

Integrated Biology, PhD

The Department of Biology's graduate programs in integrated biology (iBio) emphasize original research and developing the skills essential for publishing and communicating research findings to the scientific community. Research programs in the department cover many areas of the biological sciences: cell biology, developmental biology, ecology, evolution, genetics, and neurobiology. Graduate study in the department provides students with a broad understanding of these basic areas.

Newly admitted graduate students are assigned a temporary advisor and together they discuss the student's educational background to formulate a first-semester study plan before registration. The programs allow each student to tailor coursework to their own research interests. Students may be advised to take specific coursework in order to enhance their background in certain areas.

During the first year, students whose preparation in chemistry, genetics, mathematics, or physics is insufficient may need to remedy deficiencies by taking appropriate coursework.

Entering students typically will have taken the following courses: two semesters of organic chemistry or one semester of organic chemistry and one semester of biochemistry; one semester of calculus; two semesters of college physics; and 20 s.h. of coursework in biology, including genetics.

Students with bachelor's degrees outside the biological sciences may request modification of certain area requirements. The Graduate Affairs Committee decides whether portions of the requirements may be waived.

Learning Outcomes

Graduates will:

- master the skill of reading, understanding, and summarizing primary literature across a variety of biology subdisciplines, demonstrating effective scholarly communication in the process;
- explain in writing the experimental rationale, articulate the central hypothesis, and outline the major investigative steps that will be undertaken in a student's primary area of research;
- orally communicate established scientific concepts as well as ongoing research hypotheses, experimental design, and results to a wide array of audiences using established scientific communication norms;
- master in-depth pedagogical concepts through advanced lecture courses and engage in a vertically integrated critical analysis of a single topic over many levels of basic biology;
- learn and implement field-specific experimental processes, techniques, and data analyses in a responsible manner consistent with current bioethical protocols;
- establish networking connections within the scientific profession, from peers to established, independent researchers; and
- become a research subproject leader (evidenced by publication/meeting presentation/grant submittal) within the context of a research group.

Requirements

The Doctor of Philosophy in integrated biology requires a minimum of 72 s.h. of graduate credit. Students must maintain a graduate college program grade-point average of at least 3.00.

New PhD students typically go through three laboratory rotations with different faculty during their first semester (August–December). Students with existing mentors in the Department of Biology may also seek to directly affiliate with that laboratory. Students consult with their temporary advisor and prospective faculty research sponsors before identifying their preferences for research rotations. Based on their rotations, they choose a laboratory affiliation for their thesis late in the first semester.

The PhD in integrated biology requires the following coursework.

Requirements	Hours
Concepts, Models, and Systems Seminars	11
Core Courses	7
Data Informatics and Advanced Lectures	12-15
Research	6
Electives	33-36

Additional Requirements

Concepts, Models, and Systems Seminars

Students must take BIOL:6299 Concepts, Models, and Systems in Biology (COSMOS) Seminar II on an A-F graded basis. They may substitute another 2 s.h. seminar for BIOL:6299 with approval of the director of graduate studies.

Course #	Title	Hours
All of these (11 s.h.):		
BIOL:6298	Concepts, Models, and Systems in Biology (COSMOS) Seminar I (taken five fall semesters for 1 s.h. each)	5
BIOL:6299	Concepts, Models, and Systems in Biology (COSMOS) Seminar II (taken three spring semesters for 2 s.h. each)	6

Students enrolled longer than the typical five years to complete the degree apply additional enrollments of these courses toward electives. Should a student complete the degree in less than five years, another elective course would be substituted to reach the overall credit hours for the degree.

Core Courses

Students must earn a B-minus or above in both BIOL:5312 Critical Analysis of Biological Research: Concepts, Methods, and Interpretation and BIOL:5512 Readings in Genetics; students who earn a lower grade in either will be required to retake the course. A grade lower than B-minus in two attempts of either course will result in dismissal from the program.

Students must take BIOL:6188 Seminar: Writing in Natural Sciences on an A-F graded basis.

Students must take BIOL:7270 Principles of Scholarly Integrity every four years. Additional enrollments may apply to elective credits.

Course #	Title	Hours
All of these (7 s.h.):		
BIOL:5312	Critical Analysis of Biological Research: Concepts, Methods, and Interpretation	2
BIOL:5512	Readings in Genetics (taken in the second year, fall semester)	2
BIOL:6188	Seminar: Writing in Natural Sciences	2
BIOL:7270/ PSY:7270	Principles of Scholarly Integrity	1

Data Informatics and Advanced Lectures

Students must take one data informatics course and two advanced lecture courses. Students take a fourth class in either category.

Data Informatics Courses

Course #	Title	Hours
At least one of these:		
BIOL:3212/ IGPI:3212	Bioinformatics for Beginners	3
BIOL:4213/ GENE:4213/ IGPI:4213	Bioinformatics	4
BIOL:4386	Introduction to Scientific Computing for Biologists	3
BIOS:4120	Introduction to Biostatistics	3
BIOS:5710/ IGPI:5710	Biostatistical Methods I	4
BIOS:5720/ IGPI:5720	Biostatistical Methods II	4
BIOS:5730/ IGPI:5730	Biostatistical Methods in Categorical Data	3
BIOS:6810	Bayesian Methods and Design	3
BMB:4310/ BME:4310	Computational Biochemistry	3
BME:5335	Computational Bioinformatics	3
ISE:4172	Big Data Analytics	3
IGPI:4200/ STAT:4200	Statistical Methods and Computing	3
IGPI:5110/CS:5110	Introduction to Informatics	3

Advanced Lecture Courses

Students must complete BIOL:5412 Fundamental Genetics - Graduate Lecture unless they completed an equivalent course during their undergraduate studies, in which case they select an additional course from this list.

Course #	Title	Hours
This course:		
BIOL:5412	Fundamental Genetics - Graduate Lecture	3
At least one of these:		

BIOL:3212/ IGPI:3212	Bioinformatics for Beginners	3
BIOL:3233	Introduction to Developmental Biology	3
BIOL:3244	Animal Behavior	3
BIOL:3245	Animal Behavior Laboratory	4
BIOL:3314/ IGPI:3314	Genomics	3
BIOL:3343	Animal Physiology	3
BIOL:3363	Plant Developmental Biology	3
BIOL:3713	Molecular Genetics	4
BIOL:4333	Genes and Development	3
BIOL:4373/ IGPI:4373	Molecular Evolution: Genes, Genomes, and Organisms	3
BIOL:4386	Introduction to Scientific Computing for Biologists	3
BIOL:5172	Evolution - Graduate Lecture	3
BIOL:5472	Foundations of Evolutionary Theory	3
BIOL:5653/ NSCI:5653/ PSY:5203	Fundamental Neurobiology I	3
BIOL:5654/ NSCI:5654/ PSY:5205	Fundamental Neurobiology II	3
BMED:5207	Principles of Molecular and Cellular Biology	3
EPID:4400	Epidemiology I: Principles	3
FRRB:7001/ CBIO:7001/ PATH:7001	Molecular and Cellular Biology of Cancer	3
GENE:7191	Human Molecular Genetics	3
IMMU:6247/ MICR:6247	Graduate Immunology and Human Disease	4
PATH:5270/ IGPI:5270/ MMED:5270	Pathogenesis of Major Human Diseases	3

Alternative Advanced Lecture Courses

Students may substitute one advanced lecture course with three of the following 1 s.h. courses; they may substitute two advanced lecture courses with six of the following courses.

Course #	Title	Hours
ACB:5224	Graduate Seminar in Cell and Developmental Biology	1
ACB:6200/ GENE:6200	Current Topics in Genetics	1
ACB:6227/ MMED:6227/ MPB:6227	Cell Fate Decisions	1
ACB:6239	Critical Thinking in Cell Biology	1
ACB:6249	Critical Thinking in Cellular Physiology	1
BMB:5244/ PHAR:5542	Molecular Recognition	1
BMB:5875/ CBE:5875/ CEE:5875/ CHEM:5875/ MICR:5875/ PHAR:5875	Perspectives in Biotechnology	1

BMB:7254	Metabolism I	1
BMB:7255	Metabolism II	1
BMB:7256	Molecular Biology	1
PCOL:5204	Basic Biostatistics and Experimental Design	1

Research

Students are required to complete a minimum of 6 s.h. in BIOL:6199 Research: Biology. Additional enrollments beyond the 6 s.h. minimum can be applied toward the electives requirement.

Electives

Elective courses must bring the total credit for the degree to a minimum of 72 s.h. The remaining coursework is tailored to a student's background and career goals and is selected in consultation with the student's advisory committee; research may be counted toward elective credits as described in the preceding section titled "Research."

Elective courses may include additional courses from the preceding data informatics and advanced lecture categories; biology coursework (prefix BIOL) numbered 3000 or above, excluding BIOL:3172, BIOL:3245, BIOL:3626, BIOL:3655, BIOL:3656, BIOL:3676, BIOL:3710, BIOL:3730, BIOL:3714, and BIOL:6899; biostatistics coursework (prefix BIOS) numbered 3000 or above; or courses from the following list. Additional courses not listed here may be considered for approval by the student's advisor.

Students may count BIOL:5110 Practicum: College Teaching for Biology Teaching Assistants a maximum of twice toward this elective requirement.

Course #	Title	Hours
BAIS:6480/ IGPI:6480	Knowledge Discovery	3
CS:3010	Software Engineering Fundamentals in Java	3
CS:3210	Programming Languages and Tools	arr.
CS:3980	Topics in Computer Science I	3
CS:4400	Database Systems	3
CS:4500	Research Methods in Human-Computer Interaction	3
CS:4510	Human-Computer Interaction for Computer Science	3
CS:5110/IGPI:5110	Introduction to Informatics	3
CS:5980	Topics in Computer Science III	arr.
EALL:7475	ePortfolio in College Teaching	3
GRAD:7400	Practicum in College Teaching	arr.
PSQF:4143/ STAT:4143	Introduction to Statistical Methods	3
PSQF:6203	Tools and External Representations in Individual and Social Learning	3
PSQF:6205	Design of Instruction	3

PSQF:6211	Universal Design and Accessibility for Online Instruction	3
PSQF:6214	Design of Learning Environments: Theory, Practice, and Method	3
PSQF:6215	Online Instruction: Design and Facilitation	3
PSQF:6216	Tools and Utilities for Online Teaching	3
PSQF:6217/ GRAD:6217	Seminar in College Teaching	1-3
RHET:5352	Seminar: Topics in Teaching and Professional Development	3
RHET:7940	Public Speaking for Academics	3
SEES:4580/ IGPI:4581	Introduction to Geographic Databases	3
STAT:4540/ BAIS:4540/ DATA:4540/ IGPI:4540	Statistical Learning	3

Additional PhD Requirements

The comprehensive examination is taken in the summer of the second year in residence. Students prepare a National Institutes of Health/National Science Foundation-style grant application on their planned thesis work and orally defend this work in front of a review committee. They must demonstrate knowledge of biology fundamentals and the analytic and synthetic skills necessary to become creative, independent scientists. Once they complete the coursework and proficiency requirements and pass the comprehensive examination, students may be admitted to full candidacy for the PhD.

Students must serve as teaching assistants for at least two semesters in order to develop and demonstrate teaching proficiency. The first teaching semester takes place during the spring of a student's first year and is preceded by extensive departmental training in effective teaching skills (BIOL:5110).

The department also offers career seminars that explore types of employment outside of academic research, including teaching careers and other topics.

The program culminates in students' preparation of a dissertation based on original independent research. Students must pass a final examination that covers the thesis and its specialized field before the PhD is awarded.

Combined Programs

PhD/MD

Students may work toward the Doctor of Medicine degree and a PhD in integrated biology in a combined degree program offered by the Carver College of Medicine and the Graduate College. Applicants must be admitted to both programs before they may be admitted to the combined degree program. See the Medical Scientist Training Program (Carver College of Medicine) in the catalog.

Admission

Application materials for the graduate program must be uploaded to the university's Admissions website. These are

reviewed by the Department of Biology Graduate Recruitment and Admissions Committee. For detailed instructions, visit Graduate Admissions Process on the integrated biology graduate program website.

Applicants must hold a valid BA or BS from an accredited institution. They should supply official transcripts from each undergraduate and graduate institution they have attended. The Graduate Record Examination (GRE) General Test is not required for admission, but if students wish to have their results considered they must include their verbal, quantitative, and analytical writing scores.

Successful applicants for graduate admission typically have a grade-point average of at least 3.00 on a 4.00 scale. The admissions committee also considers letters of recommendation, a personal statement, and other appropriate criteria, especially prior research experience.

Although most applicants will have completed undergraduate programs in biology, the department also considers applicants with backgrounds in related sciences, provided they have taken the required coursework. Students with bachelor's degrees in other areas may need to register as nondegree students and complete the equivalent of the department's bachelor's degree program prior to consideration for admission. Nondegree students may be asked to complete chemistry, physics, and calculus in addition to the biology courses listed in the undergraduate program. Nondegree students should consult the department's graduate program administrator before applying.

Review of applications typically begins by Dec. 1; visit the iBio Graduate Program website for updated application information and instructions. Applications are reviewed on a rolling basis until available slots for the interview weekend (typically held in late February) are filled.

Applicants must meet the minimum admission requirements of the Graduate College; see the Manual of Rules and Regulations on the Graduate College website.

Career Advancement

The graduate program in integrated biology prepares students for careers in academic research, science education, industry, government, and a variety of other careers in which their scientific expertise can be used.

The Pomerantz Career Center offers multiple resources to help students find internships and jobs.

Academic Plans

Sample Plan of Study

Sample plans represent one way to complete a program of study. Actual course selection and sequence will vary and should be discussed with an academic advisor. For additional sample plans, see MyUI.

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This sample plan is currently being reviewed and will be added at a later date.