



**SHAHEED BENAZIR BHUTTO WOMEN  
UNIVERSITY PESHAWAR**

**SCHEME OF STUDIES AND CURRICULUM  
FOR  
M.PHIL. ZOOLOGY  
SESSION 2023 AND ONWARDS**





# SHAHEED BENAZIR BHUTTO WOMEN UNIVERSITY PESHAWAR

## DEPARTMENT OF ZOOLOGY

### M.PHIL. ZOOLOGY

#### **PROGRAM INTRODUCTION**

The M.Phil. Zoology is a full-time two-year degree program and designed to foster research skills among graduates. It is aimed at those students who want to explore further into their understanding of Zoology, and allied fields through advanced level research work. This program enables students to apply their knowledge and skills associated with research and to further strengthen these skills through practical research work. The Program provides them opportunities to participate in different Seminars, workshops, and conferences to aware them about recent advances in science and to make them able to write and publish their research papers in different journals.

#### **PROGRAM OBJECTIVES**

The program objectives are;

- To provide the students/scholars with the proper tools to build up their own research in zoology.
- To learn different concepts of research in Zoology, its applications and implementation.
- To adopt a practical approach towards different areas of zoology such as Fisheries, Entomology, Immunology, Reproductive Biology, Genetics and Parasitology and to learn investigative methods for research.
- To get positions in various government and non-governmental organizations, teaching and research, administration and management, aquaculture, fisheries, forestry, agriculture, biological control program, integrated pest management, lab diagnostics, poultry, plant protection, wildlife, livestock, and other areas.
- To inculcate high values through ethical education and to provide inexpensive educational services to the weaker sections of society.

#### **MISSION STATEMENT OF PROGRAM**

The primary aim of the M.Phil. program in the Zoology Department at Shaheed Benazir Bhutto Women University is to offer an advanced postgraduate research program for conducting research in the field of Zoology. The program is designed to enhance academic excellence by introducing an up-to-date curriculum and training students to specialize in recently emerging technological and multidisciplinary fields for higher degrees. Upon completing the degree, students will be equipped to apply their knowledge effectively in their respective fields and will graduate as responsible professionals.

#### **ELIGIBILITY CRITERIA/ENTRY REQUIREMENTS**

A candidate with 16 years of education in the relevant disciplines can apply. For eligibility criteria and entry test requirements university admission policy will be followed.



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**DEPARTMENT OF ZOOLOGY**

**SCHEME OF STUDIES FOR M.Phil. ZOOLOGY SESSION: 2023 AND ONWARDS**

**SEMESTER-I**

Course Title	Course Codes	Theory	Practical	Credit hours
Core Course -I (Advanced biological techniques)	ZOL-727	3	0	3
Core Course-II	ZOL-XXX	3	0	3
Fehm-e-Quran I/any General course for Non-Muslim	ISL-325	0	1	1
Elective-I	ZOL- XXX	3	0	3
Elective-II	ZOL- XXX	3	0	3
<b>Total credit hours</b>				<b>13</b>

**SEMESTER-II**

Course Title	Course Codes	Theory	Practical	Credit hours
Core Course –III (Statistical Analysis)	STAT-702	2	1	3
Core Course-IV	ZOL- XXX	3	0	3
Fehm-e-Quran II/any General course for Non-Muslim	ISL-325	0	1	1
Elective-III	ZOL- XXX	3	0	3
Elective-IV	ZOL- XXX	3	0	3
<b>Total credit hours</b>				<b>13</b>

Note: Courses will be selected with the respective course codes from the list of Major and Elective courses based on the availability of course instructors.

**SEMESTER-III and IV**

Course Title	Course Codes	Credit hours
Dissertation	ZOL-799	6
<b>Total credit hours</b>		<b>6</b>

**Total Credit Hours: 13+13+6=32**



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DEPARTMENT OF ZOOLOGY**

**LIST OF CORE COURSES FOR M.Phil. ZOOLOGY SESSION  
2023 AND ONWARDS**

<b>CORE COURSES</b>			
<b>S. #</b>	<b>Course Title</b>	<b>Course Code</b>	<b>Credit Hours</b>
1.	Advanced Biological Techniques	ZOL-727	3
2.	Statistical Analysis	STAT-702	3



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**LIST OF CORE COURSES FOR M. PHIL. ZOOLOGY**  
**SESSION 2023 ANDONWARDS**

<b>CORE COURSES</b>			
<b>12 Credit hours (04 courses)</b>			
<b>S. #</b>	<b>Course Title</b>	<b>Course Code</b>	<b>Credit Hours</b>
1.	Advanced Biological Techniques	ZOL-727	3
2.	Statistical Analysis	STAT-702	3
3.	Conservation Biology	ZOL-711	3
4.	Advances in Research Methodology	ZOL-713	3
5.	Biosafety and Bioethics	ZOL-714	3
6.	Biological Toxicology	ZOL-715	3
7.	Project Planning Monitoring and Evaluation	ZOL-811	3
8.	Gene Cloning and Expression	ZOL-812	3
9.	Genomics and Proteomics	ZOL-813	3
10.	Advances in Animal Biotechnology	ZOL-814	3
11.	Advanced Physiology	ZOL-815	3
12.	Advances in Biodiversity	ZOL-816	3
13.	Ecology and Environmental Zoology	ZOL-817	3



**HAHEED BENAZIR BHUTTO WOMEN UNIVERSITY PESHAWAR  
DEPARTMENT OF ZOOLOGY**

**DETAILS OF CORE COURSES**

<b>Course Title: Advanced Biological Techniques</b>	<b>Course Code: ZOL-727</b>
<b>Course Structure:</b> Lectures: 3, Labs: 0	<b>Credit Hours: 3</b>
<b>Prerequisites: None</b>	
<p><b>Course Objective:</b> The course objectives are to:</p> <ul style="list-style-type: none"> <li>• Familiarize the students with advance biological equipments and technique</li> <li>• Develop basic understanding of the equipment handling in reserch.</li> <li>• Develop scientific and technical expertise, culture and work habits.</li> </ul>	
<p><b>Course Outline:</b> <b>Spectroscopy:</b> UV Spectroscopy/Separations, Quantitative Infrared Spectroscopy, Flame Atomic Absorption Spectroscopy, Direct Potentiometry; <b>Spectrofluorimetry:</b> Determination of Fluid Volumes by Dye Dilution Techniques; <b>Chromatography:</b> Thin Layer Chromatography (TLC), Gas Chromatography, High Performance Liquid Chromatography (HPLC). Drug Monitoring Techniques, Column Techniques: Separation of Transition Metal Cations; <b>Spectrometry:</b> Principles of IR-spectrometry and its use for compound identification; understanding of the working mechanism of the basic components of spectrometric and mass-spectrometric instrumentation; <b>Molecular Techniques:</b> Amino acid sequencers, Balances, Bioreactors, Blotting Apparatus, Centrifuges, DNA Sequencers, Electroporation Instrument, Electrophoresis, Isoelectric Focusing Apparatus, Lyophilizer, Microarray Technology. <b>Principles and application of Microscopy;</b> Microtomy; Nuclear Magnetic Resonance Instrument, Geographic Information Systems and Remote sensing, ELISA, Cell culture.</p>	
<p><b>Course Outcomes:</b> After studying this course student must be able to:</p> <ul style="list-style-type: none"> <li>• Understand advanced boiological techniques</li> <li>• Apply practical and research skills</li> <li>• Operate and use the lab equipement efficiently.</li> </ul>	
<p><b>Recommended Books:</b></p> <ol style="list-style-type: none"> <li>1. Douglas A. Skoog, F. James Holler and Timothy A. Nieman, Brooks Cole. Principles of Instrumental Analysis, 7th edition 2017, Cengage Learning.</li> <li>2. Skoog, Douglas A., Holler, F. James., Crouch, Stanley R.. Custom Pub: Principles of Instrumental Analysis. 2013, Canada: Nelson Education Limited, .</li> <li>3. Francis Rouessac and AnnickRouessac, Chemical Analysis: Modern instrumentation, methods and techniques, 2000,,John Wiley &amp; Sons.</li> <li>4. Douglas A. Skoog, F. James Holler and Timothy A. Nieman, Principles of Instrumental Analysis</li> </ol>	

(5th ed), 1997., Brooks Cole.

5. Spectrometrischeanalysetechnieken, M.T.C. de Loos - Vollebregt, Heron reeks - Bohn Stafleu Van Loghum, 2004, ISBN 90-313-4142-8.
6. Rouessac, F. and Rouessac, A. Chemical Analysis: Modern instrumentation, methods and techniques, 2000, John Wiley & Sons.

<b>Course Title: Statistical Analysis</b>	<b>Course Code: STAT-702</b>
<b>Course Structure:</b> Lectures: 3, Labs: 0	<b>Credit Hours: 3</b>
<b>Prerequisites: None</b>	
<b>Course Objective:</b> The course objectives are to: <ul style="list-style-type: none"><li>• Provide the basics of statistics.</li><li>• Enable the students to perform statistical analysis independently in their research work.</li></ul>	
<b>Course Outline:</b> Basic Univariate statistical methods; Review of basic concepts, summary measures, hypothesis testing, t-test. Analysis of variance (ANOVA); Chi-Squared test; Regression and Correlation. Multivariate statistical methods; Principal Concept analysis (PCA), Factor Analysis, Discriminant Analysis, Cluster analysis, Multidimensional Scaling, Hidden Markov models, Log linear Models, Bayesian Statistics.	
<b>Course Outcomes:</b> After studying this course student must be able to: <ul style="list-style-type: none"><li>• Understand basic statistical concepts.</li><li>• Select and apply appropriate statistical methods to address real-world problems.</li><li>• Critically analyze data, interpret results, and can effectively communicate findings.</li></ul>	
<b>Recommended Books:</b> <ol style="list-style-type: none"><li>1. Oakes. M.P.(1998,2005). "Statistics for Corpus Linguistics." Edinburgh Textbooks in Empirical Linguistics. Edinburgh University Press, Edinburgh.</li><li>2. Walpole, R.E. (1982). "Introduction to Statistics." 3rd Edition, Macmillan Publishing Co. Inc. New York.</li><li>3. Johnson, R.A Wichern, D.W. (2002). "Applied Multivariate Statistical Analysis" 5th Edition, Prentice Hall, New Jersey.</li><li>4. Clark, G.M. and Cooke, D. (1998), "A Basic Course in Statistics" 4th ed, Arnold, London</li></ol>	

<b>Course Title: Conservation Biology</b>	<b>Course Code: ZOL-711</b>
<b>Course Structure:</b> Lectures: 3, Labs: 0	<b>Credit Hours: 3</b>
<b>Prerequisites: None</b>	
<b>Course Objective:</b> The course objectives are to: <ul style="list-style-type: none"><li>• To enable the student to understand and investigate the diversity of living world,</li><li>• To understand the effect of human activities on species, communities and ecosystems; and</li><li>• To develop awareness to protect and restore biological diversity.</li></ul>	

**Course Outline: Introduction to Conservation Biology:** Definition, History and Scope. **Biodiversity:** Types; Species Diversity; Genetic Diversity; Ecosystem Diversity, An Overview of World's Biodiversity, The Value of Biodiversity, Methods to measure and monitor Biodiversity. **Threats to Biodiversity:** Human Population Growth, Ecosystem degradation and Loss: Overexploitation, Deforestation, Fragmentation; Global Climate Change; Invasive Species. **Extinctions:** Extinction and Mass Extinctions; Island Biogeography; Vulnerability to Extinction; Loss of Genetic Diversity; Problems of Small Populations, Factors affecting Loss of Genetic Diversity; Demographic and Environmental Stochasticity. **Conserving Populations and Species:** Protected Areas and their categories; Management of Protected areas, Role of national and International Laws in Protection of Species; Conservation efforts at different levels; In Situ and Ex Situ Conservation Strategies, Unprotected Public and Private Lands, Restoring Damaged Ecosystems. **Sustainable Development:** Challenges Involve in Conservation and Sustainable Development at the Local Level, International Approaches to Sustainable Development, Funding for Conservation by the World Bank and international NGOs; Conservation Education and the Role of Conservation Biologists.

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

- ACQUIRE theoretical knowledge about the phenomena that affect the maintenance, loss, and restoration of biological diversity.
- ANALYSE, interpreting and synthesize data and other information about the determinants of the conservation problems.
- DEMONSTRATE sound research skills based on ecological and evolutionary principles in investigating problems in conservation biology.

**Recommended Books:**

1. Richard B. Primack, A Primer of Conservation Biology; 5th Edition: 2012, Sinauer Associates, Inc. Publishers Sunderland, MA U.S.A.
2. Groom, M.J., G.K. Meffe and C.R. Carroll, Principles of Conservation Biology, 3rd edition, 2006, Sinauer Associates, Sunderland, MA.
3. Malcolm L. Hunter, Jr. Fundamentals of Conservation Biology, 2<sup>nd</sup> Edition. 2001, Blackwell Science Inc.
4. Mills, L.S. Conservation of Wildlife Populations: Demography, Genetics and Management. 2007 Blackwell Publishing, USA.
5. Richard B. Primack. Essentials of Conservation Biology. 3<sup>rd</sup> Edition. 2002, Sinauer Associates Inc. Publishers, Sunderland, Massachusetts, U.S.A.
6. Malcolm L.; Hunter, Jr. Fundamentals of Conservation Biology, 2nd Edition. 2001, Blackwell Science Inc.

<b>Course Title: Advances in Research Methodology</b>	<b>Course Code: ZOL-713</b>
<b>Course Structure:</b> Lectures: 3, Labs: 0	<b>Credit Hours: 3</b>

**Prerequisites: None**

**Course Objective:**  
 The course objectives are to:

- To develop Research Skills.
- To emphasize the Importance of ethics in scientific research.
- To provide an understanding about designing a scientific research.

**Course Outline: Introduction to research,** its Objectives, Research methods vs. research methodology. **Research Process:** Types of research, general steps involved in research. **Research Problems:** Topic Selection, Problem identification for research, criteria and evaluation. Literature Review: Importance, sources of literature and Plagiarism. **Aims and Objectives:** Research objectives, qualities of research objectives. **Material and Methods:** Research Design: Parts, important features, important concepts in research design, Bioethics, sampling, sampling designs, data collection and data analysis, sampling requirements, scales of measurement, error of measurement and its sources. **Data Analysis:** Processing,

statistics in research, hypothesis testing, t-tests and ANOVA 9. Statistical Software a. SPSS, SAS, SATA etc. **Data Presentation:** Tabulation, graphical presentation; Presentation software. **Scientific Writing:** Difference between thesis/report/synopsis/research proposal, Parts of synopsis/project proposal, parts of thesis/report. **Referencing, Citation and bibliography:** Reference management software, Endnote, Reference Manager, Mendeley etc. **Budgeting:** Cost estimates for a research project, funding sources e.g. USAID, HEC, MOST, HED, PMRC, WWF, PSF etc.

**Course Outcomes:**

On completion of this course, the students should be able to:

- Identify the overall process of designing a research study from its inception to its report.
- Identify a research problem stated in a study.
- Become familiar with how to write a good introduction to an educational research study.

**Recommended Books:**

1. Kothari, C.R., & Gaurav, G. Research Methodology: Methods and Techniques. New Delhi: 2014, New Age International.
2. Creswell, J. W. Research Design Quantitative Qualitative and Mixed Methods Approaches. 2013, Sage.
3. Kumar, R. Research Methodology: A Step by Step Guide for Beginners. 2011, Cornwall: SAGE Publications, Inc
4. Khan, J.A. Research Methodology. New Delhi: 2008, APH Publishing.
5. Walliman, N. Your Research Project, 2nd Edition, A step by step guide for the first-time researcher. 2005, New Delhi, Vistaar Publications.
6. Hess-Biber, S. N. and P. Leavy. Approaches to Qualitative Research, A Reader on Theory and Practice. New York, 2004, Oxford University Press.
7. Paul Leedy, Practical Research: Planning and Design (8th Edition), 2004, Jeanne Ellis Ormrod.
8. Laurel, B. Design Research, Methods and Perspectives. 2003, London England, The MIT Press.

<b>Course Title: Biosafety and Bioethics</b>	<b>Course Code: ZOL-714</b>
<b>Course Structure:</b> Lectures: 3, Labs: 0	<b>Credit Hours: 3</b>
<b>Prerequisites: None</b>	
<b>Course Objective:</b> The course objectives are to:	
<ul style="list-style-type: none"> <li>• Keep their surroundings clean and hygienic.</li> <li>• Protect themselves and others from the pathogens particularly the genetically modified organisms.</li> <li>• Know about biohazards, chemical hazards and radiation hazards.</li> </ul>	
<b>Course Outline:</b> Introduction to Biosafety, Definition, Concepts, uses and abuses of genetic information, Biohazards, Good Laboratory Practices, World health organization (WHO) codes of practice: Laboratory biosafety manual, Risks Related to Genetically modified organisms (GMOs), Biosafety clearing house: International Rules & regulations for Biosafety & GMOs, Introduction to Bioethics: Ethical issues regarding GMOs, Euthanasia, Issues related to Reproductive & Cloning technologies, Issues to transplants and Eugenics, Patenting, Commercialization and Benefits Sharing, Role of National Bioethics Committees	
<b>Course Outcomes:</b> On completion of this course, the students should be able to:	

- Understand a general biosafety rules
- Become Familiar with ethical issues in research, including GMOs
- Know about patenting and commercialization

**Recommended Books:**

1. Biological Safety: Principles and Practices. (2020). United States: Wiley.
2. WHO laboratory biosafety updates. American biological safety association providence 2015.
3. Chosewood, L. C. Biosafety in Microbiological and Biomedical Laboratories. (n.p.): 2007, DIANE Publishing Company.
4. Smida, A. Lab safety manual. Department of health, safety and environment. University of Saskatchewan, 2006, Saskatoon, Canada.
5. Oles, A. Biosafety manual. Department of health, safety and environment. University of Saskatchewan, 2005, Saskatoon, Canada. 2005.
6. Laboratory Biosafety Manual: Third Edition. (2004). Switzerland: World Health Organization.

<b>Course Title: Biological Toxicology</b>	<b>Course Code: ZOL-715</b>
<b>Course Structure:</b> Lectures: 3, Labs: 0	<b>Credit Hours: 3</b>
<b>Prerequisites: None</b>	
<p><b>Course Objective:</b> The course objectives are to:</p> <ul style="list-style-type: none"> <li>• To enable the students to identify various environmental toxins.</li> <li>• Understand mode of action of various carcinogenic, mutagenic and teratogenic agents.</li> <li>• Get knowledge about the effects of these toxins on various body organs.</li> </ul>	
<p><b>Course Outline: Introduction to Principles of Toxicology:</b> The science of poison, <b>Chemicals in Environment:</b> Atmosphere, soil, water and everyday life. Inorganic Environmental Toxicants: Metalloids, heavy metals and others. Industrial Chemicals: Petrochemicals, toxic by-products and conversion products; Botanical: Biotoxins. <b>Effects of Chemicals:</b> Chemical allergies, Immediate versus delayed hypersensitivity, Local versus systemic effects, Mutagenic and carcinogenic effects, <b>Exposure Route:</b> Oral administration, Intranasal administration, Inhalation, Dermal and Parenteral routes, Duration and frequency, Accumulation: According to physiological compartment, According to chemical structure, <b>Toxicokinetics:</b> Absorption, Distribution, Biotransformation, Elimination, <b>Reproductive toxicology and teratology:</b> Effects of toxicants on male and female reproductive system; protective mechanisms, interference with cell division, interference with hormonal control. <b>Respiratory Toxicology:</b> General principles for the effects of toxicants on the system, defense mechanism, measuring the exposure levels, deposition of gases and particulates. Immediate and Delayed response. <b>Cardiovascular Toxicology:</b> Effects of toxicants on heart; arrhythmias, cardiomyopathies and other effects, myocardial infarction. Effects of toxicants on the vascular system and blood. <b>Neurotoxicology:</b> General principles of effects of toxicants, BBB. Effects on electrical conduction, synaptic function, direct effects on neurons. <b>Hepatic Toxicology:</b> Types of toxicant induced injury; fatty liver, necrosis and apoptosis, cirrhosis and miscellaneous effects. <b>Renal Toxicology:</b> General principles of effects on the system; damage to glomerulus, proximal and remainder of the tubule. <b>Immunotoxicology:</b> Effects of toxicants on immune system; toxic-induced allergies, autoimmunity and immunosuppression.</p>	
<p><b>Course Outcomes:</b> Upon successful completion of the course, the student will be able to:</p> <ul style="list-style-type: none"> <li>• Demonstrate the effects of different carcinogenic, mutagenic and teratogenic agents on living cell</li> <li>• Understand the mechanisms of biotransformation of these chemicals.</li> </ul>	
<p><b>Recommended Books:</b></p> <ol style="list-style-type: none"> <li>1. Toxicology: Principles and Methods. N.p., 2019, MJP Publisher.</li> <li>2. Stine, Karen E., and Brown, Thomas M. Principles of Toxicology. United States, CRC Press, 2015.</li> </ol>	

3. Barile, Frank A. Principles of Toxicology Testing, Second Edition. 2013, United Kingdom, Taylor & Francis.
4. Hayes, A. Wallace. Principles and Methods of Toxicology, Fifth Edition. Samoa, Taylor & Francis, 2008.
5. Siegfried, H. M., Schafer, G., Roger M., Welsch, F., Toxicology, 2004, Academic press, San Diego.

<b>Course Title: Project Planning Monitoring and Evaluation</b>	<b>Course Code: ZOL-811</b>
<b>Course Structure:</b> Lectures: 3, Labs: 0	<b>Credit Hours: 3</b>
<b>Prerequisites: None</b>	
<b>Course Objective:</b> The course objectives are to: <ul style="list-style-type: none"> <li>• To provide an understanding about planning a project.</li> <li>• To develop an understanding about how to monitor a project for accountability.</li> <li>• To understand project communication and developing effective strategies for controlling projects</li> </ul>	
<b>Course Outline: Introduction to Project</b> , its Definition and Types, <b>Project Cycle:</b> Initiation, Planning, Execution, Monitoring & Controlling, Closure. <b>Rationale identification:</b> problem perception, acquisition of information, project goal, define objectives, Cost/Benefit analysis, Success criteria, risk analysis. <b>Preparing Project Proposals. Project Financing. Hierarchy of Approving authorities. Public procurement rules. The low bidder dilemma. Hiring of manpower. Tools, Techniques and Theories for monitoring and evaluation of project. Post project liabilities:</b> follow up, fate of project capital, human resources. <b>Report preparation and presentation.</b>	
<b>Course Outcomes:</b> On completion of this course, the students should be able to: <ul style="list-style-type: none"> <li>• Identify the overall process of project cycle</li> <li>• Learn an in-depth knowledge for effective project monitoring and evaluation</li> <li>• Become familiar with how to deal with implementation problems</li> </ul>	
<b>Recommended Books:</b> <ol style="list-style-type: none"> <li>1. Meredith, J.R., J. S. Mantel and S. M. Shafer. Project Management A Managerial Approach.2016, John Wiley &amp; Sons (Asia) Pte Ltd.</li> <li>2. Kerzner, H. Project Management A Systems approach to Planning, 2013, Scheduling and controlling</li> <li>3. SCHIMEL, J. 2012. Writing Science. Oxford University Press.</li> <li>4. GOP. 2010. Planning Commission Manual for Development Projects</li> <li>5. Paul Leedy, (2004) Practical Research: Planning and Design (8th Edition), Jeanne Ellis Ormrod</li> </ol>	

<b>Course Title: Gene Cloning and Expression</b>	<b>Course Code: ZOL-812</b>
<b>Course Structure:</b> Lectures: 3, Labs: 0	<b>Credit Hours: 3</b>
<b>Prerequisites: No</b>	
<b>Course Objective:</b> The course objectives are to: <ul style="list-style-type: none"> <li>• To develop understanding of basic steps in Gene cloning technology</li> <li>• To demonstrate fundamental difference between conventional breeding and genetic engineering</li> </ul>	
<b>Course Outline: Introduction to Gene cloning:</b> General Steps in Cloning Procedure, what is Clone, Key feature of Cloning strategies in Prokaryotes and Eukaryotes, Restriction Endonucleases: Cutting DNA,	

Gene Isolation and purification. **Cloning Vectors:** Plasmid Cloning Vectors, Viral Vectors, Vectors for Cloning Very Large DNA Fragments, Bacterial Transformation, Transgene Delivery, Direct Gene Transfer, Microinjection, Mediated (Indirect) Gene Transfer, Criteria of Host cells, E. coli as an ideal host cell. **Tissue Culture and Selection, Transgene Integration, Constitutive Promoters:** Tissue-Specific and Developmentally Regulated Promoters, Inducible Promoters, Stability of Transgene Expression, Marker-Independent Transgenic Production, **Application of cloning in gene analysis:** Application of cloning in gene analysis, Study of gene location and structure, Production of Recombinant protein from cloned gene, **Stem cell Technology. Synthetic biology, Genome Mapping:** Genetic Linkage Maps, Physical Maps, Approaches to Genome Mapping, Bottom-up Mapping, Top-down Mapping. **Chromosome Walking. Sequencing:** Partial versus Whole Genome Sequencing, Automated Sequencing. **DNA fingerprinting.** Discussion on latest articles in the field of gene cloning in connection to various disciplines.

**Course Outcomes:**

On completion of this course, the students should be able to:

- Know about process of the transfer of genes from one organism to others.
- Become familiar with how to manipulate the genetic makeup of an organism.

**Recommended Books:**

1. Brown, T. A.. Gene Cloning and DNA Analysis: An Introduction. United Kingdom, 2020, Wiley.
2. Glick, B.R., & Patten, C.L. Molecular biotechnology: principles and applications of recombinant DNA (Vol. 34). 2017, John Wiley & Sons.
3. Schmid, R.D., & Schmidt-Dannert, C. Biotechnology: An illustrated primer. 2016, John Wiley & Sons.
4. Clark, D.P. and Pazdernik, N.J. Biotechnology 2nd (ed.). 2015, Elsevier Science & Technology Books
5. Acquaaah, G. Understanding biotechnology: An integrated and cyber-based approach. 2004, Pearson/Prentice Hall.

<b>Course Title: Genomics and Proteomics</b>	<b>Course Code: ZOL-813</b>
<b>Course Structure:</b> Lectures: 3, Labs: 0	<b>Credit Hours: 3</b>
<b>Prerequisites: None</b>	
<p><b>Course Objective:</b> The course objectives are to:</p> <ul style="list-style-type: none"> <li>• To enable the students to understand organization of Human genome.</li> <li>• To enable the students to analyze and predict protein models and genome database.</li> <li>• To train the students to run various databases necessary to predict the effect of certain mutations.</li> </ul>	
<p><b>Course Outline: Introduction;</b> The Human Genome, Contents and organization of genomes, Hemoglobin. From gene to protein to disease, Genomic features of model organisms. <b>Contents and Organization of Genomes;</b> Chromosomes, organelles and Plasmids, Genes, Dynamic components of genomes, Genome organization in Prokaryotes, Genome organization in Eukaryotes. <b>Mapping, Sequencing and Annotation;</b> DNA sequencing, Fredrick Sanger and development of DNA sequencing, Maxam Gilbert chemical cleavage method, Automated DNA sequencing. <b>Proteomics;</b> Protein structure and types, Protein folding patterns, Changes in folding patterns in protein evolution. <b>Separation and Analysis of protein;</b> Poly acrylamide gel electrophoresis (PAGE), SDS PAGE, Mass spectrometry. <b>Protein Engineering;</b> Multiple Sequence Alignment, Clustal Omega, Ab initio.</p>	
<p><b>Course Outcomes:</b> Upon successful completion of the course, the student will be able to:</p> <ul style="list-style-type: none"> <li>• Acquire the basic knowledge of Human genome and its organization.</li> <li>• Solve the problem by mutation detection through various databases.</li> </ul>	

- Analyze the mutation through genome databases and predict its pathogenic effect.

**Recommended Books:**

1. Arthur Lesk. Introduction to Genomics (4th Edition) 2017, Oxford University Press, USA.
2. Arthur Lesk. Introduction to Genomics (3rd Edition) 2016, Oxford University Press, USA.
3. Strachan, T., A. P. Read, Human Molecular Genetics, 3rd edition, 2003, Garland Science/Taylor & Francis.
4. Ehrlich P.R., Human Natures: Genes, Cultures, and the Human Prospect, 1st edition, 2002, Penguin USA Paper.
5. Relethford J. H., Genetics and the Search for Modern Human Origins, 2001, Wiley-Liss.

<b>Course Title: Advances in Animal Biotechnology</b>	<b>Course Code: ZOL-814</b>
<b>Course Structure:</b> Lectures: 3, Labs: 0	<b>Credit Hours: 3</b>
<b>Prerequisites: No</b>	
<p><b>Course Objective:</b> The course objectives are to:</p> <ul style="list-style-type: none"> <li>To educate students about broad scope of biotechnology</li> <li>To develop understanding of industrial processes for production of antibiotics, enzymes etc.</li> <li>To develop understanding of techniques for tissue culture, cell culture and organ transplantation</li> </ul>	
<p><b>Course Outline: Introduction:</b> Concepts of Biotechnology, historical background of biotechnology, Conventional biotechnology-green revolution. <b>Animal and health biotechnology:</b> Introduction, Engineering for vaccines, Types of Vaccines, Recombinant Vaccines, Biological Importance of Vaccines, Genetic engineering for better animal production, Introduction to AIDS vaccine, Drugs and genetic engineering a hope for remedy. <b>Animal Models for Human Disease:</b> Applications in Cancer Control and Treatment, Development of Mouse Models for Cancer Research, Human Papillomavirus (HPV): Diagnosis and Treatment, Human DNA Tumor Viruses and Oncogenesis, HIV and Antiretroviral Drugs. Animal Biotechnology as a Tool to understand and Fight Aging, Concepts of Tissue Engineering. <b>Animal Tissue Culture:</b> Principles and Applications, Nanotechnology and Its Applications to Animal Biotechnology. <b>Antibodies:</b> Monoclonal and Polyclonal; their applications. <b>Molecular Markers:</b> Tool for Genetic Analysis. <b>Gene Expression:</b> Analysis and Quantitation. <b>Ribotyping:</b> A Tool for Molecular Taxonomy, Next Generation Sequencing and Its Applications. <b>Biomolecular Display Technology:</b> A New Tool for Drug Discovery. <b>In Silico Model:</b> From Simple Networks to Complex Diseases. Transgenic animals and their applications. Biotechnological exploitation of marine animals. <b>Stem cells:</b> A trek from laboratory to clinic to industry. Role of cytogenetic and molecular genetics in human health and medicine. <b>In vivo model:</b> CAM Assay. In vitro Fertilization, Human Embryonic stem cells. Biosensor, Biosafety, Organ Transplantation, Ethical issue in animal experimentation, Intellectual property right and animal biotechnology.</p>	
<p><b>Course Outcomes:</b> On completion of this course, the students should be able to:</p> <ul style="list-style-type: none"> <li>Learn an in-depth knowledge of tools of biotechnology</li> <li>Become familiar with the broad categories of biotechnological processes based on the products formed and/or the process or substrates used, and have detailed knowledge of examples of each of these</li> <li>Have an awareness of the global significance of biotechnology and its resultant industries, and a broad knowledge of which are represented nationally and locally.</li> </ul>	
<p><b>Recommended Books:</b></p> <ol style="list-style-type: none"> <li>1. Verma, A. and A. Singh. Animal Biotechnology, Models in Discovery and Translation. 2nd Edition. 2019, ISBN: 9780128117101.</li> <li>2. Glick, B.R., &amp; Patten, C.L. Molecular biotechnology: principles and applications of recombinant DNA (Vol. 34). 2017, John Wiley &amp; Sons.</li> <li>3. Willey, J., Sherwood, L. and Wolverton. C. J. Prescott's Microbiology 10th (ed.). 2017,</li> </ol>	

McGraw Hill Publishers, Washington DC.

4. Schmid, R.D., & Schmidt-Dannert, C. *Biotechnology: An illustrated primer*. 2016, John Wiley & Sons. In addition, students should have access to recent textbooks in genetics, biochemistry and cell biology.
5. Clark, D.P., and Pazdernik, N.J., *Biotechnology 2nd (ed.)*. 2015, Elsevier Science & Technology Books.
6. Cowan, M.K., and Talaro, K.P., *Microbiology: A Systematic Approach 4th (ed.)*, 2015, McGraw Hill Publishers, Washington DC.

<b>Course Title: Advanced Physiology</b>	<b>Course Code: ZOL-815</b>
<b>Course Structure:</b> Lectures: 3, Labs: 0	<b>Credit Hours: 3</b>
<b>Prerequisites: None</b>	
<b>Course Objective:</b> The course objectives are: <ul style="list-style-type: none"> <li>To provide an in-depth understanding of physiological mechanisms at the molecular, cellular, and systemic levels.</li> <li>To develop analytical and problem-solving skills to interpret physiological data.</li> <li>To enhance research skills in physiological sciences, emphasizing experimental approaches and recent advancements.</li> </ul>	
<b>Course Outline:</b> <b>Cellular and Molecular Physiology:</b> Membrane transport mechanisms, Ion channels and electrophysiology, Cell signalling and second messengers, Molecular basis of muscle contraction; <b>Neurophysiology:</b> Functional organization of the nervous system, Synaptic transmission and neuroplasticity, Sensory and motor pathways, Autonomic nervous system regulation; <b>Cardiovascular Physiology:</b> Regulation of cardiac function, Electrophysiology of the heart, Pathophysiology of cardiovascular diseases; <b>Respiratory Physiology:</b> Mechanics of breathing and gas exchange, Regulation of respiration, Adaptations to high altitude and diving; <b>Renal Physiology:</b> Regulation of body fluids and electrolytes in kidneys, Role of kidneys in acid-base homeostasis, Renal disorders and their physiological basis; <b>Gastrointestinal Physiology:</b> Neural and hormonal control of digestion, Absorption and metabolism of nutrients, Gut microbiota and its physiological significance, Disorders of the digestive system; <b>Endocrine and Reproductive Physiology:</b> Mechanisms of hormone action and regulation, Endocrine control of metabolism and homeostasis, Reproductive physiology of males and females, Physiology of pregnancy and lactation; <b>Immune and Inflammatory Physiology:</b> Innate and adaptive immunity, Cellular and molecular basis of inflammation, Role of cytokines in immune regulation, Autoimmune disorders and immunopathology; <b>Comparative and Environmental Physiology:</b> Physiological adaptations to extreme environments, Hibernation, estivation, and torpor mechanisms, Thermoregulation and metabolic adjustments, Stress physiology and its impact on health	
<b>Course Outcomes:</b> After completing this course, students will be able to: <ul style="list-style-type: none"> <li>Explain the physiological functions of major organ systems with an advanced level of understanding.</li> <li>Analyse homeostatic mechanisms and their regulation at cellular and systemic levels.</li> <li>Critically evaluate recent research findings in physiology.</li> <li>Apply physiological principles to solve real-world biomedical and veterinary problems.</li> </ul>	
<b>Recommended Books:</b> <ol style="list-style-type: none"> <li>Medical Physiology – Guyton &amp; Hall (Latest Edition)</li> <li>Textbook of Physiology – Berne &amp; Levy</li> <li>Ganong's Review of Medical Physiology – Kim E. Barrett</li> <li>Animal Physiology– Richard W. Hill, Gordon A. Wyse, Margaret Anderson</li> <li>Human Physiology: An Integrated Approach – Dee Unglaub Silverthorn</li> <li>Principles of Physiology – Robert M. Berne &amp; Matthew N. Levy</li> <li>Endocrinology – Mac E. Hadley</li> <li>Comparative Physiology of Fasting, Starvation, and Food Limitation – Marshall D. McCue</li> </ol>	

<b>Course Title: Advances in Biodiversity</b>	<b>Course Code: ZOL-816</b>
<b>Course Structure:</b> Lectures: 3, Labs: 0	<b>Credit Hours: 3</b>
<b>Prerequisites: None</b>	
<b>Course Objective:</b> The course objectives are: <ul style="list-style-type: none"> <li>To develop an advanced understanding of biodiversity, its components, and ecological significance.</li> <li>To explore contemporary issues in biodiversity conservation, including habitat loss, climate change, and species extinction.</li> </ul>	

- To analyse biodiversity at genetic, species, and ecosystem levels using modern research tools.

**Course Outline:**

**Introduction to Biodiversity:** Definition and levels of biodiversity (genetic, species, and ecosystem), Biodiversity hotspots and global distribution patterns, Importance of biodiversity for ecosystem stability and human well-being; **Molecular and Genetic Biodiversity:** DNA barcoding and metagenomics in biodiversity studies, Phylogenetics and evolutionary relationships, Genomic approaches to species identification and conservation; **Biodiversity and Ecosystem Functioning:** Role of biodiversity in ecosystem services, Species interactions and ecological networks, Functional diversity and ecosystem resilience; **Threats to Biodiversity:** Habitat destruction and fragmentation, Climate change and its impact on biodiversity, Invasive species and their ecological consequences, Overexploitation and biodiversity loss; **Conservation Biology and Management:** In-situ and ex-situ conservation approaches, Protected areas and conservation corridors, Role of zoos, botanical gardens, and gene banks in conservation, Community-based conservation strategies; **Biodiversity Monitoring and Assessment:** Techniques for biodiversity assessment (remote sensing, GIS, ecological modelling), Ecological indicators and biodiversity indices, Bioinformatics tools in biodiversity studies; **Sustainable Use of Biodiversity:** Agro-biodiversity and sustainable agriculture, Bioprospecting and ethical considerations, Role of traditional knowledge in biodiversity conservation; **Global and Regional Biodiversity Policies:** Sustainable Development Goals (SDGs) related to biodiversity, National and international biodiversity laws and frameworks, Role of organizations like IUCN, WWF, and UNEP in biodiversity conservation; **Advances in Biodiversity Research:** Novel approaches in species discovery and taxonomy, Synthetic biology and biodiversity, Role of AI and big data in biodiversity research

**Course Outcomes:**

After completing this course, students will be able to:

- Explain the key principles and processes governing biodiversity and ecosystem functions.
- Assess biodiversity patterns and threats at local, regional, and global levels.
- Evaluate the effectiveness of conservation strategies and management approaches.

**Recommended Books:**

1. "Biodiversity" – E.O. Wilson
2. "Principles of Conservation Biology" – Martha J. Groom, Gary K. Meffe, C. Ronald Carroll
3. "Molecular Approaches to Ecology and Evolution" – R. DeSalle, B. Schierwater
4. "Biodiversity and Ecosystem Function" – Schulze & Mooney
5. "Conservation Biology: Foundations, Concepts, Applications" – Fred Van Dyke
6. "Global Biodiversity Outlook" – UNEP & CBD Reports
7. "Essentials of Conservation Biology" – Richard B. Primack
8. "Biological Diversity: Frontiers in Measurement and Assessment" – Magurran & McGill

<b>Course Title: Ecology and Environmental Zoology</b>	<b>Course Code: ZOL-817</b>
<b>Course Structure:</b> Lectures: 3, Labs: 0	<b>Credit Hours: 3</b>
<b>Prerequisites: None</b>	
<b>Course Objective:</b> The course objectives are:	
<ul style="list-style-type: none"> <li>• To develop an advanced understanding of ecological principles and environmental interactions of animal species.</li> <li>• To explore the relationship between organisms and their biotic and abiotic environments.</li> <li>• To evaluate environmental challenges such as pollution, habitat destruction, and climate change.</li> </ul>	
<b>Course Outline:</b>	
<p><b>Introduction to Ecology and Environmental Zoology:</b> Historical background and scope, Levels of ecological organization, Key principles of environmental zoology; <b>Ecosystem Structure and Function:</b> Structure and function of ecosystems, Primary and secondary productivity, biotic and abiotic factors, Energy flow and trophic dynamics, Biogeochemical cycles (carbon, nitrogen, phosphorus); <b>Population and Community Ecology:</b> Population dynamics and growth models, Species interactions: competition, predation, mutualism, and parasitism, Ecological niches and community structure, Anthropogenic impacts on ecosystems; <b>Behavioral and Evolutionary Ecology:</b> Animal behavior and ecological adaptations, Evolutionary processes in ecological systems, Speciation and biodiversity patterns; <b>Environmental Challenges and Conservation Strategies:</b> Climate change and its impact on ecosystems, Habitat destruction, fragmentation, and urbanization, Pollution and bioaccumulation in animal species, Invasive</p>	

species and their ecological consequences; **Wildlife Ecology and Management:** Principles of wildlife conservation, Human-wildlife conflict and mitigation strategies, Protected areas and biodiversity corridors, Ecological restoration and species reintroduction; **Ecotoxicology and Environmental Health:** Effects of pollutants on animal physiology and behavior, Bioindicators and biomonitoring of environmental health, Pesticide and heavy metal toxicity in ecosystems; **Applied Ecology and Sustainable Management:** Ecosystem services and sustainable resource use, Ecological footprint and sustainable development, Role of environmental policies and laws in conservation; **Advanced Techniques in Ecological Research:** Remote sensing and GIS applications in ecology, Ecological modelling and big data in environmental zoology, Molecular ecology and its applications in conservation; **Future Perspectives in Ecology and Environmental Zoology:** Emerging threats to biodiversity and ecosystems, The role of citizen science in ecological research, Integrative approaches to ecological sustainability

### **Course Outcomes:**

After completing this course, students will be able to:

- Assess the impact of environmental changes on animal populations and biodiversity.
- Analyze ecological data using modern research methodologies.
- Evaluate environmental issues and propose sustainable solutions.

### **Recommended Books:**

1. "Ecology: The Economy of Nature" – Robert E. Ricklefs
2. "Elements of Ecology" – Thomas M. Smith & Robert L. Smith
3. "Fundamentals of Ecology" – Eugene P. Odum & Gary W. Barrett
4. "Conservation Biology: Foundations, Concepts, Applications" – Fred Van Dyke
5. "Wildlife Ecology, Conservation, and Management" – Anthony R.E. Sinclair, John M. Fryxell, Graeme Caughley
6. "Ecological Modeling" – Hsiao-Hsuan Wang, William E. Grant
7. "Ecotoxicology: A Comprehensive Treatment" – Michael C. Newman
8. "Environmental Science: A Global Concern" – William P. Cunningham & Mary Ann Cunningham



**SHAHEED BENAZIR BHUTTO WOMEN UNIVERSITY PESHAWAR  
DEPARTMENT OF ZOOLOGY**

**LIST OF ELECTIVE COURSES FOR M. PHIL ZOOLOGY**

<b>ELECTIVE COURSES</b>			
<b>09 Credit hours (03 courses)</b>			
<b>S. #</b>	<b>Course Title</b>	<b>Course Code</b>	<b>Credit Hours</b>
1.	Advances in Immunology	ZOL-712	3
2.	Applied Reproductive Physiology	ZOL-721	3
3.	Advances in Aquaculture	ZOL- 725	3
4.	Clinical Endocrinology	ZOL-726	3
5.	Advances in Cancer Biology	ZOL-728	3
6.	Cancer Genetics	ZOL-729	3
7.	Advanced Enzymology	ZOL-730	3
8.	Applied Genetics	ZOL- 731	3
9.	Applied Parasitology	ZOL- 732	3
10.	Fish and Aquatic Toxicology	ZOL-733	3
11.	Desert Zoology	ZOL-734	3
12.	Clinical Teratology	ZOL- 735	3
13.	Molecular Genetics	ZOL-736	3
14.	Neurobiology	ZOL-737	3
15.	Population Biology	ZOL-738	3
16.	Wetlands Management	ZOL-739	3
17.	Advances in epidemiology and control of parasitic diseases	ZOL- 740	3
18.	Herpetology	ZOL-741	3
19.	Advances in Forensic Biology	ZOL-742	3
20.	Climate Change and Ecosystem Stability	ZOL-743	3
21.	Mariculture Technology	ZOL-744	
22.	Arachnology	ZOL-745	3
23.	Fish Physiology and Breeding	ZOL- 746	3
24.	Vaccinology	ZOL- 821	3

25.	Application of Biotechnology for Parasitic Control	ZOL- 822	3
26.	Advances in Helminthology	ZOL- 823	3
27.	Advances in Protozoology	ZOL-824	3
28.	Advances in Trematodes Biology	ZOL- 825	3
29.	Fish Parasitology	ZOL- 826	3
30.	Systematic Classification of Fishes	ZOL- 827	3
31.	Insects of Veterinary and Medical Importance	ZOL- 828	3
32.	Advanced Integrated Pest Management	ZOL- 829	3
33.	Clinical Reproductive Endocrinology	ZOL- 830	3
34.	Advanced Techniques in Reproductive Physiology	ZOL-831	3
35.	DNA Technology	ZOL-832	3

The selection of the elective courses from the list would be according to the availability of expertise of the course instructor.



**SHAHEED BENAZIR BHUTTO WOMEN UNIVERSITY PESHAWAR**  
**DEPARTMENT OF ZOOLOGY**

**DETAILS OF ELECTIVE COURSES**

<b>Course Title: Advances in Immunology</b>	<b>Course Code: ZOL-712</b>
<b>Course Structure: Lectures: 3, Labs: 0</b>	<b>Credit Hours: 3</b>
<b>Prerequisites: No</b>	
<p><b>Course Objective:</b> The course objectives are to:</p> <ul style="list-style-type: none"> <li>• To provide the knowledge about the components and role of the immune system.</li> <li>• To provide students with knowledge of different mechanisms of the immune system.</li> <li>• The students will be able to describe immunological response and how it is triggered and regulated.</li> </ul>	
<p><b>Course Outline: Spectroscopy: Introduction:</b> Components of the immune system; Antigens and Pathogens; Innate Immunity and Inflammation; Different types of leukocytes; Inflammation and Fever. <b>Recognition and Responses to foreign antigens:</b> Pattern recognition receptors; Innate immune signaling; The complement system: Complement activation pathways. <b>Antibodies:</b> B lymphocytes; Antibody structure and function; Monoclonal and polyclonal antibodies; Hybridoma technology Lymphocyte Development and Diversity; Lymphocyte development; Clonal selection and expansion; Differences between B and T lymphocytes; The generation of lymphocyte receptor diversity. <b>T Cell Activation by Antigens:</b> Antigen presentation; The role of dendritic cells; The lymphatic system and delivery of antigen to lymph nodes; Adaptive immune activation in secondary lymphoid tissues. <b>T Cell-Dependent B Cell Responses:</b> T Cell activation of B cells; Isotype switching and affinity maturation; Helper T cell functions; The role of helper T cells in disease; Cytotoxic T cell functions; Selection and expansion of cytotoxic T cells; Therapies that target; cytotoxic T cell functions. <b>Hematological Diseases:</b> Acute Leukemias; Overview of Lymphoma Classification; Hodgkin's disease; T-Cell Lymphomas; B-Cell Lymphomas; Plasma Cell Dyscrasias; Multiple Myeloma; Cryoglobulinemia; Amyloidosis. <b>Tumor Immunology:</b> Detection and identification of Tumor Antigens; Immune Escape Mechanisms of Tumor Antigens; Immunotherapeutic Strategies (I); Immunotherapeutic Strategies (II). <b>Transplantation of Autologous:</b> Bone Marrow/Hematopoietic Stem Cells; Transplantation of Allogenic Bone Marrow/Hematopoietic Stem Cells; Clinical Aspects of Organ Transplantation.</p>	
<p><b>Course Outcomes:</b> Upon successful completion of the course, the student will be able to:</p> <ul style="list-style-type: none"> <li>• Explore the basic knowledge of the mechanisms of immune system</li> <li>• Interpret the problems using immunological techniques for diagnosis of immune disorders.</li> <li>• Identify the problems using immunological diagnostic tools.</li> </ul>	
<p><b>Recommended Books:</b></p> <ol style="list-style-type: none"> <li>1. AbulAbbas , Andrew H. Lichtman, Shiv Pillai. Cellular and Molecular Immunology , 9th edition, 2017. Elsevier Pub Co.</li> <li>2. Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. RoittRoitt: Roitt's Essential Immunology, 12th ed. 2012, Blackwell.</li> <li>3. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter. Molecular Biology of the Cell, 5th ed. 2008, Garland.</li> </ol>	

4. Gerd R. Burmester, Antonio Pezzutto Color Atlas of Immunology, 2006. Thieme Stuttgart, New York.
5. Thomas J Kindt, Richard A Goldsby, Barbara A Osborne, Janis Kuby: Immunology, 2003, Freeman.

<b>Course Title: Applied Reproductive Physiology</b>	<b>Course Code: ZOL-721</b>
<b>Course Structure:</b> Lectures: 3, Labs: 0	<b>Credit Hours: 3</b>
<b>Prerequisites: None</b>	
<p><b>Course Objective:</b> The course objectives are to:</p> <ul style="list-style-type: none"> <li>• To introduce modern reproductive biotechnologies applied in the field of animal agriculture and conservation</li> <li>• To demonstrate various reproductive problems of medical and veterinary significance</li> <li>• To impart knowledge about practical application of reproductive physiology using recent published reports</li> </ul>	
<p><b>Course Outline:</b> Anatomy and physiology of female reproductive system. Anatomy and physiology of male reproductive system. Semen Collection &amp; Evaluation: Semen collection methods; Initial assessment; Appearance, volume &amp; concentration. <b>Sperm motility:</b> Computer Aided Sperm Analysis. <b>Sperm Morphology:</b> Acrosome status; Chromatin integrity. <b>Semen cryopreservation:</b> Properties of Semen Extenders; The cryopreservation technique; Application in farm animals &amp; endangered species and humans. <b>Artificial insemination:</b> Introduction and history of Artificial insemination; Artificial insemination procedures. Estrus synchronization. Superovulation and Embryos transfer. <b>Assisted Reproductive techniques for conservation of endangered species:</b> Sperm cryobanking; Embryo freezing; In vitro fertilization (IVF) and in vitro embryo production (IVEP); IVEP &amp; Transfer for genetic improvement of farm animals; IVF and ICSI for treatment of infertility in human. Causes of sterility in domestic animals. Infertility in male and female. Sperm sexing for sex pre-selection. Regulation of Fertility in Humans. Disorders of sexual development. Obesity &amp; Reproduction. Reproductive Aging. Addictions &amp; Reproduction. Endocrinology of Stress in Reproduction. Student's presentation: recent research paper/ review article in the field</p>	
<p><b>Course Outcomes:</b> After studying this course student must be able to:</p> <ul style="list-style-type: none"> <li>• IDENTIFY and EXPLAIN both normal and pathological processes of the male and female reproductive system</li> <li>• DEVELOP reproductive biotechnologies for conservation of threatened wild species.</li> <li>• UPDATE themselves with current research in the field of reproductive biotechnologies.</li> </ul>	
<p><b>Recommended Books:</b></p> <ol style="list-style-type: none"> <li>1. Pathways to Pregnancy and Parturition by P. L. Senger. 3rd edition, 2012, Published by Current Conceptions Incorporated USA.</li> <li>2. Endocrinology: Adult and Pediatric (Vol II) by J. L. Jameson and L. J. De Groot. 7th edition, 2015, Published by Elsevier - Health Sciences Division.</li> <li>3. Knobil &amp; Neill's Physiology of Reproduction by T. M. Plant and A. J. Zeleznik. 4th edition, 2014, Published by Springer, USA.</li> <li>4. Reproduction in Farm Animals by E. S. E. Hafez and B. Hafez. 7<sup>th</sup> edition, 2013. Published by Wiley-Blackwell, NY. USA.</li> <li>5. Andrology by E. Nieschlag, H. M. Behre and S. Nieschlag. 3<sup>rd</sup> edition, 2010. Published by Springer, USA.</li> <li>6. Applied Animal Reproduction by H. J. Bearden, J. W. Fuquay and S. T. Willard. 6<sup>th</sup> edition, 2004.</li> </ol>	

Published by Pearson Prentice Hall, USA.

<b>Course Title: Advances in Aquaculture</b>	<b>Course Code: ZOL-725</b>
<b>Course Structure:</b> Lectures: 3, Labs: 0	<b>Credit Hours: 3</b>
<b>Prerequisites: No</b>	
<b>Course Objective:</b> The course objectives are to: <ul style="list-style-type: none"><li>• Impart knowledge about history, needs and importance of fisheries and aquaculture.</li><li>• Describe the cultureable fish species and their biology.</li><li>• Elaborate the basics of fish culture and aquaculture facilities.</li></ul>	
<b>Course Outline: Introduction to fisheries and aquaculture</b> , national and international trends. Fish morphology and diversity in size and shape. Distribution of fishes in Pakistan, commercial fishes, marine and freshwater. <b>Types of ponds</b> , planning construction and pond preparation. Pond fertilization, dosage and methods of application. <b>Food and feeding habits of fishes</b> , feed types, artificial and natural fish feeds, feeding strategies of artificial fish feeds. <b>Aquatic habitats</b> , ecology and extant of distribution, Water quality parameters (abiotic: temperature, light, salinity, pH, turbidity etc.) and their effects on fish health and production. <b>Biotic parameters</b> (plankton, insects, aquatic vegetation etc.) of ponds, lakes, rivers, and impacts on fish growth. <b>Induced breeding techniques. Fish diseases and their control. Fishing gears, fishing techniques, fishing communities. Fisheries co-management. Fish preservation, processing, transportation and marketing.</b>	
<b>Course Outcomes:</b> After studying this course student must be able to: <ul style="list-style-type: none"><li>• Acquire knowledge about history, needs and importance of fisheries and aquaculture.</li><li>• Discuss various fish species characteristics and understand their culture requirements.</li><li>• Understand basics of pond fish culture and other advanced culture practices.</li></ul>	
<b>Recommended Books:</b> <ol style="list-style-type: none"><li>1. Davis, D. A. (Ed.). Feed and feeding practices in aquaculture. 2022, Woodhead Publishing.</li><li>2. Goddek, S., Joyce, A., Kotzen, B., &amp; Burnell, G. M. Aquaponics food production systems: combined aquaculture and hydroponic production technologies for the future (p. 619). 2019, Springer Nature.</li><li>3. Lucas, J. S., Southgate, P. C., &amp; Tucker, C. S. (Eds.). Aquaculture: Farming aquatic animals and plants. 2019, John Wiley &amp; Sons.</li><li>4. Stickney R.R. Aquaculture an introductory text, CABI. 2016, Publishing, London, UK.</li><li>5. Fitzsimmons, K., R.S.N. Janjua and M. Ashraf. Aquaculture Handbook—Fish Farming and Nutrition in Pakistan. 2015.</li></ol>	

<b>Course Title: Clinical Endocrinology</b>	<b>Course Code: ZOL-727</b>
<b>Course Structure:</b> Lectures: 3, Labs: 0	<b>Credit Hours: 3</b>
<b>Prerequisites: No</b>	
<b>Course Objective:</b> The course objectives are to:	

<ul style="list-style-type: none"> <li>• To understand recent advancements in the field of endocrinology</li> <li>• To understand clinical aspects of endocrinology</li> </ul>
<p><b>Course Outline: Recent advancements in the field of endocrinology</b> with specific reference to clinical aspects. <b>Diseases of the endocrine system;</b> Mechanism of the hypothalamic releasing factors ; Neurotransmitters <b>Hormones:</b> Growth Hormone; Adrenocorticotropins (ACTH); Gonadotrophins (FSH, LH, LTH); Thyroid stimulating hormone (TSH); Oxytocin; Vasopressin; Thyroid hormones; Insulin and glucagons; Adrenal hormones; Gastrointestinal hormones; <b>Organs of uncertain endocrine functions;</b> their synthesis, biochemistry &amp; biological actions.</p>
<p><b>Course Outcomes:</b> After studying this course student must be able to:</p> <ul style="list-style-type: none"> <li>• Demonstrate a sound knowledge of Endocrinology.</li> <li>• Apply the knowledge obtained for the interpretation of case studies.</li> <li>• Critically asses the clinical relevance of results obtained in the laboratory.</li> </ul>
<p><b>Recommended Books:</b></p> <ol style="list-style-type: none"> <li>1. Igaz, P. (Ed.). Practical clinical endocrinology. 2021, Springer Nature.</li> <li>2. Badiu, C. Williams textbook of endocrinology. 2019, Acta Endocrinologica (Bucharest), 15(3), 416.</li> <li>3. Lucas, J. S., Southgate, P. C., &amp; Tucker, C. S. (Eds.). Aquaculture: Farming aquatic animals and plants. 2019, John Wiley &amp; Sons.</li> <li>4. Soskin, S. (Ed.). (2016). Progress in clinical Endocrinology.</li> <li>5. Melmed, S., Polonsky, K. S., Larsen, P. R., &amp; Kronenberg, H. M. (2015). Williams textbook of endocrinology E-Book. Elsevier Health Sciences.</li> <li>6. Jameson, J. L., &amp; De Groot, L. J. Endocrinology: adult and pediatric E-Book. 2015, Elsevier Health Sciences.</li> <li>7. Borer, K. T. Advanced exercise endocrinology. 2013, Human Kinetics.</li> <li>8. Medvei, V. C. A history of endocrinology. 2012, Springer Science &amp; Business Media.</li> </ol>

<b>Course Title: Advances in Cancer Biology</b>	<b>Course Code: ZOL-728</b>
<b>Course Structure:</b> Lectures: 3, Labs: 0	<b>Credit Hours: 3</b>
<b>Prerequisites: No</b>	
<p><b>Course Objective:</b> The course objectives are to:</p> <ul style="list-style-type: none"> <li>• To enhance the knowledge in the area of Cancer Biology.</li> <li>• To provide core concepts involved in the transformation of normal cell in to cancer cell.</li> <li>• To introduce the major signaling circuitry programs contributing</li> </ul>	
<p><b>Course Outline: Introduction;</b> Introduction of Cancer, General features and types of cancers, The nature of Cancer, Arise of Cancer from normal and specialized cells. Monoclonal growth of tumor cells. Physical and chemical carcinogens. Mutagens causing cancers. <b>Tumor Viruses,</b> RNA viruses , DNA Viruses causing cancer. Transformation of cells by tumor viruses. <b>Cellular oncogenes:</b> Oncogenes in the cell , Proto-oncogenes, Activation of proto-oncogenes, myc oncogene. <b>Growth factors, Receptors, and Cancer;</b> Receptors and their ligands, Growth factor genes, EGF receptor, TGF. <b>Signaling Circuitry programs;</b> Introduction to signaling pathway, The Ras protein; Tyrosine phosphorylation; Cascade of kinases. <b>Cell Cycle:</b> Cell cycle, Cell cycle regulation, Tumor suppressor genes, Apoptosis. Significance of apoptosis, <b>Extrinsic and Intrinsic apoptosis.</b></p>	

**Course Outcomes:**

After studying this course student must be able to:

- ACQUIRE the advanced knowledge of Cancer Biology.
- Define the risk factors for different cancer

**Recommended Books:**

1. Pecorino, L. Molecular biology of cancer: mechanisms, targets, and therapeutics. 2021, Oxford university press.
2. Fox, B. A., Figdor, C. G., Slingluff, C., Klinke, D., Sanchez-Perez, L., & Ascierto, P. A. Advances in Cancer Immunotherapy. 2016, Advances in Cancer Immunotherapy, 510.
3. Hejmadi, M. Introduction to cancer biology. 2014, Bookboon.
4. Hesketh, R. Introduction to cancer biology. 2013, Cambridge University Press.
5. Weinberg, R. The biology of cancer. 2013, Garland science.
6. Weinberg, R. A. The biology of cancer. 2013, Garland science.
7. Walker, J. M., & Gaastra, W. (Eds.). Techniques in molecular biology. 2012, Springer Science & Business Media.

<b>Course Title: Cancer Genetics</b>	<b>Course Code: ZOL-729</b>
<b>Course Structure:</b> Lectures: 3, Labs: 0	<b>Credit Hours: 3</b>
<b>Prerequisites: None</b>	
<b>Course Objective:</b> The objectives of the course are:- <ul style="list-style-type: none"> <li>• To enhance the knowledge in the area of Cancer Genetics.</li> <li>• To provide core concepts involved in the activation of proto-oncogenes.</li> <li>• To introduce the major genes involved in signaling circuitry programs contributing towards cancer.</li> </ul>	
<b>Course Outline:</b> <b>Introduction:</b> Genetic basis of cancer. Oncogenes, Proto-oncogenes, Tumor Suppressor Genes. <b>Cell Cycle Control Genes:</b> Types of Cyclins, CDKs, pRb, E2F transcription factor, Myconcoprotein. <b>DNA Repair Pathways:</b> Genes involved in Repair pathways, p53, Mdm2, ARF. <b>Oncogenes and cancer metastasis:</b> How faulty genes lead to cancer, Proto-oncogenes, Tumor, suppressor genes, DNA repair genes, Metastasis suppressor genes, Genetic instability and cancer. <b>Apoptosis:</b> Introduction to apoptosis, Proapoptotic genes, Antiapoptotic genes, How cell maintains balance between pro and anti-apoptotic genes. <b>Genetic Screening for Cancer:</b> SNP and Cancer, Case Studies, P53, BRCA1, RRCA2	
<b>Course Outcomes:</b> Upon successful completion of the course, the student will be able to: <ul style="list-style-type: none"> <li>• <b>ACQUIRE</b> the basic knowledge of Cancer Genetics.</li> <li>• <b>UNDERSTAND</b> the concepts of genes involved in signaling circuitry programs of tumor cell.</li> <li>• <b>ANALYZE</b> the activation of proto-oncogenes in to oncogenes.</li> </ul>	
<b>Recommended Books:</b> <ol style="list-style-type: none"> <li>1. Francesco Pezzella, Mahvash Tavassoli. Oxford Textbook of Cancer Biology. United Kingdom, 2019. Oxford University Press,</li> <li>2. Introduction to Cancer Metastasis. Netherlands, 2016. Elsevier Science,</li> <li>3. Hanahan, D. Hallmarks of cancer: new dimensions. (2022). <i>Cancer discovery</i></li> <li>4. Hejmadi, M. (n.d.). Introduction to Cancer Biology. United Kingdom: 2010. BoonBooks.com.</li> <li>5. Krebs, J. E., Goldstein, E. S., &amp; Kilpatrick, S. T. <i>Lewin's Genes Twelve</i>. (2017). Jones &amp; Bartlett Learning.</li> <li>6. Gibbon, S., Joseph, G., Mozersky, J., Zur Nieden, A., &amp; Palfner, S. <i>Breast cancer gene research and medical practices: transnational perspectives in the time of BRCA</i>. (Eds.). (2014). Routledge.</li> </ol>	

<b>Course Title:</b> Advanced Enzymology	<b>Course Code:</b> ZOL-730
<b>Course Structure:</b> Lectures: 3, Labs: 0	<b>Credit Hours:</b> 3
<b>Prerequisites:</b> None	
<p><b>Course Objective:</b> The course aims to:</p> <ul style="list-style-type: none"> <li>• To Introduce students to various theoretical and practical aspects of enzymology</li> <li>• To stimulate students interest in learning the structure, function and kinetics of enzymes and their role as catalyst and regulator of cell metabolism.</li> <li>• To understand the mechanism of enzymes action and important components of the enzyme molecules.</li> <li>• To evaluate the basics of enzyme kinetics, pathways, mechanisms of their control and the importance of the parameters describing the kinetics.</li> </ul>	
<p><b>Course Outline:</b>  <b>Introduction and History of Enzymes:</b> Historical aspects, Discovery and chemistry of enzymes, Function and importance, Enzymes in Biotechnology. <b>Characteristics and Properties:</b> Catalytic power and specificity, Enzyme-substrate interactions, Lock and key model, Induce fit model, Transition state model, Quantum tunnelling model, Enzymes as proteins, Non-protein cofactors-metal ions, Organic cofactors. <b>Multi-substrates Reactions and Substrate Binding Analysis:</b> Multi-substrates reactions, Ordered and random mechanisms, Sequential and Non-sequential mechanisms, Substrate binding analysis. <b>Determination of Enzyme-Substrate Dissociation Constants:</b> Equilibrium dialysis, Equilibrium gel filtration, Ultracentrifugation, Spectroscopic methods. <b>Experimental analysis of catalytic and kinetic mechanisms:</b> Spectrometry, X-ray crystallography, stopped flow, isotope effects, structure/reactivity relationships), Mathematical data analysis (regression analysis, model discrimination), Modelling of enzymatic reactions. Stereo chemistry (mechanisms). Structure/function relationships (protein folding, mutagenesis, enzyme inhibition, Catalytic mechanism, catalytic antibodies, catalytic nucleic acids ribozymes, catalytic DNA. <b>Enzyme Purification and Assay:</b> Enzyme units of activity, Turnover number and properties, Purification and assessment, Methods for measurements. <b>Enzyme Engineering and Design:</b> Substitution, Insertion, Hybrid proteins, Genes for novel enzymes, Engineering more stable enzymes, Incorporation of non-natural amino acids into enzymes, Protein engineering by combinatorial methods, DNA shuffling.</p>	
<p><b>Course Outcomes:</b> Upon successful completion of the course the student will be able to:</p> <ul style="list-style-type: none"> <li>• <b>ACQUIRE</b> the basic knowledge of the major classes of enzymes and their functions in the cell; role of co-cofactor in enzyme catalyzed reaction.</li> <li>• <b>DIFFERENTIATE</b> between equilibrium and steady state kinetics and analyzed simple kinetic data and estimate important parameter (<math>K_m</math>, <math>V_{max}</math>, <math>K_{cat}</math>etc).</li> <li>• <b>EVALUATE</b> the different possible catalytic mechanisms of given reaction types</li> </ul>	
<p><b>Recommended Books:</b></p> <ol style="list-style-type: none"> <li>1. Bedford, M. R., Partridge, G. G., Hruby, M., &amp; Walk, C. L. <i>Enzymes in farm animal nutrition</i>. (Eds.). (2022). Cabi.</li> <li>2. Gupta, M. N., &amp; Uversky, V. N. (Eds.). <i>Structure and Intrinsic Disorder in Enzymology</i>. (2022). Elsevier.</li> <li>3. Bouaziz, A., Houfani, A. A., &amp; Baoune, H. Enzymology of Microbial Biofilms. In <i>Ecological Interplays in Microbial Enzymology</i> (pp. 117-140). (2022). Singapore: Springer Nature Singapore.</li> <li>4. Maddela, N. R., Abiodun, A. S., &amp; Prasad, R. <i>Ecological Interplays in Microbial Enzymology</i>. (Eds.). (2022). Springer Nature.</li> <li>5. Bisswanger, H. <i>Practical enzymology</i>. (2019). John Wiley &amp; Sons.</li> <li>6. Okotore, R.O., <i>Essentials of Enzymology</i>. 2015. Publisher XLIBRIS.</li> </ol>	

7. Bowden, A.C., Fundamentals of Enzyme Kinetics 4th Edition. 2012. Wiley-Blackwell.
8. Mckee, T. and Mckee, J. R. Biochemistry, the Molecular Basis of Life.5<sup>th</sup> edition, 2011. Oxford University Press, New York.

<b>Course Title: Applied Genetics</b>	<b>Course Code: ZOL-731</b>
<b>Course Structure:</b> Lectures: 3, Labs: 0	<b>Credit Hours: 3</b>
<b>Prerequisites: None</b>	
<b>Course Objective:</b> The objectives of the course are:- <ul style="list-style-type: none"> <li>• To give basic understanding of genetic transformation processes.</li> <li>• To develop understanding of Transposable elements and their mechanism of Transposition</li> <li>• To enable the students to understand the genetic factors influencing human development and behavior.</li> </ul>	
<b>Course Outline:</b> <b>Nucleic acids:</b> Plant and animal viruses, Tumor viruses, Retroviruses <b>Genetic Transformation:</b> Conjugation, , Transformation, Transduction, Integration of viral DNA <b>Transposition:</b> Transposable Elements, Detection of Transposition In Bacteria, Types of Bacterial Transposons, Modes of Transposition In Bacteria <b>Gene expression:</b> Regulation of Gene expression in Prokaryotes, Regulation of gene expression in Eukaryotes <b>Quantitative Genetics of Human Behavior:</b> Intelligence, Personality <b>genetic perspective on development:</b> Maternal effect genes, Determination of dorsal-ventral and anterior posterior axis, Body segmentation, Organ formation	
<b>Course Outcomes:</b> Upon successful completion of the course, the student will be able to: <ul style="list-style-type: none"> <li>• <b>Describe</b> the phenomenon involved in transformation of genetic material.</li> <li>• <b>Understand</b> the Transposable elements and bacterial transposition.</li> <li>• <b>Interpret</b> the roles of various genes and genetic factors in development and human behavior.</li> </ul>	
<b>Recommended Books:</b> <ol style="list-style-type: none"> <li>1. LeRoy, B. S., Veach, P. M., &amp; Callanan, N. P. <i>Genetic counseling practice: advanced concepts and skills.</i> (Eds.). (2020). John Wiley &amp; Sons.</li> <li>2. Turnpenny, P. D., Ellard, S., &amp; Cleaver, R. <i>Emery's Elements of Medical Genetics E-Book.</i> (2020). Elsevier Health Sciences.</li> <li>3. Mills, M. C., Barban, N., &amp; Tropf, F. C. <i>An introduction to statistical genetic data analysis.</i> (2020). Mit Press.</li> <li>4. Caballero, A. <i>Quantitative genetics.</i> (2020). Cambridge University Press.</li> <li>5. Marjanović, D., Primorac, D., &amp; Dogan, S. Forensic genetics: Theory and application. (2018). Sarajevo, Bosnia and Herzegovina: International Burch University.[Google Scholar].</li> </ol>	

<b>Course Title: Applied Parasitology</b>	<b>Course Code: 732</b>
<b>Course Structure:</b> Lectures: 3, Labs: 0	<b>Credit Hours: 3</b>
<b>Prerequisites: None</b>	
<b>Course Objective:</b> The course objectives are: <ul style="list-style-type: none"> <li>• To enable students get familiarized with the most important parasites of humans and domestic animals</li> </ul>	

- Their transmission patterns, diagnosis, treatment, prevention, control, Their economic and medical importance

**Course Outline:**

**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. **Control and Vaccine Development Against Parasitic Infections. Chemotherapeutic agents used against parasitic infections:** a) eg. anthelmintics, insecticides etc. b) The mode of action of chemotherapeutic agents. c) The mechanisms of parasite resistance to drugs. **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 helminthes d) Genetic engineering. The application of genetically engineered vaccines will be discussed. Cultivation of Parasites tissue culture techniques, cryopreservation

**Course Outcomes:**

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

- Discover the most important parasites of humans and domestic animals
- Examine transmission patterns, diagnosis, treatment, prevention, control, their economic and medical importance

**Recommended Books:**

1. Scholz, T., & Choudhury, A. (2021). John Mackiewicz (1930–2020).
2. Carlson, C. J., Hopkins, S., Bell, K. C., Doña, J., Godfrey, S. S., Kwak, M. L., ... & Wood, C. L. A global parasite conservation plan. (2020). *Biological Conservation*, 250, 108596.
3. Bowman, D. D. *Georgis' Parasitology for Veterinarians E-Book*. (2020). Elsevier Health Sciences.
4. Pacheco, G. A. B., & Kamboh, A. A. (Eds.). *Parasitology and Microbiology Research*. (2020). BoD–Books on Demand.
5. Sastry, A. S., & Bhat, S. *Essentials of medical parasitology*. (2018). Jp Medical Ltd.
6. Stothard, J. R., & Rollinson, D. An important milestone in parasitology: celebrating a hundred volumes of *Advances in Parasitology*. (2018). *Advances in Parasitology*, 100, 1-27.

<b>Course Title: Fish and Aquatic Toxicology</b>	<b>Course Code: ZOL-733</b>
<b>Course Structure: Lectures: 3, Labs: 0</b>	<b>Credit Hours: 3</b>
<b>Prerequisites: None</b>	
<p><b>Course Objective:</b> The objectives of the course are:-</p> <ul style="list-style-type: none"> <li>• To review the basic toxicological principles of uptake, elimination, and bioaccumulation, emphasizing processes unique to aquatic organisms.</li> <li>• 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.</li> <li>• To become familiar with the concept of risk assessment and to extend its use to assess ecological risks resulting from aquatic pollution.</li> </ul>	
<p><b>Course Outline:</b></p> <p><b>Introduction to Aquatic Toxicology:</b> History of Aquatic Toxicology, Main Present and Future Challenges, Classification and Types of Toxicity, Effects of Aquatic Toxicology on Organisms, Bioindicators and Biomarkers. <b>Sources and Causes of Aquatic Contamination:</b> Major Sources of Pollutants, Transport of Pollutants in the Environment, Metals, Metalloids, and Organometallic Compounds, Other Inorganic Compounds, Including Factors Causing Eutrophication, Organic Compounds, Nano-materials, Radiation, Genetic Modification. <b>Uptake, Distribution, Detoxification and Excretion of Compounds in Aquatic Organisms:</b> Uptake of Compounds by Organisms, Distribution and Storage Sites of Chemicals in Organisms, Biotransformation and Detoxification, Cellular Excretion, Excretion from</p>	

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

**Course Outcomes:**

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

- **ACQUIRE** the knowledge of the various toxic agents and their sources in aquatic ecosystem
- **UNDERSTAND** the effects of toxic substances on fishes and other aquatic organisms
- **SOLVE** the pollution problems in aquatic system and its toxicity on different organs of fish

**Recommended Books:**

1. Kamble, N. P. *AQUATIC TOXICOLOGY*. (2022). Ashok Yakkaldevi.
2. Rand, G. M., Wells, P. G., & McCarty, L. S. Introduction to aquatic toxicology. In *Fundamentals of aquatic toxicology* (pp. 3-67). (2020). CRC Press.
3. Kalčíková, G. Beyond ingestion: Adhesion of microplastics to aquatic organisms. *Aquatic Toxicology*, (2023)
4. Kibenge, F. S., Baldisserotto, B., & Chong, R. S. M. *Aquaculture toxicology*. (Eds.). (2020). Academic Press.
5. Malins, Donald C.. *Aquatic Toxicology: Molecular, Biochemical, and Cellular Perspectives*. United States, 2018.CRC Press,

<b>Course Title: Desert Zoology</b>	<b>Course Code: ZOL-734</b>
<b>Course Structure:</b> Lectures: 3, Labs: 0	<b>Credit Hours: 3</b>
<b>Prerequisites: None</b>	
<b>Course Objective:</b> The course aims to: <ul style="list-style-type: none"> <li>• Impart the knowledge in biology and Environmental sciences related to the desert organisms.</li> <li>• Develop concepts about threats/risk factors of animals in desert.</li> <li>• Study the history of desertification and desert fauna.</li> </ul>	
<b>Course Outline:</b> <b>Origin of desert life:</b> Exhibited features including soil, water, temperature, atmospheric pressure, and oceanic role. <b>Desert Ecology:</b> Introduction to local habitats; identification of local animals; Morphological and physiological adaptations of desert organisms. Principles of classifying and naming species. <b>Desert biomes:</b> (Hot and Dry, semiarid, Costal and Cold); Desertification its Causes and impacts on animals. Deserts of Pakistan. Conservation of Animals; Advantages and disadvantages of Deserts. Major threats/risk factors and management strategies to conserve the animals in deserts.	
<b>Course Outcomes:</b> After studying the course the student should be able to: <ul style="list-style-type: none"> <li>• <b>ACQUIRE</b> the knowledge about various ecosystems of desert</li> <li>• <b>UNDERSTAND</b> the effect of desertification on desert animals</li> </ul>	
<b>Recommended Books:</b> <ol style="list-style-type: none"> <li>1. Polis, G. A. <i>The ecology of desert communities</i>. (Ed.). (2023). University of Arizona Press.</li> <li>2. Monson, G., &amp; Sumner, L. <i>The desert bighorn: its life history, ecology, and management</i>. (Eds.). (2023). University of Arizona Press.</li> <li>3. Fleming, T. H. (<i>Sonoran Desert Journeys: Ecology and Evolution of Its Iconic Species</i>).</li> </ol>	

2022). University of Arizona Press.

4. Tan, E., & Gresham, J. *In This Desert, There Were Seeds*. (Eds.). (2023). Ethos Books.
5. G. W Brown, *Desert Biology: Special Topics on the Physical and Biological*. 2013.
6. D. Ward, *The Biology of Deserts*. 2016. Oxford University Press. 416p.

<b>Course Title: Clinical Teratology</b>	<b>Course Code: ZOL- 735</b>
<b>Course Structure: Lectures: 3, Labs: 0</b>	<b>Credit Hours: 3</b>
<b>Prerequisites: None</b>	
<b>Course Objective:</b> COURSE OBJECTIVES: <ul style="list-style-type: none"><li>• To introduce the basic concepts of developmental errors and birth defects</li><li>• To impart knowledge about the environmental, infectious, genetic and physiological causes of congenital abnormalities</li><li>• To develop understanding on the biological mechanisms of teratogenesis and their possible solutions in biomedical sciences</li></ul>	
<b>Course Outline:</b> Teratogenesis introduction, Environmental assaults on human development, Teratogenic agents: Alcohol, Retinoic acid, Hydroflouorocarbons and others, Role of degradation products used as refrigerants in teratogenesis, Possible role of drugs and neuro-toxicants such as Heroin in congenital defects, Heavy metal as teratogens, Pathogens: <i>Rubella</i> , <i>Toxoplasma gondii</i> , <i>Treponema pallidum</i> (Syphilis bacterium) inflicting teratogenesis, Endocrine disruptors such as diethylstilbestrol (drug used to prevent premature births) causing inborn defects, Possible roles of Nonylphenol(Plastic wrappings around food) and Bisphenol(a water bottles, baby feeders) in prenatal and postnatal developmental errors, Tobacco and Cannabis causing embryonic and postembryonic disruptions, Alcoholism and fetal alcohol syndrome, Antimalarial and antiprotozoal medicines as developmental disruptors, Role of tranquilizers, anti-nauseant and anti-hyperglycemic medicines in embryonic development, Oxidative stress and embryonic development, Ectopic pregnancies, Placental errors, Breach babies, Polyhydromenosis and oligohydromenosis, Major inborn defects like imperforated anus, cardiac septal defects, intestinal atresia, cleft lip and cleft palate, Organ ectopia, hydrocephaly, microcephaly, Congenial neural tube and nervous system defects, Testicular dysgenesis and declining sperm counts, Developmental biology and future of medicine, Germ-line gene therapy, Stem cell therapy, Regenerative medicine, Regeneration therapy, In utero surgeries, Neonatal surgeries, Biophysical organ transplants, Regenerative organs and organoids, Fraternal and monozygotic twinning, Organ twinning	
<b>Course Outcomes:</b> <ul style="list-style-type: none"><li>• The students will be acquainted with the emerging threats of birth defects imposed by various infectious agents, radiation, heavy metals, medicines, drugs, and environmental chemicals (pesticides) in the developing embryos.</li><li>• The basic understandings will help the students to suggest possible precautionary measures and the biomedical and surgical solutions to the parents during the course of pregnancy</li><li>• Further exploration will help the students to excel this knowledge in reproductive and developmental counseling.</li></ul>	
<b>Recommended Books:</b> <ol style="list-style-type: none"><li>1. Juch, H. Teratology. In <i>The Placenta: Basics and Clinical Significance</i> (pp. 105-120). Berlin, Heidelberg: (2023). Springer Berlin Heidelberg.</li><li>2. Alwan, S., &amp; Friedman, J. M. Clinical Teratology. In <i>Emery and Rimoin's Principles and Practice of Medical Genetics and Genomics</i> (pp. 15-60). (2019). Academic Press.</li><li>3. Belanger, B. G., &amp; Lui, F. Embryology, teratology (2019). TORCH.</li><li>4. Teratogenicity Testing: Methods and Protocols. United States: (2019). Springer New York.</li></ol>	

5. Matevosyan, N. Lectures in Teratology. (n.p.): (2017). CreateSpace Independent Publishing Platform.  
 6. Moore K, Persaud T V N, Torchia M The Developing Human Clinically Oriented Embryology 10th Edition. (2015) Elsevier inc.

<b>Course Title: Molecular Genetics</b>	<b>Course Code: ZOL-736</b>
<b>Course Structure:</b> Lectures: 3, Labs: 0	<b>Credit Hours: 3</b>
<b>Prerequisites: None</b>	
<b>Course Objective:</b> The Objectives of the course are: <ul style="list-style-type: none"> <li>• To understand the organization of human nuclear genome and mitochondrial genome.</li> <li>• To develop understanding of different types gene families and superfamilies'</li> <li>• To equip the student with different modern molecular Techniques</li> </ul>	
<b>Course Outline:</b> <b>Genome structure:</b> Human mitochondrial genome, Human Nuclear genome, Protein Coding gene, RNA genes, <b>Gene Families:</b> Solitary gene and gene family, Gene superfamily, Pseudogenes, Retrogenes, Cluster gene families, Interspersed gene families, <b>Transposable Genetic Elements:</b> LINES, SINES, Fossil Transposons, <b>Repeat Instability and Genetic Disorders:</b> TRED1, TRED2, Fragile X- Syndrome, Mytonic Dystrophy, <b>DNA Methylation and Cancer:</b> Differential methylation and cancer, Imprinting, Epigenetics and its implications in the genome, ,Telomere and Telomerase and their role in cancer and aging, RNA interference, RNA mediated pathways in nucleus, <b>Study of Molecular Techniques:</b> Southern blotting, Western blotting, Northern blotting, PCR, Gel Electrophoresis, RFLP, RAPDS, <b>Microsatellite DNA, Discussion on latest articles in the field of genotyping in connection to various disciplines</b>	
<b>Course Outcomes:</b> Upon successful completion of the course, the student will be able to: <ul style="list-style-type: none"> <li>• Acquire the basic knowledge of human nuclear genome and mitochondrial genome.</li> <li>• Illustrate the key features of human genome and certain gene families.</li> <li>• Discover the role of certain RNA coding genes along with protein coding genes.</li> </ul>	
<b>Recommended Books:</b> <ol style="list-style-type: none"> <li>1. Strachan, Tom, and Read, Andrew. Human Molecular Genetics. United 2018.States, CRC Press,</li> <li>2. Glick, B.R., &amp; Patten, C.L. Molecular biotechnology: principles and applications of recombinant DNA (Vol. 34). (2017). John Wiley &amp; Sons.</li> <li>3. Clark, D.P., and Pazdernik, N.J., Biotechnology 2nd (ed.). (2015). Elsevier Science &amp; Technology Books</li> <li>4. Park, S. F., &amp; Dale, J. W. <i>Molecular genetics of bacteria</i>. (2013). John Wiley &amp; Sons.</li> <li>5. Lewin, B. Gene-VIII. 2004. Oxford University Press, Oxford, UK.</li> </ol>	

<b>Course Title: Neurobiology</b>	<b>Course Code: ZOL-737</b>
<b>Course Structure:</b> Lectures: 3, Labs: 0	<b>Credit Hours: 3</b>
<b>Prerequisites: None</b>	
<b>Course Objective:</b> <ul style="list-style-type: none"> <li>• To provide the knowledge about the structure and function of cells that comprises the nervous system.</li> <li>• To impart understanding of chemical and electrical signaling in the nervous system.</li> <li>• To provide knowledge of sensory and motor systems and brain development and complex brain functions.</li> </ul>	

**Course Outline:**

The organization of the nervous system; neurons, types of neurons, nerves, Electrical signals of nerve cells; Membrane permeability; Channels and transporters; Nerve Impulse, **Synaptic Transmission**, Neurotransmitters; their receptors and effects; Intracellular signal transduction, **Sensory somatic system:** The somatic sensory system; Pain; **Vision**, Vision; molecular basis of photoreception, central visual pathways; Neural basis of visual perception, types of eyes, photoreceptor and photo-transduction, retinal circuits, visual cortex. **Hearing:** Nature of Sound, The auditory system; the vestibular system; Lateral line organs and electroreceptor, The mammalian ear, the auditory nerve fibers. Brainstem auditory pathways, Auditory cortex, **The chemical senses;** Taste system, Olfactory system. **Motor Neurons/system**, lower motor neuron circuits and motor control; upper motor neuron control of the brainstem and spinal cord; modulation of movement by the basal ganglia and the cerebellum; eye movements and sensory motor integration; the visceral motor system. **Brain development:** brain development; construction of neural circuits; modification of brain circuits as result of experience; plasticity of mature synapses and circuits;. **Association Cortices:** The association cortices; Language and lateralization; sleep and wakefulness; emotions; sex, sexuality and brain; human memory.

**Course Outcomes:**

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

- Understand the properties of cells that make up the nervous system including the propagation of electrical signals used for cellular communication
- Understand how the interaction of cells and neural circuits leads to higher level activities such as cognition and behavior
- Evaluate and discuss primary research literature and evaluate the validity of hypotheses generated by others

**Recommended Books:**

1. Jänig, W. *The integrative action of the autonomic nervous system: neurobiology of homeostasis*. (2022). Cambridge University Press.
2. Zigmond, M. J., Wiley, C. A., & Chesselet, M. F. (Eds.). *Neurobiology of brain disorders: biological basis of neurological and psychiatric disorders*. (2022). Academic press.
3. Golowasch, J. *Principle of Neurobiology*. (2020). BIOL
4. Luo, L. *Principles of neurobiology*. (2020). Garland Science.
5. Garrett, B., & Hough, G. *Brain & behavior: An introduction to behavioral neuroscience*. (2017). Sage Publications.
6. Haier, R. J. *The neuroscience of intelligence*. (2016). Cambridge University Press.

<b>Course Title: Population Biology</b>	<b>Course Code: ZOL-738</b>
<b>Course Structure:</b> Lectures: 3, Labs: 0	<b>Credit Hours: 3</b>
<b>Prerequisites: None</b>	
<b>Course Objective:</b> The objectives of the course are:- <ul style="list-style-type: none"> <li>• To familiarize the students with the basic concepts of population diversity &amp; ecology</li> <li>• To educate the students with the methods of population samplings</li> <li>• To educate the students with the population dynamics in an ecosystem and their biotic &amp; abiotic factors</li> </ul>	
<b>Course Outline:</b> <b>Population: a)</b> Population, basic population characters, population dynamics, exponential, logistic, b) Forms of population growth, density dependent and independent growth c) Animal behavior, ecology and evolution, Structural population, population genetics, adaptation and speciation. <b>Population ecology; a)</b>	

Basic concepts, Population ecology of plants, population simulation b) Community ecology, community analysis, succession, ecotones, predator-prey systems, competition, mutualism, commensalism and carrying capacity, c) Population estimation methods, relative and absolute measures, age and sex composition. **Life history:** a) Demographic and life history parameters, evolution of life history parameters: R and K selection b) Allometry, aging and sexing, life tables, age and stage structures models c) Methods of estimation of life history parameters. **Population sampling:** a) Preparation of sampling designs for population estimation, b) Analysis of census data, Studies of various population parameters and use of census techniques.

**Course Outcomes:**

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

- Acquire the basic knowledge of biological population and their evolutionary processes
- Understand the concepts of basic methods of population samplings
- Evaluate the population dynamics of biotic and abiotic factors of ecosystem

**Recommended Books:**

1. Neal, Dick. Introduction to Population Biology. India, Cambridge University Press, 2019.
2. Elton, C. S. *The ecology of invasions by animals and plants*. (2020). Springer Nature.
3. Caswell, H. *Sensitivity analysis: matrix methods in demography and ecology* (p. 299). (2019). Springer Nature.
4. Mittelbach, G. G., & McGill, B. J. *Community ecology*. (2019). Oxford University Press.
5. Thieme, H. R. *Mathematics in population biology* (Vol. 1). (2018). Princeton University Press.

<b>Course Title: Wetlands Management</b>	<b>Course Code: ZOL-739</b>
<b>Course Structure:</b> Lectures: 3, Labs: 0	<b>Credit Hours: 3</b>
<b>Prerequisites: None</b>	
<p><b>Course Objective:</b> The objective of this course is:</p> <ul style="list-style-type: none"> <li>• to enable the student to understand basics of wetlands, wetlands in Pakistan and its significance</li> <li>• to understand values, valuation and management of wetlands</li> <li>• to understand how National and International agencies involved in conservation and management of wetlands</li> </ul>	
<p><b>Course Outline:</b> <b>Wetlands of Pakistan:</b> Aquatic ecosystems, Introduction to Wetlands, Classification, Wetlands hydrology, Clarity on wetlands and Water Use, Wetlands and Water Quality, Wetlands and Environmental Flows. <b>Biogeochemistry, Wetlands and Climate change, Human Impacts and Management of wetlands, Values and valuation of wetlands:</b> Lakes and rivers, <b>Degradation of aquatic ecosystems, Wetlands and Nutrient Retention. Restoration of wetlands:</b> Passive restorations, Active Restoration, <b>The Ramsar strategic plans, Research on Sustainable Agriculture and Wetlands.</b></p>	
<p><b>Course Outcomes:</b> Upon successful completion of this course, the student will be able to:</p> <ul style="list-style-type: none"> <li>• ACQUIRE theoretical knowledge about wetlands in Pakistan, its importance with reference to migratory birds.</li> <li>• EVALUATE the wetland conservation management by government department, National and International organizations</li> <li>• DEMONSTRATE the ecological assessment and importance of wetlands to certain area.</li> </ul>	
<p><b>Recommended Books:</b></p> <ol style="list-style-type: none"> <li>1. Anne A. van Dam, Beth A. Middleton, C. Max Finlayson. <i>The Wetland Book: I: Structure and Function, Management, and Methods</i>. Netherlands, 2018. Springer Netherlands,</li> <li>2. Wasserman, R. J., &amp; Dalu, T. Tropical freshwater wetlands: an introduction. In <i>Fundamentals of</i></li> </ol>	

- Tropical Freshwater Wetlands* (pp. 1-22). (2022). Elsevier.
3. Gokce, D. (Ed.). (2019). *Wetlands Management: Assessing Risk and Sustainable Solutions*. BoD–Books on Demand.
  4. Finlayson, C., Everard, M., Irvine, K., McInnes, R. J., Middleton, B. A., van Dam, A., & Davidson, N. *The wetland book I: Structure and function, management and methods*. (2018). Springer.
  5. Finlayson, C., Milton, G. R., Prentice, R. C., & Davidson, N. *The Wetland Book II: Distribution, Description and Conservation*. (2018). Springer.

<b>Course Title: Advances in epidemiology and control of parasitic diseases</b>	<b>Course Code: ZOL-740</b>
<b>Course Structure: Lectures: 3, Labs: 0</b>	<b>Credit Hours: 3</b>
<b>Prerequisites: None</b>	
<b>Course Objective:</b>	
<ul style="list-style-type: none"> <li>• To Describe basic principles of epidemiology, including descriptive/analytical epidemiology</li> <li>• To elaborate techniques used to conduct disease outbreak investigations and develop disease prevention programs</li> <li>• To describe causal models, distribution/patterns and control of disease or other health-related events in populations.</li> </ul>	
<b>Course Outline:</b>	
<p><b>Introduction of Epidemiology:</b> Significance, Basis terminology, general concepts. <b>Selection of epidemiological parameters:</b> Surveillance study, Host parasite associations. <b>Population biology and genetics:</b> Genetic variability and parasite transmission, Age- intensity and age prevalence profile of parasite infections. <b>Ecological and evolutionary dynamics of parasites:</b> Parasite prevalence and seasons, Epidemiological approaches for the control of parasites, Application of molecular techniques in Epidemiology of parasitic infections.</p>	
<b>Course Outcomes:</b>	
<p>Upon successful completion of the course, the student will be able to:</p> <ul style="list-style-type: none"> <li>• Learn basic principles of epidemiology, including descriptive/analytical epidemiology</li> <li>• Demonstrate techniques used to conduct disease outbreak investigations and develop disease prevention programs</li> <li>• Compute causal models, distribution/patterns and control of disease or other health-related events in populations.</li> </ul>	
<b>Recommended Books:</b>	
<ol style="list-style-type: none"> <li>1. Stothard, R., &amp; Rollinson, D. <i>Advances in Parasitology</i>. (2023). Elsevier.</li> <li>2. Gunn, A., &amp; Pitt, S. J. <i>Parasitology: an integrated approach</i>. (2022). John Wiley &amp; Sons.</li> <li>3. Nelson, K. E., &amp; Williams, C. M. <i>Infectious disease epidemiology: theory and practice</i>. (Eds.). (2014). Jones &amp; Bartlett Publishers.</li> <li>4. Bowman, D. D. <i>Georgis' Parasitology for Veterinarians E-Book</i>. (2020). Elsevier Health Sciences.</li> <li>5. Crook, T. (2020). Human parasitic diseases: a diagnostic atlas. <i>Emerging Infectious Diseases</i>, 26(8).</li> <li>6. Pacheco, G. A. B., &amp; Kamboh, A. A. (Eds.). <i>Parasitology and Microbiology Research</i>. (2020). BoD–Books on Demand.</li> </ol>	

<b>Course Title: Herpetology</b>	<b>Course Code: ZOL-741</b>
<b>Course Structure: Lectures: 3, Labs: 0</b>	<b>Credit Hours: 3</b>

<b>Prerequisites: None</b>
<b>Course Objective:</b> The objective of this course is <ul style="list-style-type: none"> <li>• To enable the student to identify herpeto-fauna.</li> <li>• To understand the factors affecting their distribution</li> <li>• To understand how National and International agencies involved in conservation and management of herpeto-fauna as part of wildlife</li> </ul>
<b>Course Outline:</b> <b>Herpetofauna of Pakistan:</b> Introduction, Important Definitions, Identification, Distribution, Status, Conservation and Management of amphibians and reptiles of major importance in Pakistan, <b>Systematics and Zoogeography, Factors affecting distribution and abundance of amphibian and reptilian fauna of Indian Sub-continent. Biology of major Herpetofauna:</b> Major amphibians, Fresh water and Marine Turtle, Crocodiles, Lizards, Snakes. <b>Thermo-regulation and its role:</b> Aestivation, Hibernation, Other Eco-Physiological Adaptations. <b>Role of temperature in sex determination in reptiles</b>
<b>Course Outcomes:</b> Upon successful completion of this course, the student will be able to: <ul style="list-style-type: none"> <li>• Acquire theoretical knowledge about the identification, distribution, status, conservation and management of amphibians and reptiles of major importance in Pakistan</li> <li>• Understand the critical habitats and biodiversity hotspots with reference to herpetofauna</li> <li>• Solve the threats to reptiles and amphibians by applying the scientific principles and modern technologies.</li> </ul>
<b>Recommended Books:</b> <ol style="list-style-type: none"> <li>1. Jha, A. (2023). <i>Ethno-herpetology of Sikkim</i>. Shhalaj Publishing House.</li> <li>2. VANDEWALLE, T. J. Amphibians and Reptiles of Wisconsin. (2023). <i>Herpetological Review</i>.</li> <li>3. Pough, F, and Andrews, Robin M.. Herpetology. 2016.United States, Sinauer,</li> <li>4. Herpetology, J. L. G. I. S. (2020). Call for Applications. <i>Herpetologica</i>, 76(3), 354.</li> <li>5. Seburn, D. (2019). " The Field Herping Guide: Finding Amphibians and Reptiles in the Wild" by Mike Pingleton and Joshua Holbrook, 2019.</li> <li>6. Vitt, L. J., &amp; Caldwell, J. P. <i>Herpetology: an introductory biology of amphibians and reptiles</i>. (2013). Academic press.</li> <li>7. Publications, Ectotherm. Eat. Sleep. Herpetology. Repeat: Herpetology Notebook 120 Lined Pages (6 X 9 ). N.p., 2019.Independently Published,</li> </ol>

<b>Course Title: Advances in Forensic Biology</b>	<b>Course Code: ZOL-742</b>
<b>Course Structure: Lectures: 3, Labs: 0</b>	<b>Credit Hours: 3</b>
<b>Prerequisites: None</b>	
<b>Course Objective:</b> The objectives of the course are: <ul style="list-style-type: none"> <li>• To give the students basic understanding of forensic Science with reference to biology.</li> <li>• To equip the students for biological sample collection, handling and storing from crime scene.</li> <li>• To elaborated certain types of test which are involved in forensic biology.</li> </ul>	

**Course Outline:**

**Biological material – collection, characterization and storage:** Sources of biological evidence, Collection and handling of material at the crime scene, Identification and characterization of biological evidence, Evidence collection, Sexual and physical assault, Presumptive testing, Storage of biological material. **Serology Testing:** Identification of Semen, Acid Phosphatase Screening, Alternate Light Source or Ultraviolet (UV) Light, Microscopic Identification of Spermatozoa, Protein Confirmation of Semen. **Identification of Blood:** Presumptive Testing for Blood, Species Testing of Blood, ABO Blood Typing, Blood Spatter Interpretation. **DNA Testing:** DNA Extraction, Differential DNA Extraction, DNA Quantification, Restriction Fragment Length Polymorphism (RFLP), Early PCR-Based Methods, Tandem Repeat (STR) Analysis, Mitochondrial DNA (mtDNA) Sequencing, Y-Chromosome STR Analysis, Single-Nucleotide Polymorphism (SNP) Analysis.

**Course Outcomes:**

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

- **Acquire** the basic knowledge of forensic science and forensic biology.
- **Understand** the key steps in forensic biology from examination of crime scene to sample collection processing and final interpretation.
- **Analyze** certain types of sample with serology testing, DNA quantification and PCR analysis.

**Recommended Books:**

1. Primorac, D., & Schanfield, M. (Eds.). *Forensic DNA applications: An interdisciplinary perspective*. (2023). CRC Press.
2. Rivers, D. B., & Dahlem, G. A. *The science of forensic entomology*. (2022). John Wiley & Sons.
3. Shrivastava, P., Dash, H. R., Lorente, J. A., & Imam, J. (Eds.). *Forensic DNA Typing: Principles, Applications and Advancements*. (2020). Springer.
4. Meakin, G. E., Kokshoorn, B., van Oorschot, R. A., & Szkuta, B. (2021). Evaluating forensic DNA evidence: Connecting the dots. *Wiley Interdisciplinary Reviews: Forensic Science*, 3(4), e1404.
5. Gunn, A. *Essential forensic biology*. (2019). John Wiley & Sons.
6. Katz, E., & Halámek, J. *Forensic science: A multidisciplinary approach*. (2016). John Wiley & Sons.
7. Mallett, X., Blythe, T., & Berry, R. (Eds.). *Advances in forensic human identification*. (2014). CR Press.

<b>Course Title: Climate Change and Ecosystem Stability</b>	<b>Course Code: ZOL-743</b>
<b>Course Structure:</b> Lectures: 3, Labs: 0	<b>Credit Hours: 3</b>
<b>Prerequisites: None</b>	
<b>Course Objective:</b> The objective of this course is	
<ul style="list-style-type: none"> <li>• to enable the student to understand ecosystem, climate change, Stability and Ecological constraints.</li> <li>• to understand the Regime shift, Assembly rules, Theories and biogeography.</li> <li>• to understand how National and International agencies involved in controlling constraints and increasing biotic and Abiotic resistance</li> </ul>	
<b>Course Outline:</b>	
<p><b>The Earth System:</b> Introduction, Climate change, Ecosystem Resilience, Resistance, Stability, Ecological Constraints. <b>Alternative Stable States:</b> Regime shift, Restoring Alternative Stable States, Assembly Rules. <b>Sequence Introduction, Species Compatibility, Ecosystem Thresholds and Ecosystem filters, Unified Neutral Theory of Biodiversity and Biogeography, Invasive species:</b> Process of Invasion, Effects of Invasion on Ecosystem, Methods of control, Eradication, Containment. <b>Chemical and Biological Control. Restoration to Constrain Invasion:</b> Niche Preemption, Fire Management, Increasing Biotic and abiotic</p>	

Resistance
<p><b>Course Outcomes:</b></p> <p>Upon successful completion of this course, the student will be able to:</p> <ul style="list-style-type: none"> <li>• ACQUIRE theoretical knowledge about Climate change, causes, impacts and mitigation measures.</li> <li>• UNDERSTAND the species compatibility, Ecosystem Threshold and Restoration to Constrain Invasion.</li> <li>• ANALYSE interpreting and synthesize data and other information about Ecosystem Resilience, climatic alterations and Restoration</li> </ul>
<p><b>Recommended Books:</b></p> <ol style="list-style-type: none"> <li>1. Canadell, J. G., &amp; Jackson, R. B. <i>Ecosystem collapse and climate change</i>. (Eds.). (2021). Springer International Publishing.</li> <li>2. Castro, P., Azul, A. M., Leal Filho, W., &amp; Azeiteiro, U. M. <i>Climate change-resilient agriculture and agroforestry: Ecosystem services and sustainability</i>. (Eds.) (2019). Springer International Publishing.</li> <li>3. Lee Hannah, Thomas E. Lovejoy. <i>Biodiversity and Climate Change: Transforming the Biosphere</i>. Germany, Yale University Press, 2019.</li> <li>4. Jhariya, M. K., Banerjee, A., Meena, R. S., &amp; Yadav, D. K. <i>Sustainable agriculture, forest and environmental management</i>. (Eds.). (2019). Springer.</li> <li>5. Root, Terry Louise, et al., eds. <i>Biodiversity in a changing climate: linking science and management in conservation</i>. 2015. Univ of California Press,</li> <li>6. Duca, Gheorghe, and Ashok Vaseashta, eds. <i>Handbook of research on emerging developments and environmental impacts of ecological chemistry</i>. 2019. IGI Global,</li> </ol>

<b>Course Title: Mariculture Technology</b>	<b>Course Code: ZOL-744</b>
<b>Course Structure:</b> Lectures: 3, Labs: 0	<b>Credit Hours: 3</b>
<b>Prerequisites: None</b>	
<p><b>Course Objective:</b></p> <p>The objectives of the course are:-</p> <ul style="list-style-type: none"> <li>• To familiarize the students with integrated aquaculture and management modes of mariculture facilities.</li> <li>• To provide an exposure about various preservation techniques of fish and fish products.</li> <li>• Demonstrate techniques for shrimp farming, monitoring and management of water quality in aquaculture facilities.</li> </ul>	
<p><b>Course Outline:</b></p> <p>Introduction to mariculture technology, An overview of mariculture in the world, Artificial breeding of abalone, Techniques of larval rearing and farming in the white shrimp (<i>Litopenaeusvannamei</i>), Living food organism and their cultivation, Culture techniques of Scylla, Breeding and rearing of grouper, Oyster farming techniques, Grey mullet culture techniques, Marine algae culture, Tilapia culture, Production techniques for aquatic feeds, Artificial breeding and culture technique of ovate pompano, Marine biodiversity protection and sustainable development of mariculture industry, Disease occurrence and control strategy of mariculture organisms, Monitoring and management of water quality in aquaculture.</p>	
<p><b>Course Outcomes:</b></p> <p>After completing this course students will be able to:</p> <ul style="list-style-type: none"> <li>• Develop understanding about culture of marine organisms and management of mariculture facilities.</li> <li>• Understand integrated aquaculture and artificial breeding of marine organisms.</li> <li>• Practical skills of artificial fish breeding of tilapia and marine organisms.</li> </ul>	

**Recommended Books:**

1. Stickney, R. R., & Gatlin III, D. M. *Aquaculture: An introductory text*. (2022). Cabi.
2. Zonn, I. S., Kostianoy, A. G., Semenov, A. V., Joksimović, A., & Đurović, M. Mariculture. In *The Adriatic Sea Encyclopedia* (pp. 219-220). (2021). Cham: Springer International Publishing.
3. Lekang, O. I. *Aquaculture engineering*. (2020). John Wiley & Sons.
4. Athithan, S. *Coastal Aquaculture and Mariculture*. (2020). CRC Press.
5. Lucas, J. S., Southgate, P. C., & Tucker, C. S. (Eds.). *Aquaculture: Farming aquatic animals and plants*. (2019). John Wiley & Sons.

<b>Course Title: Arachnology</b>	<b>Course Code: ZOL-745</b>
<b>Course Structure:</b> Lectures: 3, Labs: 0	<b>Credit Hours: 3</b>
<b>Prerequisites: None</b>	
<b>Course Objective:</b> The course aims to: <ul style="list-style-type: none"> <li>• Impart in-depth knowledge of Arachnids.</li> <li>• Develop concepts about importance of the classification of class Arachnids.</li> <li>• Demonstrate about identifications of Arachnids.</li> </ul>	
<b>Course Outline:</b> Importance and applications of Arachnology, Importance and its future perspectives, History of arachnology, Introduction of arachnology according to history, Structure of the Arachnids, Characters of Arachnids, classification position of class Arachnid, External and internal anatomy, Life history of Arachnids, Defense mechanisms, Arachnid with relationship to man, Role of Arachnids as a biological control, Arachnids families identification.	
<b>Course Outcomes:</b> After completing this course students will be able to: <ul style="list-style-type: none"> <li>• Develop understanding about Arachnids and their importance.</li> <li>• Differentiate between different classes and types of Arachnids</li> </ul>	
<b>Recommended Books:</b> <ol style="list-style-type: none"> <li>1. Logunov, D. V. (2022). John Alan Murphy (1922–2021) and his contribution to arachnology. <i>Arachnology</i>, 19(sp1), 77-103.</li> <li>2. Küntzel, N., Dunlop, J., &amp; Scholtz, G. (2019). Morphology and evolution of spider book lungs (Araneae). <i>Arthropod Systematics &amp; Phylogeny</i>, 77, 267-284.</li> <li>3. Westwood, J. O. <i>The Entomologist's Text Book: An Introduction to the Natural History, Structure, Physiology and Classification of Insects, Including the Crustacea and Arachnida</i>. (1838). Wm. S. Orr and Company.</li> <li>4. Eberhard, W. (2020). <i>Spider webs: behavior, function, and evolution</i>. University of Chicago Press.</li> <li>5. Tim Williams. <i>A Dictionary for Arachnology</i>. 2021. Publisher:Lulu.com</li> </ol>	

<b>Course Title: Fish Physiology and Breeding</b>	<b>Course Code: ZOL- 746</b>
<b>Course Structure:</b> Lectures: 3, Labs: 0	<b>Credit Hours: 3</b>
<b>Prerequisites: None</b>	
<b>Course Objective:</b> The objectives of the course are:- <ul style="list-style-type: none"> <li>• To provide sufficient knowledge about all physiological phenomena in fishes.</li> </ul>	

- To provides practical information to obtain better growth by following physiological aspects during extensive or semi-intensive culture.
- To emphasize thoroughly in breeding of most cultivable freshwater fishes by manipulating reproductive and endocrinological aspects during natural season as well as off seasons.

**Course Outline:**

**Fish nutrition:** Digestive system, Stomach less fishes, Stomach fishes, Digestion and absorption, Food; Plant origin; Animal origin, Feeding; Fresh food; Dry concentrates; Pelleted food. **Transportation:** Blood; Blood cells (Erythrocytes, leukocytes, Platelets and plasma), Circulation; Arterial system; Venous system; Capillaries, Transport of food material. **Respiration:** Gills, Lungs, Skin Swimbladder, Homeostasis. **Excretion:** Kidneys; Hypo-osmotic urine; Hyper-osmotic urine; Osmoregulation. **Reproduction:** Gonads; Testes and ovaries, Maturation, Reproductive cells (egg and sperm), Artificial fertilization of sex cells. **Breeding:** Natural (seasonal); Artificial, Hormonal induced breeding, Temperature & photoperiod; Control induced breeding. **Growth:** Extensive culture (due to the consumption of natural food), Semi-intensive culture (due to natural & artificial food), Intensive culture (due to only dry concentrates). **Fish health:** Water quality, Hygiene of fish culture facilities, Hygiene of equipments used in fish culture. **Diseases and their control:** Viral; Bacterial; Fungal; Parasitic, Protozoan, Helminths (trematodes, cestodes, nematodes, acanthocephalons); Crustaceans (cladocera), Annelids (leeches); Arthropods (water ticks, water flea, water mites). **Fish migration:** To nursery ground, To maturation grounds, Freshwater to marine water, Marine water to freshwater. **Fish behavior:** Learning and memory, Light response for maturation, Courtship behavior, Aquarium fish behavior.

**Course Outcomes:**

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

- **Relate** the key concepts of fish physiology and breeding techniques.
- **Describe** the different systems and their coordination and understand fish behavior and migration patterns
- **Assess** problems associated with natural and artificial breeding.

**Recommended Books:**

1. Currie, S., & Evans, D. H. (Eds.). *The physiology of fishes*. (2020). CRC Press.
2. King, M. *Fisheries biology, assessment and management*. (2013). John Wiley & Sons
3. Norris, D. O., & Lopez, K. H. (Eds.). *Hormones and reproduction of vertebrates* (Vol. 1). (2010). Academic Press.
4. Pillay, T. V. R. *Aquaculture and the Environment*. (2008). John Wiley & Sons
5. Yadav, M. *Fish endocrinology* (Vol. 1). (2008). Discovery Publishing House.
6. Thomas, P. C. (2003). *Breeding and seed production of fin fish and shell fish*.
7. Kestin, S. C. and Warris, P.D. (Editors). *KESTIN FARMED FISH QUALITY*, 2002, Blackwell Science, Oxford, UK.

<b>Course Title: Vaccinology</b>	<b>Course Code: ZOL- 821</b>
<b>Course Structure:</b> Lectures: 3, Labs: 0	<b>Credit Hours: 3</b>
<b>Prerequisites: None</b>	
<b>Course Objective:</b> The objectives of the course are: <ul style="list-style-type: none"> <li>• To be able to know the history of vaccines.</li> <li>• To provide students with knowledge of different mechanisms of vaccine working.</li> </ul>	
<b>Course Outline:</b> History of vaccines: How vaccine originated, Targeted proteins as Vaccine, Viral proteins as potential targets for vaccine, Types of Vaccine and Production, Live versus attenuated vaccines, Role of multinational companies in vaccines production, DNA as vaccine, Peptide & Subunits vaccine, Adjuvants	

in vaccines, Population Genetic analysis: immunity to vaccine, Recombinant vaccine, Animal models of vaccine testing, Cost-effective approaches for production of new vaccines, Human testing and efficacy of vaccines: ethical issues, Recommendations of the Advisory Committee on Immunization Practices (ACIP), Quadrivalent vaccine against human papillomavirus to prevent high-grade cervical lesions, Understanding the demand and supply of popular vaccine, Launching of vaccine and clinical trials, Anti-rabies immunoglobulin preparation based on F(ab')<sub>2</sub> fragments, Effect of Panavir/Zanamivir on influenza A virus reproduction, Vaccine safety.

**Course Outcomes:**

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

- To describe vaccine types and their advantages.
- To describe how vaccine can be produced

**Recommended Books:**

1. Brundle, Joanna. Vaccines. 2020. United States, Enslo Publishing, LLC,
2. Vijay Kumar, 2019. Vaccines: The History and Future Recombinant vectors in vaccine development by Fred Brown.
3. Maureen C. Ferran, Gary R. Skuse. Recombinant Virus Vaccines: Methods and Protocols (2018), Springer New York.
4. **Davidson, Tish. Vaccines: History, Science, and Issues. United States, 2017. Bloomsbury Academic,**
5. Igor S Lukashevich, Haval Shirwan, Novel Technologies for Vaccine Development. (2016) Springer Vienna. 2nd edition.

<b>Course Title: Application of Biotechnology for Parasitic Control</b>	<b>Course Code: ZOL- 822</b>
<b>Course Structure: Lectures: 3, Labs: 0</b>	<b>Credit Hours: 3</b>
<b>Prerequisites:</b>	
<b>Course Objective:</b> The Objectives of the course are:	
<ul style="list-style-type: none"> <li>• Familiarize the students with biotechnology</li> <li>• Develop basic concept of diseases and their control using biotechnology.</li> </ul>	
<b>Course Outline:</b> Introduction: Scope of biotechnology in parasite vaccines development; Application of biotechnology in parasite control strategies, Molecular concepts, principles and approaches in biotechnology, Application of recombinant DNA technology to genetic analysis of sporozoan parasites, Expression vectors, Molecular adjuvants, advances in adjuvant technology and application, The genetic of host response and its influence on control strategies, Genetic markers for the selection of parasite resistance in livestock, Prospective of DNA vaccines against parasites, Control of gastrointestinal and tissue nematodes, trematodes and cestodes, Control of intraerythrocytic and other intracellular parasites, Biotechnology and control of mosquitoes and myiasis causing flies.	
<b>Course Outcomes:</b> Upon successful completion of the course, the student will be able to:	
<ul style="list-style-type: none"> <li>• Understand role of Biotechnology in disease control</li> <li>• Apply practical and research skills to control diseases of economic importance</li> <li>• Enable the students to determine the Biological control of Diseases</li> </ul>	

**Recommended Books:**

1. Mowat, N. and M. Rweyemance, Vaccine Manual, the Production and Quality Control of Veterinary Vaccines for Use in Developing Countries. 2004. Daya Publishing House Delhi.
2. Gupta. P. K. Elements of Biotechnology. 2001. Rastogi Publications, India.
3. Peters, A. R. Vaccines for Veterinary Applications, Butterworth-Heinemann Ltd., 2006. Jordon Hill, Oxford OX2 8DP, UK.
4. Warren, K. S. Immunology and Molecular Biology of parasitic infections, 2001. Blackwell Scientific Publications Oxford.
5. Hyde, J. E. Molecular Parasitology. 2004. Van nostrang Reinhold, New York.

<b>Course Title:</b> Advances in Helminthology	<b>Course Code:</b> ZOL- 823
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<b>Course Structure:</b> Lectures: 3, Labs: 0	<b>Credit Hours:</b> 3
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**Prerequisites:**None

**Course Objective:**

The objectives of the course are:-

- To understand basic aspects of trematodes, cestodes and nematodes affecting man and animals.
- To impart knowledge on various Helminthic infection affecting livestock, its morphology, life cycle, transmission, pathogenesis, clinical signs, diagnosis, treatment and control.
- To familiarize students with morphologic criteria to differentiate the most common helminthes.

**Course Outline:**

**Platyhelminthes:**Introduction, General Characteristics with examples. Taxonomy, etiology, epidemiology, biology, host-parasite interactions, Pathology and pathogenesis, immunological aspects, diagnosis, control and treatment of given parasites. **Trematodes:** Digenians: trematodes; Tissue flukes: Schistosoma haematobium, S. japonicum, S. mansoni. Liver flukes: Fasciola hepatica, Clonorchis sinensis. Intestinal flukes: Fasiolopsis buski Lung flukes: Paragonimus westermani. Monogenea: Dactylogyrus vastator. **Cestoidea:** Taenia solium, Taenia saginata, T. pissiformis (Taeniasis), Echinococcus granulosus, multilocularis, Hymenolepis nana, H. diminuta, Diphylidium caninum, Moniezia species. **Nematoda:** Trichuris trichiura, Capillaria hepatica, Anatrchosoma ocularis. Strongyloides stercoralis, Strongylida, bursate rhabolitidians, Bunostomum, Necator americanus, Ancylostoma duodenale, Synagamus trachea, Trichostrongylus species, Ostertagia species, Prostrongylus rufescens, Ascaris lumbricoides, Toxocara canis, Heterakis gallinarum, Enterobius vermicularis. **Filaroidea:** the filarial worms, Wuchereria bancrofti, Brugia malayi, Loa loa, Mansonella perstans, M. ozzardi, Onchocerca volvulus, Dirofilaria immitis Camallanina, the Guinea worms and others; Dracunculus mediensis. **Helminth Zoonosis:** (Trematode, Cestodes and Nematode Zoonosis). Characterization of parasites causing emerging zoonosis.

**Course Outcomes:**

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

- Acquire basic knowledge of various helminthe including trematodes, cestodes and nematodes.
- Understand the concepts of helminthic infection affecting livestock, its morphology, life cycle, transmission, pathogenesis, clinical signs, diagnosis, treatment and control.
- Solve the complications related to the pathogenesis of the helminthes and successfully treating these infections.

**Recommended Books:**

1. K.D. Chatterjee, Parasitology: Protozoology and Helminthology, 13<sup>th</sup> edition, 2015,

2. Robberts, L. Sand Janovy John Jr., Foundation of Parasitology, 9<sup>th</sup> edition, 2015, McGraw-Hill, Boston.
3. David Rollinson., Advances in Parasitology, 2017, The Natural History Museum, London UK
4. Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt., Roitt's Essential Immunology, 13<sup>th</sup> edition, 2017, Wiley-Blackwell, New York, London.
5. Paniker, C. J., & Ghosh, S., Paniker's textbook of medical parasitology, 2017, JP Medical Ltd.

<b>Course Title: Advances in Protozoology</b>	<b>Course Code: ZOL-824</b>
<b>Course Structure:</b> Lectures: 3, Labs: 0	<b>Credit Hours: 3</b>
<b>Prerequisites: None</b>	
<p><b>Course Objective:</b> The objectives of the course are:-</p> <ul style="list-style-type: none"> <li>• To understand principles of parasitic infection and the host immunological responses.</li> <li>• To familiarize students to differentiate among the common groups of protozoan parasites.</li> <li>• To provide a basic knowledge of the immune response and its involvement in health and disease.</li> </ul>	
<p><b>Course Outline:</b></p> <p><b>Parasitology:</b> Introduction, elementary definitions. <b>Animal associations:</b> concept of harm; parasite hosts. Association to other sciences, Parasitology and human well-being. Carriers in Parasitology. <b>Parasitic Protozoa;</b> Classification, Morphological features, Life cycles, host-parasite interactions, geographical distribution, reservoir hosts, methods of transmission and control, pathology, immunological aspects, diagnosis and treatment of the following protozoan parasites: <i>Giardia species</i>, <i>Trichomonas species</i>, <i>Entamoeba species</i>, <i>Naegleria species</i>, <i>Trypanosoma species</i>, <i>Leishmania species</i>. <i>Plasmodium species</i>, <i>Babesia species</i>, <i>Anaplasma species</i>. <i>Cryptosporidium species</i>. <i>Toxoplasma species</i>. <i>Histomonas meleagridis</i>. Parasitic Zoonosis and Risk of Zoonotic infections in Pakistan.</p>	
<p><b>Course Outcomes:</b> Upon successful completion of the course, the student will be able to:</p> <ul style="list-style-type: none"> <li>• Attain the basic acquaintance of Protozoans and philosophy of host-parasite interface</li> <li>• Understand the perception of parasitism and other animal associations; clarify the concept of damage; understand the basic features and characteristics of hosts</li> <li>• Articulate protozoan parasite infections affecting livestock, its morphology, life cycle, epidemiology, pathogenesis, treatment and control approaches.</li> </ul>	
<p><b>Recommended Books:</b></p> <ol style="list-style-type: none"> <li>1. Patricia Marques., Parasitology: A Conceptual Approach, 2018, Academic Press, Cambridge, UK.</li> <li>2. David Rollinson., Advances in Parasitology, 2017, The Natural History Museum, London UK</li> <li>3. Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt., Roitt's Essential Immunology, 13<sup>th</sup> edition, 2017, Wiley-Blackwell, New York, London.</li> <li>4. Paniker, C. J., &amp; Ghosh, S., Paniker's textbook of medical parasitology, 2017, JP Medical Ltd.</li> <li>5. K.D. Chatterjee., Parasitology: Protozoology and Helminthology 13<sup>th</sup> edition, 2015.</li> <li>6. Roberts, L. S and Janovy John Jr., Foundation of Parasitology, 2015, McGraw Hill, Boston USA.</li> </ol>	

<b>Course Title: Advances in Trematodes Biology</b>	<b>Course Code: ZOL-825</b>
<b>Course Structure:</b> Lectures: 3, Labs: 0	<b>Credit Hours: 3</b>
<b>Prerequisites: None</b>	
<b>Course Objective:</b> The objectives of the course are:- <ul style="list-style-type: none"> <li>• To explain the physiology and biochemistry of trematodes.</li> <li>• To explain advance diagnosis of Trematodes for professional employment in the field of Parasitology or a related discipline.</li> </ul>	
<b>Course Outline:</b>  <b>Trematodes:</b> Introduction, Biology, Modes of transmission of Trematodes infections and their control, Encystations of trematodes, Cultivation of Trematodes, Structure of the alimentary tract in Trematodes, Function of the, alimentary tract in Trematodes, Reproductive physiology of digenetic Trematodes, Behavior of digenetic Trematodes, Physiology of snail-larval trematodes relationships, Biochemistry of snail-larval trematodes relationships, Host recognition by trematode miracidia, Host recognition by trematode cercariae, Specificity of larval digenean-snail associations. Immunobiology of larval digenean-snail associations; Proteases involved in host association, Biochemistry of trematodes in vertebrate hosts, Neurobiology of trematodes in vertebrate hosts, Immunobiology of trematodes in vertebrate hosts. Molecular biology of Trematodes, Approaches of Trematode Biology, Applications Trematode Biology, Excystations of trematodes, Specie Specific host recognition, <i>In vitro</i> activity of anti trematode drugs, Diagnosis of Trematodes, Treatment against Trematodes, Pathogenesis, Incubation periods, Biological Control.	
<b>Course Outcomes:</b> Upon successful completion of the course, the student will be able to: <ul style="list-style-type: none"> <li>• Learn physiology and biochemistry of trematodes.</li> <li>• To apply their expertise in controlling trematodes infections.</li> </ul>	
<b>Recommended Books:</b> <ol style="list-style-type: none"> <li>1. Toledo, R., &amp; Fried, B., Trematoda (flukes). Emerging Topics in Life Sciences, 1<sup>st</sup> edition, 2017.</li> <li>2. Toledo, R., &amp; Fried, B., Digenetic Trematodes. 2<sup>nd</sup> edition, 2019, Springer Cham.</li> <li>3. Latest journals on helminthology and Parasitology.</li> <li>4. Foreyt, W. J., Veterinary parasitology reference manual. 2013, John Wiley &amp; Sons.</li> <li>5. K. D. Chattergee., Parasitology: Protozoology And Helminthology, 13<sup>th</sup> edition, 2015, CBS Publishers &amp; Distributors Pvt Ltd, India.</li> </ol>	

<b>Course Title: Fish Parasitology</b>	<b>Course Code: ZOL-826</b>
<b>Course Structure:</b> Lectures: 3, Labs: 0	<b>Credit Hours: 3</b>
<b>Prerequisites:None</b>	

**Course Objective:**

The Objectives of the course are:

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

**Course Outline:**

Fish Parasitology: Introduction, Host and parasite, Types of host and parasite, Ectoparasite and endoparasite concepts, Overview and Adaptation, association of parasites: symbiosis, commensalism, mutualism, parasitism. Classes of fish parasites: Ecto-parasites, Endo-parasites. Identification of parasitic problems. Methods of diagnosis, physical examination, Pathogenesis, Life cycles and treatment methods of following parasites: Protozoa, Monogenean trematodes, Degenean trematodes, Nematodes, Cestodes, Crustaceans and Leeches. Medically important Parasites: Introduction, Protection and the treatment of fish parasite.

**Course Outcomes:**

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

- UNDERSTAND very well about the life style of parasites and hosts. They can easily differentiate between various host and parasites.
- SOLVE the problems of identification of fish parasites with the help of latest illustrations in the field of fish parasitology.
- DEMONSTRATE the dissection of fishes and showing the location of various endo and ecto parasites.

**Recommended Books:**

1. Garcia, L. S., & Procop, G. W., Diagnostic medical parasitology. Manual of Commercial Methods in Clinical Microbiology, 2016, International Edition.
2. Sankar Sastry, A., Essentials of Medical Parasitology, 2014.
3. Zeibig, E., Clinical parasitology: A practical approach, 2014, Elsevier Health Sciences.
4. Foreyt, W. J., Veterinary parasitology reference manual. 2013, John Wiley & Sons.
5. K. D. Chatterjee., Parasitology: Protozoology And Helminthology, 13<sup>th</sup> edition, 2015, CBS Publishers & Distributors Pvt Ltd, India.

<b>Course Title: Systematic Classification of Fishes</b>	<b>Course Code: ZOL- 827</b>
<b>Course Structure: Lectures: 3, Labs: 0</b>	<b>Credit Hours: 3</b>
<b>Prerequisites:None</b>	
<b>Course Objective:</b> The objectives of the course are: - <ul style="list-style-type: none"> <li>• To make the students know the basic classes of fishes.</li> <li>• This will provide the technical and general knowledge necessary for competent fish farming and fisheries management.</li> <li>• This knowledge will make know the students about rich fish species of Pakistan and will provide information of the pond fish culture</li> </ul>	

**Course Outline:**

Characteristics of different fishes; Principles of classification; The phylogenetic relationship (Account of fossil groups) of fishes. Comparative study of Agnatha and Gnathostomata; Base of differences in Agnatha and Gnathostomata; Study of representatives from Agnatha; Study of representatives from Gnathostomata. Distribution of major groups of fishes; Fish habitats in Pakistan; Shellfish habitats in Pakistan. Concept of fisheries in Pakistan; History of fisheries in Pakistan; Current status of fisheries in Pakistan. Concept of fish farming in Pakistan; Distribution of fish farms in Pakistan; Farming related biology of food fish, important shellfish of Pakistan; Farming and Ponds. Criteria for farm site selection, Criteria for pond site selection. Construction and designing of fish farm, Designing of fish pond. Manuring of fish farm, Alternate source of manuring, Liming of fish farm. Fish rearing, Rearing Pond, Size of rearing pond, Fish for rearing pond; Characteristics of rearing pond; Fish stocking; Factor effecting stock density. Harvesting of fishponds. Maintenance of fish ponds.

**Course Outcomes:**

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

- **ACQUIRE** the knowledge of the various classes of fishes
- **UNDERSTAND** the basics of fish classification
- **ANALYZE** the characteristics of fishes
- **EVALUATE** the different groups of fishes on the basis of their characteristics
- **DEVELOP** critical thinking about systematics and classification

**Recommended Books:**

1. Robert R. Stickney., Aquaculture (OP) An introductory Textbook, 2017, CABI.
2. Templeton ROBIN G., Freshwater Fisheries Management, 2014, Wiley India Pvt Ltd
3. Boyd, C. E., & Tucker, C. S., Pond aquaculture water quality management. 2012, Springer Science & Business Media.
4. Meade, J. W., Aquaculture management, 2012, Springer Science & Business Media.
5. K. C. Jarayam., Fundamentals of Fish Taxonomy, Latest edition, 2021, Narendra Publishing House.

<b>Course Title: Insects of Veterinary and Medical Importance</b>	<b>Course Code: ZOL-828</b>
<b>Course Structure: Lectures: 3, Labs: 0</b>	<b>Credit Hours: 3</b>
<b>Prerequisites: None</b>	
<b>Course Objective:</b> The objectives of the course are:- <ul style="list-style-type: none"> <li>• Contribute in the understanding towards the role of insect vectors in the transmission of different pathogens to man and livestock.</li> <li>• Enhance the knowledge about their breeding biology and control measure.</li> <li>• Additionally, this course will contribute in student knowledge about symptoms of insect infestations/ infections and their first aid treatment.</li> </ul>	
<b>Course Outline:</b> Introduction to Insects and their roles in animal life: Successful stories in the world of insects, Medical and Veterinary importance of Insects. Biology and Classification of Arthropods: Order Diptera: Classification, External morphology, Life cycle. Medical importance and control; Introduction to Mosquitoes, morphological identification of various species of mosquitoes, Chemical, biological and genetic control of	

mosquitoes; Sand flies: life cycles, adult behavior, vector of leishmaniasis; Tsetse flies: life cycles, adult behavior, trypanosomiasis, Flies and myiasis. Order Siphonaptera: External morphology, Internal Anatomy, Sucking lice and biting lice, Medical importance and control. Order Phthiraptera: External morphology, Ecology. Internal Anatomy, Phylogeny. Medical importance and control. Order Dictyoptera: External morphology, Internal Anatomy, Medical importance and control. Order Coleoptera: Classification, Life cycle. External morphology, Internal Anatomy. Medical importance and Control. Order Hymenoptera: Classification, Morphology, Anatomy, Reproduction, Diet, Medical importance. Order Lepidoptera: External morphology, Internal morphology and Ecology. Polymorphism, Reproduction and development. Order Acarinae: Morphology, Anatomy and Classification, Ontogeny, Diversity and lifestyle. Order Aranae: External morphology, Internal Anatomy. Medical importance, Life cycle and Behavior. Order Scorpionida: Life cycle, External morphology, Medical importance, Sting and venom. General Life Cycle of Arthropods; Arthropods: Effects of bites and allergies; Arthropods Pathology as a vector; Arthropods immunology as a vector; Arthropods as Parasites and bloodsucker; Insects and Hygiene. Control Methods: Chemical, Physical, Biological, IPM. Forensic Entomology; Medico-legal forensic entomology; Factor involved in Forensic Entomology; Modern techniques in Forensic Entomology.

**Course Outcomes:**

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

- Define an insect as a vector
- Describe how insects transmit pathogen of major diseases;
- Indicate the course of action to be taken in any given sting/bite situation;

**Recommended Books:**

1. Erin E. McClure, Contributors : Dana K. Shaw., Veterinary Entomology: Arthropod Ectoparasites of Veterinary Importance, 2019, Koros Press Limited.
2. Vidal-Naquet, N. Honeybee Veterinary Medicine: Apis Mellifera, 2015, L5M Publishing.
3. Russell, R.C., Otranto, D., & Wall, R.L., The Encyclopedia of Medical and Veterinary Entomology, 2013, CABI.
4. Service, M., Medical Entomology for Students, revised 5<sup>th</sup> edition, 2012, Publisher Cambridge University Press.
5. Burgess, N., & Cowan, G.O., A colour atlas of medical entomology, 2012, Springer Science & Business Media.

<b>Course Title: Advanced Integrated Pest Management</b>	<b>Course Code: ZOL-829</b>
<b>Course Structure:</b> Lectures: 3, Labs: 0	<b>Credit Hours: 3</b>
<b>Prerequisites: None</b>	
<p><b>Course Objective:</b>          Upon successful completion of the course, the student will be able to:</p> <ul style="list-style-type: none"> <li>• Assess the new approaches towards better management practices in IPM program.</li> <li>• Understand the advanced and scientific approaches to minimize the use of pesticides and make wards better use of available methodologies for IPM program.</li> </ul>	

**Course Outline:**

Introduction and Management of Arthropods in Agricultural Systems; Concepts of Development of sustainable integrated pest management programme; The utilization and integration of pest control tactics (cultural methods, biological control, chemical, host resistance) for management of insects, Study of pheromones and its applications; Pest Management Theories; Surveillance and sampling; Risks in IPM; Chemical control and its safe use with other techniques; Integrated Pest Management of major pests of crops, fruits, and vegetables; Impact of Pesticide Residue/Food Safety Issues on Pest Management; IPM for the future, sustainable agriculture and organic crop; Insecticide Resistance Management as a Component of IPM; Integration of GM Crops in IPM Programs; Environment safe and un-safe methods of IPM.

**Course Outcomes:**

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

- Assess the new approaches towards better management practices in IPM program.
- Understand the advanced and scientific approaches to minimize the use of pesticides and make wards better use of available methodologies for IPM program.

**Recommended Books:**

1. Pedigo, L.P. & M.E. Rice., Entomology and Pest Management, 6th Edition, 2009, Prentice Hall. Upper Saddle River, NJ.
2. Ciancio A, Mukerji KG., Integrated Management of Arthropod Pests and Insect Borne Diseases, 1st edition, 2010, Springer., London, UK.
3. Gilbert LI, Gill SS., Insect Control: Biological and Synthetic Agents, 2010, Academic Press., New York, USA.
4. Radcliffe EB, Hutchison WD, Cancelado RE., Integrated Pest Management: Concepts, Tactics, Strategies and Case Studies, 1st edition, 2009, Cambridge University Press., New York, USA.
5. P. J. Gullan, P. S. Cranston., The Insects: An Outline of Entomology, 3<sup>rd</sup> edition, 2010, Wiley-Blackwell.

<b>Course Title: Clinical Reproductive Endocrinology</b>	<b>Course Code: ZOL-830</b>
<b>Course Structure: Lectures: 3, Labs: 0</b>	<b>Credit Hours: 3</b>
<b>Prerequisites: None</b>	
<b>Course Objective:</b> The main objectives of this course are to: <ul style="list-style-type: none"> <li>• Get knowledge about various disorders of gonads and secondary sex organs.</li> <li>• Learn techniques for diagnosis and treatment of endocrine diseases and measurement of hormones.</li> <li>• Understand mechanism of action of reproductive hormones.</li> </ul>	
<b>Course Outline:</b> Disorders of Gonads and Reproductive Tract: Ovaries, Testes, Female and Male Reproductive Tract. Endocrine Disorders: Breast. Fertility Control and Its Complications. Sexual Function and Dysfunction. Development and Growth. Endocrine Changes of Pregnancy. Endocrinology of Fetal Development. Neuroendocrine disorder of gonadotropin. Disorders of Sexual Differentiation: Normal and Aberrant Growth. Puberty and Its Disorders. Polyendocrine Disorders. Infertility: Causes and mechanisms of infertility in both genders.	
<b>Course Outcomes:</b> Upon successful completion of the course, the student will be able to:	

- Interpret role of reproductive endocrine hormones in fertility.
- Explore recent trends of endocrinology in relation to reproduction

**Recommended Books:**

1. Shlomo Melmed, M. D., Koenig R, Rosen C., Textbook of Endocrinology, 14<sup>th</sup> Edition, 2019, Elsevier.
2. Shlomo Melmed, Kenneth S, Polonsky., William text book of endocrinology, 13<sup>th</sup> edition, 2015.
3. Lachelin, G.C.L., Introduction to Clinical Reproductive Endocrinology, 2010, Butterworth-Heinemann.
4. Thomas Fox, Endocrinology, Latest edition, 2015, JP Medical Ltd.
5. Katarina S Borer, Advance exercise endocrinology, 1<sup>st</sup> edition, 2013, advance exercise Physiology.

<b>Course Title: Advanced Techniques in Reproductive Physiology</b>	<b>Course Code: ZOL-831</b>
<b>Course Structure:</b> Lectures: 3, Labs: 0	<b>Credit Hours: 3</b>
<b>Prerequisites:None</b>	
<p><b>Course Objective:</b></p> <ul style="list-style-type: none"> <li>• To provide students with a comprehensive understanding of the physiological processes underlying human and animal reproduction.</li> <li>• To introduce students to advanced techniques and technologies used in reproductive physiology, including assisted reproduction and genetic testing.</li> <li>• To examine the endocrine regulation of the reproductive system, including the roles of key hormones and their feedback mechanisms.</li> </ul>	
<p><b>Course Outline:</b>  <b>Reproductive Failure in Males and Females:</b> Diagnostic approaches to male and female infertility; Genetic causes of infertility and risk assessment; The impact of pharmaceuticals and toxic substances on fertility; Autoimmune infertility and immunomodulatory therapies. <b>Overview of Assisted Reproductive Techniques (ART):</b> Indications for ART treatment and patient selection; Ovarian reserve testing and controlled ovarian hyperstimulation (COH); Laboratory techniques of ART, including IVF, ICSI, PGT; Embryo transfer methods and luteal phase support. <b>Ovulation Induction, Embryo Production and Transfer:</b> Ovulation Induction; The role of Anti-Müllerian Hormone (AMH) in predicting ovarian reserve; Techniques for in vitro embryo production and culture; Strategies for embryo transfer and implantation. <b>Artificial insemination, IVEP and embryo transfer in farm animals. Preservation and Cryopreservation of Gametes:</b> The preservation of eggs, sperm, and embryos for future use; Cryopreservation techniques, storage, and utilization. <b>Endometriosis and Assisted Reproductive Strategy:</b> How endometriosis affects fertility and treatment strategies; ART options and outcomes for patients with endometriosis. <b>PCOS and Assisted Reproduction:</b> Polycystic Ovary Syndrome (PCOS) and its impact on fertility; Specialized approaches for PCOS patients in ART. <b>Viral Disease and Assisted Reproductive Techniques:</b> Managing viral infections during fertility treatment; Implications of COVID-19 and other viruses on ART. <b>Complications and Outcomes of ART:</b> Potential complications of ART, including Ovarian Hyperstimulation Syndrome (OHSS); Multiple gestations and the associated risks; Perinatal outcomes of ART-conceived pregnancies. <b>Emerging Topics in Reproductive Physiology:</b> Environmental and Lifestyle Factors; Reproductive Aging; Strategies for preserving fertility; Regenerative Medicine in Reproductive Biology. <b>Assisted Reproductive techniques for conservation:</b> mammals and birds. <b>Assisted Reproductive techniques in fish:</b> sex reversal, Control of sexual maturation, and induced sterilization. Cryopreservation of fish gametes and embryos. Assisted Reproduction, ethical and legal issues.</p>	

**Course Outcomes:**

- Apply advanced techniques in assisted reproduction and understand their indications and limitations.
- Implement reproductive technologies in animal breeding programs, including artificial insemination and embryo transfer.
- Master molecular and cellular techniques, advanced imaging, and research methodologies to investigate reproductive physiology.

**Recommended Books:**

1. Strauss, J. F., Barbieri, R. L., Dokras, A., Williams, C. J., & Williams, S. Z., Yen & Jaffe's Reproductive Endocrinology-E-Book: Physiology, Pathophysiology, and Clinical Management., 2023, Elsevier Health Sciences.
2. AL-Jaryan, I. L., AL-Thuwaini, T. M., Merzah, L. H., & Alkhammas, A. H., Reproductive Physiology and Advanced Technologies in Sheep Reproduction, 11<sup>th</sup> edition, 2023, Reviews in Agricultural Science.
3. Sundaray, J. K., Rather, M. A., Kumar, S., & Agarwal, D., Recent updates in molecular endocrinology and reproductive physiology of fish, 2019, Springer Singapore.
4. Blackburn, S., Maternal, Fetal, & neonatal physiology-E-book: a clinical perspective, 2017, Elsevier Health Sciences.
5. Gordon, I. Reproductive technologies in farm animals. Revised edition, 2017.

<b>Course Title: DNA Technology</b>	<b>Course Code: ZOL-832</b>
<b>Course Structure:</b> Lectures: 3, Labs: 0	<b>Credit Hours: 3</b>
<b>Prerequisites: None</b>	
<b>Course Objective:</b> The Objectives of the course are: <ul style="list-style-type: none"> <li>• To illustrate creative use of modern tools and techniques for manipulation and analysis of genomic sequences.</li> <li>• To expose students to the application of recombinant DNA technology in biotechnological research.</li> </ul>	
<b>Course Outline:</b> Distribution of the Contents. Introduction and basic concept: Basic Techniques. Gel Electrophoresis, Applications of Gel Electrophoresis. Blotting techniques: Southern, Northern, Western and Eastern blotting Cutting and joining DNA molecules. Cloning vectors. Characterization of recombinant molecules. Verification and amplification of desired genes. PCR and its modification as per requirement. DNA sequencing techniques: Maxam-Gilbert technique, Dideoxy Method. Hybridization and Polymorphism techniques. Genetic libraries constructions. Applications of genetic engineering in medicine, agriculture, environmental biology and molecular biology. Gene patenting. Potential risks of DNA technology raise legal questions for society. Discussion on latest articles in the field of biotechnology in connection to various disciplines	
<b>Course Outcomes:</b> Upon successful completion of the course, the student will be able to: <ul style="list-style-type: none"> <li>• Students will train in strategizing research methods</li> </ul>	

**Recommended Books:**

1. Glick, B.R., & Patten, C.L., Molecular biotechnology: principles and applications of recombinant DNA, 2017, John Wiley & Sons.
2. Clark, D.P., and Pazdernik, N.J., Biotechnology, 2<sup>nd</sup> edition, 2015, Elsevier Science & Technology Books.
3. Watson, J.D., T.A. Baker, S.P. Bell, A. Gann, M. Levine, and R. Losick. Molecular biology of the gene, 2004, Pearson Education.
4. David E. Newton, DNA Technology, 2<sup>nd</sup> edition, 2016, Bloomsbury Publishing publishers.