

PBIO 4800/6800

eDNA: One Mixture, Multiple Meanings

Environmental DNA is transforming how scientists detect organisms, monitor biodiversity, reconstruct ecosystems, and investigate biological processes without direct observation. This immersive, research-based course follows the complete eDNA workflow—from environmental sampling and laboratory methods to DNA sequencing, bioinformatics, and interpretation of environmental genomic data.

From molecules to meaning: transforming environmental DNA into biological evidence.

[View Course Bulletin](#)

[Explore Course Roadmap](#)



Instructor:
Dr. Magdy S. Alabady

Format

30% lectures
40% laboratory
30% bioinformatics

Audience

Upper-level undergraduate and graduate students

Co-requisite

PBIO 4800L/6800L

Final Products

Research project
Scientific report
Oral presentation

Course Information

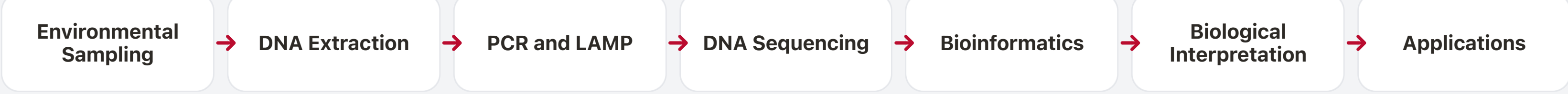
COURSE PBIO 4800/6800	CO-REQUISITE PBIO 4800L/6800L	SCHEDULE Twice weekly, approximately four hours per meeting
MEETING LOCATION MPS 1604	INSTRUCTOR Magdy S. Alabady	EMAIL malabady@uga.edu
OFFICE MPS 4520	LABORATORY MPS 4504	UGA COURSE BULLETIN View official course listing

Why eDNA — and why now?

Environmental DNA allows scientists to recover biological information from the environment without directly observing or collecting the organisms that produced it.

Environmental DNA (eDNA) consists of genetic material recovered from water, soil, sediment, air, host-associated samples, and other environmental matrices. By integrating molecular biology, genomics, and computation, eDNA has become an important tool for biodiversity assessment, ecosystem monitoring, conservation, public health, forensics, and archaeological research.

This course follows the complete environmental DNA workflow—from sampling and DNA extraction to sequencing, bioinformatics, and biological interpretation. Rather than focusing solely on sequencing technologies, students learn how biological, chemical, and physical processes shape DNA persistence, degradation, transport, preservation, and ultimately the information that can be recovered from environmental samples.



Why This Course Is Different

Most environmental DNA courses emphasize either laboratory methods or computational analysis. This course integrates **environmental sampling, molecular biology, DNA sequencing, bioinformatics, and critical interpretation** into a single research experience.

Students participate in a semester-long collaborative research project that mirrors the workflow used in modern environmental genomics laboratories. They generate and analyze their own data rather than working exclusively with pre-existing datasets.

Who Is This Course For? Interdisciplinary Connections

This course is designed for students interested in applying molecular, genomic, and computational approaches to questions spanning ecosystems, organisms, human history, and public health.

Ecology & Conservation - Biodiversity assessment and species detection - Rare, invasive, and endangered species monitoring - Community ecology and ecosystem change	Genetics, Genomics & Microbiology - Environmental and comparative genomics - Microbial communities and host-associated microbiomes - Sequencing, databases, and taxonomic classification	Marine & Environmental Sciences - Freshwater and marine monitoring - Soil, sediment, and water assessment - DNA transport, persistence, and environmental filtering	Anthropology & Forensics - Archaeological and sedimentary DNA - Reconstruction of past environments - Human-associated eDNA and forensic applications	Public Health & Epidemiology - Pathogen and wastewater surveillance - Environmental transmission and biosurveillance - Rapid detection using LAMP and sequencing
--	---	--	--	---

What You Will Learn

eDNA Foundations - History and current state - Sources and composition - Intracellular vs. extracellular DNA - Environmental genomics approaches	DNA in the Environment - DNA degradation and repair - Persistence and transport - Temperature, pH, UV, microbes - Mineral binding and filtering	Laboratory Methods - Environmental sampling - DNA extraction and purification - Contamination control - PCR, qPCR, and LAMP - Library preparation
Sequencing & Genomics - Metabarcoding - Shotgun metagenomics - Metatranscriptomics - Microbiomics and viromics - Portable sequencing	Bioinformatics & HPC - Read quality control - Taxonomic assignment - Reference databases - Complex mixture analysis - HPC workflows	Interpretation & Communication - False positives and negatives - Experimental design - Validation and uncertainty - Scientific literature - Reports and presentations

Course Roadmap

Module 1	Foundations of Environmental DNA - Historical development, principles, and major applications - Sources and composition of environmental DNA - Intracellular and extracellular DNA
Module 2	DNA as an Environmental Molecule - DNA structure, damage, and cellular repair mechanisms - Environmental degradation, persistence, transport, and preservation - Effects of temperature, UV, pH, microbes, and mineral binding
Module 3	Experimental Design & Laboratory Methods - Sampling strategies for water, soil, sediment, air, and host-associated samples - DNA extraction, purification, contamination prevention, and quality assurance - Positive controls, negative controls, field blanks, extraction blanks, and PCR controls
Module 4	Molecular Methods & Sequencing - PCR, qPCR, and isothermal amplification using LAMP - Library preparation and DNA sequencing technologies - Metabarcoding, shotgun metagenomics, and portable sequencing
Module 5	Bioinformatics & Environmental Genomics - Sequence quality control, preprocessing, and reference databases - Taxonomic and functional profiling - High-performance computing and reproducible workflows
Module 6	Applications of Environmental DNA - Biodiversity, conservation, freshwater and marine systems - Soil ecology, sedimentary DNA, and host-associated microbiomes - Epidemiology, pathogen surveillance, forensics, and anthropology
Module 7	Interpretation, Limitations & Future Directions - Uncertainty, validation, false positives, and false negatives - Critical interpretation of environmental genomic evidence - Emerging technologies, artificial intelligence, and the future of eDNA research

Laboratory & Bioinformatics Research Project

Every student contributes to an authentic research project using real environmental samples and sequencing data.

Throughout the semester, students work in collaborative teams to address a biological or environmental research question. Each team follows the complete eDNA workflow—from sample collection and laboratory analysis to sequencing, bioinformatics, scientific interpretation, and communication.

Laboratory Activities - Environmental sample collection and experimental design - DNA extraction, purification, and quality assessment - PCR, qPCR, and LAMP assays - DNA library preparation and sequencing - Experimental controls and contamination prevention	Bioinformatics Activities - Sequence quality control and preprocessing - Taxonomic classification using reference databases - High-performance computing workflows - Biodiversity and community analysis - Interpretation of environmental genomic data
Final Deliverables - Team research project - Documented bioinformatics analyses - Scientific research report - Oral presentation of findings	Core Scientific Competencies - Molecular biology - Experimental design - DNA sequencing - Bioinformatics - Data analysis - Scientific communication - Team science

Learning Outcomes

Scientific Understanding - Explain the principles and major approaches of eDNA analysis - Describe how biological, chemical, and physical processes influence DNA persistence, degradation, transport, and preservation - Compare metabarcoding, metagenomics, metatranscriptomics, microbiomics, and viromics - Evaluate the strengths, limitations, and uncertainties of eDNA studies - Interpret eDNA results within their biological and environmental context	Research Competencies - Design environmental DNA experiments and sampling strategies - Perform DNA extraction, PCR/LAMP assays and sequencing-library preparation - Analyze sequencing data using bioinformatics tools and HPC resources - Critically evaluate primary scientific literature - Communicate findings through reports, presentations, and collaborative research
---	---

Logistics

Prerequisites Intended for upper-level undergraduate and graduate students. Introductory biology is recommended. Prior experience with molecular biology, bioinformatics, or computer programming is not required.	Course Format Thirty percent interactive lectures, forty percent hands-on laboratory research, and thirty percent bioinformatics and data analysis.	Resources Students will use modern molecular biology facilities, DNA sequencing technologies, high-performance computing resources, real environmental samples, and guided laboratory and computational protocols.
--	---	--

Frequently Asked Questions

Do I need previous laboratory experience? No. Environmental DNA methods are introduced from the ground up, and laboratory protocols are taught step by step.	Do I need programming experience? No. Students use established bioinformatics tools and guided computational workflows. Prior programming experience is helpful but not required.
Will we generate our own sequencing data? Yes. Students participate in sampling, laboratory processing, sequencing, bioinformatics, and interpretation of the resulting data.	Who should take this course? Students interested in ecology, genetics, genomics, microbiology, marine science, environmental science, anthropology, conservation, public health, bioinformatics, and related fields.

Interested in Learning More?

Whether your interests are in biodiversity, conservation, genomics, microbiology, archaeology, or public health, this course provides the conceptual foundation and practical skills needed to investigate biological systems using one of the fastest-growing approaches in modern biology. Course: PBIO 4800/6800 Co-requisite: PPBIO 4800L/6800L Instructor: Dr. Magdy S. Alabady Email: malabady@uga.edu Location: MPS 1604
