

# MOLECULAR, CELLULAR AND DEVELOPMENTAL BIOLOGY

In view of the strong research orientation of the fields involved, the department does not accept applications from students seeking the MA as a terminal degree. The master of arts degree, either with a thesis (Plan I) or without (Plan II), is awarded under special circumstances.

Course code for this program is MCDB.

## Doctoral Degree

- Molecular, Cellular and Developmental Biology - Doctor of Philosophy (PhD) (<https://catalog.colorado.edu/graduate/colleges-schools/arts-sciences/programs-study/molecular-cellular-developmental-biology/molecular-cellular-developmental-biology-doctor-philosophy-phd/>)

## Faculty

While many faculty teach both undergraduate and graduate students, some instruct students at the undergraduate level only. For more information, contact the faculty member's home department.

Abbott, Lois A.  
Senior Instructor Emerita

Anseth, Kristi S. ([https://experts.colorado.edu/display/fisid\\_103471/](https://experts.colorado.edu/display/fisid_103471/))  
Distinguished Professor; PhD, University of Colorado Boulder

Arnoult, Nausica Christine ([https://experts.colorado.edu/display/fisid\\_164094/](https://experts.colorado.edu/display/fisid_164094/))  
Assistant Professor; PhD, Pierre and Marie Curie University (France)

Betterton, Meredith D. ([https://experts.colorado.edu/display/fisid\\_125396/](https://experts.colorado.edu/display/fisid_125396/))  
Professor; PhD, Harvard University

Blumenthal, Thomas ([https://experts.colorado.edu/display/fisid\\_143346/](https://experts.colorado.edu/display/fisid_143346/))  
Professor, Visiting Professor; PhD, Johns Hopkins University

Boswell, Robert E. ([https://experts.colorado.edu/display/fisid\\_100196/](https://experts.colorado.edu/display/fisid_100196/))  
Professor; PhD, University of Colorado Boulder

Brumbaugh, Justin J. ([https://experts.colorado.edu/display/fisid\\_164025/](https://experts.colorado.edu/display/fisid_164025/))  
Assistant Professor; PhD, University of Wisconsin-Madison

Cech, Thomas R. ([https://experts.colorado.edu/display/fisid\\_103252/](https://experts.colorado.edu/display/fisid_103252/))  
Distinguished Professor; PhD, University of California, Berkeley

Chen, Zhe ([https://experts.colorado.edu/display/fisid\\_148754/](https://experts.colorado.edu/display/fisid_148754/))  
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Copley, Shelley ([https://experts.colorado.edu/display/fisid\\_104067/](https://experts.colorado.edu/display/fisid_104067/))  
Professor; PhD, Harvard University

DeDecker, Brian S. ([https://experts.colorado.edu/display/fisid\\_143934/](https://experts.colorado.edu/display/fisid_143934/))  
Senior Instructor; PhD, Yale University

Detweiler, Corrella Scott ([https://experts.colorado.edu/display/fisid\\_128240/](https://experts.colorado.edu/display/fisid_128240/))  
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Associate Professor; DSc, Washington University

Dubin, Mark W.  
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Espinosa, Joaquin Maximiliano ([https://experts.colorado.edu/display/fisid\\_134378/](https://experts.colorado.edu/display/fisid_134378/))  
Visiting Associate Professor; PhD, Univ of Buenos Aires (Argentina)

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Guild, Nancy Ann ([https://experts.colorado.edu/individual/fisid\\_111361/](https://experts.colorado.edu/individual/fisid_111361/))  
Professor Attendant Rank; PhD, University of Colorado

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Krauter, Kenneth S. ([https://experts.colorado.edu/display/fisid\\_107978/](https://experts.colorado.edu/display/fisid_107978/))  
Professor, Associate Chair; PhD, Yeshiva University

Kuempel, Peter L.  
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McConkey, Edwin H.  
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McIntosh, J. Richard  
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Weaver, Benjamin  
Assistant Professor; PhD, University of Kansas

Wood, William B. III  
Distinguished Professor Emeritus

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Professor; PhD, Columbia University

Yarus, Michael J.  
Professor Emeritus

## Courses

### MCDB 5201 (1) Graduate Lab in Molecular Evolution

Ever wonder what functional clues might reside in the DNA sequence of your favorite gene? In this course, graduate students will learn the fundamentals of phylogenetics with an emphasis on evolutionary models that infer selective pressures in protein-coding DNA sequences (genes). During the course, students will be working on their favorite gene and using it as a case study for applying all of the concepts that we will cover. By the end of the course they will have generated a publication-quality summary figure, along with appropriate supplemental figures, of the selective pressures shaping their favorite gene. Additionally, they will learn how to design and execute an experimental approach based off of findings from the evolutionary analysis.

**Requisites:** Restricted to graduate students only.

**Grading Basis:** Letter Grade

### MCDB 5210 (3) Cell Structure and Function (Lecture and Discussion)

#### MCDB 5220 (3) Graduate Core 2

**Requisites:** Restricted to graduate students only.

#### MCDB 5230 (3) Graduate Core 1

**Requisites:** Restricted to graduate students only.

### MCDB 5250 (3) Topics in Developmental Genetics (Methods and Logic)

**Repeatable:** Repeatable for up to 6.00 total credit hours.

### MCDB 5301 (3) Immunology

Emphasizes cellular and molecular mechanisms by which organisms protect themselves from pathogens and the experimental basis for our understanding of these processes. Discusses development, function, and malfunction of t-cells, b-cells and other components of the immune system, focusing on the human immune system.

**Equivalent - Duplicate Degree Credit Not Granted:** MCDB 4300

**Requisites:** Restricted to graduate students only.

### MCDB 5310 (3) Microbial Genetics and Physiology

Examines the physiology and genetics of bacteria, Archaea and viruses. Particular emphasis will be on metabolism, regulation of gene expression and protein function, mechanisms of interactions with and manipulation of the environment, and evolution in response to environmental pressures.

**Equivalent - Duplicate Degree Credit Not Granted:** MCDB 4310

**MCDB 5312 (3-4) Quantitative Optical Imaging**

Explores the fundamentals of optical imaging in biology, especially molecular and cellular biology. Covered topics include an introduction to optics and microscopes, fluorescence microscopy and image analysis, and biological applications. MATLAB will be taught at the beginning of the course and used throughout for image processing. Prior experience with MATLAB (or Python) is highly recommended but not required.

**Equivalent - Duplicate Degree Credit Not Granted:** BCHM 5312, MCDB 4312 and BCHM 4312

**Grading Basis:** Letter Grade

**MCDB 5350 (3) Microbial Diversity and the Biosphere**

Provides a molecular phylogeny-based perspective on microbial diversity and the interactions between organisms that result in the biosphere.

Provides overview of recent methods and findings in microbial ecology, as well as computer-based workshop in molecular phylogeny.

**Equivalent - Duplicate Degree Credit Not Granted:** MCDB 4350

**Requisites:** Restricted to graduate students only.

**MCDB 5361 (3) Evolution and Development**

Relates how recent discoveries in the molecular mechanisms of development are shaping our understanding of animal evolution. Reviews basic principles of molecular developmental biology and applies these concepts to critically discuss current research in the field of Evo-Devo (evolution and development).

**Equivalent - Duplicate Degree Credit Not Granted:** MCDB 4361

**MCDB 5425 (3) Topics in Membrane Biology: Cell Biology, Physiology and Disease**

Students will apply their knowledge of basic biology to exploring several of the most exciting topics in biomedicine including protein folding and stress responses, nutrient sensing and balance and signal transduction across membranes. Emphasis will be placed upon human physiology and associated human diseases including Alzheimer's disease, diabetes and cardiovascular disease.

**Equivalent - Duplicate Degree Credit Not Granted:** MCDB 4425

**Requisites:** Restricted to graduate students only.

**MCDB 5426 (3) Cell Signaling and Developmental Regulation**

Introduces several cell signaling processes and their biological functions. Students read and analyze original research articles to learn the thinking processes of scientific research. Writing assignments and oral presentations are required.

**Equivalent - Duplicate Degree Credit Not Granted:** MCDB 4426

**MCDB 5427 (3) Biology of the Visual System**

Explores the neurobiology, cell biology, genetics and developmental biology of the visual system. Discusses neurodegenerative and vascular diseases that lead to blindness. Students read and analyze original research articles to train scientific reasoning. Involves student-organized presentations and classroom discussion.

**Equivalent - Duplicate Degree Credit Not Granted:** MCDB 4427

**Requisites:** Requires prerequisite courses of MCDB 3135 and MCDB 3145 (all minimum grade C-).

**MCDB 5441 (4) Animal Developmental Diversity**

Surveys development in a range of vertebrate and invertebrate systems to reconstruct the common bilaterian ancestor, and elucidate the developmental genetic changes underlying animal diversification. Lab focuses on vertebrate embryos and explores key methods in evolutionary developmental biology including in situ hybridization, embryo microinjection, and transgenesis.

**Equivalent - Duplicate Degree Credit Not Granted:** MCDB 4441 and EBIO 4440 and EBIO 5440

**Requisites:** Restricted to graduate students only.

**MCDB 5471 (3) Mechanisms of Gene Regulation in Eukaryotes**

Focuses on manifestations of regulated gene expression. Studies gene regulation at multiple steps, including transcription, RNA processing and translation. Is based on critical analysis of primary research papers. Written assignments and oral presentations are required.

**Equivalent - Duplicate Degree Credit Not Granted:** MCDB 4471

**MCDB 5520 (3) Bioinformatics and Genomics**

Computational and experimental methods in bioinformatics and genomics, and how these methods provide insights into protein structure and function, molecular evolution, biological diversity, cell biology and human disease. Topics include database searching, multiple sequence alignment, molecular phylogeny, microarrays, proteomics and pharmacogenomics.

**Equivalent - Duplicate Degree Credit Not Granted:** MCDB 4520

**Requisites:** Restricted to graduate students only.

**MCDB 5521 (1) Bioinformatics and Genomics Laboratory**

Provides experience with, and exposure to, computational and experimental methods in bioinformatics and genomics. Meets once a week. Students are expected to read original research papers, discuss findings, plan and execute data analysis in selected areas.

**Equivalent - Duplicate Degree Credit Not Granted:** MCDB 4521

**Grading Basis:** Letter Grade

**MCDB 5550 (3) Cells, Molecules and Tissues: A Biophysical Approach**

Focuses on the biophysics governing the structure/function of enzymes, cells, extracellular matrix and tissue. Synthesizes ideas from molecular biology, physics, and biochemistry, emphasizing how low Reynolds number physics, not Newtonian physics, is relevant to life inside a cell.

**Equivalent - Duplicate Degree Credit Not Granted:** MCDB 4550 and PHYS 4550 and PHYS 5550

**MCDB 5560 (3) Introduction to Biophysics**

Covers an introduction to the physics of living systems. Focuses on how living systems are able to generate order, with both physical principles and biological examples. Covers the development of quantitative models for biological systems, including estimates. Taught from a physics perspective, with biology background introduced as needed.

**Equivalent - Duplicate Degree Credit Not Granted:** MCDB 4560 and PHYS 4560 and PHYS 5560

**Grading Basis:** Letter Grade

**MCDB 5615 (3) Biology of Stem Cells**

Stem cells have received considerable notice in both the scientific and social arena. Examines the stem cell concept by a critical examination of the primary scientific literature. Topics will include pluripotency and plasticity, environment, technology, self-renewal, transdifferentiation, molecular signature, epigenetic programming and stem cell versus cancer cell. Fulfills MCDB scientific reasoning requirement.

**Equivalent - Duplicate Degree Credit Not Granted:** MCDB 4615

**Requisites:** Restricted to graduate students only.

**MCDB 5621 (3) Genome Databases: Mining and Management**

Lec. Develops essential skills for performing genomic analyses, with focus on developing practical research tools. Introduces human genome and microbiome projects, Python/Sql scripting, accessing and understanding genomic data, sequence alignment and search, evolutionary models, expression data, biological networks, and macromolecular structure.

**Equivalent - Duplicate Degree Credit Not Granted:** BCHM 5621, MCDB 4621 and BCHM 5621

**MCDB 5650 (2) Teaching and Learning in Undergraduate Science Courses**

Discusses recent research on how students learn and applications to the teaching of undergraduate science courses. Conducted as an interactive workshop, in which active-engagement in learning approaches are modeled and experienced by participants. Open to undergraduate and graduate students. May be used to fulfill the pedagogical training requirement for undergraduate Learning Assistants in upper division science courses. Post-doctoral and faculty auditors are welcome to participate as regular auditors.

**MCDB 5651 (3) Developmental Biology**

Explores the development of invertebrate and vertebrate organisms, emphasizing cellular, molecular and genetic mechanisms. Focuses on conceptual understanding and experimental approaches to topics such as embryology, developmental control of gene expression in eukaryotic cells, mechanisms of differentiation and morphogenesis and developmental genetics.

**Equivalent - Duplicate Degree Credit Not Granted:** MCDB 4650

**Requisites:** Restricted to graduate students only.

**MCDB 5680 (3) Mechanisms of Aging**

Studies aging as a developmental process emphasizing genetic, cellular and molecular mechanisms.

**Equivalent - Duplicate Degree Credit Not Granted:** MCDB 4680

**Requisites:** Restricted to graduate students only.

**MCDB 5750 (3) Animal Virology**

Encompasses the structure and replication of both lytic and transforming animal viruses. Emphasizes diversity of naturally occurring genomic structures and the resulting strategies of infection as well as the impact of viral epidemics on society. Includes critical analysis of primary research papers. Fulfills MCDB scientific reasoning requirement. Course has additional graduate student level requirements.

**Equivalent - Duplicate Degree Credit Not Granted:** MCDB 4750

**Requisites:** Restricted to graduate students only.

**MCDB 5776 (1) Scientific Ethics and Responsible Conduct in Research**

Lect. Advanced discussion of topics in scientific ethics, including requirements for responsible conduct of research, case histories of fraud, research misconduct, ethical misconduct and development of professional values and ethical standards.

**Equivalent - Duplicate Degree Credit Not Granted:** BCHM 5776

**Requisites:** Requires a corequisite course of MCDB 5230 or BCHM 5771.

**MCDB 5777 (3) Molecular Neurobiology**

Introduces the functional anatomy of the nervous system and explores current knowledge regarding the molecular and genetic basis of the development and function of the nervous system. Studies recent insights into the molecular basis of neurodegenerative diseases, in the last portion of the course.

**Equivalent - Duplicate Degree Credit Not Granted:** MCDB 4777

**MCDB 5811 (3) Teaching and Learning Biology**

Provides an introduction to recent research into student learning on the conceptual foundations of modern biology, together with pedagogical methods associated with effective instruction and its valuation. Students will be involved in active research into conceptual and practical issues involved in biology education, methods to discover student preconceptions, and the design, testing and evaluation of various instructional interventions.

**Equivalent - Duplicate Degree Credit Not Granted:** MCDB 4811 and EDUC 4811 and EDUC 6811

**Requisites:** Restricted to graduate students only.

**MCDB 6000 (3) Introduction to Laboratory Methods**

Introduces methodology and techniques used in biological research. Designed as a tutorial between a few students and one faculty member. Students are expected to read original research papers, discuss findings, and to plan and execute experiments in selected areas.

**Repeatable:** Repeatable for up to 15.00 total credit hours. Allows multiple enrollment in term.

**Requisites:** Restricted to Biological Sciences (MCDB) graduate students only.

**MCDB 6440 (1-3) Special Topics in MCD Biology**

Acquaints students with various topics not normally covered in the curriculum. Offered intermittently or upon student demand, and often presented by visiting professors.

**Repeatable:** Repeatable for up to 6.00 total credit hours. Allows multiple enrollment in term.

**Requisites:** Restricted to graduate students only.

**MCDB 6441 (1) Faculty Res Seminar**

Acquaints students with various topics not normally covered in the curriculum. Offered intermittently or upon student demand, and often presented by visiting professors.

**Requisites:** Restricted to graduate students only.

**Grading Basis:** Letter Grade

**MCDB 6442 (2) Research Grant Writing**

Acquaints students with various topics not normally covered in the curriculum. Offered intermittently or upon student demand, and often presented by visiting professors.

**Requisites:** Restricted to graduate students only.

**Grading Basis:** Letter Grade

**MCDB 6940 (1) Master's Candidate for Degree**

Registration intended for students preparing for a thesis defense, final examination, culminating activity, or completion of degree.

**MCDB 6950 (1-6) Master's Thesis**

Students seeking a master's degree should consult a departmental advisor. Plan I or Plan II is offered.

**MCDB 7840 (1-6) Graduate Independent Study**

An independent study contract is required.

**Repeatable:** Repeatable for up to 7.00 total credit hours. Allows multiple enrollment in term.

**MCDB 7910 (1) Seminar Practicum**

Designed for graduate students to give oral presentations on their thesis research, field questions, respond to critiques, and present background information.

**Repeatable:** Repeatable for up to 2.00 total credit hours.

**Requisites:** Restricted to graduate students only.

**MCDB 8990 (1-10) Doctoral Dissertation**

All doctoral students must register for not fewer than 30 hours of dissertation credit as part of the requirements for the degree. For a detailed discussion of doctoral dissertation credit, refer to the Graduate School section.

**Repeatable:** Repeatable for up to 30.00 total credit hours.

**Requisites:** Restricted to graduate students only.