

INTEGRATIVE BIOLOGY

Chair: Michael Greene

Program Assistant: Barbara Schmidt, Barbara McClure

Graduate Program Director: Michael Wunder
(michael.wunder@ucdenver.edu)

Health Careers Advising: Trishia Vasquez, Kenneth English

BA/BS-MD Program Coordinator: Kenneth English

Lab Coordinator: James Salmen

Office: Science, 2071

Telephone: 303-556-8440

Fax: 303-556-4352

Website: clas.ucdenver.edu/biology/ (<http://clas.ucdenver.edu/biology/>)

Overview

MS in Biology

The MS in Biology program offers students the opportunity to receive advanced training and research experience in an area of specialization of one of our nationally and internationally recognized faculty members. The master's program is designed to prepare graduate students for careers in research and teaching; for employment in business, industry and government; for existing career advancement; and for continuing post-baccalaureate work in PhD and professional programs. Students in the program specialize in fields ranging from cell and molecular biology to ecology and evolution.

The master's program is a research-based program. Applicants to the program must have a declared area of specialization that aligns with the research focus of a biology graduate faculty member. Faculty expertise can be found undergraduate faculty profiles on the Department of Integrative Biology website (clas.ucdenver.edu/biology/ (<http://clas.ucdenver.edu/biology/>)). Students must contact prospective faculty advisors to determine if openings are available within the faculty member's research group.

Click here (<http://catalog.ucdenver.edu/cu-denver/graduate/schools-colleges-departments/college-liberal-arts-sciences/integrative-biology/biology-ms/>) to learn about the **Biology MS** requirements.

PhD in Integrative and Systems Biology

The PhD program in Integrative and Systems Biology at the University of Colorado Denver is a multidisciplinary, dual campus program that offers students opportunities to address complex questions in biology using computational, laboratory and field approaches. The more than 40 program faculty members allow students to participate on a diversity of projects at all levels of biological organization, ranging from ecology and environmental microbiology to biochemistry, developmental biology and neuroscience. Depending on the track an incoming student chooses, the approach will either be to explore the problem at multiple levels of biological organization (integrative biology) or to explore the multi-component nature of a biological system (systems biology).

The PhD program is research-based. Applicants to the program must have a declared area of specialization that aligns with the research focus of a program graduate faculty member. Faculty expertise can be found undergraduate faculty profiles on the Department of Integrative Biology website (clas.ucdenver.edu/biology/ (<http://clas.ucdenver.edu/biology/>)). Students must contact prospective faculty advisors to determine if openings are available within the faculty member's research group.

Click here (<http://catalog.ucdenver.edu/cu-denver/graduate/schools-colleges-departments/college-liberal-arts-sciences/integrative-biology/integrative-systems-biology-phd/>) to learn about the **Integrative and Systems Biology PhD** requirements.

Requirements for Admission MS

- A BA/BS from an accredited institution awarded within the last 10 years (validation of current content may be required)
- Minimum undergraduate GPA: 3.0
- TOEFL: required for international applicants from countries in which English is not the official language
- 3 letters of recommendation
- Official transcripts from all attended institutions
- Students are required to contact faculty in advance. Prior to application, applicants must have identified and contacted an available Faculty Advisor to ensure the availability of a position and appropriate research interests

Prerequisite courses required:

- One year of general biology (lecture and laboratory)
- One year of any combination of chemistry, physics or mathematics
- One course in applied or biological statistics (through regression and ANOVA)
- Additional prerequisite requirements may be set by individual faculty

Application deadline is December 1 for both domestic U.S. and international students. Application to the master's in biology program is through CU Denver Admissions.

Requirements for Admission PhD

- A BA/BS or MS from an accredited institution awarded within the last 10 years (validation of current content may be required). Minimum undergraduate GPA: 3.0
- TOEFL: required for international applicants from countries in which English is not the official language
- 3 letters of recommendation
- Official transcripts from all attended institutions
- Students are required to contact faculty in advance. Prior to application, applicants must have identified and contacted an available Faculty Advisor to ensure availability of a position and appropriate research interests

Prerequisite courses required:

- One year of General Biology is preferred. Where needed, supplementary courses or reading programs may be designed to provide background information of sufficient depth for the Program curriculum
- One course in applied or biological statistics (through regression and ANOVA)
- Additional prerequisite requirements may be set by individual faculty

Applications will be considered annually starting December 1 for both domestic US students and international students. Application to the PhD program is through CU Denver Admissions.

Programs

- Biology, MS (<http://catalog.ucdenver.edu/cu-denver/graduate/schools-colleges-departments/college-liberal-arts-sciences/integrative-biology/biology-ms/>)
- Integrative and Systems Biology, PhD (<http://catalog.ucdenver.edu/cu-denver/graduate/schools-colleges-departments/college-liberal-arts-sciences/integrative-biology/integrative-systems-biology-phd/>)

Faculty

Professors:

Michael J. Greene, PhD, Oregon State University
John G. Swallow, PhD, University of Wisconsin Madison
Diana F. Tomback, PhD, University of California, Santa Barbara

Associate Professors:

Laurel Hartley, PhD, Colorado State University
Christopher S. Miller, PhD, University of California Los Angeles
Annika Mosier, PhD, Stanford University
Christopher J. Phiel, PhD, Thomas Jefferson University
Gregory Ragland, PhD, University of North Carolina Chapel Hill
Timberley M. Roane, PhD, University of Arizona
Alan Vajda, PhD, University of Colorado Boulder
Michael Wunder, PhD, Colorado State University

Assistant Professors:

Sara Branco, PhD, University of Chicago
Carlos Infante, PhD, Harvard University
Michael Moore, PhD, Case Western Reserve University

Senior Instructors:

Hannah Anchochoquy, PhD, University of Colorado Boulder
Laurel Beck, PhD, Michigan State University
Gene Brooks, DDS, University of Missouri
David Knochel, PhD, University of Colorado Boulder
Lisa Johansen, PhD, University of Alabama
Erin Kelso, PhD, University of Indiana
Paul Le, PhD, University of Colorado Denver
Molly Nepokroeff, PhD, University of Wisconsin Madison
Kimberly F. Regier, EdD, University of Colorado Denver

Emeritus Faculty:

Gerald Audesirk, PhD, California Institute of Technology
Teresa E. Audesirk, PhD, University of Southern California
Leo P. Bruederle, PhD, Rutgers, the State University of New Jersey
Linda K. Dixon, PhD, University of Illinois
John H. Freed, PhD, Stanford University
Charles A. Ferguson, PhD, University of Colorado Boulder
Bradley J. Stith, PhD, Washington State University

Biology (BIOL) Courses

BIOL 5024 - Introduction to Biotechnology (3 Credits)
 Introduces aspects of biotechnology within a historical context, including medical, forensic, agricultural and microbial biotechnology. Addresses principles behind state-of-the-field techniques in recombinant DNA technology, bioinformatics, proteomics and genomics. Biotechnology regulations and ethics will also be discussed. Restriction: Restricted to degree granting graduate programs on the downtown campus as well as the School of Medicine on the Anschutz Medical campus. Cross-listed with BIOL 4024. Max hours: 3 Credits.

Grading Basis: Letter Grade

Restriction: Restricted to degree granting graduate programs on the downtown campus as well as the School of Medicine on the Anschutz Medical campus.

BIOL 5050 - Advanced Biology Topics (1-8 Credits)

Examines current topics in the field of biology. Topics vary from term to term. See Schedule Planner for current topics. Restriction: Restricted to degree-granting graduate programs. Cross-listed with BIOL 4050.

Repeatable. Max hours: 9 Credits.

Grading Basis: Letter Grade

Repeatable. Max Credits: 9.

Restriction: Restricted to degree-granting graduate programs

BIOL 5052 - Advanced Ecology (3 Credits)

This combination seminar and lecture course focuses on state-of-field knowledge, current theories and recent models in selected areas of ecology, such as theoretical ecology, evolutionary ecology, population biology and ecosystems ecology. Restriction: Restricted to degree-granting graduate programs. Cross-listed with BIOL 4052. Max hours: 3 Credits.

Grading Basis: Letter Grade

Restriction: Restricted to degree-granting graduate programs

BIOL 5053 - Infectious Disease Ecology (3 Credits)

The study of the underlying principles that influence the spatio-temporal patterns of infectious disease in environments. Students will apply ecological theories about concepts such as biodiversity, trophic interactions, landscape structure, and nutrient cycling to the study of disease. Restriction: Restricted to degree-granting graduate programs. Cross-listed with BIOL 4053. Max hours: 3 Credits.

Grading Basis: Letter Grade

Restriction: Restricted to degree-granting graduate programs

BIOL 5055 - Virology (3 Credits)

This is an upper level undergraduate/graduate class providing an in-depth study of the history of virology, different types of viruses, viral disease, research to combat viral infections, and different uses of viruses in biotechnology. Note: Students will not earn credit for this course if they have already earned credit for BIOL 4051 or BIOL 5051. Restriction: Restricted to degree-granting graduate programs. Cross-listed with BIOL 4055. Max hours: 3 Credits.

Grading Basis: Letter Grade

Restriction: Restricted to degree-granting graduate programs

BIOL 5064 - Cell Biology of Disease (3 Credits)

Builds on the foundations laid in the prerequisite courses. How alterations in membrane transport, autophagy, mitochondria, lysosomes, cilia, unfolded protein response and autophagy lead to major human diseases. A major emphasis is the control and integration of cellular activities. Restriction: Restricted to degree-granting graduate programs. Cross-listed with BIOL 4064. Max hours: 3 Credits.

Grading Basis: Letter Grade

Restriction: Restricted to degree-granting graduate programs

BIOL 5125 - Molecular Biology Lab (3 Credits)

Provides hands-on experiences in molecular biology and an appreciation for using the tools of molecular biology to study biological systems.

Emphasis is placed on DNA cloning, PCR, mRNA and protein detection in the context of gene editing. Experimental design and the theories underlying the techniques are also discussed. Restriction: Restricted to degree granting graduate programs on the downtown campus as well as the School of Medicine on the Anschutz Medical campus. Cross-listed with BIOL 4125. Term offered: spring. Max hours: 3 Credits.

Grading Basis: Letter Grade

Restriction: Restricted to degree granting graduate programs on the downtown campus as well as the School of Medicine on the Anschutz Medical campus.

Typically Offered: Spring.

BIOL 5126 - Molecular Genetics (3 Credits)

Examines molecular techniques and their application to experimental genetics, specifically organization and mapping of genomes, application and model systems in defining hereditary components of disease, and mechanisms of identifying mutations and their implications for disease. Also addresses application of recombinant DNA technology. Restriction: Restricted to degree-granting graduate programs. Cross-listed with BIOL 4126. Max hours: 3 Credits.

Grading Basis: Letter Grade

Restriction: Restricted to degree-granting graduate programs

BIOL 5134 - Human Genetics (3 Credits)

Advanced survey of the current status of the field. Emphasis on understanding, diagnosis and treatment of genetic disease and on the impact of molecular biology on human genetics. Restriction: Restricted to degree-granting graduate programs. Cross-listed with BIOL 4134. Max hours: 3 Credits.

Grading Basis: Letter Grade

Restriction: Restricted to degree-granting graduate programs

BIOL 5144 - Medical Microbiology (3 Credits)

Provides an understanding of the relationship between pathogenic organisms and their host. Emphasis is placed on the area of medical bacteriology, with attention given to mechanisms of pathogenesis, genetics of disease, serology and treatment. Restriction: Restricted to degree-granting graduate programs. Cross-listed with BIOL 4144. Max hours: 3 Credits.

Grading Basis: Letter Grade

Restriction: Restricted to degree-granting graduate programs

BIOL 5154 - Conservation Biology (3 Credits)

Basic concepts and theories in population biology and genetics as they apply to issues relating to the preservation of biodiversity, such as the genetics of small populations, captive propagation, restoration ecology and the design of nature reserves. Restriction: Restricted to degree-granting graduate programs. Cross-listed with BIOL 4154. Max hours: 3 Credits.

Grading Basis: Letter Grade

Restriction: Restricted to degree-granting graduate programs

BIOL 5165 - Neurobiology (3 Credits)

Overview of neuroscience, covering the cellular basis of neuronal activity, sensory structures and the structure and function of the human brain. Restriction: Restricted to degree-granting graduate programs. Cross-listed with BIOL 4165. Max hours: 3 Credits.

Grading Basis: Letter Grade

Restriction: Restricted to degree-granting graduate programs

BIOL 5225 - Genomics and Bioinformatics (3 Credits)

Explores how genome-wide data are collected and analyzed. Example applications include human disease, microbial evolution, ecological genomics, and parasite drug resistance. Students implement projects based on real DNA sequencing data. Restriction: Restricted to degree-granting graduate programs. Cross-listed with BIOL 4225. Max hours: 3 Credits.

Grading Basis: Letter Grade

Restriction: Restricted to degree-granting graduate programs

BIOL 5250 - Mechanisms of Animal Behavior (3 Credits)

The proximate and ultimate mechanisms of animal behavior are analyzed using comparative animal examples from the scientific literature.

Proximate mechanisms include genetic and physiological processes.

Ultimate mechanisms include the role of natural and sexual selection in the evolution of behavior. Restriction: Restricted to degree-granting graduate programs. Cross-listed with BIOL 4250. Max hours: 3 Credits.

Grading Basis: Letter Grade

Restriction: Restricted to degree-granting graduate programs

BIOL 5335 - Plant Structure and Development (4 Credits)

Inclusive and in-depth study of functional anatomy and biology of vascular plants. Topics include: plant biochemistry, biology of the plant cell, simple and complex tissues, secretory structures, functional anatomy, primary and secondary growth, angiosperm reproduction and life cycles, development and additional topics. Responsibilities include lectures, lab, and potential field trips. Course must be taken with both lecture and lab together. Restriction: Restricted to degree-granting graduate programs. Cross-listed with BIOL 4335. Max hours: 4 Credits.

Grading Basis: Letter Grade

Restriction: Restricted to degree-granting graduate programs

Typically Offered: Spring.

BIOL 5345 - Flora of Colorado (4 Credits)

Inclusive and in-depth study of functional anatomy and biology of vascular plants. Topics include: plant biochemistry, biology of the plant cell, simple and complex tissues, secretory structures, functional anatomy, primary and secondary growth, angiosperm reproduction and life cycles, development and additional topics. Responsibilities include lectures, lab, and potential field trips. Course must be taken with both lecture and lab together. Restriction: Restricted to degree-granting graduate programs. Cross-listed with BIOL 4345. Max hours: 4 Credits.

Grading Basis: Letter Grade

Restriction: Restricted to degree-granting graduate programs

BIOL 5410 - Microbial Genomics (3 Credits)

Microbial genomics is being used to address many current medical and environmental challenges (e.g., COVID-19 pandemic, bioremediation of contaminated water). In this class, you will learn how to investigate microbial genomes and predict microbial function (e.g., metabolism, motility) through gene/protein analyses. We will predict microbial responses to environmental conditions such as viral infection (e.g., CRISPR signatures) and antibiotic exposure (e.g., resistance genes). We will apply our knowledge to analyze real microbial genome sequence data and synthesize our findings in a written manuscript format. We will communicate our science to non-scientists in order to deepen our own learning and to make an impact on our communities. Restriction: Restricted to Graduate and Graduate Non-Degree Majors. Cross-listed with BIOL 4410. Max hours: 3 Credits.

Grading Basis: Letter Grade

Restriction: Restricted to Graduate and Graduate Non-Degree Majors

BIOL 5415 - Applied Microbial Ecology (3 Credits)

An in-depth study of ecology as it relates to microorganisms; abiotic and biotic interactions within microbial populations in macro- and microhabitats; and the role of microorganisms in influencing and responding to environmental conditions in natural and anthropogenic ecosystems. Emphasis is placed on how the ecology of microorganisms impacts how we engage with our environment. Restriction: Restricted to degree-granting graduate programs. Cross-listed with BIOL 4415. Max hours: 3 Credits.

Grading Basis: Letter Grade

Restriction: Restricted to degree-granting graduate programs

Typically Offered: Fall, Spring.

BIOL 5425 - Biogeography (3 Credits)

An in-depth study of biological populations through analysis of geographic distribution patterns in space and time. Emphasis on how biogeography informs studies of evolution and ecology and on applied studies in conservation, sustainability, epidemiology, and disease dynamics. Restriction: Restricted to degree-granting graduate programs. Cross-listed with BIOL 4425. Max hours: 3 Credits.

Grading Basis: Letter Grade

Restriction: Restricted to degree-granting graduate programs

BIOL 5430 - Introduction to Spatial Ecology (3 Credits)

Focuses on patterns of life and ecological interactions in space. Emphasis on drivers of patterns, practical application of spatial ecology software, programming, and introductory spatial statistics on the quantification of patterns. Main topics: Scale and scaling, pattern development, detecting and characterizing patterns, temporal dynamics, and implications of spatial structure to conservation biology, resilience, and ecosystem functioning. Cross-listed with BIOL 4430. Restriction: Restricted to degree-granting graduate programs. Max hours: 3 Credits.

Grading Basis: Letter Grade

Restriction: Restricted to degree-granting graduate programs

BIOL 5440 - Ethnobotany: Medicine, Human Health and the Ecosystem Services of Plants (3 Credits)

This course explores various aspects of ethnobotany. One emphasis will be on the utilization of plants in various aspects of life including human health, fiber, nutrition, and shelter, beginning with a consideration of indigenous wisdom and traditions in native cultures, in primarily north, central, and south America. A second major emphasis will be on plant secondary metabolites and their utilization in traditional and modern medications and medical breakthroughs. A third major course emphasis will survey and explore several case-studies on the roles of plants in applied ecological contexts, global economies, and ecosystem services, highlighting case studies in conservation and sustainability. Note: Recommended completion of at least one upper division BIOL course.

Prereq: BIOL 2010 (or 2061/2097/2030), BIOL 2011 (or 2081/2098/2031), BIOL 2020 (or 2051/2095/2040), and BIOL 2021 (or 2071/2096/2041) with a C- or higher AND junior standing. Cross-listed with BIOL 4440. Max hours: 3 Credits.

Grading Basis: Letter Grade

Prereq: BIOL 2010 (or 2061/2097/2030), BIOL 2011 (or 2081/2098/2031), BIOL 2020 (or 2051/2095/2040), and BIOL 2021 (or 2071/2096/2041) with a C- or higher AND junior or higher status.

Typically Offered: Fall.

BIOL 5460 - Environmental Toxicology (3 Credits)

Text and literature-based course provides students with background knowledge concerning environmental toxins, the nature and extent of environmental contamination, and toxicant effects on individual organisms and populations. Restriction: Restricted to degree-granting graduate programs. Cross-listed with BIOL 4460. Max hours: 3 Credits.

Grading Basis: Letter Grade

Restriction: Restricted to degree-granting graduate programs

BIOL 5463 - Exercise Physiology (4 Credits)

Examines how the systems of the body function to support increased and sometimes extreme energy expenditure associated with exercise. Laboratory component provides the opportunity to learn about the techniques and measurements associated with the assessment of fitness. Restriction: Restricted to degree-granting graduate programs. Cross-listed with BIOL 4463. Term offered: fall. Max hours: 4 Credits.

Grading Basis: Letter Grade

Restriction: Restricted to degree-granting graduate programs

Typically Offered: Fall.

BIOL 5494 - Population and Evolutionary Genetics (3 Credits)

Introduces the genetic processes underlying evolutionary change in microbial, plant and animal populations. Topics include: sources of variation, Hardy-Weinberg equilibrium, population genetic structure, natural selection and other evolutionary forces, quantitative genetics and molecular phylogenetics. Emphasis on experimental data. Restriction: Restricted to degree-granting graduate programs. Cross-listed with BIOL 4494. Max hours: 3 Credits.

Grading Basis: Letter Grade

Restriction: Restricted to degree-granting graduate programs

BIOL 5550 - Cell Signaling (3 Credits)

Lecture by faculty and student presentations cover mechanism of hormones and regulation of various cellular processes through second messenger systems. Restriction: Restricted to degree-granting graduate programs. Cross-listed with BIOL 4550. Max hours: 3 Credits.

Grading Basis: Letter Grade

Restriction: Restricted to degree-granting graduate programs

BIOL 5634 - Biology of Cancer (3 Credits)

Cancer is the second leading cause of death in the United States. This course offers an overview of recent research into the causes, treatments and possible prevention of cancer. Includes a detailed look at the mechanisms of action of various oncogenes. Restriction: Restricted to degree-granting graduate programs. Cross-listed with BIOL 4634. Max hours: 3 Credits.

Grading Basis: Letter Grade

Restriction: Restricted to degree-granting graduate programs

BIOL 5644 - Advanced Human Anatomy Laboratory (2 Credits)

Advanced laboratory course in human anatomy. In-depth look at the structural aspects of the human body, emphasizing function. Models, microscope slides, and visual media will supplement cadaver-based dissections. Restriction: Restricted to degree-granting graduate programs. Cross-listed with BIOL 4644. Term offered: fall, spring. Max hours: 2 Credits.

Grading Basis: Letter Grade

Restriction: Restricted to degree-granting graduate programs

Typically Offered: Fall, Spring.

BIOL 5674 - Endocrinology (3 Credits)

This systematic survey of the endocrine system looks at the cellular basis and biochemical characteristics of individual endocrine tissues. Their function in the regulation of other endocrinological, physiological, and behavioral events is analyzed. The course emphasizes the human system and complements studies in physiology, behavior and neurobiology. Restriction: Restricted to degree-granting graduate programs. Cross-listed with BIOL 4674. Max hours: 3 Credits.
Grading Basis: Letter Grade
Restriction: Restricted to degree-granting graduate programs

BIOL 5780 - Aquatic Ecology (3 Credits)

This course explores the physical, chemical, and biological (including human) properties of aquatic ecosystems, and how the interrelationships between these properties define and influence advanced ecological processes. Special focus is given to lakes, reservoirs, wetlands, streams, rivers, and groundwater. Learning is facilitated through lectures, discussions, student presentations, laboratory and data exercises, and periodic (often virtual) field excursions. Restriction: Restricted to degree-granting graduate programs. Cross-listed with BIOL 4780, ENVS 4780, and ENVS 5780. Max hours: 3 Credits.
Grading Basis: Letter Grade
Restriction: Restricted to degree-granting graduate programs

BIOL 5815 - Structural Biology of Neurodegenerative Diseases (3 Credits)

Advanced course in Biochemistry/Biophysics. Principles of Protein Folding, Structure-Function Relationship, and spectroscopic techniques related to characterization of these processes as applied to neurodegenerative diseases such as Parkinson's and Alzheimer's. Restriction: Restricted to degree-granting graduate programs. Cross-listed with CHEM 4815, BIOL 4815, and BIOL 4815. Max hours: 3 Credits.
Grading Basis: Letter Grade
Restriction: Restricted to degree-granting graduate programs

BIOL 5825 - Biochemistry of Metabolic Disease (3 Credits)

Advanced course in biochemistry. An expanded study of selected topics in metabolism and how they relate to diseases, including inflammation, diabetes, obesity, and rare genetic disorders. Restriction: Restricted to degree-granting graduate programs. Cross-listed with CHEM 4825, CHEM 5825, and BIOL 4825. Max hours: 3 Credits.
Grading Basis: Letter Grade
Restriction: Restricted to degree-granting graduate programs

BIOL 5835 - Biochemistry of Gene Regulation and Cancer (3 Credits)

Explores the biochemical and molecular aspects of cancer biology. Topics include DNA mutations and repair, gene regulation, oncogenes and tumor suppressors, stem cells and differentiation, and cancer drug development. Restriction: Restricted to degree-granting graduate programs Cross-listed with CHEM 4835, CHEM 5835, and BIOL 4835. Max hours: 3 Credits.
Grading Basis: Letter Grade
Restriction: Restricted to degree-granting graduate programs

BIOL 5840 - Independent Study: BIOL (1-3 Credits)

Note: Students must submit a special processing form completely filled out and signed by the student and faculty member, describing the course expectations, assignments and outcomes, to the CLAS Graduate Academic Services Coordinator for approval. Term offered: fall, spring, summer. Repeatable. Max hours: 6 Credits.
Grading Basis: Letter Grade
Repeatable. Max Credits: 6.
Restriction: Restricted to degree-granting graduate programs
Typically Offered: Fall, Spring, Summer.

BIOL 5910 - Field Studies (3 Credits)

Field studies of individuals, populations and communities comprising a specified ecosystem. Emphasis on field identification of vascular plants and vertebrate animals. Topics include the physical environment, biotic and abiotic interactions, life history, ecological adaptations and biogeography. Note: Lectures and a week-long field trip. Restriction: Restricted to degree-granting graduate programs. Cross-listed with BIOL 4910. Max hours: 3 Credits.
Grading Basis: Letter Grade
Restriction: Restricted to degree-granting graduate programs

BIOL 5939 - Internship (1-6 Credits)

Designed experience involving application of specific, relevant concepts and skills in supervised employment situations. Note: Students must submit a special processing form completely filled out and signed by the student and faculty member, describing the course expectations, assignments and outcomes, to the CLAS Graduate Academic Services Coordinator for approval. Restriction: Restricted to degree-granting graduate programs. Term offered: fall, spring, summer. Repeatable. Max hours: 9 Credits.
Grading Basis: Letter Grade
Repeatable. Max Credits: 9.
Restriction: Restricted to degree-granting graduate programs
Typically Offered: Fall, Spring, Summer.

BIOL 5974 - Advanced Evolution (3 Credits)

A capstone course that draws upon concepts from all fields of biology. Topics include the fossil record mass extinctions, the historical development of the modern synthesis, principles and mechanisms of evolution, current viewpoints and controversies. Restriction: Restricted to degree-granting graduate programs. Cross-listed with BIOL 4974. Max hours: 3 Credits.
Grading Basis: Letter Grade
Restriction: Restricted to degree-granting graduate programs

BIOL 6002 - Biology Skills Sets - Pedagogy (2 Credits)

The purpose is to introduce sound practice in teaching and innovation in pedagogy. Topics covered will include assessment techniques, creation of learning goals, and research methods in biological education. Restriction: Restricted to degree-granting graduate programs. Term offered: fall. Max hours: 2 Credits.
Grading Basis: Letter Grade
Restriction: Restricted to degree-granting graduate programs
Typically Offered: Fall.

BIOL 6655 - Seminar (1 Credit)

The purpose is to introduce disciplinary practices in presenting scientific research. Provides instruction for oral and poster presentations through a combination of seminars and panels comprising faculty and visiting scholars. Restriction: Restricted to degree-granting graduate programs. Cross-listed with BIOL 4990. Repeatable. Max Hours: 2 Credits.
Grading Basis: Letter Grade
Repeatable. Max Credits: 2.
Restriction: Restricted to degree-granting graduate programs

BIOL 6705 - Biological Research Workshop (2 Credits)

For graduate and advanced undergraduate students who are directly engaged in original research. Provides introduction to the discovery dissemination and peer review process associated with writing research proposals, manuscripts, and grants, as well as poster and oral presentations. Students will workshop each other's original research. Graduate students enroll in 6705; research-active undergraduates enroll in 5705. Cross-listed with BIOL 5705. Prereq: Students involved in original research and permission of instructor. Restriction: Restricted to degree-granting graduate programs. Term offered: fall, spring. Repeatable. Max Hours: 8 Credits.

Grading Basis: Letter Grade

Repeatable. Max Credits: 8.

Restriction: Restricted to degree-granting graduate programs

Typically Offered: Fall, Spring.

BIOL 6764 - Biological Data Analysis (4 Credits)

Addresses quantitative aspects of research design, data collection and analysis in the biological sciences. Emphasizes relationships among probability theory, estimation, testing, inference, and interpretation. Includes intensive computer lab using the statistical programming software R to demonstrate both traditional analytical and contemporary simulation based (permutation, bootstrap, and Bayesian) approaches for inference in biology. Restriction: Restricted to degree-granting graduate programs. Max hours: 4 Credits.

Grading Basis: Letter Grade

Restriction: Restricted to degree-granting graduate programs

BIOL 6880 - Directed Research (1-6 Credits)

Students will engage in original research projects supervised and mentored by faculty. Students must work with faculty prior to registration to develop a proposal for their project and receive permission to take this course. Note: Students must submit a special processing form completely filled out and signed by the student and faculty member, describing the course expectations, assignments and outcomes, to the CLAS Graduate Academic Services Coordinator for approval. Restriction: Restricted to degree-granting graduate programs. Term offered: fall, spring, summer. Repeatable. Max hours: 12 Credits.

Grading Basis: Letter Grade

Repeatable. Max Credits: 12.

Restriction: Restricted to degree-granting graduate programs

Typically Offered: Fall, Spring, Summer.

BIOL 6950 - Master's Thesis (1-6 Credits)

Note: Students must submit a special processing form completely filled out and signed by the student and faculty member, describing the course expectations, assignments and outcomes, to the CLAS Graduate Academic Services Coordinator for approval. Restriction: Restricted to degree-granting graduate programs. Term offered: fall, spring, summer. Repeatable. Max hours: 6 Credits.

Grading Basis: Letter Grade with IP

Repeatable. Max Credits: 6.

Restriction: Restricted to degree-granting graduate programs

Additional Information: Report as Full Time.

Typically Offered: Fall, Spring, Summer.

BIOL 7010 - Integrative and Systems Biology (3 Credits)

Addresses current research problems in integrative biology and system biology by surveying the peer-reviewed literature. Particular attention will be paid to research topics that integrate multiple levels of biological organization and that investigate how properties of systems emerge from interactions of sub-units. Note: New students in the Integrative and Systems Biology PhD program will enroll in this course during their first year. Restriction: Restricted to degree-granting graduate programs. Max hours: 3 Credits.

Grading Basis: Letter Grade

Restriction: Restricted to degree-granting graduate programs

BIOL 7050 - Special Topics (1-3 Credits)

Readings in current biology topics. Specific topics vary and may be proposed by groups of graduate students who identify a suitable faculty instructor or by a faculty member who identifies a need for advanced study in a specialized topic of biology. Restriction: Restricted to degree-granting graduate programs. Repeatable. Max hours: 9 Credits.

Grading Basis: Letter Grade

Repeatable. Max Credits: 9.

Restriction: Restricted to degree-granting graduate programs

BIOL 7650 - Research in Integrative and Systems Biology (1-10 Credits)

Designed to allow doctoral students to conduct research for course credit prior to advancement to candidacy. Note: Students must submit a special processing form completely filled out and signed by the student and faculty member, describing the course expectations, assignments and outcomes, to the CLAS Graduate Academic Services Coordinator for approval. Prereq: Ph.D. student and permission of instructor. Restriction: Restricted to degree-granting graduate programs. Term offered: fall, spring, summer. Repeatable. Max hours: 10 Credits.

Grading Basis: Letter Grade

Repeatable. Max Credits: 10.

Restriction: Restricted to degree-granting graduate programs

Typically Offered: Fall, Spring, Summer.

BIOL 7920 - Directed Reading/Grant Writing (3 Credits)

Allows students to examine current literature related to their specialty area of biological research and to work in collaboration with a research mentor to develop a grant-based dissertation proposal in preparation for the comprehensive review examination. Note: Students must submit a special processing form completely filled out and signed by the student and faculty member, describing the course expectations, assignments and outcomes, to the CLAS Graduate Academic Services Coordinator for approval. Prereq: Students must be in the Integrative and Systems Biology PhD program and have permission from the instructor. Restriction: Restricted to degree-granting graduate programs. Term offered: fall, spring, summer. Repeatable. Max hours: 9 Credits.

Grading Basis: Letter Grade

Repeatable. Max Credits: 9.

Restriction: Restricted to degree-granting graduate programs

Typically Offered: Fall, Spring, Summer.

BIOL 8990 - Doctoral Dissertation (1-10 Credits)

Designed to allow doctoral students to conduct research for course credit after advancement to candidacy. Note: Students must submit a special processing form completely filled out and signed by the student and faculty member, describing the course expectations, assignments and outcomes, to the CLAS Graduate Academic Services Coordinator for approval. Prereq: Students must be in the Integrative and Systems Biology PhD program and have permission from the instructor. Restriction: Restricted to degree-granting graduate programs. Term offered: fall, spring, summer. Repeatable. Max hours: 30 Credits. Grading Basis: Letter Grade with IP Repeatable. Max Credits: 30. Restriction: Restricted to degree-granting graduate programs Additional Information: Report as Full Time. Typically Offered: Fall, Spring, Summer.