

Department of Biotechnology

School of Engineering and Technology

Nagaland University, (Hqrs: Lumami), Meriema, Kohima

(Central University established by an Act of Parliament No. 35 of 1989)



PhD Course Work Syllabus

Latest Revision: 2026

**[Approved by 43rd Academic Council
(AC:43:12:5) held on 12th May 2026]**

Department of Biotechnology
School of Engineering and Technology
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Syllabus for Ph.D. Course Work

Approved by 43rd Academic Council (AC:43:12:5) held on 12th May, 2026

The Ph.D. coursework programme offered by the Department of Biotechnology, Nagaland University, is a one-semester course and forms an integral part of the Ph.D. programme. Research scholars are required to earn a total of 14 credits across five papers to complete the coursework. The programme comprises five papers, of which Papers I, II, and V are compulsory. Papers III and IV are elective, and scholars are required to select two papers from the list of electives provided in the syllabus. This coursework must be undertaken immediately after admission to the Ph.D. programme. Upon successful completion, the scholar becomes eligible to submit the "Synopsis of Ph.D. Thesis" for approval. The date of admission to the Ph.D. programme shall be considered as the date of registration.

Duration of the Course: One Semester

Total credit: 14

S. No	Course Code	Course Title	Marks	Credit
1	SETP-01	Research Methodology	100	4-0-0 = 4
2	SETP-02	Research and Publication Ethics	100	1-0-1 = 2
3	BTP-103	Departmental Elective-01	100	3-0-0 = 3
4	BTP-104	Departmental Elective-02	100	3-0-0 = 3
5	BTP-111	Seminar	100	0-0-2 = 2
		Total Credit		14

Departmental Electives-01 & 02 (Any Two courses from the list below)

- [A]. Biostatistical Methods
- [B]. Methods for Determining and Prediction of Protein Structures
- [C]. Sequence Similarity Search Methods
- [D]. Genetic Engineering
- [E]. Protein Stability and Folding
- [F]. Molecular Markers and Non-coding DNA
- [G]. Microscopic Imaging Techniques
- [H]. Waste Water Treatment

SETP-01

Research Methodology [4-0-0]

Unit – I Research Methodology

Introduction, Meaning of Research, Objectives of Research, Motivation in Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research Process, Criteria of Good Research, Common Problems for Researchers

Unit – II: Research Problem

What is a Research Problem?, Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem

Research Design:

Meaning of Research Design, Need for Research Design, Features of a Good Design, Important Concepts Relating to Research Design, Different Research Designs, Basic Principles of Experimental Designs.

Unit – III: Interpretation & Report Writing

Meaning of interpretation, technique of interpretation, Types and structures of research documentation; Approaches and guidelines for documenting and reporting research process and outcomes; scientific publication writing: elements of a scientific paper including abstract, introduction, materials & methods, results, discussion, references; publishing scientific papers-peer review process and problems; recent developments such as open access and non-blind review; ethical issues; scientific misconduct.

Unit-IV: Intellectual Property Right (IPR) issues

IPR introduction and origin, Basics of patents, types of patents, Indian Patent Rules and validity, International Patent Rules and validity, Necessity and advantages and disadvantages of doing Patent to an invention, patent infringement- meaning, scope, litigation, case studies and examples; Commercialisation of patented innovations; licensing – outright sale, licensing, royalty; patenting by research students and scientists, university/organisational rules in India and abroad, collaborative research.

References

1. C. R. Kothari, *Research Methodology: Methods and Techniques*, New Age Publishers.
2. Krishnan Nallaperumal, *Engineering Research Methodology*.
3. Online materials on WIPO and IPR
4. *On Being a Scientist: a Guide to Responsible Conduct in Research*. (2009). Washington, D.C.: National Academies Press.
5. Gopen, G. D., & Smith, J. A. *The Science of Scientific Writing*. *American Scientist*, 78(Nov-Dec 1990), 550-558.

SETP-02

Research And Publication Ethics [1-0-1]

Unit - I: Introduction to philosophy

Definition, nature and scope, concept, branches; Ethics: definition, moral philosophy, nature of moral judgments and reactions; Ethics in science and research; Intellectual honesty and research integrity.

Unit - II: Scientific misconducts

Falsification, fabrication, and plagiarism (FFP); Redundant publications: duplication and overlapping publications; Selective reporting and misrepresentation of data; Use of plagiarism software like iThenticate, Turnitin, Urkund, Plagiarism Checker X, and other subscription-based and open-source software tools.

Unit - III Publication ethics

Definition, introduction, and importance; Best practices; Conflicts of interest; Publication misconduct: definition, concept, problems that lead to unethical behavior, violation of publication ethics, authorship and contributorship; Identification of publication misconduct, complaints and appeals; Predatory publishers and journals.

Unit - IV [A] Indexing databases, citation databases

Web of Science, Scopus, etc.; Impact factor of journal as per Journal Citation Report, SNIP, SJR, IPP, Cite Score; Metrics: h-index, g-index, i10-index etc.

[B] Group Discussions:

Subject-specific ethical issues, FFP, authorship, Conflicts of interest; Complaints and appeals: examples and fraud from India and abroad.

References

1. **Resnik, D. B.** (2015). *The Ethics of Science: An Introduction*. New York, NY: Routledge. ISBN: **978-0415704762**.
2. **Shamoo, A. E., & Resnik, D. B.** (2015). *Responsible Conduct of Research* (3rd ed.). Oxford, UK: Oxford University Press. ISBN: **978-0199937472**.
3. **Day, R. A., & Gastel, B.** (2016). *How to Write and Publish a Scientific Paper* (8th ed.). Santa Barbara, CA: ABC-CLIO / Greenwood. ISBN: **978-1440836505**.
4. **Bird, A.** 2006. *Philosophy of Science*. Routledge.
5. **MacIntyre, A.** 1967. *A Short History of Ethics*. London.
6. **Chaddah, P.** 2018. *Ethics in Competitive Research: Do Not get scooped, do not plagiarized*.
7. **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 edn. National Academies Press.
8. **Beall, J.** 2012. Predatory publishers are corrupting open access. *Nature*, 489(7415), 179. Doi: 10.1038/489179a
9. **Indian National Science Academy (INSA).** 2019. *Ethics in Science Education, Research and Governance*. www.insaindia.res.in/pdf/Ethics_Book.pdf

BTP-103 & BTP-104

Departmental Electives-01 & 02 [3-0-0]

[A] Biostatistical Methods

Unit-I: Sample Survey, Elementary concept; Advantages of sample survey over census; Simple random sampling (SRS); SRSWR and SRSWOR; Drawing of random sample & estimation of average, total etc.; Sampling and non-sampling errors; Concept of stratified random sampling.

Unit-II: Statistical Methods Population and its parameters; Sample and its statistics; Frequency distribution; Graphical representation; Measures of central tendency; Measures of dispersion; Moments; Simple correlation and regression.

Unit-III: Tests of Significance Concept of sampling distribution: chi-square, t, and F distributions. Tests of significance based on Normal, chi-square, t, and F distributions. Large sample theory, Introduction to theory of estimation and confidence intervals.

Unit-IV: Probability Theory of Probability. Random variable and mathematical expectation, Discrete and continuous probability distributions: Binomial, Poisson, Negative Binomial, Normal distribution, Beta and Gamma distributions, and their applications.

References

1. Anderson T. W. 1958. An Introduction to Multivariate Statistical Analysis. John Wiley.
2. Dillon W. R & Goldstein M. 1984. Multivariate Analysis - Methods and Applications. John Wiley.
3. Goon A. M, Gupta MK & Dasgupta B. 1977. An Outline of Statistical Theory. Vol. I. The World Press.
4. Goon A. M, Gupta MK & Dasgupta B. 1983. Fundamentals of Statistics. Vol. I. The World Press.
5. Hoel P. G. 1971. Introduction to Mathematical Statistics. John Wiley.
6. Hogg RV & Craig TT. 1978. Introduction to Mathematical Statistics. Macmillan

[B] Methods for Determining and Predicting Protein Structures

Unit I: Force-Fields in Protein Structure

Hydrogen bonds, hydrophobic interactions, electrostatic interactions, van der Waals forces, disulfide bonds; govern primary, secondary, tertiary, quaternary structures; used in molecular mechanics and dynamics simulations.

Unit II: Experimental Methods

X-ray crystallography, NMR spectroscopy, Cryo-EM; challenges: crystallization, size limitations, conformational flexibility, time-consuming nature.

Unit III: Comparative Models

Homology modeling, Modeller software; predicts structure using homologous templates when experimental data is unavailable.

Unit IV: Threading and New Models

Threading/fold recognition, hybrid models; AlphaFold, RoseTTAFold; deep learning-based accurate structure prediction.

References

1. Branden, C., & Tooze, J. (1999). *Introduction to Protein Structure* (2nd ed.). New York: Garland Science. ISBN: 978-0815331385.
2. Fersht, A. R. (1999). *Structure and Mechanism in Protein Science: A Guide to Enzyme Catalysis and Protein Folding*. New York: W.H. Freeman. ISBN: 978-0716734175.
3. Durbin, R., Eddy, S. R., Krogh, A., & Mitchison, G. (1998). *Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids*. Cambridge: Cambridge University Press. ISBN: 978-0521629713.

[C] Sequence Similarity Search Methods

Unit I: Evolutionary Relationships and Scoring Matrices

Evolutionary relationships between amino acids in protein sequences, PAM matrices (based on accepted mutations), BLOSUM matrices (based on conserved blocks in protein families).

Unit II: Global and Local Sequence Alignments

Global alignment (Needleman-Wunsch) aligns entire sequences, local alignment (Smith-Waterman) finds similar regions or motifs.

Unit III: BLAST and FASTA Sequence Alignments

BLAST: fast local alignment against databases, identifies homologs; FASTA: heuristic local alignment, detects conserved regions; both use scoring matrices.

Unit IV: Implementation of Alignment Methods

Implementation using dynamic programming for global/local, heuristic methods for BLAST/FASTA, software tools like Biopython, EMBOSS, Clustal Omega; applications in phylogenetics, functional annotation, motif identification.

References

1. **Mount, D. W.** (2004). *Bioinformatics: Sequence and Genome Analysis* (2nd ed.). Cold Spring Harbor Laboratory Press. ISBN: **978-0879697129**.
2. **Pevsner, J.** (2015). *Bioinformatics and Functional Genomics* (3rd ed.). Wiley-Blackwell. ISBN: **978-1118581780**.
3. **Durbin, R., Eddy, S. R., Krogh, A., & Mitchison, G.** (1998). *Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids*. Cambridge University Press. ISBN: **978-0521629713**.

[D] Genetic Engineering

Unit I: Enzymes and Cloning Vectors

Restriction endonucleases, modification methylases, other enzymes in genetic engineering, plasmids and plasmid vectors, phages and phage vectors, phagemids, cosmids, artificial chromosome vectors (YAC, BAC), CHEF analysis, animal virus-derived vectors: SV40, retroviral vectors.

Unit II: Molecular Cloning and Expression

Molecular cloning, recombinant DNA techniques, construction of genomic DNA and cDNA libraries, screening of recombinants, expression strategies for heterologous genes.

Unit III: DNA Analysis and Gene Expression Techniques

Labeling of DNA and RNA probes, Southern hybridization, fluorescence in situ hybridization (FISH), DNA fingerprinting, chromosome walking, Northern and Western blotting, gel retardation, DNA footprinting, primer extension, S1 mapping, reporter assays.

Unit IV: Advanced Techniques and Applications

DNA sequencing, chemical synthesis of oligonucleotides, in vitro mutagenesis, site-directed mutagenesis, gene replacement, gene targeting, polymerase chain reaction (PCR) and applications, use of transposons in genetic analysis: transposon and T-DNA tagging, applications of genetic engineering: transgenic animals, recombinant pharmaceuticals, gene therapy, disease diagnosis.

Reference

1. **Sambrook, J., & Russell, D. W.** (2001). *Molecular Cloning: A Laboratory Manual* (3rd ed.). Cold Spring Harbor Laboratory Press. ISBN: **978-0879695774**.
2. **Pierce, B. A.** (2017). *Genetics: A Conceptual Approach* (6th ed.). W. H. Freeman & Company. ISBN: **978-1464126126**.
3. **Brown, T. A.** (2016). *Gene Cloning and DNA Analysis: An Introduction* (7th ed.). Wiley-Blackwell. ISBN: **978-1118390938**.

[E] Protein Stability and Folding

Unit I: Introduction to Protein Structure, Forces in Protein Folding

Protein structure levels: primary, secondary, tertiary, quaternary; forces in folding: hydrogen bonds, hydrophobic interactions, electrostatic interactions, van der Waals forces, disulfide bonds.

Unit II: Protein Denaturation, Folding Pathway and Mechanism

Denaturation by heat, pH, chemical agents; folding pathways: hierarchical, nucleation-condensation, framework, diffusion-collision; importance in stability and misfolding diseases.

Unit III: Tools for Studying Denaturant-Induced Equilibrium Unfolding

Spectroscopy: UV-visible, fluorescence, circular dichroism; calorimetry: DSC; NMR, mass spectrometry; parameters: midpoint denaturant concentration (C_m), folding free energy (ΔG°), stability.

Unit IV: High-Throughput Protein Unfolding Kinetic Assay

Fluorescence-based microplate assays, stopped-flow experiments; applications in protein engineering, drug discovery, disease research; automated, rapid analysis of folding/unfolding kinetics.

References

1. **Branden, C., & Tooze, J.** (1998). *Introduction to protein structure* (2nd ed.). New York: Garland Science. ISBN: **978-0815331385**.
2. **Fersht, A.** (1999). *Structure and mechanism in protein science: A guide to enzyme catalysis and protein folding*. New York: W.H. Freeman. ISBN: **978-0716734175**.
3. **Dobson, C. M., Karplus, M., & Sauer, R. T. (Eds.)**. (2008). *Protein folding: A perspective from theory and experiment*. Weinheim: Wiley-VCH. ISBN: **978-3527310807**.

[F] Molecular Markers and Non-coding DNA

Unit I: Types of Molecular Markers

Principle & Methodology of following molecular markers: RFLP, RAPD, AFLP, SCAR, SSR, SNP, ITS, EST; application of molecular markers in diagnosis, gene tagging, genetic diversity.

Unit II: Identification Using Molecular Markers

Molecular Typing for Identification, such as 16S rRNA sequencing, 18S rRNA sequencing, internal transcribed spacer (ITS), ESTs, mitochondrial genome markers, and SNPs.

Unit III: Phylogenetic Classification & Genomic Tools

QTL (quantitative trait locus) mapping, microarray, DNA barcoding, and microsatellite markers; Use molecular markers to study evolutionary relationships

Unit IV: Genomic Regions & Non-Coding RNAs

Genome Structure, such as Intragenic regions, intergenic regions, regulatory sequences (Promoters, enhancers), telomeres, and centromeres. Non-coding RNAs such as eRNA, lncRNAs, siRNAs, and piRNAs.

References:

1. **Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2022).** *Molecular Biology of the Cell* (7th ed.). New York: W. W. Norton & Company. ISBN: **978-0393884852**.
2. **Lodish, H., Berk, A., Zipursky, S. L., Matsudaira, P., Baltimore, D., & Darnell, J. (2021).** *Molecular Cell Biology* (9th ed.). New York: W. H. Freeman and Company. ISBN: **978-1319208523**.
3. **Cooper, G. M., & Hausman, R. E. (latest ed.).** *The Cell: A Molecular Approach*. Washington, DC: ASM Press/Sinauer Associates. ISBN (example): **978-0878933006**.

[G] Microscopic Imaging Techniques

Unit I: Microscopy and Light Sources

Microscopy, introduction to optics and limitations, light sources: mercury lamp, halogen lamp, xenon lamp, laser, LED, fluorophores: chemical dyes and probes, protein tags: photoswitching, photoconversion, photoactivation.

Unit II: Fluorescence Microscopy Techniques

Wide-field microscopy, confocal microscopy: laser scanning, spinning disc, super-resolution microscopy: STED, SIM, Airy scan, single-molecule localization microscopy, FRAP, FRET, FLIM, CLEM, FIB-SEM.

Unit III: Image Acquisition and Detectors

Basic digital imaging formats, camera types: CCD, CMOS, detectors: PMT, hybrid photodetectors, properties of images: pixel, image size, lookup table (LUT).

Unit IV: Applications of Microscopy

Live cell imaging, colocalization studies, interaction studies, protein aggregation studies, dynamic cellular processes, real-time observation of molecular events.

References

1. **Kubitscheck, U.** (2020). *Fluorescence Microscopy: From Principles to Biological Applications* (2nd ed.). Wiley-VCH. ISBN: **978-3-527-33837-5**.
2. **Ruzin, S. E.** (1999). *Plant Microtechniques and Light Microscopy Techniques*. Oxford University Press. ISBN: **978-0198885832**.
3. **Nechyporuk-Zloy, V.** (2023). *Principles of Light Microscopy: From Basic to Advanced*. Springer, Cham. ISBN: **978-3-031-04476-2**.

[H] Wastewater Treatment

Unit I: Introduction

Principles of waste management and waste utilization, environmental impact of waste, waste management hierarchy, 3R principle: Reduce, Reuse, Recycle, waste as a resource, characterization of alternate energy sources, types of industrial pollutants.

Unit II: Physical Treatment Processes

Adsorption, activated carbon, membrane filtration.

Unit III: Chemical Treatment Processes

Oxidative processes, ozonation, photochemical processes, Fenton process.

Unit IV: Physicochemical and Biological Treatment

Sedimentation, coagulation, flocculation, aerobic treatment, anaerobic treatment, enzymatic decolorization.

References

1. **Letcher, T. M., & Vallero, D. A. (Eds.),** *Waste: A Handbook for Management* (2nd ed.). Academic Press, ISBN: 978-0-12-815060-3
2. **Wang, L. K., Sung Wang, M.-H., & Hung, Y.-T. (Eds.),** *Solid Waste Engineering and Management* (Handbook of Environmental Engineering, Vol. 1). Springer, Cham, ISBN: 978-3-030-84178-2.
3. **Kumar, V., Bhat, S. A., Kumar, S., & Verma, P. (Eds.),** *Environmental Engineering and Waste Management: Recent Trends and Perspectives*. Springer, Cham, ISBN: 978-3-031-58440-4

BTP-111

Seminar [0-0-2]

Each scholar will be assigned a specific topic for literature review. Based on a comprehensive survey of the relevant literature, the scholar shall prepare a scientific report and subsequently present the findings in the form of a PowerPoint presentation.