

# BIOLOGY

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## **Interim Chair**

Jialing Xiang

## **Associate Chair**

Tanya Bekyarova

## **Faculty with Research Interests**

For more information regarding faculty visit the Department of Biology website.

The Department of Biology offers B.S., M.S., and Ph.D. degrees in the fields of biology, molecular biochemistry, and biophysics. Within the department, there are many opportunities for interdisciplinary education and research experiences; students in any of the disciplines have easy access to the expertise that the full faculty brings. In addition, the department offers several professional master's degrees and related certificate programs for part-time students, both on campus and through distance learning.

## **Research Facilities**

The department has state-of-the-art computer and laboratory equipment and conducts research in the areas of biochemistry, bioinformatics, cell and molecular biology, microbiology, molecular biophysics and biochemistry. In addition, the department constructs and operates facilities for x-ray scattering and imaging at the Advanced Photon Source at Argonne National Laboratory. The department offers graduate programs leading to M.S. and Ph.D. degrees in biology, concentrating educational and research activities in the areas of biochemistry, bioinformatics, cell and molecular biology, and microbiology. Graduate education in biology is available on either a full- or a part-time basis. Master's degree programs are designed so that they may be completed by part-time students. Specific programs can be completed entirely online. Each new graduate student is assigned a graduate student adviser and must obtain the approval of the adviser each semester before registering for any graduate classes.

## **Departmental Graduate Examinations**

All full-time students in the M.S. and Ph.D. programs are required to take and pass the written M.S. comprehensive/Ph.D. qualifying examination by the end of their fourth semester of study. Part-time students must pass this examination by a comparable stage of their programs. The examination is offered twice each academic year. A student may sit officially for the examination a maximum of two times. Students passing this examination at the Ph.D. level are judged to be qualified to continue in the Ph.D. program. Students passing at the master of science level or above may obtain their master's degree after completing the requirements described in the following sections. All students in the Ph.D. program who have passed the written qualifying examination must take and pass a comprehensive examination before the end of the sixth semester of full-time study. Part-time students must pass this examination by a comparable stage of their programs. This examination consists of a written proposal, an oral presentation, and a defense of the proposal before a faculty committee. A student may take this examination a maximum of two times. Students passing this examination may continue with their research and will receive a Ph.D. upon satisfactory completion of all other required courses and general requirements of the Graduate College, a written dissertation, and final oral thesis defense.

## **Admission Requirements**

### **Minimum Cumulative Undergraduate GPA**

3.0/4.0

### **Minimum GRE Scores**

The Graduate Record Examination (GRE) is required, but it can be waived on case by case bases for qualified applicants.

- Master's/Master of Science: 299 (quantitative + verbal), 2.5 (analytical writing)
- Ph.D.: 310 (quantitative + verbal), 3.0 (analytical writing)

### **Minimum TOEFL Scores**

80/550 (internet-based/paper-based test scores)

Applicants to the doctoral program in molecular biochemistry and biophysics are strongly encouraged to take one of the subject exams in biology, molecular biology, chemistry, or physics.

Meeting the minimum GPA and test score requirements does not guarantee admission. Test scores and GPA are just two of several important factors considered.

Applicants to one of the department's programs (biology or molecular biochemistry and biophysics) are expected to have a bachelor's degree from an accredited institution with a major in that same discipline, or a closely allied major with additional coursework that prepares the student for graduate study in the chosen program. Students who have not completed all required courses may be accepted for general admission and can begin coursework, but must remove any deficiencies before the master's and M.S. comprehensive/Ph.D. qualifying examination.

## Degrees Offered

- Master of Science in Biology
- Master of Science in Biology for the Health Professions
- Master of Science in Biology with Specialization in Applied Life Sciences
- Master of Science in Biology with Specialization in Biochemistry
- Master of Science in Biology with Specialization in Cell and Molecular Biology
- Master of Science in Biology with Specialization in Computational Genomics
- Master of Science in Biology with Specialization in Microbiology
- Master of Science in Molecular Biochemistry and Biophysics
- Doctor of Philosophy in Biology
- Doctor of Philosophy in Molecular Biochemistry and Biophysics

## Certificate Programs

- Certificate in Cell and Molecular Biology
- Certificate in Genomics
- Certificate in Microbiology and Immunology

## Course Descriptions

### BIOL 501

#### Graduate Laboratory Techniques

This course will provide training in biological laboratory techniques. This will include basic laboratory protocols, safety, record keeping, proper use of equipment, and fundamental techniques common to many sub-specializations.

**Lecture: 0 Lab: 3 Credits: 2**

### BIOL 503

#### Virology

This course will cover topics related to animal viruses including the life cycles of major viral classes, viral pathogenesis, emergence, and control. Recent advances in these areas will be discussed in conjunction with readings from the original literature.

**Prerequisite(s):** BIOL 445 with min. grade of C or BIOL 515 with min. grade of C

**Lecture: 3 Lab: 0 Credits: 3**

### BIOL 504

#### Biochemistry

Molecules of biological significance; reaction thermodynamics and kinetics; metabolism; cellular localization of biochemical function; proteins; nucleic acids; transcription; translation.

**Lecture: 3 Lab: 0 Credits: 3**

### BIOL 510

#### Medical Microbiology

Properties of pathogenic bacteria, fungi, viruses, and parasites and their mechanisms of pathogenesis with a focus on organisms that cause human disease, including current trends in infectious disease. Credits cannot be granted for both BIOL 510 and BIOL 410.

**Lecture: 3 Lab: 0 Credits: 3**

### BIOL 511

#### Project Management: Business Principles

Introduction to concepts and techniques used to design and/or analyze a project to develop a set of tasks to accomplish the project, to coordinate and to monitor the work involved in the tasks, and to deliver a final product or service. Budgetary considerations will also be discussed.

**Lecture: 2 Lab: 0 Credits: 2**

### BIOL 512

#### Advanced Biochemistry

This course provides an advanced view of modern biochemistry building on studies done in BIOL 504 of metabolism, enzyme mechanisms, and kinetics, as well as theoretical aspects of various laboratory techniques used in biochemistry. Instructor permission required.

**Prerequisite(s):** BIOL 504 with min. grade of C

**Lecture: 3 Lab: 0 Credits: 3**

### BIOL 514

#### Toxicology

Initial lectures cover basic principles in chemical toxicity, such as dose response, indices of numerical toxicity, metabolism and factors influencing toxicity. Mechanisms of organic toxicity will be presented to include central nervous system, liver, kidney, respiratory system, reproductive system and the hematological system. Special topic lectures will emphasize the mechanism of toxicity for specific metals, pesticides, solvents and substances of abuse.

**Lecture: 3 Lab: 0 Credits: 3**

### BIOL 515

#### Molecular Biology

A survey of topics including structure of nucleic acids, translation, transcription, replication, organization of DNA, RNA processing, genomics, and control of gene expression.

**Lecture: 3 Lab: 0 Credits: 3**

### BIOL 520

#### Laboratory Rotation

Independent study in the research laboratory of a faculty member.

**Lecture: 0 Lab: 9 Credits: 3**

### BIOL 521

#### Population Genetics

The study of genetic variation in natural populations is the foundation for modern evolutionary biology. Population genetics covers both the theoretical study of the effects of various forces on genetic diversity and the empirical analysis of genetic variation observed in real populations. Throughout the course, students' understanding of population genetics theory will be reinforced with examples of applications. Topics will include genetic drift, genealogical approaches and coalescence, structured populations and migration mutation and natural selection.

**Lecture: 3 Lab: 0 Credits: 3**

### BIOL 522

#### Research Techniques in the Biological Sciences I

Experimental techniques in biochemistry, cell Biology, biotechnology, and microbiology are offered as discreet modules. Students select appropriate modules to complement other laboratory courses. Thus a student who has completed, for example, BIOL 533, (Laboratory in Cell and Molecular Biology) would select two modules chosen from cell biology, biotechnology, or microbiology. A written report is required at the completion of each module. Instructor permission required.

**Lecture: 1 Lab: 6 Credits: 3**

### BIOL 523

#### Research Techniques in Biological Sciences II

This course is a continuation of BIOL 522 where students have to complete the research project started in BIOL 522 and a write a report in the form of a scientific paper.

**Lecture: 0 Lab: 3 Credits: 3**

**BIOL 524****Science and Law: An Introduction to Intellectual Property Law and Patents**

"This course focuses on the interaction of science and law, specifically intellectual property and regulatory law. Topics will include patents, the ethical and legal issues involved with patenting biological inventions, inventorship and collaborations, trade secrets, Food and Drug regulatory law, generic drugs and the legal system as it relates to scientific issues."

**Lecture: 3 Lab: 0 Credits: 3**

**BIOL 526****Developmental Biology**

This course covers the cellular and molecular processes involved in generating an embryo, in creating various tissues and organs, and the effect of external stimuli on development. Topics include: genome structure, gene expression and regulation, cell cycle control, pattern formation, signal transduction, gametogenesis, organogenesis, and methods used in studying developmental biology. In addition to studies of model organisms, examples relevant to human diseases are covered.

**Lecture: 3 Lab: 0 Credits: 3**

**BIOL 527****Immunology and Immunochemistry**

Basic concepts of immunology, immunochemistry, both biological and molecular.

**Lecture: 3 Lab: 0 Credits: 3**

**BIOL 530****Human Physiology**

This course is designed to provide the students with comprehensive knowledge about how the human body functions. It will cover cell physiology, autonomic nervous system, neurophysiology, acid base physiology, cardiovascular physiology, respiratory physiology, renal physiology, gastrointestinal physiology, endocrine physiology, and reproductive physiology. Credits cannot be earned to both BIOL 430 and BIOL 530.

**Lecture: 3 Lab: 0 Credits: 3**

**BIOL 533****Advanced Graduate Laboratory Techniques**

This course covers a number of essential techniques in cell and molecular biology, biochemistry, and structural biology with emphases on both the methodologies and the experimental details. Laboratory procedures include cell culture skills and relevant laboratory procedures. This course is arranged modules from which students choose according to their areas of specialization.

**Prerequisite(s):** BIOL 501 with min. grade of B

**Lecture: 0 Lab: 6 Credits: 3**

**BIOL 542****Advanced Microbiology**

Advanced Microbiology (Biol 542) is a lecture course designed to review concepts of contemporary microbiology and the diversity of the microbial world with an emphasis on the biochemical and molecular strategies used to survive in different environments. The course will cover diverse microbiological topics such as metabolism, growth, production of foods, agriculture, biotechnology, fuel production, bioremediation, environment, etc.

**Prerequisite(s):** BIOL 544 with min. grade of C and BIOL 504 with min. grade of C

**Lecture: 3 Lab: 0 Credits: 3**

**BIOL 543****Advanced Microbiology and Immunology Laboratory**

This course provides hands-on experience on the main techniques used in microbiology and immunology. The course allows graduate and undergraduate students to acquire the necessary experience to continue their careers in academy or in industry. Focus on implementing aseptic technique, identification of microorganisms by several methods and Biotechnology procedures such as bacterial genome editing and yeast fermentation. Antibody properties will be explored and exploited, including antigen-antibody reaction, immunodetection of microorganisms, co-immunoprecipitation of proteins and ELISA. Properties of immune cells will be studied, such as phagocytosis and macrophage migration.

**Prerequisite(s):** BIOL 225 or BIOL 533 with min. grade of C

**Lecture: 0 Lab: 6 Credits: 3**

**BIOL 544****Molecular Biology of Cells**

This is a graduate-level cell biology course. The course contains two parts: initial lectures cover cellular structure and function emphasizing the molecular components, organelles, and regulation of cellular processes; the second part covers special topics emphasizing experimental approaches and molecular mechanisms of cellular regulation.

**Lecture: 3 Lab: 0 Credits: 3**

**BIOL 545****Advanced Cell Biology**

This course is a continuation of BIOL 544 and focuses on recent advances in the area of cell biology. The course covers, in depth, eukaryotic cellular processes, structure-function relationships, and cellular signaling networks in response to physiological and pathological stimuli. The course will also cover frontier topics in the area of cell biology. Emphasis will be on experimental approaches. Instructor permission required.

**Prerequisite(s):** (BIOL 445 with min. grade of C and BIOL 446 with min. grade of C) or (BIOL 533 with min. grade of C and BIOL 544 with min. grade of C)

**Lecture: 3 Lab: 0 Credits: 3**

**BIOL 550****Bioinformatics**

This course is tailored for life science graduates having little to no prior knowledge of Unix/Linux-like operating systems. Topics covered will include Linux/UNIX-like operating systems, the Bash shell, Perl programming, collecting and storing sequences in the lab, multiple sequence alignments, database searching for similar sequences, gene prediction, genome analysis, and phylogenetic prediction.

**Lecture: 3 Lab: 0 Credits: 3**

**BIOL 551****Microbial Genomics**

Microbes and associated microbiomes are highly relevant to human health and environmental issues. Advances in DNA sequencing technologies enabled investigations of microbes and microbiomes at an unprecedented depth. In this lab course, students will use a combination of wet lab approaches including high-throughput sequencing technologies and dry lab computational techniques to investigate various microbial genomes, metagenomes and biomes.

**Prerequisite(s):** BIOL 501 with min. grade of C and BIOL 550 with min. grade of B and BIOL 515 with min. grade of C

**Lecture: 0 Lab: 6 Credits: 3**

**BIOL 555****Macromolecular Structure**

Macromolecular crystallographic methods, including crystallization, data processing, phasing, and structure refinement, multi-dimensional NMR techniques, spectroscopic techniques, structural comparisons and characterizations, fiber diffraction, and solution scattering. Instructor permission required.

**Lecture: 3 Lab: 0 Credits: 3**

**BIOL 561****Radiation Biophysics**

Energy loss by ionizing radiation. Target theory. Direct and indirect action. Radiation inactivation of proteins, nucleic acids, microorganisms, and humans. Role of DNA repair in mitigating damage. Stochastic and non-stochastic damage. Radiation effects in vivo. Radiation therapy. Effects of non-ionizing radiation. Same as PHYS 561.

**Lecture: 3 Lab: 0 Credits: 3**

**BIOL 562****Current Topics in Functional Genomics**

This course is designed to give students a foundation in advanced theoretical and applied methods in modern molecular research. It will emphasize both established and novel approaches to solving problems of functional and comparative genomics, and systems biology. It will also focus on applications of advanced molecular techniques in areas of significant economic and biomedical importance.

**Lecture: 3 Lab: 0 Credits: 3**

**BIOL 572****Literature in Biochemistry**

A topic from the current literature in biochemistry is selected by students for preparation of a paper. Instructor permission required.

**Lecture: 0 Lab: 3 Credits: 3**

**BIOL 574****Literature in Biotechnology**

A topic from the current literature in biotechnology is selected by students for preparation of a paper. Instructor permission required.

**Lecture: 0 Lab: 3 Credits: 3**

**BIOL 576****Literature in Cell and Molecular Biology**

A topic from the current literature in cell and molecular biology is selected by students for preparation of a paper. Instructor permission required.

**Lecture: 0 Lab: 3 Credits: 3**

**BIOL 578****Literature in Microbiology**

A topic from the current literature in microbiology is selected by students for preparation of a paper. Instructor permission required.

**Lecture: 0 Lab: 3 Credits: 3**

**BIOL 581****Capstone**

In this course, students will be provided with the opportunity to perform a research project that is the culmination of their Master's education. This course involves the research and preparation of a group project. Students will develop a formal work reflecting integration of the scientific knowledge and technical skills learned in the Master's programs through a project chosen by the group. The course will explore online collaboration tools to allow participation of online students. Each group will present its Capstone project at the end of the class. Instructor consent is required.

**Lecture: 3 Lab: 0 Credits: 3**

**BIOL 584****Graduate Seminar in Biology**

To foster scientific communication skills, students are required to present seminars based on the scientific literature.

**Lecture: 0 Lab: 1 Credits: 1**

**BIOL 591****Research and Thesis M.S.**

Instructor permission required.

**Credit: Variable**

**BIOL 594****Research Problems**

Instructor permission required.

**Credit: Variable**

**BIOL 595****Biology Colloquium**

Lectures by invited scientists in areas of biology generally not covered in the department.

**Lecture: 0 Lab: 1 Credits: 1**

**BIOL 597****Special Problems**

Special problems in biology. Instructor permission required.

**Credit: Variable**

**BIOL 600****Continuation of Residence**

**Lecture: 0 Lab: 1 Credits: 1**

**BIOL 691**

**Research and Thesis PHD**

Research and Thesis for Ph. D. students.

**Credit:** Variable

**SCI 511**

**Project Management**

Successful project management links the basic metrics of schedule adherence, budget adherence, and project quality. But, it also includes the 'people components' of customer satisfaction and effective management of people whether it is leading a project team or successfully building relationships with co-workers. Through course lectures, assigned readings, and case studies, the basic components of leading, defining, planning, organizing, controlling, and closing a project will be discussed. Such topics include project definition, team building, budgeting, scheduling, risk management and control, evaluation, and project closeout.

**Lecture:** 3 **Lab:** 0 **Credits:** 3

**SCI 522**

**Public Engagement for Scientists**

This course presents strategies for scientists to use when engaging a variety of audiences with scientific information. Students will learn to communicate their knowledge through correspondence, formal reports, and presentations. Students will practice document preparation using report appropriate formatting, style, and graphics. Written assignments, discussion questions, and communication exercises will provide students with a better understanding of the relationship between scientists and their audiences whether in the workplace, laboratory, etc.

**Lecture:** 3 **Lab:** 0 **Credits:** 3

**SCI 595**

**Ethics for the Health Professions**

Lectures and discussion relating to ethics relating to the health professions. This course exposes students to current ethical and social issues surrounding health care, including health care provider and patient interactions and institutional considerations using case study examples.

**Lecture:** 1 **Lab:** 0 **Credits:** 1