Department of Zoology
University of Delhi
Delhi-110007

Syllabus for Ph.D. Programme

Students admitted to the Department of Zoology Ph.D. programme are required to complete coursework as per the guidelines laid down in Ordinance VI-B.

Department will offer following courses in one semester:

Paper	Course Title	Credit
1	Research and Publication Ethics (RPE)	2
2	Research Methodology	4
3	Presentation & Communication Skills	2
4	Advanced module (Choose one option)	4

Paper 1, 2 and 3 are core papers for all students. These papers aim to introduce students to research publication and research ethics, several research techniques, and improve their presentation and communication skills. Paper 4 has multiple options, specifically focusing on advanced courses in Zoology; it is mandatory for each student to choose one of the given courses.

Evaluation

Students will be evaluated in the middle (Internal assessment) and at the end of the semester (Final Examination). Passing marks for all the papers is a 55% marks. The distribution of marks will be as follows:

Papers	Examination	Internal Assessment	Total Marks
Research and Publication Ethics	40	10	50
Research Methodology	80	20	100
Presentation & Communication Skills	40 (Oral presentation	10 (write-up)	50
Advanced module (Choose one option)	80	20	100
		Total	300

Paper 1- Research and Publication Ethics (RPE)

(Credit- 2)

RPE is a 2 credit mandatory course as per UGC guideline (UGC vide D.O. No. F.1- 1/2018) for Ph.D. course work. This course will provide a better understanding of research, publication ethics and misconduct.

Unit- I. Research and Publication

Introduction on Research Methodology & Publication, Publication ethics, Data ethics (Citation, Plagiarism, Conflict of Interest, Peer Review, Open Access and Subscription, Publication biasness), Preprints, Journal Selection

Unit- II. Ethical guideline and Policies

Authorship and Collaboration, Misconduct and Misrepresentation, Experimentation on animals, Ethical Guidelines and Regulations, CPCSEA guideline, Institutional ethical guideline, Policy and Advocacy (Retraction & Correction Policies, Intellectual property rights (IPRs), Authorship Disputes), Laboratory and Biosafety Practices

Suggested Readings:

1. K. Muralidhar, Amit, G., & AK, S. (2019). Ethics in science education, research and governance. Indian National Science Academy, New Delhi.
2. "Authorship and Collaboration: A Guide for Researchers" by COPE (Committee on Publication Ethics) (2018)
3. "Misconduct and Misrepresentation in Research: A Guide for Researchers" by COPE (Committee on Publication Ethics) (2018)
4. "Ethical Guidelines for Research Involving Animals" by National Institutes of Health (NIH) (2019)
5. "Laboratory and Biosafety Practices: A Guide for Researchers" by Centers for Disease Control and Prevention (CDC) (2020)

Paper 2- Research Methodology **(Credit- 4)**

Unit- I. Molecular Biology Techniques

Electrophoresis, PCR techniques, Cloning and expression in Prokaryotes and Eukaryotes, Experimental Approaches to study Epigenetics (Bisulfite sequencing, Chromatin immunoprecipitation (ChIP), Methylation-sensitive restriction enzyme, Topologically associating domains (TADs)), Immunological techniques

Unit- II. Bioinformatics

Sequencing, Biological Database (Primary and Secondary Database), Sequence alignment, File format, Phylogenetics, Annotation, Introduction to genomics, Transcriptomics, Metagenomics, Proteomics and metabolomics, Protein structure prediction, Template building and protein-protein interaction, Structure refinement

Unit- III. Imaging and Analytical techniques

Imaging Techniques (Bright field and Fluorescence microscopy), Electron microscopy, Advanced microscopy techniques, Introduction to single cell technology, Colorimetry and Chromatography, Spectroscopic analysis, Centrifugation

Unit- IV. Experimental Design and Data Analysis

Maintenance and storage of data, Concept of sampling, Biostatistics and data analysis, Descriptive (Central tendency (Mean, Median, Mode), Variance, Standard deviation), Inferential (Confidence interval, Regression), Parametric and non-parametric test, Cluster analysis, Principal component analysis, Correlation

Demonstration of Instruments in Central Instrumentation Facility of the Department.

Suggested Readings:

1. "Molecular Cloning: A Laboratory Manual" by Michael R. Green and Joseph Sambrook (2012)
2. "Immunological Techniques" by Helen Chapel and Mansel Haeney (2018)
3. "Genomics and Bioinformatics" by David W. Mount (2017).
4. "Imaging and Spectroscopy of Living Cells" by Karsten König and Andreas Ostendorf (2018)
5. "Chromatography: A Laboratory Handbook" by Heinz Schmidt-Traub and Andreas Seidel-Morgenstern (2018)
6. "Experimental Design and Data Analysis for Biologists" by Gerry P. Quinn and Michael J. Keough (2017)

Paper 3- Presentation & Communication Skills **(Credit- 2)**

A. Write-up of a research note (500 words)

B. Oral presentation of research work

In this paper students have to write a review (A) from the topic of their choice in "Recent Trends in Zoology" and has to give oral presentation (B) which will be evaluated by concerned teachers allotted to them.

Paper 4- Advanced Module (Choose any one of the following) **(Credit – 4)**

1. **Advances in Evolutionary Biology**
2. **Virus Host interaction**
3. **Cancer Biology**
4. **Frontiers in Fish and Fisheries Research**
5. **Immunobiology of Host-Pathogen Interactions**

Advanced Module 1- Advances in Evolutionary Biology **(Credit-4)**

Unit- I. Constraints in Evolution, Coevolution

Life-History theory, Developmental constraints – Canalization, Red queen hypothesis, The Arms race - Host-Pathogen, Sexual traits

Unit- II. Evolutionary Applications

Aging, Population dynamics, Cancer biology, Human evolution using Ancient DNA

Unit- III. Evolutionary Biology of Lifestyle Diseases

Obesity, Diabetes, Cardiovascular diseases, Microbiome

Unit- IV. Model Organisms in Evolutionary Biology

Lab-based (Bacteria, *Drosophila*, *C. elegans*), Field-based (Deer, Sheep, Mouse), Key factors in experimental design – Effective population size, Outbreeding, Variation

Suggested Readings:

1. Arney, Kat. Rebel Cell: Cancer, Evolution, and the New Science of Life's Oldest Betrayal. BenBella Books, (2020).
2. Perlman, Robert L. "Evolution and medicine." Perspectives in biology and medicine 56.2 (2013): 167-183.
3. Russell, Gareth. "BIOL 468-H01: Disease Ecology & Evolution." (2023).
4. Herron and Freeman. "Evolutionary Analysis. " United Kingdom, Pearson, (2014).
5. Flatt, Thomas, and Andreas Heyland, eds. Mechanisms of life history evolution: the genetics and physiology of life history traits and trade-offs. Oxford university press, (2011).

Advanced Module 2- Virus Host Interaction (Credit-4)

Unit- I. Introduction to Viruses

Detection and identification of viruses and virus strains, Classification of viruses, Disease symptoms and host range of viruses, Architecture and assembly of viral particles, Transmission of viruses

Unit- II. Virus-host cell interactions

Virus entry into the host cell, Viral genome expression, Replication of viruses (positive sense RNA, Negative sense RNA, dsRNA, Retroviruses, dsDNA, ssDNA), Intra- and inter-cellular movement, Pathogenesis and inhibition of host gene transcription by RNA viruses

Unit- III. Host cell response to viral infections

Apoptosis, Necrosis, Stress response, Alteration of different cell signalling pathways, Viral proteins and their role in infection, Replication and host defence evasion, Role of post-translational modifications in host-virus interactions

Unit- IV. Viruses in Biotechnology

Viruses for gene therapy, Viral vaccines, Virus for gene silencing, Gene transfer to animal cells, Gene transfer to plant cells, Viruses in pest control

Suggested Readings:

1. Flint, S. J., et al. "Principles of virology, 3rd edition." (2000).
2. Howley, Peter M., David M. Knipe, and Lynn W. Enquist. Fields Virology: Fundamentals. Lippincott Williams & Wilkins, (2023).

3 Matthews, Richard Ellis Ford, and Roger Hull. Matthews' plant virology. Gulf professional publishing, (2002).

Advanced Module 3- Cancer Biology **(Credit-4)**

Unit- I. The Cancer Problem

Introduction to Cancer, Global and Indian incidence and prevalence, Various types of cancers, Epidemiology, Global Cancer Observatory, Environmental carcinogens, Chemical and physical carcinogens types with examples, Various risk factors, Life style, Changing patterns, The Indian scenario, Benign and malignant tumors, Localized and metastatic disease, Schemes of classification, WHO classification, Staging and grading, Degree of malignancy, Cancer diagnosis

Unit- II. Mechanisms of Carcinogenesis

Hallmarks of Cancer, Initiation, Promotion and Progression of cancer, Role of DNA damage, Repair and mutations by physicochemical agents and virus, Current treatment modalities

Unit- III. Modulation of the Eukaryotic Cell Cycle and Cell Death in Cancer

Cell cycle and check points, role of kinases, Mechanism of deregulation of cell cycle during cancer, Various proteins involved and their mechanism, Apoptosis and Necrosis regulation in normal cell and dysregulation in cancer, Proapoptotic and Anti-apoptotic proteins and mechanism of action in controlling apoptosis

Unit- IV. Advances in Carcinogenesis

Cell-cell interaction, Integrins, and other proteins involved in cellular adhesion; Concept of invasion, Changes in cellular proteins, Mechanism of invasion by cancerous cells (EMT), Cancer stem cell hypothesis, Angiogenesis and various factors involved in angiogenesis, Concept of tumor suppressor proteins and oncoproteins, Transformed cells and immortal cells, Emerging anti-cancer therapeutics

Suggested Readings:

1. Stewart, B. W. K. P., and Christopher P. Wild. "International agency for research on cancer." World cancer report 2014 (2014).
2. Lodish, Harvey, et al. "Molecular cell biology 4th edition." National Center for Biotechnology Information, (2000).
3. Robinson, Murray O. "Telomerase and cancer." Genetic Engineering: Principles and Methods (2000): 209-222.
4. Camacho, Javier, ed. "Molecular Oncology Principles and Recent Advances." (2012).

5. Hanahan, Douglas. "Hallmarks of cancer: new dimensions." Cancer discovery 12.1 (2022): 31-46.

Advanced Module 4- Frontiers in Fish and Fisheries Research **(Credit-4)**

Unit- I. Introduction to Fisheries Science

Overview of fisheries science and its significance, Historical perspective and current trends in fisheries research, Key global challenges: Climate change, Overfishing and habitat degradation.

Unit- II. Aquatic Microbiome and applications

Introduction to microbiomes and their significance in aquatic ecosystems, Fish gut microbiome: composition, diversity, and functions., Environmental microbiomes in aquatic habitats, Methods for studying microbiomes: 16S rRNA, Metagenomics, Metatranscriptomics and metabolomics, Microbiota-based solutions for improving fish health, microbial interactions in aquaculture systems, microbiomes as indicators of ecosystem health.

Unit- III. Innovations in Aquaculture and merging topics in Fisheries research

Advances in aquaculture practices for sustainability, probiotics and prebiotics in aquaculture, Genomic tools for selective breeding, Antimicrobial resistance (AMR) in aquatic systems, Role of microbiota in fish immune system and disease resistance, Structure and function of growth hormone (GH) and insulin-like growth factors (IGFs), Regulation of growth by nutritional and environmental factors, Molecular cross-talk between GH/IGF axis and other hormonal pathways.

Unit- IV. Conservation and sustainable management and practical and field training

Strategies for conserving fish diversity, eDNA for monitoring fish populations and invasive species, Policy frameworks for sustainable fisheries management, Sampling techniques: fish and environmental samples, laboratory techniques, microbiome analysis, water quality testing, and fish health assessment, Fieldwork: studying fish habitats and environmental monitoring.

Suggested Readings:

1. "Fisheries Biology, Assessment and Management" by Michael L. Jones, et al. (2012)
2. "Introduction to Fisheries Science" by Thomas P. Smith (2017)
3. "Microbiomes and the Future of Aquaculture" edited by Jorge Galindo-Villegas, et al. (2020)

4. "Environmental DNA (eDNA) in Aquatic Ecosystems: A Review of the Current State of Knowledge" by International Union for Conservation of Nature (2020)

Advanced Module 5- Immunobiology of host-pathogen interactions (Credit-4)

Unit- I. Evolution of host-pathogen relationship

Effect of climate changes on pathogens, Microbial immune evasion mechanisms: How do viruses, bacteria, parasites and fungi evade host immune responses

Unit- II. Host-pathogen crosstalk in bacterial infections

Tuberculosis: Epidemiology, mode of infection and detection, Pathology, Immune evasion mechanisms, Drug targets and mechanism of drug resistance, Vaccine strategies

Unit- III. Parasite immunity

Blood parasite and enteric pathogens: (Malaria/Leishmaniasis/Amoebiasis), Epidemiology, Mode of infection and detection, pathology, immune evasion mechanisms; Drug targets and mechanism of drug resistance, Vaccine strategies

Unit- IV. Immunomodulation during infection

Pathogen induced alteration in signaling, Cytokine modulation, Cellular immunomodulation, Molecular immunomodulation, Immunomodulatory Therapies

Suggested Readings:

1. Selzer, Paul M. Host-pathogen interaction: microbial metabolism, pathogenicity and anti-infective. John Wiley & Sons, (2016).
2. Markell and Voge's Medical Parasitology Authors: David T. John, William A. Petri Editor: Greg Martin Hardback ISBN: 9780808923572.
3. "Immunomodulatory Therapies" by Robert P. Lisak (2012)
4. Cytokine modulation during infection: a review" (Cytokine & Growth Factor Reviews, 2019)
5. "Molecular immunomodulation: a new frontier in infectious disease therapy" (Trends in Molecular Medicine, 2020)

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