

# INTERDISCIPLINARY BIOLOGICAL SCIENCES PROGRAM

Degree Types: PhD

The Interdisciplinary Biological Sciences (IBiS) Program (<https://www.ibis.northwestern.edu/>) provides the resources and training environment necessary to promote the development of Ph.D. students into independent, creative research scientists and teachers. The program includes approximately 55 training faculty from various science and engineering departments on Northwestern's main campus, who are linked by common interests in addressing fundamental questions in the biological and biomedical sciences.

Increasingly, the life sciences require interdisciplinary approaches in order to make essential progress in understanding normal cellular processes, diseases such as cancer, and the development of complex systems. With closely connected faculty from the departments of Molecular Biosciences, Biomedical Engineering, Neurobiology, Chemistry, and Chemical and Biological Engineering, and with strong ties to numerous interdisciplinary centers including the Center for Cell and Developmental Systems Biology, the Chemistry of Life Processes Institute, the Center for Structural Biology, and the NSF-Simons Center for Quantitative Biology, IBiS promotes innovative research that crosses traditional disciplinary boundaries.

IBiS students also benefit from a close-knit scientific community, a supportive advising structure, an active and involved student organization that sponsors scientific and social activities, and a multifaceted professional development program that further prepares them for a broad range of post-degree career options in academia, industry, teaching and other areas.

## Additional resources:

- Program website (<https://www.ibis.northwestern.edu/>)
- Program handbook

## Degree Offered

- Interdisciplinary Biological Sciences Program PhD (<https://catalogs.northwestern.edu/tgs/interdisciplinary-biological-sciences/interdisciplinary-biological-sciences-program-phd/>)

Learning objective(s)/Students should be able to...

- acquire comprehensive knowledge of concepts in Biological Sciences
- critically assess scientific ideas and data
- develop excellent scientific communication and teaching skills
- master experimental methods and experimental design
- contribute new fundamental knowledge in Biological Sciences

## Interdisciplinary Biological Sciences Program Courses

### IBIS 401-0 Molecular Biophysics (1 Unit)

Protein structure; nucleic acids structure; forces that determine macromolecular structure; transport and diffusion; macromolecular assemblies; molecular machines and single molecule studies; x-ray

crystallography; electron microscopy and image reconstruction; nuclear magnetic resonance; spectroscopy.

### IBIS 402-0 Molecular Biology of Human Disease (1 Unit)

Chromosome and genomic organization, gene structure, transmission of genetic information, transcriptional regulation of gene expression; Principles of protein folding; cellular mechanisms of protein quality control; transmission of prions and prion-like aggregates and amyloid and protein conformational diseases; Scales of organization of the transcriptome and proteome from individual pathways to complex networks, and from cellular to organismal levels.

### IBIS 404-0 Principles and Methods in Systems Biology (1 Unit)

Systems biologists use mathematical-based experimental analysis and modeling to study biological problems. Quantitative techniques and computational tools help investigators analyze heterogeneous complex data about molecular networks to uncover meaningful relationships about key components. These studies inspire a framework for understanding the activity of living states. Related principles about dynamic biological systems are the focus of the systems biology course.

### IBIS 406-0 Advanced Topics in Cell Biology (1 Unit)

This course provides the opportunity to explore areas of eukaryotic cell biology through analysis of scientific literature and in-depth background research. Students investigate cellular components, mechanisms, and methods used in cell biology research. Students present topics orally to their colleagues and use primary data from scientific publications to design, propose, and defend cell biology research projects.

### IBIS 407-0 Genetics & Epigenetics (1 Unit)

Exploration of the classic and contemporary scientific literature on genetic and epigenetic control of phenotype, genetic analysis, genetic interactions, genetic model systems and genetic experiments. The focus of the course will be on learning to think about genetic data and to design genetic experiments and screens to answer biological questions.

### IBIS 409-0 Biophysical Methods for Macromolecular Analysis (1 Unit)

The course will explore the principles and practical applications of biophysical methods in contemporary research, with an emphasis on understanding macromolecular structure and function. A broad range of techniques including various forms of spectroscopy and microscopy will be covered. Students will learn practical aspects of design and conduct of experiments and review scientific literature demonstrating the value of these methods.

### IBIS 410-0 Quantitative Biology (1 Unit)

Quantitative approach to molecular and cell biology, focused on developing an understanding of connections between biomolecule structure and dynamics, and behavior of cells. The course will also include review of topics from statistics of random variables and statistical data analysis relevant to biology and biophysics.

### IBIS 411-0 Fundamentals in Biological Sciences: Biochem, Molecular Biology, and Genetics (1 Unit)

Fundamental concepts in the areas of biochemistry, molecular biology, and genetics will be discussed. We will use both foundational discoveries and current advances to introduce concepts relevant to these fields. In addition, we will discuss the historical and modern approaches and logic used to address fundamental biological questions regarding these concepts. For each concept, we will end with a discussion of what outstanding questions remain and how to critically and rigorously address these questions using a variety of approaches.

Prerequisites: IBiS Students Only.

### IBIS 412-0 Fundamentals in Biological Sciences: Genomics, Cell Bio, and Developmental Bio (1 Unit)

Fundamental concepts in the areas of genomics, cell biology, and developmental biology will be discussed. We will use both foundational discoveries and current advances to introduce concepts relevant to these fields. In addition, we will discuss the historical and modern approaches and logic used to address fundamental biological questions regarding these concepts. For each concept, we will end with a discussion of what outstanding questions remain and how to critically and rigorously address these questions using a variety of approaches.

**IBIS 416-0 Practical Training in Chemical Biology Methods and Experimental Design (1 Unit)**

Experimental design, data analysis, mass spectrometry; proteomics, in vivo and molecular imaging, small molecule synthesis and purification; high-throughput screening, x-ray crystallography, analysis of bioelements.

**IBIS 421-0 Rigor & Reproducibility in Research (0 Unit)**

Experimental design and data analysis will be discussed through analysis of case studies on the topics of rigorous statistical analysis, transparency in reporting, data and material verification and sharing.

**IBIS 423-0 Ethics in Biological Research (0 Unit)**

The focus of this course will be on education in the responsible conduct of research (RCR). Topics discussed include: conflict of interest, the use of animals and human subjects in research, mentoring and lab management, collaborative research, data ownership and management, peer review, authorship, misconduct and the processes for handling misconduct.

**IBIS 432-0 Statistics for Life Sciences (1 Unit)**

Statistics course with emphasis on the application of statistical methods and data analysis techniques to the life sciences. Topics include descriptive statistics, normal distribution, random variables, sampling distribution, confidence intervals, hypothesis tests, p-values and multiple correction, linear regression, model selection, diagnostics, logistic regression, contingency tables, resampling, clustering, dimension reduction, and genomics data analysis.

**IBIS 455-0 Special Topics (1 Unit)**

Offered regularly for small groups of graduate students. The teaching faculty and topics change each quarter.

**IBIS 462-0 Seminar in Biological Sciences (0 Unit)**

**IBIS 491-0 Development and Evolution of Body Plans (1 Unit)**

Molecular mechanisms underlying early embryonic development, including establishment of the body and organogenesis. Discussion of original literature.

**IBIS 499-0 Independent Study (1 Unit)**

**IBIS 519-0 Responsible Conduct of Research Training (0 Unit)**

This course is a review of concepts introduced in IBIS 423-0.

Prerequisite: IBIS 423-0 or equivalent.

**IBIS 590-0 Research (1-3 Units)**