press, Oxford, UK.
2. **Wildlife Ecology, Conservation and Management** – A. R. E. Sinclair, J. M. Fryxell & G. Caughley. 3rd Edition (2014), Wiley-Blackwell, Oxford, UK / Hoboken, NJ, USA.
3. **The Conservation Handbook: Research, Management and Policy** – W. J. Sutherland. 1st Edition (2000), Blackwell Science, Oxford, UK.
4. **Applied Environmental Biology** – M. M. Sexena. Edition year not widely indexed (circa 2000s), Agro Botanical Publishers, Bikaner, India.
5. **Long Term Ecological Research: An International Perspective** – P. G. Rigger. Edition year not widely indexed (likely 2000s), John Wiley & Sons, New York, NY, USA.
6. **Wildlife of Pakistan SS Ali (Latest Edition)**

Uni. Option	**ZOO-725**	**Wildlife Of Pakistan**	**3(3+0)**

Course Objectives:

1. Teach the wildlife diversity biology ecology and conservation status of Pakistan's fauna.
2. Develop understanding of wildlife management conservation methods protected areas and legal frameworks.
3. Build skills to identify wildlife threats and apply basic management strategies for sustainable conservation.

Course Learning Outcomes (CLOs)

1. Describe major wildlife groups of Pakistan their distribution status and ecological roles.
2. Explain wildlife management principles conservation methods protected areas and relevant laws.

3. Identify key threats to wildlife and suggest appropriate conservation and management measures.

Course Outline:

1. **Introduction:**
a. An Introduction to Wildlife of Pakistan
b. Existing Wildlife in Pakistan (Province)
c. Wildlife biology
d. Wildlife Population Ecology
e. National and International organizations involved in conservation and management of wildlife
2. **Wildlife Management:**
a. Wildlife Management at Wetlands
b. Terrestrial Wildlife Management
c. Wildlife Damage Management
d. Captive Wildlife Management
3. **Wildlife Conservation:**
a. Philosophy and significance of wildlife conservation
b. Essentials of Wildlife Conservation and National Perspectives
c. Conservation of Amphibians and Reptiles
d. In-situ conservation and Ex-situ conservation.
4. **Biodiversity of Pakistan:**
a. Biodiversity and sustainability of wildlife
b. Identification, distribution, status and endangered species
c. Mammals, Birds, Reptiles and Amphibians
d. Fresh water and Marine fish fauna of Pakistan, Insects and plants
5. **Wildlife Conservation:**
a. Philosophy and significance of wildlife conservation
b. Essentials of Wildlife Conservation and National Perspectives
c. Conservation of Amphibians and Reptiles
d. In-situ conservation and Ex-situ conservation
6. **Biodiversity of Pakistan:**
a. Biodiversity and sustainability of wildlife
b. Identification, distribution, status and endangered species
c. Mammals, Birds, Reptiles and Amphibians
d. Fresh water and Marine fish fauna of Pakistan, Insects and plants
7. **Protected Areas:**
a. Protected Areas Systems, Zoo and Breeding Centers
b. Wildlife Sanctuaries, National Parks and Game Reserves
c. Wetlands and Ecological Zones
8. **Issues and challenges:**
a. Threats to Wildlife
b. Species of Special Concern and Invasive species
c. Habitat destruction and fragmentation
d. Deforestation and urbanization
9. **Wildlife Rules and Regulations and importance:**
a. Laws, Policy and social issues

b. Values and Economics of Wildlife

Recommended Books:

1. Wildlife of Pakistan – Punjab Wildlife Department. 1st Edition (2002), Punjab Wildlife Department, Lahore, Pakistan.
2. Living in the Environment: Principles, Connections and Solutions – G. T. Miller. 12th Edition (2002), Thomson Learning Inc., Australia.
3. The Birds of Pakistan – T. J. Roberts. Latest Edition (1998), Oxford University Press, Oxford, UK.
4. Mammals of Pakistan – T. J. Roberts. Latest Edition (1997), Oxford University Press, Karachi, Pakistan
5. Wildlife Ecology and Management – W. L. Robinson & E. G. Bolen. Latest Edition (1984), McMillan, Cambridge, UK.

Uni. Option	**ZOO-726**	**Advances In Protozoology**	**3(3+0)**

Course Objectives

1. To provide students with a comprehensive understanding of the **biology, ecology, and evolution of protozoa**, including their structure, metabolism, locomotion, and reproduction.
2. To develop practical skills in **diagnostic and immunological techniques** for identifying protozoan and helminth infections in human and environmental samples.
3. To introduce the **epidemiology and clinical significance** of medically important protozoa and to link protozoological knowledge with other fields of biological sciences.

Course Learning Outcomes

By the end of the course, students will be able to:

1. **Explain and analyze** the structure, physiology, ecology, and evolutionary adaptations of protozoa, and their interactions with biotic and abiotic environmental factors.
2. **Perform and interpret** laboratory techniques for detection, culturing, and immunodiagnosis of protozoan and helminth infections, including stool and blood sample examinations.
3. **Apply knowledge** of protozoan epidemiology to assess and discuss the public health

Course Outlines:

Evolutionary perspectives of protozoa, skeleton in protozoa, feeding and metabolism, excretion and osmoregulation, endosymbionts, locomotors organelles and mode of locomotion in protozoa. Reproduction in protozoa, Ecology of protozoans, abiotic and biotic factors influencing on distribution of protozoans (temperature, humidity, light, water), nutrition in protozoa, Protozoology with other field of biological sciences, Epidemiology of some protozoa infection of human origin with emphasis on *Entamoeba histolytica; E.coli,E.gingivalis, Endolimax nana and Acanthamoeba castellanii, Trypanosoma gambiense, Schizotrypanum cruzi, Leishmania*

donovani; L.tropica; Giardia intestinalis and Trichomonas vaginalis, Balantidium coli, Plasmodium parasites of man and Coccidiosis. Examination of stool samples for cystic stages of protozoa, Investigation on pitfall and pseudo-parasites, Examination of blood parasites, Culturing of blood parasites, Immunodiagnosis techniques (Immuno-electrophoresis) helminth, Double diffusion in Agar (DDA) protozoa/helminth, counter Immuno-electrophoresis) helminth (CEP) protozoa/helminth, complement fixation (CF) protozoa/helminth, Agglutination protozoa, Enzyme linked immunosorbent assay (ELISA) protozoa/helminth, Immunoflourescence (IF) protozoa/helminth, Radio immune assay (RIA), indirect haemagglutination (IHA) protozoa/helminth.

Recommended Books:

1.General Parasitology – T. C. Cheng. 2nd Edition (1986), Elsevier/Academic Press, Orlando, USA.

2. Parasitic Diseases – D. D. Despommier, R. W. Gwadz, P. J. Hotez & C. A. Knirsch. 7th Edition (2019), Apple Trees Productions/Parasites Without Borders, New York, USA.

3. Advances in Parasitology – J. R. Baker, R. Muller & D. Rollinson (eds.). Latest Volume Edition (2025), Academic Press, Amsterdam, Netherlands.

4. Tropical Infectious Diseases: Principles, Pathogens and Practice – R. L. Guerrant, D. H. Walker & P. F. Weller. 3rd Edition (2011), Churchill Livingstone/Elsevier, Philadelphia, PA, USA.

5. Protozoal Diseases – H. M. Giles. Edition year not widely indexed, Oxford University Press, Oxford, UK.

5. Human Parasitology – B. J. Bogitsh, C. E. Carter & T. N. Oeltmann. 5th Edition (2018), Academic Press/Elsevier, London, UK.

6. Protozoology – K. Hausmann, N. Hulsmann, H. Machemer, M. Mulisch & G. Steinbruck. Edition year not widely indexed, Thieme Medical Publishers, Stuttgart, Germany.

Uni. Option	**ZOO-727**	**Avian Haemosporidian Parasites**	**3(3+0)**

Course Objectives

1. To provide advanced knowledge of the biology, taxonomy, and molecular diversity of avian haemosporidian parasites.
2. To understand host–parasite–vector relationships and their ecological and evolutionary implications.
3. To develop analytical skills for interpreting genomic, phylogenetic, and epidemiological data related to avian blood parasites.

Course Learning Outcomes (CLOs)

After completing this course, students will be able to:

1. Explain the life cycles, morphology, and classification of avian haemosporidians.
2. Describe the molecular taxonomy and genetic diversity of *Plasmodium*, *Haemoproteus*, and *Leucocytozoon*.
3. Analyze host–parasite–vector interactions using molecular and ecological perspectives.

4. Evaluate genomic and phylogenetic data to understand evolutionary patterns of avian blood parasites.
5. Critically assess current research on disease ecology and conservation implications of avian haemosporidian infections.

Course Outline

1. Introduction to Avian Haemosporidians
a. Overview and historical background of avian blood parasites
b. Classification and distinguishing features of *Plasmodium*, *Haemoproteus*, and *Leucocytozoon*
c. Global distribution, host range, and importance in avian health

2. Morphology and Life Cycles
a. Morphological stages: sporozoite, merozoite, gametocyte
b. Complete life cycles in vertebrate hosts and dipteran vectors
c. Differences between avian and mammalian *Plasmodium* species

3. Molecular Taxonomy and Phylogeny
a. Molecular identification markers (*cyt b*, *cox1*, *mtDNA*)
b. Use of MalAvi and GenBank databases for lineage identification
c. Molecular phylogenetics and lineage diversification
d. Advances in classification using genomic and transcriptomic data

4. Genomics and Molecular Biology of Infection
a. Genomic organization and evolution of avian *Plasmodium* and *Haemoproteus*
b. Gene expression and regulation during infection
c. Molecular mechanisms of immune evasion and antigenic variation
d. Comparative genomics and evolutionary adaptation

5. Host–Parasite–Vector Relationships
a. Avian immune responses to haemosporidian infection
b. Vector biology: *Culex*, *Culicoides*, and *Simulium* species
c. Host specificity, co-evolution, and host switching
d. Ecological factors influencing transmission dynamics

6. Disease Ecology and Conservation Implications
a. Pathology and clinical effects in wild and captive birds
b. Chronic and latent infections: impact on fitness and reproduction
c. Molecular epidemiology and spread through migration and climate change
d. Role in avian population decline and conservation biology

7. Current Trends and Research Frontiers
a. Next-generation sequencing and metabarcoding in haemosporidian research
b. Phylogeography and global distribution modeling
c. Integration of molecular, ecological, and GIS data
d. Emerging parasites and climate-driven host range expansion

Recomended Books:

1. Valkiūnas, G. (2005). *Avian Malaria Parasites and Other Haemosporidia.* CRC Press.
2. Santiago-Alarcon, D. & Marzal, A. (2020). *Avian Malaria and Related Parasites in the Tropics.* Springer.
3. Bensch, S., Hellgren, O., & Pérez-Tris, J. (2009). "MalAvi: A public database of malaria parasites and related haemosporidians in avian hosts." *Molecular Ecology Resources*, 9(5), 1353–1358.
4. Martinsen, E. S., & Schall, J. J. (2011). "Phylogenetic relationships of haemosporidian parasites of birds and lizards." *Journal of Parasitology*, 97(5), 869–877.
5. Perkins, S. L. (2014). *Molecular Systematics of Haemosporidian Parasites.* Springer.
6. Ricklefs, R. E., & Fallon, S. M. (2002). "Diversification and host switching in avian malaria parasites." *Proc. R. Soc. B*, 269, 885–892.
7. Atkinson, C. T., & LaPointe, D. A. (2009). "Introduced avian diseases, climate change, and the future of Hawaiian honeycreepers." *Journal of Avian Biology*, 40, 111–120.

ZOO-728	**Advance Mammalogy**	3+0

Course Learning Outcomes

After completing this course, students will be able to:

1. **Critically analyze** the diversity, taxonomy, and distribution of mammalian fauna with special reference to Pakistan.
2. **Evaluate** adaptive, ecological, and behavioral strategies of mammals in response to environmental and evolutionary pressures.
3. **Apply** advanced knowledge of mammalian physiology and conservation principles in research and management of mammalian species.

Course Contents

Unit 1: Introduction to Mammalogy

4. Introduction and scope of mammalogy, important definitions and terminology.
5. Origin and evolution of mammals, overview of global mammalian diversity.

Unit 2: Mammals of Pakistan

1. Description and identification of major mammalian groups of Pakistan.
2. Zoogeographical distribution and status of mammals in Pakistan.
3. Endangered and endemic species.

Unit 3: Evolution and Structural Adaptations

1. Phylogenetic relationships and evolutionary trends in mammals.
2. Evolution and diversity of dental characteristics, Structural adaptations to habitat and diet.

Unit 4: Mammalian Behavior and Ecology

1. Patterns of social behavior, communication, feeding ecology and activity rhythms.
2. Population dynamics and community interactions, Habitat selection and migration.
3. Selection, survival strategies, and predator–prey relationships.

Unit 5: Reproductive Physiology and Environmental Adaptations

1. Introduction to mammalian reproduction.
2. Environmental constraints on reproduction (temperature, photoperiod, food availability).
3. Adaptive responses to changing environments.
4. Mammalian responses to environmental cues (seasonality, hormonal control).
5. Physiological adaptations for thermoregulation, water balance, and high-altitude living.

Unit 6: Mammalian Conservation and Management

1. Concept and importance of mammalian conservation, Threats to mammalian biodiversity in Pakistan. Habitat loss, fragmentation, and human-wildlife conflict..

Recommended Books

1. Vaughan, T.A., Ryan, J.M., & Czaplewski, N.J. (2015). *Mammalogy.* Jones & Bartlett.
2. Feldhamer, G.A. et al. (2020). *Mammalogy: Adaptation, Diversity, Ecology.* Johns Hopkins Univ. Press.
3. Nowak, R.M. (1999). *Walker's Mammals of the World.* Johns Hopkins Univ. Press.
4. Roberts, T.J. (1997). *The Mammals of Pakistan.* Oxford Univ. Press.
5. Wilson, D.E. & Reeder, D.M. (2005). *Mammal Species of the World.* Smithsonian Institution Press.

ZOO-729	**Advance Ornithology**	3+0

Course Learning Outcomes

By the end of this course, students will be able to:

1. Critically analyze the evolutionary relationships, systematics, and adaptive radiation of birds in the light of modern phylogenetic and molecular evidence.
2. Evaluate ecological, behavioral, and physiological adaptations of birds to diverse environments.
3. Apply advanced research methods and field techniques for avian monitoring, conservation, and management.

Course Contents

Unit 1: Introduction

1. Introduction to Aves, Key ornithologists
2. Role of birds in ecosystems

Unit 2: Evolution and Systematics of Birds

1. Origin and evolution of birds (from theropod dinosaurs)
2. Fossil evidence and transitional forms (e.g., *Archaeopteryx*)
3. Modern avian classification: Phylogenetics and molecular taxonomy
4. Convergent evolution and adaptive radiation in birds

Unit 3: Bird Structure and Function

1. Feather morphology: structure, growth, and types
2. Feathers as ornaments: sexual selection and signaling functions
3. Tail morphology and its functional adaptations (flight, display, balance)
4. Pterylography: feather tracts and distribution patterns
5. Maintenance and care of plumage: preening, dust bathing, and oiling
6. Molting and plumages: cycles, patterns, and hormonal control

Unit 4: Ecology and Adaptation

1. Habitat selection, feeding ecology and foraging strategies
2. Avian communities and guild structures

Unit 5: Migration and Navigation

1. Origin and evolution of flight, volant adaptation
2. Patterns and types of bird migration
3. Orientation and navigation mechanisms (solar, magnetic, olfactory cues)

Unit 6: Breeding Systems and Reproductive Ecology

1. Avian mating systems: monogamy, polygyny, polyandry, and promiscuity
2. Egg laying, incubation strategies, and nesting behavior and parental care
3. Brood parasitism: mechanisms, evolutionary significance, and economic implications

4. Cooperative breeding systems: kin selection and fitness advantages
5. Sexual selection, courtship behavior

Unit 7: Modern Research and Techniques in Ornithology

1. Bird ringing and banding
2. Bioacoustics and telemetry (GPS, satellite tracking)
3. Population estimation and census techniques
4. Molecular tools: DNA barcoding and phylogeography
5. Use of GIS and remote sensing in avian studies

Recommended Books and References

1. Gill, F. B. (2007). *Ornithology* (3rd Ed.). W. H. Freeman and Company.
2. Newton, I. (2008). *The Migration Ecology of Birds.* Academic Press.
3. Proctor, N. S., & Lynch, P. J. (2012). *Manual of Ornithology: Avian Structure and Function.* Yale University Press.
1. Sibley, D. A. (2014). *The Sibley Guide to Birds.* Alfred A. Knopf.
2. Podulka, S., Rohrbaugh, R. W., & Bonney, R. (2004). *Handbook of Bird Biology.* Cornell Lab of Ornithology.
3. Birdlife International (Latest Reports). *State of the World's Birds.*
4. Ali, S., & Ripley, S. D. (1983). *Handbook of the Birds of India and Pakistan.* Oxford University Press.

ZOO-730	**Hematology**	3+0

Course Learning Outcomes (CLOs)

By the end of this course, students will be able to:

1. **Explain** the composition, formation, and functions of blood and its components.
2. **Analyze** normal and abnormal hematological parameters, and interpret laboratory results.
3. **Apply** hematological techniques for studying blood cells, hemoglobin, and common blood disorders.

Course Outline

Unit I: Introduction and Blood Composition

1. Introduction to hematology: scope, significance, and applications in zoology and medicine.
2. Composition and functions of blood — plasma, formed elements.
3. Physical and chemical properties of blood.
4. Blood sampling, anticoagulants, and preservation.

Unit II: Blood Cells and Hematopoiesis

1. Hematopoiesis: sites stem cells, and differentiation pathways.
2. Erythropoiesis: formation, regulation, and destruction of RBCs.
3. Leukopoiesis: types, functions, and regulation of WBCs.
4. Thrombopoiesis: platelets, structure, and role in hemostasis.

Unit III: Hemoglobin and Blood Indices

1. Structure, synthesis, and function of hemoglobin.
2. Hemoglobin derivatives and abnormal hemoglobins.
3. Blood indices: MCV, MCH, MCHC — calculation and interpretation.
4. Oxygen transport and buffering capacity of blood.

Unit IV: Immunohematology and Blood Groups

1. Blood group systems (ABO, Rh, and others).
2. Antigens, antibodies, and agglutination reactions.
3. Blood transfusion principles and compatibility testing.
4. Cross-matching and transfusion reactions.

Unit V: Hemostasis and Coagulation

1. Mechanisms of hemostasis: vascular, platelet, and coagulation phases.
2. Blood coagulation factors and pathways.
3. Anticoagulant mechanisms and fibrinolysis.
4. Laboratory evaluation of coagulation (PT, APTT, bleeding/clotting time).

Unit VI: Hematological Disorders

1. Anemias: types, causes, and laboratory diagnosis.
2. Leukemias and lymphomas: classification and diagnosis.
3. Hemophilia and other coagulation disorders.
4. Parasitic infections affecting blood (malaria, filariasis, trypanosomiasis).

Unit VII: Applied Hematology and Diagnostic Techniques

1. Microscopic examination of blood smears (RBC and WBC morphology).
2. Erythrocyte sedimentation rate (ESR) and packed cell volume (PCV).
3. Automated hematology analyzers: principles and interpretation.
4. Modern molecular techniques in hematology (PCR, flow cytometry — introduction).

Recommended Books (Latest Editions)

1. **Hoffbrand, A. V., Higgs, D. R., & Keeling, D. M. (2023).** *Postgraduate Haematology* (7th ed.). Wiley-Blackwell.
2. **Hoffbrand, A. V., & Moss, P. A. H. (2024).** *Essential Haematology* (8th ed.). Wiley-Blackwell.

3. **Turgeon, M. L. (2022).** *Clinical Hematology: Theory and Procedures* (7th ed.). Jones & Bartlett Learning.

4. **Rodak, B. F., Fritsma, G. A., & Keohane, E. M. (2021).** *Hematology: Clinical Principles and Applications* (6th ed.). Elsevier.

5. **Dacie, J. V., & Lewis, S. M. (2021).** *Practical Haematology* (13th ed.). Elsevier.

6. **Alberts, B. et al. (2023).** *Molecular Biology of the Cell* (7th ed.). Garland Science. *(For molecular aspects of blood and cell function.)*

ZOO-731	**Herpetology**	3+0

Course Learning Outcomes:

After completing this course, students will be able to:

1. Understand and evaluate the evolutionary history, taxonomy, and systematics of amphibians and reptiles.
2. Analyze their ecological adaptations, physiology, and reproductive biology.
3. Assess their ecological importance, conservation needs, and economic value.

Course Contents

Unit 1: Introduction and Importance

1. **General background of Herpetofauna**

Role of amphibians and reptiles containing pest populations.

Medicinal importance of reptiles and amphibians.

2. Economic values of reptiles and amphibians

Unit 2: Evolution and Classification

3. Early origins of amphibians and reptiles
4. Major evolutionary trends and phylogenetic relationships

Unit 3: Distribution and Biogeography

1. Global and regional distribution patterns, endemism

Unit 4: Anatomy and Physiology

2. Structural adaptations to terrestrial and aquatic life
3. Homeostasis, temperature regulation, and respiration
4. Feeding, digestion, and energy metabolism

Unit 5: Reproduction and Development

1. Modes of reproduction and parental care
2. Breeding behavior and environmental influences
3. Larval development, metamorphosis, and life cycles

Unit 6: Behavioral Ecology

1. Communication, defense mechanisms, and territoriality
2. Migration, hibernation, and aestivation
3. Social behavior and predator-prey interactions

Recommended Books

1. Vitt, L. J., & Caldwell, J. P. (2013). *Herpetology: An Introductory Biology of Amphibians and Reptiles.* Academic Press.
2. Pough, F. H., Andrews, R. M., Cadle, J. E., Crump, M. L., Savitzky, A. H., & Wells, K. D. (2004). *Herpetology.* Pearson Prentice Hall.

3. Zug, G. R., Vitt, L. J., & Caldwell, J. P. (2001). *Herpetology: An Introductory Biology of Amphibians and Reptiles.* Academic Press.
4. Wells, K. D. (2007). *The Ecology and Behavior of Amphibians.* University of Chicago Press.

Compulsory	**ZOO-728**	**Fahm-e-Quaran I**	**1+0**

As per the HEC contents

Compulsory	**ZOO-729**	**Fahm-e-Quaran II**	**1+0**

As per the HEC contents

Compulsory	**ZOO-726**	**Research**	**6+0**