

**DEPARTMENT OF ZOOLOGY
NAGALAND UNIVERSITY
HEADQUARTERS LUMAMI**



**SYLLABUS
FOR
Ph.D. COURSE WORK**

Latest Revision: 2024 (38th Academic Council dated 07th June, 2024)

**DEPARTMENT OF ZOOLOGY
NAGALAND UNIVERSITY LUMAMI**

Syllabus for Ph.D. Course Work

Duration of the Course: One Semester

Total credit: 16

Paper	Name of Paper	Paper No.	Credits
Paper 1	Research Methodology	ZOO-PhD-01	4
Paper 2	Optional Paper	ZOO-PhD-02 (A-G)	4
Paper 3	Review of Literature & Report Writing	ZOO-PhD-03 (a)	2
	Seminar	ZOO-PhD-03 (b)	2
Paper 4	Research and Publication Ethics	ZOO-PhD-04	4

Optional Papers offered:

ZOO-PhD-02 (A): Molecular Genetics, Genetic Engineering and Applications

ZOO-PhD-02 (B): Entomology

ZOO-PhD-02 (C): Biodiversity Conservation and Environmental Issues

ZOO-PhD-02 (D): Neuroendocrinology and Chronobiology

ZOO-PhD-02 (E): Fisheries

ZOO-PhD-02 (F): Integrated Zoology

ZOO-PhD-02 (G): Cell and Molecular Biology

ZOO-PhD-01: Research Methodology

Credits: 4

Unit 1: Microscopy: Fluorescent and Confocal; Electron microscopy: SEM and TEM; In-situ hybridization techniques: FISH and MCFISH; Chromosome painting. Chromatography: Ion-exchange, Gel filtration, Affinity, HPLC and GC; Spectroscopy: Fluorescent, MS and AAS; Electrophoresis and Isoelectric focusing.

Unit 2: DNA and RNA extraction; Preparation of cDNA; RT-PCR; Designing of primers; Real Time PCR; DNA cloning; Southern, Northern and Western blots; DNA and Protein sequencing; ELISA and RIA.

Unit 3: Bio-computing: Biological data base (protein, nucleotide and natural products); BLAST and FASTA: Sequence comparison and alignment techniques; Bibliographic resources: PubMed and PLoS.

Unit 4: Statistics and its application in Biology: Tests of Statistical significance = 't' test. chi-square test; Analysis of Variance; Simple correlation and regression; Use of statistical packages for ANOVA and Multiple regression.

Suggested Readings:

1. Harris, R. (1991, Ed.). Electron Microscopy in Biology: A Practical Approach. IRL Press, Oxford University Press, New York, Tokyo.
2. Maniatis, T. et al (1982). Molecular cloning: A Laboratory Manual. Cold Spring Harbor Laboratory.
3. Murad, H. and Atique, M.V.A. (1991). Biological Techniques in Electron microscopy, CBS Publication.
4. Nelson, D.L. and Cox M.M (2009). Principles of Biochemistry, 5th Edition.
5. Plummer, D.T. (1987). An Introduction to Practical Biochemistry, 3rd edition. Tata Mc Graw Hill.
6. Stiles et al (1991). Basic and Clinical Immunology, Prentice-Hall International Inc.
7. Awitser, R.L. and Garry, L.F. (1999). Experimental Biochemistry, 3 Edition, W.H. Freeman Company.
8. Wilson, K. and Walker, J. (1994). Principles and Techniques of Practical Biochemistry, Cambridge University Press.
9. Letovsky, S.I. (1999). Bioinformatics. Kluwer Academic Publishers.
10. Setubal, J. and Meidanis, J. (1996). Introduction to Computational Molecular Biology, PWS Publishing Company, Boston.
11. Lesk, A.M. (2002). Introduction to Bioinformatics. Oxford University Press.
12. Zar, R. (1974). Biostatistic Analysis. Prentice Hall Inc.
13. SPSS-2010, SPSS Inc., USA.

ZOO-PhD-02 (A): Molecular Genetics, Genetic Engineering and Applications

Credits: 4

Unit 1: Structural and Functional Genomics; Gene location by DNA sequence inspection; Experimental methods for gene location; in silico analysis of gene function. Experimental analysis to assign the function of a gene. Comparative Genomics in understanding the human disease genes.

Unit 2: Molecular genetics of Mitochondria: Mitochondrial DNA; Expression of Mitochondrial genes; Interplay between Mitochondrial and Nuclear gene products; Mitochondrial DNA and Human disease. Signal Transduction Role of Protein Kinases in signal transduction and relevance to human disease. Cyclic AMP and activation of CREB. JAK-STAT pathway.

Unit 3: Genetics and Disease Cancer and Programmed cell death; Oncogenes: Tumor inducing Retroviruses and Viral Oncogenes; Cellular homologues of Viral Oncogenes: Proto-Oncogenes; Mutant cellular Oncogenes and Cancer; Tumor suppressor genes: Cellular roles of Tumor suppressor proteins (emphasis on p53).

Unit 4: Recombinant DNA cloning Technology Construction of Genomic libraries. Screening DNA libraries for Genes/specific DNA sequence of interest; Application of Genetic Engineering in Biomedical research; Therapy and Evolution; Stem cell therapy in health care.

Suggested Readings:

1. Lewin, B. (2003). Gene IX, John Wiley & Sons.
2. Setubal, J. and Meidanis, J. (1996). Introduction to Computational Molecular Biology, PWS Publishing Company, Boston
3. Hart, D.A. and Jones E.W (2000). Genetics: Analysis of Genes and Genomes, 5th edition, Jones and Bartlett Publication.
4. Strachan, T and Read, A.P. (1999). Human Molecular Genetics, John Wiley and Sons
5. Alberts et al (2003). Molecular Biology of the Cell, 4th edition, Garland Publ.
6. Moniatis et al (1982). Molecular cloning: A Laboratory M Cold Spring, Harbor Laboratory.
7. Nelson, D.L. and Cox, M.M. (2009). Lehninger Principles of Biochemistry, 5th edition, W. H. Freeman Company.
8. Gardner, E.J. and Snustad, D.P. (2000). Principles of Genetics, John Wiley & Sons.
9. Tollefsbol, T. (2008). Cancer Epigenetics, CRC Press, Taylor and Francis group, USA.
10. Teicher, B.A. (2008). Tumor models in cancer research. Humana Press.

ZOO-PhD-02 (B): Entomology

Credits: 4

Unit 1: Concept of Entomology: Introduction to Entomology, Outline of Classification; Life history patterns; Insect and human life, Cultural Entomology, Forensic Entomology. Insect Physiology Neuroendocrine System; Metamorphosis; Thermoregulation; Hormonal regulation of growth and differentiation; Pheromones.

Unit 2: Industrial Entomology: Beneficial Insects; Apiculture (honey-bee types; life histories, bee castes, beekeeping practices); Sericulture (wild silk moths, strains of silk worms, rearing and processing of cocoons).

Unit 3: Insects as Pests: Concept of insect pests; insect pest control-IPM (principles and practices; biological control); Pests of fruit crops and stored grains-their symptoms, damage and control measures

Unit 4: Entomological techniques Collection and preservation of insects-tools and techniques, Identification (identification keys and other resources).

Suggested Readings:

1. Imms, A.D. (1964). The Text Book of Entomology. Methuen Co, London.
2. Romoser, W.S. (1973). The Science of Entomology. McMillan Publ. Co. Inc., New York.
3. Imms, A.D. (1964). A general textbook of Entomology. Methuen & Co. Ltd... London.
4. Blum, M.S. (1985). Fundamentals of insect physiology. John Wiley & Sons, New York, Chicester, Brisbane, Toronto, Singapore.
5. Wigglesworth, V.B. (1984). Insect Physiology. Chapman and Hall, London and New York.
6. Chown, S.L. and Nicolson, S.W. Insect physiological ecology. Oxford Univ. Press.
7. Wadhawani, A.M. & Chhahra, N.N. (1972). Beekeeping in India, ICAR Publication, New Delhi.
8. Pradhan, S. (1983). Agricultural Entomology and Pest control. ICAR Publ., New Delhi.
9. Fenemore, P.G. and Prakash, A. (1992). Applied Entomology. Wiley Eastern Ltd.
10. Srivastava, K.P. (1993). Textbook of Applied Entomology, Vol. I & II, Kalyani Publishers, Ludhiana.
11. Tembhare, D.B. (1997). Modern Entomology. Himalayan Publishing House, Mumbai.

ZOO-PhD-02 (C): Biodiversity Conservation and Environmental Issues

Credits: 4

Unit 1: Conservation, Resource Management, Restoration Ecology and Bio-remediation
Conservation-basic concept, regional importance and resource use. Biosphere reserve
Protected area network in NE and threat factors. Wildlife conservation and management
Keystone and umbrella species, endangered and endemic fauna of NE India. Wildlife corridor,
human animal conflict. Restoration Ecology - Concept, Principle, application in NE region and
impact analysis. Bioremediation-Principles and applications, needs and limitation, bio-
remediation in soil.

Unit 2: Biodiversity and Environmental Education: Biodiversity-Concept, biodiversity
assessment and measurement of biodiversity, threat and uses of biodiversity, biodiversity act
and human livelihood, International and National efforts for biodiversity conservation, NE
region as biodiversity hotspots. Environmental education Environmental laws and regulations,
international concern of environmental education. Environmental ethics-Causes of problems,
religion, social culture, science and technology. Environmental conflicts Future of
environmental ethics, ecological economics and its evaluation techniques. Intellectual property
rights Terminology associated with IPR. patent, copy right, geographical indicator, biopiracy,
traditional ecological knowledge.

Unit 3: Environmental Pollution Studies: Air Pollution-types, sources, gases, smokes,
particulate matters, solvents and vapors, interaction with plants, animals and humans, air
quality monitoring effects and control strategies. Water pollution sources, biodegradation,
eutrophication. Soil and Noise Pollution: Environmental priorities in India-effect and control
strategies, laws and legislation concerned with environmental pollution.

Unit 4: Environmental Impact Analysis and Assessment: Worldwide environmental issue-
climatic changes, risks to Ozone layers, acid rain, emission of CO₂, Greenhouse effect,
desertification, loss of tropical forest, Impact of Power generation - River valley and hydel
power project, mining and oil exploration, thermal and nuclear power generation, impact of
Dam construction with special reference to NE India. Environmental assessment Guidelines
for planning and conservation of national heritage, industrial tragedy, measuring environmental
values and environmental damage valuation methodologies, environmental auditing.

Suggested Readings:

1. Allan, J.A. (1995). Stream Ecology: Structure and function of running waters. Chapman and Hall.
2. Goldman, C.R. and Home, A.J. (1983). Limnology. McGraw Hill International Book Company.
3. Jefferies, M. and Mills, D. (1992). Freshwater Ecology, CBS Publishers
4. Kalff, J. (2002). Limnology. Prentice-Hall
5. Moss, B. (1988). Ecology of fresh waters. Blackwell Scientific Publications.
6. Payne, A.I. (1986). The Ecology of Tropical lakes and Rivers. John Wiley and Sons.
7. Wetzel, R.G. (1983). Limnology, Sounders College Publ.
8. Wetzel, R.G. (2001). Limnology: Lakes and River Ecosystem. Academic Press, New York.
9. Wetzel, R.G. and Likens, G.E. (2000). Limnological analysis. Springer-Verlag, Berlin.

ZOO-PhD-02 (D): Neuroendocrinology and Chronobiology

Credits: 4

Unit 1: Neurohormone and neurotransmitter regulation of feminine sexual behaviour, Influence of neurotransmitters and neuromodulators on masculine sexual behavior, General features of hormone-CNS interactions Hormones and the duration of motor programs; hormones and the coordination of behavioral sequences; Priming actions of hormones on invertebrate CNS; Organizational effects of hormones in invertebrates; Role of local versus systematically released hormone in the alteration of behavior.

Unit 2: General concepts and terminology; Evolution and adaptive significance of biological clocks, Geophysical environment and seasons; Proximate and Ultimate factors; Types of biological rhythms. Free running rhythm, Entrainment, masking and Zeitgeber cycles; Parametric and non-parametric entrainment; Phase response curve (PRC) and phase transition curve (PTC); Phase shift.

Unit 3: Diversity of the clock system; Organization of the clock system in invertebrates and vertebrates. Melatonin: Input and output signal of the clock system; Molecular clock works in *Drosophila* and mammals.

Unit 4: Role of photic and non-photoc cues in seasonality, Photoperiodism: Photoreception and photo-transduction; Measurement of daylength; Circannual rhythms and seasonal responses, biological rhythms in humans.

Suggested Readings:

1. Dugatkin, L.A. (2009). Principles of Animal behavior, 2nd Edn., W.W. Norton Company Inc. New York, USA.
2. Dunlap, J.C., Jennifer, J.Loros, Patricia, J. DeCoursey (Eds.) (2004). Chronobiology Biological Timekeeping, Sinauer Associates, Inc. Sunderland. MA, USA.
3. Kumar, V. (2002). Biological rhythms, Narosa Publishing House, Delhi.
4. Nelson, R.J. (2005). An Introduction to behavioral Endocrinology, 3rd Edn., Sinauer Associate, Inc. Sunderland, USA.
5. Refinetti, R. (2006). Circadian physiology, 2 Edn. CRC Press Taler & Francis Group, Boca Raton, USA.
6. Saunders, D.S., C.G.H. Steel, X. Afopoulou, R.D. Lewis (2002). Insect clocks. 3. Edn., Baren and Noble Inc. New York, USA.
7. Becker, J.B., Breedlove, S.M., Crews, D. (1992). Behavioural Endocrinology, 2 Edn., MIT Press, Cambridge, Massachusetts, London England.

ZOO-Ph.D-02 (E): Fisheries

Credits: 4

Unit 1: Inland capture fisheries: Riverine fisheries-River system & capture fisheries of the Ganges & Brahmaputra river system., Lake Sterine fisheries-Types of lakes, Principal fresh water & brackish water lakes and fisheries, Cold-water fisheries-Principal indigenous cold water fishes, Exotic cold water fishes. Estuarine Fisheries-Ecological characteristics, Principal Estuaries and Fisheries. Reservoir Fisheries-Distribution of Reservoir, Fisheries.

Unit 2: Ornamental fish culture: Concepts of ornamental fishes, Classification & Resources of ornamental fishes; Construction, setting up & maintenance of aquarium; Water quality management and egg layers ornamental fishes; Indigenous ornamental fish and their export potential.

Unit 3: Biotechnology and Fisheries: Fish genetics, Genetic engineering & aquaculture; Fish hybridization and selective breeding of carps, Gynogenesis, Androgenesis & Polyploidy, Transgenic fishes, Genes used in Transgenic fish production; Ex-situ conservation, Technique of Cryopreservation of male gametes.

Unit 4: Methods in fishery science study: Collection and preservation of specimens; Morphometry, meristic counts and biometric index: Methods of measuring condition factor, food and feeding analysis of fish; Fecundity and reproductive analysis, length weight relationship of fish, Analysis of primary productivity (light & dark bottle method) of fish pond.

Suggested Readings:

1. Berg, L.S.- Classification of Fishes, both recent and Fossil.
2. Day, Francis- Fresh water fishes of India, Burma and Ceylon.
3. Jayaraman, K.C.- The fresh water fishes of the Indian region.
4. Chonder, S.L.-A handbook of Breeding of Indian Carps
5. Jhingran, V.G.-Fish and Fisheries of India (3 edn.).
6. Nikolsky. G.V. - The ecology of fishes.
7. Rao, N.R.-A N.R.-An introduction to fisheries.
8. Singh, H.R. & Iakra, W.S.- Cold water Aquaculture & Fisheries, Narendra Publ. House, Delhi.
9. Srivastava, C.B.L.- A text book of fishery science & Indian fisheries, Kitab Mahal, Allahabad.
10. Khanna, S.S. & Singh, H.R. -A textbook of fish biology & fisheries.
11. Khanna, S.S.- An Introduction to Fishes.

ZOO-Ph. D-02 (F): Integrated Zoology

Credits: 4

Unit 1: Recombinant DNA cloning Technology: Construction of Genomic libraries. Screening DNA libraries for Genes/specific DNA sequence of interest; Application of Genetic Engineering in Biomedical research; Therapy and Evolution; Stem cell therapy in health care. Insect Physiology: Neuroendocrine System; Metamorphosis; Thermoregulation; Hormonal regulation of growth and differentiation, Pheromones.

Unit 2: Environmental Impact Analysis and Assessment: Worldwide environmental issue - climatic changes, risks to Ozone layers, acid rain, emission of CO₂, Greenhouse effect, desertification, loss of tropical forest, Impact of Power generation, impact of Dam construction with special reference to NE India. Environmental assessment Guidelines for planning and conservation of national heritage, industrial tragedy, measuring environmental values and environmental damage valuation methodologies, environmental auditing.

Unit 3: Role of photic and non-photoc cues in seasonality; Photoperiodism; Photoreception and photo-transduction; Measurement of daylength; Circannual rhythms and seasonal responses; Biological rhythms in humans.

Unit 4: Biotechnology and Fisheries: Fish genetics, Genetic engineering & aquaculture; Fish hybridization and selective breeding of carps; Gynogenesis, Androgenesis & Polyploidy; Transgenic fishes, Genes used in Transgenic fish production; Ex-situ conservation, Technique of Cryopreservation of male gametes.

Suggested Readings:

1. Lewin, B. (2003). Gene IX, John Wiley & Sons.
2. Setubal, J. and Meidanis, J. (1996). Introduction to Computational Molecular Biology, PWS Publishing Company, Boston.
3. Hart, D.A. and Jones E.W (2000). Genetics: Analysis of Genes and Genomes, 5th edition, Jones and Bartlett Publication.
4. Strachan, T and Read, A.P. (1999). Human Molecular Genetics, John Wiley and Sons.
5. Alberts et al (2003). Molecular Biology of the Cell, 4th edition, Garland Publ.
6. Moniatas et al. (1982). Molecular cloning: A Laboratory M Cold Spring, Harbor Laboratory.
7. Nelson, D.L. and Cox, M.M. (2009). Lehninger Principles of Biochemistry, 5th edition, W. H. Freeman Company.
8. Gardner, E.J. and Snustad, D.P. (2000). Principles of Genetics, John Wiley & Sons.
9. Tollefsbol, T. (2008). Cancer Epigenetics, CRC Press, Taylor and Francis group, USA.
10. Teicher, B.A. (2008). Tumor models in cancer research. Humana Press.

ZOO-PhD-02 (G): Cell and Molecular Biology

Credits: 4

Unit 1: Cell culture techniques

Cell culture: Introduction to sterile cell culture technique. Counting viable cells and subculture into multiwell plates. Cell attachment (adhesion) and growth. Cell attachment (adhesion) and growth. Cell staining techniques: Culturing of primary cells, Application of primary cell culture techniques. Isolation of chromosomal DNA, Preparation of cellular extract, isolation of nuclear and cytoplasmic extract.

Unit 2: Principles and Techniques of Molecular Biology

FISH techniques and cytogenetics. Role of chromosome labeling in neonatal disorders. Chromosomal disorders. Cancer cytogenetic and role of cytogenetics in research. Potential applications of molecular biology techniques in drug discovery and development.

Unit 3: Genome analysis techniques

Isolation and purification of plasmic and genomic DNA samples from different cell types and tissues, DNA concentration techniques, restriction digestion and analysis. Agarose gel electrophoresis, DNA transfer techniques, isotopic and non-isotopic probe labeling methods, DNA fingerprinting.

Unit 4: DNA Sequencing

Basics and applied methods of DNA sequencing, modern day tools and instruments for sequencing, dideoxy sequencing, applications of sequencing in drug discovery and development, single nucleotide polymorphism (SNP)s identification and characterization techniques, SNPs applications in modern day drug discovery, CNV identification, identification of gross chromosomal deletions.

Suggested readings

1. Wang, K., Gan, L., Boysen, C., and Hood, L. (1995) A microtiter plate-based high-throughput DNA purification method. *Analyt. Biochem.* **226**, 85–90.
2. Mardis, E. R. and Roe, B. A. (1989) Automated methods for single-stranded DNA isolation and dideoxynucleotide DNA sequencing reactions on a robotic workstation. *Biotechniques* **7**, 840–850.
3. Smith, V., Brown, C. M., Bankier, A. T., and Barrell, B. G. (1990) Semiautomated preparation of DNA templates for large-scale sequencing projects. *DNA Seq.* **1**, 73–78.
4. Cao, X., and Brosius, F. C. (1993) Direct sequencing of double-stranded PCR products isolated from conventional agarose gels. *Biotechniques* **15**, 384–386.
6. Anderson, B., Lu, J., Edwards, K. E., Muzny, D. M., and Gibbs, R. A. (1996) Method for 96-well M13 DNA template preparations for large-scale sequencing. *Biotechniques* **20**, 1022–1027.

ZOO-PhD-04: Research and Publication Ethics

Credits: 4

Unit 1: PHILOSOPHY, ETHICS & SCIENTIFIC CONDUCT: Introduction to philosophy: definition, nature and scope, concept, branches, Ethics: definition, moral philosophy, nature of moral judgments and reactions. Ethics with respect to science and research, Intellectual honesty and research integrity, Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP), Redundant publications: duplicate and overlapping publications, salami slicing, Selective reporting and misrepresentation of data.

Unit 2: PUBLICATION ETHICS & MISCONDUCT: Publication ethics: definition, introduction and importance, best practices/standards setting initiatives and guidelines: COPE, WAME, etc. Conflicts of interest Publication misconduct: definition, concept, problems that lead to unethical behavior and vice versa, types Violation of publication ethics, authorship and contributorship, Identification of publication misconduct, complaints and appeals, Predatory publishers and journals Practice. *Group discussion:* Subject specific ethical issues, FFP, authorship, Conflicts of interest, Complaints and appeals: examples and fraud from India and abroad, *Software tools:* Use of plagiarism software like Turnitin, Urkund and other open-source software tools.

Unit 3: OPEN ACCESS PUBLISHING: Open access publications and initiatives, SHERPA/ROMEO online resource to check publisher copyright & self-archiving policies, Software tool to identify predatory publications developed by SPPU, Journal finder / journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggester, etc.

Unit 4: DATA BASES AND RESEARCH METRICS: A. Databases: Indexing databases, Citation databases: Web of Science, Scopus, etc. B. Research Metrics: Impact Factor of journal as per Journal Citation Report, SNIP, SJR, IPP, Cite Score. Metrics: h-index, g index, i10 index, altmetrics.

Suggested Readings:

1. Bird, A. (2006). Philosophy of Science. Routledge.
2. MacIntyre, Alasdair (1967) A Short History of Ethics. London.
3. P. Chaddah, (2018) Ethics in Competitive Research: Do not get scooped; do not get plagiarized, ISBN:978- 9387480865
4. National Academy of Sciences, National Academy of Engineering and Institute of Medicine. (2009). On Being a Scientist: A Guide to Responsible Conduct in Research: Third Edition. National Academies Press.
5. Resnik, D. B. (2011). What is ethics in research & why is it important. National Institute of Environmental Health Sciences, 1-10. Retrieved from <https://www.niehs.nih.gov/research/resources/bioethics/whatis/index.cfm>
6. Beall, J. (2012). Predatory publishers are corrupting open access. Nature, 489(7415), 179-179. <https://doi.org/10.1038/489179a>
7. 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