

**DOCTOR OF PHILOSOPHY (Ph.D)
COURSEWORK SYLLABUS
2021**

**DEPARTMENT OF ZOOLOGY
BODOLAND UNIVERSITY
Kokrajhar 783 370, BTC, Assam**

**According to the Revised Ph.D Regulations, 2020
(Resolution No. 05, dated 08/02/2020)**

After being admitted to the Coursework, a scholar will have to undertake a compulsory one semester (six month) Coursework of five papers. The first four papers are of 12 credits (each paper having three credits) and the fifth paper is of two credits; thus there will be total of 14 credit coursework.

The following five papers are offered:

Paper I (ZOOPHD-I): Research Methodology in Zoological Research

Paper II (ZOOPHD-II): Computer Application in Zoological Research

Paper III (ZOOPHD-III): Overview in Zoology

Paper IV (ZOOPHD-IV): In-depth Study in Zoology: Specialized Papers (Optional A: Molecular Biology and Immunology, Optional B: Fish & Fisheries Science, and Optional C: Wildlife Ecology)

Paper V (ZOOPHD-V): Research & Publication Ethics.

The total marks in each paper (Paper I through Paper IV) are 100, and the Paper V is of 50. The course structure is 60:20:20 for the first four papers; 60% of theory having three units each carrying 20%, home assignment is of 20%, and seminar presentation/internal assessment is of 20%. The Paper V is common of the whole university of 50% marks.

A scholar must have a minimum of 70% attendance during the Coursework. A scholar has to obtain a minimum 55% of marks or its equivalent grade in the Coursework examination. For detail, vide Revised Ph.D Regulations, 2020 of Bodoland University.

Paper Code	Name of the Paper	Written examination	Home Assignment	Internal Assessment or Seminar presentation
ZOOPHD-I Credit = 3 48 lectures	Research Methodology in Zoological Research	Marks: 60%	Marks: 20%	Marks: 20%
ZOOPHD-II Credit = 3 48 lectures	Computer Application in Zoological Research	Marks: 60%	Marks: 20%	Marks: 20%
ZOOPHD-III Credit = 3 48 lectures	Overview in Zoology	Marks: 60%	Marks: 20%	Marks: 20%
ZOOPHD-IV Credit = 3 48 lectures	In-depth Study in Zoology: Specialized Papers*	Marks: 60%	Marks: 20%	Marks: 20%
ZOOPHD-V Credit = 2 32 lectures	Research & Publication Ethics	Marks: 50%	Nil	Nil

*Three Optional Papers:

Optional: A: Molecular Biology and Immunology

Optional B: Fish & Fisheries Science

Optional C: Wildlife Ecology

ZOOPHD - I: Research Methodology in Zoological Research (Marks: 100)

Unit I: General Introduction

Research methodology: meaning of research, types of research, approaches; Concept of Research Design: meaning, features of a good research design, types of research design; defining aim & objectives. Selection and formulation of Research Problem– Researching a scientific problem; Research Questions and Research hypotheses generation; Validation and interpretation of data. Reading and critical analysis of scientific literature, Communicating research results in peer-reviewed journals. Writing scientific articles: Various forms of scientific writings, Citations and references; Good presentation. Journal matrix.

Unit II: Biological Tools & Techniques used in Zoological Research

Animal handling and ethics— Maintenance of animals, various routes of injections and sample collection; Ethical consideration in research on human beings. Good laboratory practice; Safety and bio-hazards, disposal of biological and chemical wastes. Preparation of Reagents, chemicals, buffers; Qualitative and quantitative tests; Histology: microtomy; Bioassays: in-vitro and in-vivo, Biomolecule separating techniques; Principles and applications of Spectrophotometry; Chromatography techniques; Hybridisation techniques; Electron microscopy; PCR, DNA sequencer; DNA markers and their applications; Metagenomics and Epigenomics.

Unit III: Application of Biostatistics in Research Design and Data Analyses

Concept of Biostatistics; Descriptive Statistics, Scales of Measurement, Collection of Primary and Secondary Data, Difference between Questionnaires and Schedules; Graphical Representation of Data; Data transformation. Populations, Samples and Study Design: concept of sampling unit, sample and statistical population; simple random sampling design, stratified random sampling design; Measures of Central Tendency, Measures of Variability and Dispersion. Significance Tests and Tests of Hypotheses: Concept of Probability and Normal Distribution Curve; Null and alternative hypothesis, type I and type II errors, one tailed and two tailed tests. Parametric and Non-parametric Statistics: Product Moment Correlation, regression, ANOVA, F-test, z-test, t-test, Spearman Rank correlation, Mann-Whitney U test, Wilcoxon matched paired test, Chi-square test, G- test, Kruskal-Wallice test.

Suggested Readings

Emden, Helmut F.van (2008). *Statistics for Terrified Biologists*. Blackwell Publishing. 343 pp.

Elston, R. Johnson, W. (2008). *Basic Biostatistics for Geneticists and Epidemiologists: A Practical Approach*. John Wiley & Sons, Ltd. 373 pp.

Fowler, J., Cohen, L. (1989). *Statistics for Ornithologists*. BTO Guide No. 22. Pp 175.

Kothari, C.R. (2004). *Research Methodology, Methods and Techniques*. Second Revised Edition. New Age International Publication. New Delhi. 401 pp.

Voet, D., Voet, J.G., Pratt, C.W. (2013). *Fundamentals of Biochemistry (4th edition)*. John Wiley & Sons Inc.

Wilson, K. and Walker, J. (2010). *Principles and Techniques OF Biochemistry and Molecular Biology (Seventh edition)*, Cambridge University Press.

Zar, J.H. (1984). *Biostatistical Analysis (Second Edition)*. New Jersey: Prentice-Hall International Editions. 718 pp.

ZOOPHD-II: Computer Application in Zoological Research (Marks: 100)

Unit I: General Computer Application in Research

Operating system, System Software, Application Software. Use of Microsoft office Word in word processing, graphical presentation and preparation of documents. Power Point in graphical presentation and preparation of documents, Creating and printing a presentation, producing a slide show. Excel in data analysis, Editing and formatting worksheets, performing basic calculations, working with charts. Browsing internet for related literature and Inter Groups for sharing of data and results.

Unit II: Applied Computer Knowledge in Zoological Research

Computer application for research—Word processing, line numbering and pagination, Editing and reviewing in word and pdf file. Data processing: Data entry, Data security and management. Figures and Table formats, Image editing— DPI, pixel. Use of web tools, graphical software; multimedia tools. Internet: Evaluating internet resources: Authority, Accuracy and objectivity. Online databases and resources: eBooks and virtual library. Common software applications— online and offline.

Unit III: Bioinformatics and its Applications

Databases— protein, nucleic acid; Sequence analysis— BLAST, sequence alignments and comparison, primer designing; Protein study— primary, secondary and tertiary structures, protein modelling from sequences, Bioinformatic tools for protein study; Phylogenetic analysis— criteria for selecting sequences, construction of a phylogenetic trees, Clustal-W/2W; Bioinformatics in drug analysis— PubChem, ChemSpider, DrugBank; In-silico toxicity study; Drug-likeness analysis; ADMET profiling of a compound.

Suggested Readings

Bhattacharjee, D. (2010) *Practical Statistics Using Microsoft Exel*. Asian Books Pvt. Ltd.

Bhise, S.B., Dias, R.J., Mali, K.K., GHanwat, P.H. (2011). *Textbook of Computer Applications and Biostatistics*. Trinity Publishing House, Satara, India.

Sarma, K.V.S. (2012). *Statistics Made Simple: Do it Yourself on PC*. PHI Learning Pvt.Ltd, New Delhi.

Walkenbach, J. (2011) *Excel 2013 Bible*. John Wiley & Sons.

Xion, J. (2006). *Essential Bioinformatics*. Cambridge University Press.

ZOOPHD-III: Overview in Zoology (Marks: 100)

Unit I: Molecular Biology and Immunology

Basics of biomolecules: nucleic acids and nucleotides, structures, bonding and stability, DNA replications; Protein synthesis; Post-translational Processing; Protein sorting; Mutation and mutagenesis; Cloning— restriction enzymes, vectors, gene libraries, screening of transformations; Expression cloning; Cell culture techniques; Receptor Biology: Study of receptors in biological research; DNA polymorphisms; Molecular Evolutionary study; Molecular Pharmacology— selection of therapeutic target, gene therapy, anti-sense technology, iRNA technology; Basics of immunology and immunization.

Unit II: Fish & Fisheries Science

Introduction and taxonomic position of fish, Classification and characteristic of major groups of fish, Methods employed in Phylogenetic Studies and Fish Identification. Nutrition of fish: environmental factors and feed intake, digestive physiology and nutrient digestibility in fish, nutritional energetic. Fish immune system and Modulators of fish immune responses, Aquatic Resources: Riverine fisheries, Cold water fisheries, Estuarine fisheries, Marine fisheries of India. Aquaculture and its principles, significance in present context. Current Research areas in fish biology and aquaculture.

Unit III: Wildlife Ecology

Basics concept of Wildlife Ecology: definition of wildlife according to Wildlife (Protection) Act, 1972. Concept of Biodiversity: its relationship with wild animal in terms of habitat and niche; Biodiversity indices; Bioinvasive and bioindicator species. Population and Community Ecology: population characteristics and population dynamics; intra- and inter species interactions in a community; solitary versus social living among animals; Behavioural ecology of animals. Conservation and Wildlife Management: Human-wildlife interactions; wildlife crime; Wildlife health. Concept of Conservation Genetics: demographic bottleneck and inbreeding depression

Suggested Readings

Anonymous. (2004) *The Wildlife Protection Act, 1972 (as amended up to 2004)*. Natraj Publisher, Dehradun.

Begon, M.; Harper, J.L. and Townsend, C.R. (2006) *Ecology: Individuals, Populations and Communities*. Blackwell Scientific Publications.

Bone, Q., Moore, R. (2008). *Biology of Fishes (Third Edition)*, Talyor and Francis Group, CRC Press, U.K.

Dash, M.C.and Dash, S.P. (2009) *Fundamentals of Ecology* (3rd edn.). Tata McGraw-Hill Publishing Co., New Delhi.

De Silva, S. S., Anderson, T. A. (1995). *Fish Nutrition in Aquaculture*. Chapman and Hall Aquaculture Series, London.

Gopal, R. (2011) *Fundamentals of Wildlife Management*. Natraj Publishers.

Jhingran V.G. (1997). *Fish and Fisheries of India*. Hindustan Publications, Delhi, India.

Kormondy, E.J. (1996) *Concepts of Ecology* (4th edn.). Prentice Hall of India, New Delhi.

Odum, E.P. and Barrett, G.W. (2005) *Fundamentals of Ecology*. (5th edn.) Thompson

Smith, R.L. (1977). *Elements of ecology and Filed Biology*. Longman. 497 pp.

Watson, J.D., Tania, A.B., Stephen, P.B., Alexander, G., Michael, L., Richard, L. (2017). *Molecular Biology of the Gene*. 7th Edition, Cold Spring Harbor Laboratory Press, New York.

ZOOPHD-IV: In-depth Study in Zoology (100 Marks)

Optional Paper A: MOLECULAR BIOLOGY AND IMMUNOLOGY

Unit I. Fundamentals of Molecular Biology

Basic and advanced information on DNA, RNA and protein; Replication, Transcription and Translation; Fidelity of DNA and Protein synthesis; comparative genomics; overview of gene silencing, gene targeting and destruction; mutation and its detection techniques; DNA damage and repair mechanisms; SOS-response; role of SNP and its importance in molecular studies; molecular drug targeting; Molecular pharmacology; Molecular phylogenetic; Bioinformatics and data mining

UNIT II. Molecular tools and techniques

Nucleic Acids: Isolation, Purification, Detection, and Hybridization techniques; Genomics and DNA sequencing methods; Proteomics and global analysis of proteins; Basics of gene manipulation and r-DNA, construction of synthetic vectors, DNA library construction; DNA barcoding in animals; Genome mapping techniques; Molecular diagnostic techniques; Bloating and microarray techniques

UNIT III. Molecular Immunology

Basics of immunology, Immunogenicity and Antigenicity, haptens, Toxioids, hapten, genetic bases of immune response– Heterogeneity; Role and properties of adjuvants, Immune modulators; Hybridoma rabbit and human; Antigen – Antibody interaction, Thermodynamics and binding strength of Ag-Ab interaction, affinity, cross-reactivity, specificity, epitope mapping; Identification of B-cell epitopes on a protein, Precipitation, Agglutination; Advanced immunological techniques - RIA, ELISA, Western blotting, ELISPOT assay and Immunofluorescence, Immunization and different vaccines, designing vaccines; Transfusion of immuno-competent cells, Stem cell therapy.

Suggested Readings

Brown, T.A. (2007). *Genome 3*. Garland Science Publishing

Clerk, D.P. (2010). *Academic Cell - Molecular Biology*. Publisher - Elsevier Science

Delves, P.J., Martin, S.J., Burton, D.R., Roit, I.M. (2011). *Essential Immunology*. 12th Edition, Wiley Blackwell Publishing.

Glick, B.R., Pasternak, J.J., Patten, C.L. (2010). *Molecular Biotechnology: Principles and Application of r-DNA*. 4th edition, ASM Press, USA

Primrose, S.B., Twyman, R.M. (2006). *Principles of Gene Manipulation*. 7th edition, Blackwell Publishing, USA.

Optional Paper B: Fish and Fisheries Science

Unit I. Nutritional Biology of Fish: Nutritional requirement of adult and larval fish. Nutritional Bioenergetics and Physiology. Quality of larval feeds (particle size, digestibility). Fish food organisms: live feed and their role in larval nutrition. Bioenrichment, biofilm/periphyton and its use. Single cell proteins and their nutritional quality. Feeding techniques. Formulation and preparation of artificial feeds. Fortification of feed; use of nutraceuticals, Immunostimulants, attractants, growth stimulants and probiotics. Antinutritional factors and their treatments. Alternative protein sources. Testing the nutritional quality and digestibility of feed: *in vitro* and *vivo*.

Unit II. Aquaculture Research: Definition, Different Culture technology – freshwater, brackish water, mariculture, fish food organisms. Water Quality Requirements and management for Aquaculture - Role of temperature, pH, salinity, dissolved oxygen, ammonia, nitrite, nitrate, phosphate, Biological oxygen demand, Chemical oxygen demand. Predatory fish and aquatic weed management.

Unit III. Biotechnology in Fish Biology Research: Molecular techniques of fish identification and phylogeny. Fish seed technology - induced breeding, cryopreservation of gametes and embryos. Gynogenesis, androgenesis, polyploidy, hybridization, monosex and supermales. Production of transgenic fish. Molecular markers used in fisheries and aquaculture: allozymes, mitochondrial DNA, RAPD, AFLP, nuclear DNA markers-RFLP,

microsatellites. Biotechnology in fish conservation. Biotechnology in health management: molecular (nucleic acid and antibody based) diagnostics, vaccines.

Suggested Readings

Bone, Q., Moore, R. (2008). *Biology of Fishes (Third Edition)*, Talyor and Francis Group, CRC Press, U.K.

De Silva, S.S., Anderson, T.A. (1995). *Fish Nutrition in Aquaculture*. Chapman and Hall Aquaculture Series, London.

Evans, D.H., Claiborne, J.B. (2006). *The Physiology of Fishes*. CRC Press.

Halver, J.E., Hardy, R.W. (2002). *Fish Nutrition*. Academic Press, London.

Helfman, G.S., Collette, B.B., Facey, D.E. (Eds) (1994). *The Diversity of Fishes*. Blackwell Sceince, USA.

Jhingran V.G. (1997). *Fish and Fisheries of India*. Hindustan Publications, Delhi, India.

Lovell, R.T. (1998). *Nutrition and Feeding of Fishes*. Kluwer Academic Publishers.

Pillay, T.V. R., Kutty, M.N. (2005). *Aquaculture Principles and Practices (Second Edition)*. Blackwell Publishing, USA.

ICAR (2018). *Handbook of fish and fisheries of India*. ICAR Publications, New Delhi India.

Optional Paper C: Wildlife Ecology

Unit I. Fundamental Knowledge in Wildlife Ecology

Natural selection and speciation: biological, phylogenetic, evolutionary and ecological species concepts. Wildlife diversity in different habitats: wetlands, grasslands, forests, caves, urban areas and Factors affecting distribution and abundance. Niche and resource partitioning. Animal corridor. Ecotone and Edge effect. Fundamentals of Landscape Ecology. Concept of Keystone, Flagship and Umbrella species; IUCN Criteria of Threatened Wildlife. Wildlife Biology: few Case Studies in amphibian, birds and mammals.

Unit II. Applied Wildlife Research

Population estimation techniques: Distance sampling method, Line Transect Method, Point Count Method, Species Richness Methods, Animal Sign Surveys. Viable population, Population and Habitat Viability Assessment (PHVA), carrying capacity. Occupancy Modelling. Concept of Ethology: Ethograms, Predator-Prey Dynamics; parental care and mating systems in animals, optimal foraging theory; Home Range, Territory. Measuring habitats of animals: Vegetation sampling; Nearest individual method, Point-centred Quarter Mehtod, Line intercept method, Quadrat Sampling method; concept of sampling effort and species area curve. Preparation of datasheet.

Unit III. Modern Research Techniques in Wildlife Ecology

Introduction, reintroduction and translocation of wild animals; Conservation Breeding Programme. Introduction to Remote Sensing, Basic concepts of GIS; use of Transmitters, PTT, Radio telemetry, Micro Chips, Radio collar; Satellite tracking. Application of genetics for wildlife conservation: PCR, DNA Sequencing, DNA Finger Printing; Molecular markers used in wildlife forensics. Mark-release-recapture technique, Camera trapping; Bird Ringing. Scat/dung analysis techniques; hair and feather analysis techniques. Techniques of field data collection for study of food and feeding habits. Methods of assessing dependence & impact on biodiversity resources, People's perception study, PRA exercise, Questionnaire and Schedule Survey.

Suggested Readings

Alcock, J. (2005) *Animal Behaviour: An Evolutionary Approach* (8th edn.). Sinauer Associates, Inc.

Allendorf, Fred W. and Gordon Luikart (2007). *Conservation and the Genetics of Populations*. Blackwell Publishing. 642 pp.

Awise, J. C. (1994). *Molecular Markers, Natural History & Evolution* (Chapman & Hall, New York).
Begon, M.; Harper, J.L. and Townsend, C.R. (2006) *Ecology: Individuals, Populations and Communities*. Blackwell Scientific Publications.

BNHS (2004) *The Wildlife of India*. Bombay Natural History Society.

Javed, Salim and Rahul Kaul (2002). *Field Methods for Bird Surveys*. Bombay Natural History Society; Department of Wildlife Sciences, Aligarh Muslim University, Aligarh, and World Pheasant Association, South Asia Regional Office, New Delhi. 61 pp.

Michael, P. (1984) *Ecological Methods for Field and Laboratory Investigation*. Tata McGraw-Hill, New Delhi.

Odum, E.P. and Barrett, G.W. (2005) *Fundamentals of Ecology*. (5th edn.) Thompson.

Pear, Mary C. (ed) (2000). *Research Techniques in Animal Ecology*. Columbia University Press, 442 pp.

Prater, S. H. (1971) *The Book of Indian Animals*. Bombay Natural History Society, Mumbai.

Raymond, Y.A. and Ronald G.L. (2003) *Introduction to Forest Ecosystem: Science and Management* (3rd edn.) John Wiley and sons.

Rolf A. de By (ed.) (2001). *Principles of Geographic Information Systems*. (ITC Educational Textbook Series; 1) Second edition. The International Institute for Aerospace Survey and Earth Sciences (ITC). Enschede, The Netherlands. 490 pp.

ZOOPHD_V

Ethics in Research & Publications

Course Structure:

The course comprises of six modules as listed in the table below. Each module has 4-5 units.

Modules	Unit Titles	Teaching Hours
Theory		
RPE 01	Philosophy and Ethics	4
RPE 02	Scientific Conduct	4
RPE 03	Publication Ethics	7
Practice		
RPE 04	Open Access Publishing	4
RPE 05	Publication Misconduct	4
RPE 06	Databases and Research Metrics	7
	Total	30

Syllabus in Details:

THEORY

- RPE 01: PHILOSOPHY AND ETHICS (3 hrs.)
 1. Introduction to Philosophy: Definition, nature and scope, concept, branches
 2. Ethics: Definition, moral philosophy, nature of moral judgments and reactions

- RPE 02: SCIENTIFIC CONDUCT (5 hours)
 1. Ethics with respect to science and research
 2. Intellectual honesty and research integrity
 3. Scientific misconducts: Falsification. Fabrication and Plagiarism(FFP)
 4. Redundant publications: duplicate and overlapping publications, salami slicing. ·
 5. Selective reporting and misrepresentation of data

- RPE 03: PUBLICATION ETHICS(7 hrs)
 1. Publication Ethics: definition, introduction and importance
 2. Best practices /standards setting initiatives and guidelines: COPE, WAME etc
 3. Conflicts of Interest
 4. Publication misconduct: definition, concept, problems that lead to unethical behavior and vice versa, type.
 5. Violation of publication ethics, authorship and contributorship
 6. Identification of publication misconduct, complaints and appeals
 7. Predatory publishers and journals.

PRACTICE:

- RPE 04: OPEN ACCESS PUBLISHING(4 hrs)
 1. Open access publications and initiative
 2. SHERPA/RoMEO online resource to check publisher copyright & self-archiving policies
 3. Software tool to identify predatory publications developed by SPPU
 4. Journal finder /journal suggestion tools viz. JANE,

Elsevier Journal Finder, Springer Journal Suggester, etc

- RPE 05: PUBLICATION MISCONDUCT (4 hrs.)
 - A. Group Discussions (2 hrs.)
 1. Subject specific ethical issues, FFP, authorship
 2. Conflicts of interest
 3. Complaints and appeals: examples and fraud from India and abroad
 - B. Software tools (2 hrs.)

Use of plagiarism software like Turnitin, Urkund and other open source software tools

- RPE 06: DATABASES AND RESEARCH METRICS (7hrs.)
 - A. Databases (4 hrs)
 1. Indexing databases
 2. Citation databases: Web of Science, Scopus etc.
 - B. Research Metrics (3 hrs)
 1. Impact Factor of journal as per Journal Citation Report, SNIP, SJR, IPP. Cite Score
 2. Metrics: h-index, g index. i10index. Altmetrics

References:

Bird, A (2006). Philosophy of Science. Routledge

MacIntyre, Alasdair (1967) A Short History of Ethics. London

P, Chaddah, (2018) Ethics in Competitive Research: Do not get scooped; do not get plagiarized ISBN-978- 9387480865

National Academy of Sciences, National Academy of engineering and Institute of Medicine. (2009) On being a scientist: A Guide to Responsible Conduct in Research 3rd edition National Academies Press

Resnik, D. B. (2011). What is ethics in research & why it is important. National Institute of Environmental Health Sciences, 1-10, Retrieved from

<https://www.niehs.nih.gov/research/resources/bioethics/whatis/index.cfm>

Beall, J. (2012). Predatory Publishers are corrupting open access. Nature, 489(7415), 179-179 <https://doi.org/10.1038/489179a>

Indian National Science Academy (INSA). Ethics in Science Education, Research and governance (2019) ISBN: 978-81-939482-1-7 http://www.insaindia.res.in/pdf/Ethics_Book.pdf