SHAHEED BENAZIR BHUTTO WOMENUNIVERSITY PESHAWAR

DEPARTMENT OF ZOOLOGY

SCHEME OF STUDIES AND CURRICULUM
FOR
PHD ZOOLOGY
2023 AND ONWARDS

SHAHEED BENAZIR BHUTTO WOMEN UNIVERSITY PESHAWAR
DEPARTMENT OF ZOOLOGY

Ph.D. Zoology

PROGRAM INTRODUCTION

The Zoology department of Shaheed Benazir Bhutto women university Peshawar wants to initiate PhD Zoology program. The aim of this program is to develop individuals who want to pursue a professional career in academia or research. It is a three to five years program which is based on rigorous research.

MISSION STATEMENT

The primary aim of PhD program of Zoology Department, Shaheed Benazir Bhutto Women University is to provide a learning environment for females, in which faculty, staff and students can discover, examine critically, preserve, and transmit the knowledge, wisdom and values that will help ensure the survival of this and future generations and improve the quality of life for all. The program seeks to help students to develop an understanding and appreciation for the complex cultural and physical worlds in which they live and to realize their highest potential of intellectual, physical, and human development that will help to improve human resource in the discipline of Zoology. It also seeks to attract and serve students from diverse social, economic, and ethnic backgrounds and to be sensitive and responsive to those groups which have been neglected in the past by higher education.

PROGRAM OBJECTIVES

The main objectives of this program are;

- ✓ To train students for better planning and management of animal resources and environment.
- ✓ To prepare students with the depth of knowledge and research competence of international level
- ✓ To improve the quantitative and qualitative problem-solving skills of scholars
- ✓ To promote research activity in the domain of agriculture, livestock and human health for promoting animal and human health and quality of life

ELIGIBILITY CRITERIA/ENTRY REQUIREMENTS

The candidates who have Master of Philosophy (2-years) degree (18 years education) in zoology/relevant fields, from HEC recognized institution can apply. For eligibility criteria and entry test requirements university admission policy will be followed.

DURATION OF PROGRAM

The normal duration is 3-5 years. However, special approval for extension in time duration can be granted by board considering the gravity of the matter. After the enrolment of the student in the program the department will follow the policies of the university for following;

Comprehensive Examination	As per university policy
Research thesis Evaluation	As per university policy
Research thesis Format	As per university policy
Conduction of Public Defense	As per university policy

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DEPARTMENT OF ZOOLOGY

STRUCTURE OF PHD ZOOLOGY PROGRAM

S#	Course Title	Credit Hours (No of Courses)
1	CORE COURSES	10 (04 courses)
2	ELECTIVE COURSES	10 (04 courses)
3	DISSERTATION	09
	Total	29

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DEPARTMENT OF ZOOLOGY

SCHEME OF STUDIES FOR PHD ZOOLOGYSESSION 2023 AND ONWARDS

SEMESTER-I

Course Title	Course Codes	Theory	Practical	Credit hours
Core Course-I	ZOL-XXX	3	0	3
Core Course-II	ZOL-XXX	3	0	3
Elective Course-I	ZOL- XXX	3	0	3
Fehm-e-Quran I/any General course for Non-Muslim	ISL-325	0	1	1
Total credit hours				**10**

SEMESTER-II

Course Title	Course Codes	Theory	Practical	Credit hours
Core Course-III	ZOL- XXX	3	0	3
Elective Course-II	ZOL- XXX	3	0	3
Elective Course-III	ZOL- XXX	3	0	3
Fehm-e-Quran II/any General course for Non-Muslim	ISL-325	0	1	1
Total credit hours				**10**

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

SEMESTER-III to VI

Course Title	Course Codes	Credit hours
Dissertation	ZOL-899	9
Total credit hours		**9**

Total Credit Hours: 10+10+9=29

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SHAHEED BENAZIR BHUTTO WOMEN UNIVERSITY PESHAWAR
DEPARTMENT OF ZOOLOGY

LIST OF CORE COURSES PHD ZOOLOGY

SESSION 2023 AND ONWARDS

CORE COURSES			
09 Credit hours (03 courses)			
S. #	**Course Title**	**Course Code**	**Credit Hours**
1.	Project Planning Monitoring and Evaluation	ZOL-811	3
2.	Gene Cloning and Expression	ZOL-812	3
3.	Genomics and Proteomics	ZOL-813	3
4.	Advances in Animal Biotechnology	ZOL-814	3
5.	Advanced Physiology	ZOL-815	3
6.	Advances in Biodiversity	ZOL-816	3
7.	Ecology and Environmental Zoology	ZOL-817	3

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SHAHEED BENAZIR BHUTTO WOMEN UNIVERSITY PESHAWAR
DEPARTMENT OF ZOOLOGY

DETAILS OF CORE COURSES

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

Course Title: Gene Cloning and Expression	**Course Code: ZOL-812**
Course Structure: Lectures: 3, Labs: 0	**Credit Hours: 3**
Prerequisites: No	
Course Objective: The course objectives are:	

- To develop understanding of basic steps in Gene cloning technology
- To demonstrate fundamental difference between conventional breeding and genetic engineering

Course Outline: Introduction to Gene cloning: 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 the 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. Acquaah, G. Understanding biotechnology: An integrated and cyber-based approach. 2004, Pearson/Prentice Hall.

Course Title: Genomics and Proteomics	**Course Code: ZOL-813**
Course Structure: Lectures: 3, Labs: 0	**Credit Hours: 3**

Prerequisites: None

Course Objective:

The course objectives are:

- To enable the students to understand organization of Human genome.
- To enable the students to analyze and predict protein models and genome databases.
- To train the students to run various databases necessary to predict the effect of certain mutations.

Course Outline: Introduction; The Human Genome, Contents and organization of genomes, Hemoglobin. From gene to protein to disease, Genomic features of model organisms. **Contents and Organization of Genomes**; Chromosomes, organelles and Plasmids, Genes, Dynamic components of genomes, Genome organization in Prokaryotes, Genome organization in Eukaryotes. **Mapping, Sequencing and Annotation;** DNA sequencing, Fredrick Sanger and development of DNA sequencing, Maxam Gilbert chemical cleavage method, Automated DNA sequencing. **Proteomics;** Protein structure and types, Protein folding patterns, Changes in folding patterns in protein evolution. **Separation and Analysis of protein;** Poly acryalamide gel electrophoresis (PAGE), SDS PAGE, Mass spectrometry. **Protein Engineering;** Multiple Sequence Alignment, Clustal Omega, Ab initio.

Course Outcomes:

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

- Acquire the basic knowledge of Human genome and its organization.
- Solve the problem by mutation detection through various databases.
- 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.

Course Title: Advances in Animal Biotechnology	**Course Code: ZOL-814**
Course Structure: Lectures: 3, Labs: 0	**Credit Hours: 3**
Prerequisites: No	

Course Objective:

The course objectives are:

- To educate students about the broad scope of biotechnology
- To develop an understanding of industrial processes for production of antibiotics, enzymes etc.
- To develop expertise in techniques for tissue culture, cell culture and organ transplantation

Course Outline: Introduction: Concepts of Biotechnology, historical background of biotechnology, Conventional biotechnology-green revolution. **Animal and health biotechnology**: 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. **Animal Models for Human Disease**: 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. **Animal Tissue Culture**: Principles and Applications, Nanotechnology and Its Applications to Animal Biotechnology. **Antibodies**: Monoclonal and Polyclonal; their applications. **Molecular Markers**: Tool for Genetic Analysis. **Gene Expression**: Analysis and Quantitation. **Ribotyping**: A Tool for Molecular Taxonomy, Next Generation Sequencing and Its Applications. **Biomolecular Display Technology**: A New Tool for Drug Discovery. **In Silico Model**: From Simple Networks to Complex Diseases. Transgenic animals and their applications. Biotechnological exploitation of marine animals. **Stem cells**: A trek from laboratory to clinic to industry. Role of cytogenetic and molecular genetics in human health and medicine. **In vivo model**: CAM Assay. In vitro Fertilization, Human Embryonic stem cells. Biosensor, Biosafety, Organ Transplantation, Ethical issue in animal experimentation, Intellectual property right and animal biotechnology.

Course Outcomes:

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

- Learn an in-depth knowledge of tools of biotechnology
- 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
- Have an awareness of the global significance of biotechnology and its resultant industries, and a broad knowledge of which are represented nationally and locally.

Recommended Books:

1. Verma, A. and A. Singh. Animal Biotechnology, Models in Discovery and Translation. 2nd Edition. 2019, ISBN: 9780128117101.

2. Glick, B.R., & Patten, C.L. Molecular biotechnology: principles and applications of recombinant DNA (Vol. 34). 2017, John Wiley & Sons.
3. Willey, J., Sherwood, L. and Wolverton. C. J. Prescott's Microbiology 10th (ed.). 2017, 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.

Course Title: Advanced Physiology	**Course Code: ZOL-815**
Course Structure: Lectures: 3, Labs: 0	**Credit Hours: 3**

Prerequisites: None

Course Objective:

The course objectives are:

- To provide an in-depth understanding of physiological mechanisms at the molecular, cellular, and systemic levels.
- To develop analytical and problem-solving skills to interpret physiological data.
- To enhance research skills in physiological sciences, emphasizing experimental approaches and recent advancements.

Course Outline:

Cellular and Molecular Physiology: Membrane transport mechanisms, Ion channels and electrophysiology, Cell signalling and second messengers, Molecular basis of muscle contraction; **Neurophysiology:** Functional organization of the nervous system, Synaptic transmission and neuroplasticity, Sensory and motor pathways, Autonomic nervous system regulation; **Cardiovascular Physiology:** Regulation of cardiac function, Electrophysiology of the heart, Pathophysiology of cardiovascular diseases; **Respiratory Physiology:** Mechanics of breathing and gas exchange, Regulation of respiration, Adaptations to high altitude and diving; **Renal Physiology:** Regulation of body fluids and electrolytes in kidneys, Role of kidneys in acid-base homeostasis, Renal disorders and their physiological basis; **Gastrointestinal Physiology:** Neural and hormonal control of digestion, Absorption and metabolism of nutrients, Gut microbiota and its physiological significance, Disorders of the digestive system; **Endocrine and Reproductive Physiology:** Mechanisms of hormone action and regulation, Endocrine control of metabolism and homeostasis, Reproductive physiology of males and females, Physiology of pregnancy and lactation; **Immune and Inflammatory Physiology:** Innate and adaptive immunity, Cellular and molecular basis of inflammation, Role of cytokines in immune regulation, Autoimmune disorders and immunopathology; **Comparative and Environmental Physiology:** Physiological adaptations to extreme environments, Hibernation, estivation, and torpor mechanisms, Thermoregulation and metabolic adjustments, Stress physiology and its impact on health

Course Outcomes:

After completing this course, students will be able to:

- Explain the physiological functions of major organ systems with an advanced level of understanding.
- Analyse homeostatic mechanisms and their regulation at cellular and systemic levels.
- Critically evaluate recent research findings in physiology.
- Apply physiological principles to solve real-world biomedical and veterinary problems.

Recommended Books:

1. Medical Physiology – Guyton & Hall (Latest Edition)
2. Textbook of Physiology – Berne & Levy
3. Ganong's Review of Medical Physiology – Kim E. Barrett
4. Animal Physiology– Richard W. Hill, Gordon A. Wyse, Margaret Anderson
5. Human Physiology: An Integrated Approach – Dee Unglaub Silverthorn
6. Principles of Physiology – Robert M. Berne & Matthew N. Levy
7. Endocrinology – Mac E. Hadley
8. Comparative Physiology of Fasting, Starvation, and Food Limitation – Marshall D. McCue

Course Title: Advances in Biodiversity	**Course Code: ZOL-816**
Course Structure: Lectures: 3, Labs: 0	**Credit Hours: 3**

Prerequisites: None

Course Objective:

The course objectives are:

- To develop an advanced understanding of biodiversity, its components, and ecological significance.
- To explore contemporary issues in biodiversity conservation, including habitat loss, climate change, and species extinction.
- 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

Course Title: Ecology and Environmental Zoology	**Course Code: ZOL-817**
Course Structure: Lectures: 3, Labs: 0	**Credit Hours: 3**

Prerequisites: None

Course Objective:

The course objectives are:

- To develop an advanced understanding of ecological principles and environmental interactions of animal species.
- To explore the relationship between organisms and their biotic and abiotic environments.

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- To evaluate environmental challenges such as pollution, habitat destruction, and climate change.

Course Outline:

Introduction to Ecology and Environmental Zoology: Historical background and scope, Levels of ecological organization, Key principles of environmental zoology; **Ecosystem Structure and Function:** Structure and function of ecosystems, Primary and secondary productivity, biotic and abiotic factors, Energy flow and trophic dynamics, Biogeochemical cycles (carbon, nitrogen, phosphorus); **Population and Community Ecology:** Population dynamics and growth models, Species interactions: competition, predation, mutualism, and parasitism, Ecological niches and community structure, Anthropogenic impacts on ecosystems; **Behavioral and Evolutionary Ecology:** Animal behavior and ecological adaptations, Evolutionary processes in ecological systems, Speciation and biodiversity patterns; **Environmental Challenges and Conservation Strategies:** Climate change and its impact on ecosystems, Habitat destruction, fragmentation, and urbanization, Pollution and bioaccumulation in animal species, Invasive 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

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DEPARTMENT OF ZOOLOGY

LIST OF ELECTIVE COURSES FOR Ph.D. ZOOLOGY

ELECTIVE COURSES			
09 Credit hours (03 courses)			
S. #	**Course Title**	**Course Code**	**Credit Hours**
1.	Vaccinology	ZOL- 821	3
2.	Application of Biotechnology for Parasitic Control	ZOL- 822	3
3.	Advances in Helminthology	ZOL- 823	3
4.	Advances in Protozoology	ZOL-824	3
5.	Advances in Trematodes Biology	ZOL- 825	3
6.	Fish Parasitology	ZOL- 826	3
7.	Systematic Classification of Fishes	ZOL- 827	3
8.	Insects of Veterinary and Medical Importance	ZOL- 828	3
9.	Advanced Integrated Pest Management	ZOL- 829	3
10.	Clinical Reproductive Endocrinology	ZOL- 830	3
11.	Advanced Techniques in Reproductive Physiology	ZOL-831	3
12.	DNA Technology	ZOL-832	3

Note: 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

Course Title: Vaccinology	**Course Code:** ZOL- 821
Course Structure: Lectures: 3, Labs: 0	**Credit Hours: 3**
Prerequisites: None	
Course Objective: The objectives of the course are: • To be able to know the history of vaccines. • To provide students with knowledge of different mechanisms of vaccine working.	
Course Outline: 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')2 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, Enslow 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.	

Course Title: Application of Biotechnology for Parasitic Control	**Course Code: ZOL- 822**
Course Structure: Lectures: 3, Labs: 0	**Credit Hours: 3**
Prerequisites:	

Course Objective:
The Objectives of the course are:

- Familiarize the students with biotechnology
- Develop basic concept of diseases and their control using biotechnology.

Course Outline:
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.

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

- Understand role of Biotechnology in disease control
- Apply practical and research skills to control diseases of economic importance
- Enable the students to determine the Biological control of Diseases

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.

Course Title: Advances in Helminthology	**Course Code:** ZOL- 823
Course Structure: Lectures: 3, Labs: 0	**Credit Hours: 3**
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 helminths.

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, Anatrichosoma ocularis. Strongyloides stercoralis, Strongylida, bursate rhabolitidians, Bunostomum, Necator americanus, Ancyclostoma 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, 13th edition, 2015,
2. Robberts, L. Sand Janovy John Jr., Foundation of Parasitology, 9th 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, 13th edition, 2017, Wiley-Blackwell, New York, London.
5. Paniker, C. J., & Ghosh, S., Paniker's textbook of medical parasitology, 2017, JP Medical Ltd.

Course Title: Advances in Protozoology	**Course Code: ZOL-824**
Course Structure: Lectures: 3, Labs: 0	**Credit Hours: 3**

Prerequisites: None

Course Objective:

The objectives of the course are:

- To understand principles of parasitic infection and the host immunological responses.
- To familiarize students with the differentiation among common groups of protozoan parasites
- To provide a basic knowledge of the immune response and its involvement in health and disease.

Course Outline:

Parasitology: Introduction, elementary definitions. **Animal associations:** concept of harm; parasite hosts. Association to other sciences, Parasitology and human well-being. Carriers in Parasitology. **Parasitic Protozoa;** 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: *Giardia species, Trichomonas species, Entamoeba species, Naegleria species, Trypanosoma species, Leishmania species. Plasmodium species, Babesia species, Anaplasma species. Cryptosporidium species. Toxoplasma species.* Histomonas meleagridis. Parasitic Zoonosis and Risk of Zoonotic infections in Pakistan.

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

- Attain the basic acquaintance of Protozoans and philosophy of host-parasite interface
- Understand the perception of parasitism and other animal associations; clarify the concept of damage; understand the basic features and characteristics of hosts
- Articulate protozoan parasite infections affecting livestock, its morphology, life cycle, epidemiology, pathogenesis, treatment and control approaches.

Recommended Books:

1. Patricia Marques., Parasitology: A Conceptual Approach, 2018, Academic Press, Cambridge, UK.
2. David Rollinson., Advances in Parasitology, 2017, The Natural History Museum, London UK
3. Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt., Roitt's Essential Immunology, 13th edition, 2017, Wiley-Blackwell, New York, London.
4. Paniker, C. J., & Ghosh, S., Paniker's textbook of medical parasitology, 2017, JP Medical Ltd.
5. K.D. Chatterjee., Parasitology: Protozoology and Helminthology 13th edition, 2015.
6. Roberts, L. S and Janovy John Jr., Foundation of Parasitology, 2015, McGraw Hill, Boston USA.

Course Title: Advances in Trematodes Biology	**Course Code: ZOL-825**
Course Structure: Lectures: 3, Labs: 0	**Credit Hours: 3**

Prerequisites: None

Course Objective:
The objectives of the course are:

- To explain the physiology and biochemistry of trematodes.
- To explain advance diagnosis of Trematodes for professional employment in the field of Parasitology or a related discipline.

Course Outline:

Trematodes: 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, *Invitro* activity of anti-trematode drugs, Diagnosis of Trematodes, Treatment against Trematodes, Pathogenesis, Incubation periods, Biological Control.

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

- To learn physiology and biochemistry of trematodes.
- To apply their expertise in controlling trematodes infections.

Recommended Books:

1. Toledo, R., & Fried, B., Trematoda (flukes). Emerging Topics in Life Sciences, 1st edition, 2017.
2. Toledo, R., & Fried, B., Digenetic Trematodes. 2nd edition, 2019, Springer Cham.
3. Latest journals on helminthology and Parasitology.
4. Foreyt, W. J., Veterinary parasitology reference manual. 2013, John Wiley & Sons.
5. K. D. Chattergee., Parasitology: Protozoology and Helminthology, 13th edition, 2015, CBS Publishers & Distributors Pvt Ltd, India.

Course Title: Fish Parasitology	**Course Code: ZOL-826**
Course Structure: Lectures: 3, Labs: 0	**Credit Hours: 3**

Prerequisites:None

Course Objective:

The Objectives of the course are:

- To familiarize the students with common fish parasites 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 hosts 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 lifestyle of parasites and hosts. They can easily differentiate between various hosts and parasites.
- SOLVE the problems of identification of fish parasites with the help of the 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. Chattergee., Parasitology: Protozoology and Helminthology, 13th edition, 2015, CBS Publishers & Distributors Pvt Ltd, India.

Course Title: Systematic Classification of Fishes	**Course Code:** ZOL- 827
Course Structure: Lectures: 3, Labs: 0	**Credit Hours: 3**

Prerequisites: None

Course Objective:

The objectives of the course are:

- To make the students know the basic classes of fishes.
- This will provide the technical and general knowledge necessary for competent fish farming and fisheries management.
- This knowledge will make know the students about rich fish species of Pakistan and will provide information of the pond fish culture

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; 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 fish farms, Designing fishpond. Manuring 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 fishponds. Maintenance of fishponds.

Course Outcomes:

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

- Acquiring the knowledge of the various classes of fishes
- Understand the basics of fish classification
- Analyze the characteristics of fish
- Evaluate the different groups of fish based on 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.

Course Title: Insects of Veterinary and Medical Importance	**Course Code: ZOL-828**
Course Structure: Lectures: 3, Labs: 0	**Credit Hours: 3**

Prerequisites: None

Course Objective:

The objectives of the course are:

- Contribute in the understanding towards the role of insect vectors in the transmission of different pathogens to man and livestock.
- Enhance the knowledge about their breeding biology and control measure.
- Additionally, this course will contribute to student knowledge about symptoms of insect infestations/ infections and their first aid treatment.

Course Outline:

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 mportance 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, L.5M 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 5th edition, 2012, Publisher Cambridge University Press.
5. Burgess, N., & Cowan, G.O., A colour atlas of medical entomology, 2012, Springer Science & Business Media.

Course Title: Advanced Integrated Pest Management	**Course Code: ZOL-829**
Course Structure: Lectures: 3, Labs: 0	**Credit Hours: 3**

Prerequisites: None

Course Objective:

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

- Develop an understanding of sustainable integrated pest management (IPM) strategies.
- Explore various pest control tactics, including cultural, biological, chemical, and host resistance methods.
- Assess the risks and challenges associated with IPM, including pesticide residues and food safety issues.

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:

- Apply various pest control methods, including biological, cultural, chemical, and host resistance techniques.
- Conduct pest surveillance, sampling, and risk assessments in agricultural ecosystems.
- Differentiate between environmentally safe and unsafe IPM practices.

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, 3rd edition, 2010, Wiley-Blackwell.

Course Title: Clinical Reproductive Endocrinology	**Course Code: ZOL-830**
Course Structure: Lectures: 3, Labs: 0	**Credit Hours: 3**

Prerequisites: None

Course Objective:

The main objectives of this course are to:

- Get knowledge about various disorders of gonads and secondary sex organs.
- Learn techniques for diagnosis and treatment of endocrine diseases and measurement of hormones.
- Understand the mechanism of action of reproductive hormones.

Course Outline: Overview of endocrine regulation in reproduction, Hypothalamic-pituitary-gonadal (HPG) axis, Hormonal feedback mechanisms, Gonadotropins (LH, FSH) and their functions, Steroid hormones (estrogen, progesterone, testosterone), Prolactin and oxytocin in reproductive function, Role of inhibin, activins, and follistatin, GnRH secretion and pulsatility, Pituitary control of gonadal function, Disorders of the pituitary affecting reproduction, Disorders of Gonads: Ovaries, Testes, Disorders of Female and Male Reproductive Tract. Endocrine disruptors and reproductive health, Stress, nutrition, and reproductive hormones, Impact of systemic diseases on reproductive endocrinology, Polycystic ovary syndrome (PCOS), Endometriosis and hormonal implications, Reproductive aging and menopause, Male and female infertility: hormonal causes and treatments, Endocrine Changes of Pregnancy. Placental endocrinology and fetal-maternal interactions, Hormonal control of lactation and postpartum recovery, Endocrinology of Fetal Development. Disorders of Sexual Differentiation, Puberty and Its Disorders. Polyendocrine Disorders.

Course Outcomes:

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, 14th Edition, 2019, Elsevier.
2. Shlomo Melmed, Kenneth S, Polonsky., William text book of endocrinology, 13th 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 excercise endocrinology, 1st edition, 2013, advance exercise Physiology.

Course Title: Advanced Techniques in Reproductive Physiology	**Course Code: ZOL-831**
Course Structure: Lectures: 3, Labs: 0	**Credit Hours: 3**

Prerequisites: None

Course Objective:

The main objectives of this course are:

- To provide students with a comprehensive understanding of the physiological processes underlying human and animal reproduction.
- To introduce students to advanced techniques and technologies used in reproductive physiology,

including assisted reproduction and genetic testing.

- To examine the endocrine regulation of the reproductive system, including the roles of key hormones and their feedback mechanisms.

Course Outline:

verview of reproductive system: Overview of male and female reproductive physiology, Spermatogenesis and oogenesis: mechanisms and regulation, Endocrine regulation of reproduction, **Reproductive Failure in Males and Females:** Causes and classification of infertility (male and female), Hormonal assays and their significance in infertility diagnosis, Semen analysis and sperm function tests, Ovarian reserve testing and follicular monitoring, Genetic screening for reproductive disorders; The impact of pharmaceuticals and toxic substances on fertility; Autoimmune infertility and immunomodulatory therapies. **Overview of Assisted Reproductive Techniques (ART):** 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. **Ovulation Induction, Embryo Production and Transfer:** 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. **Artificial insemination, IVEP and embryo transfer in farm animals. Preservation and Cryopreservation of Gametes:** The preservation of eggs, sperm, and embryos for future use; Cryopreservation techniques, storage, and utilization. **Endometriosis and Assisted Reproductive Strategy:** How endometriosis affects fertility and treatment strategies; ART options and outcomes for patients with endometriosis. **PCOS and Assisted Reproduction:** Polycystic Ovary Syndrome (PCOS) and its impact on fertility; Specialized approaches for PCOS patients in ART. **Viral Disease and Assisted Reproductive Techniques:** Managing viral infections during fertility treatment; Implications of COVID-19 and other viruses on ART. **Complications and Outcomes of ART:** Potential complications of ART, including Ovarian Hyperstimulation Syndrome (OHSS); Multiple gestations and the associated risks; Perinatal outcomes of ART-conceived pregnancies. **Emerging Topics in Reproductive Physiology:** Environmental and Lifestyle Factors; Reproductive Aging; Strategies for preserving fertility; Regenerative Medicine in Reproductive Biology. **Assisted Reproductive techniques for conservation:** mammals and birds. **Assisted Reproductive techniques in fish:** sex reversal, Control of sexual maturation, and induced sterilization. Cryopreservation of fish gametes and embryos. Assisted Reproduction, ethical and legal issues.

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, 11th 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.

Course Title: DNA Technology	**Course Code: ZOL-832**
Course Structure: Lectures: 3, Labs: 0	**Credit Hours: 3**

Prerequisites: None

Course Objective:

The Objectives of the course are:

- Provide an in-depth understanding of fundamental and advanced genetic engineering techniques.
- Develop practical knowledge of gene cloning, vector selection, and recombinant DNA technology.
- Examine the applications of genetic engineering in medicine, agriculture, and environmental biology.

Course Outline:

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 with various disciplines

Course Outcomes:

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

- Explain the principles of DNA manipulation, cloning vectors, and gene expression techniques.
- Conduct genetic screening, verification, and amplification of recombinant molecules.
- Evaluate the impact of genetic engineering applications in medicine, agriculture, and environmental biology.

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, 2nd 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, 2nd edition, 2016, Bloomsbury Publishing publishers.