MOLECULAR, CELLULAR AND DEVELOPMENTAL BIOLOGY

The undergraduate program in molecular, cellular and developmental biology (MCDB) is directed toward understanding the molecular and cellular mechanisms that provide the basis for biological structure, growth, evolution, embryonic development and genetic inheritance. Undergraduate majors learn about the scientific method, experimental approaches and groundbreaking discoveries that have made modern molecular and cellular biology such an important force in medicine, agriculture, and the growing biotechnology industry. They also learn about the diverse tools of modern biology, including recombinant DNA, genomic mapping, transgenic organisms, gene targeting, analysis of mutants, biochemical purification, antibody probes, laser manipulation of living cells, light and electron microscopy, and computer modeling. In addition to academic and laboratory classes, MCDB majors have many opportunities to participate in ongoing research in the department.

Learn how living systems operate at the cellular and molecular levels of organization, their assembly and structure, with heavy emphasis on genetic information and regulation, including embryonic development.

Course code for this program is MCDB.

Animal Use Policy

Biology is the science of life, and a major in it must include some hands-on experience with living organisms to be complete. Exercises involving the use of living animals or animal tissues are included, therefore, in MCDB laboratory courses. Majors with objections on moral grounds may arrange to limit their participation in these exercises, although their educational experience is compromised by doing so.

Nonmajors may take MCD biology lecture courses without the accompanying laboratories. Laboratory courses in which living vertebrate animals or tissues are used are identified in the course description section of this catalog. For additional information, please contact the department.

Bachelor’s Degree

- Molecular, Cellular and Developmental Biology - Bachelor of Arts (BA) (catalog.colorado.edu/undergraduate/colleges-schools/arts-sciences/programs-study/molecular-cellular-developmental-biology/molecular-cellular-developmental-biology-bachelor-arts-ba)

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 (https://experts.colorado.edu/display/fisid_103471)
Distinguished Professor; PhD, University of Colorado Boulder

Betterton, Meredith D (https://experts.colorado.edu/display/fisid_125396)
Associate Professor; PhD, Harvard University

Blumenthal, Thomas (https://experts.colorado.edu/display/fisid_143346)
Professor; PhD, Johns Hopkins University

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

Cech, Thomas R (https://experts.colorado.edu/display/fisid_103252)
Distinguished Professor; PhD, University of California-Berkeley

Chen, Zhe (https://experts.colorado.edu/display/fisid_148754)
Asst Research Professor; PhD, University of Colorado Boulder

Coley, Shelley (https://experts.colorado.edu/display/fisid_104067)
Professor; PhD, Harvard University

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

Detweiler, Corrella Scott (https://experts.colorado.edu/display/fisid_128240)
Associate Professor; PhD, University of California-San Francisco

Donaldson, Zoe (https://experts.colorado.edu/display/fisid_157087)
Assistant Professor; PhD, Emory University

Dowell-Deen, Robin DeAnne (https://experts.colorado.edu/display/fisid_147779)
Associate Professor; DSc, Washington University

Dubin, Mark W.
Professor Emeritus

Fillman, Christy L. (https://experts.colorado.edu/display/fisid_145115)
Senior Instructor; PhD, University of Colorado Boulder

Garcea, Robert L (https://experts.colorado.edu/display/fisid_146103)
Professor; MD, University of California-San Francisco

Gold, Lawrence (https://experts.colorado.edu/display/fisid_100581)
Professor; PhD, University of Connecticut

Guild, Nancy
Professor Attendant Rank; PhD, University of Colorado

Han, Min (https://experts.colorado.edu/display/fisid_105512)
Professor; PhD, University of California-Los Angeles

Harvey, Pamela Ann (https://experts.colorado.edu/display/fisid_148012)
Instructor; PhD, Tufts University

Hoenger, Andreas (https://experts.colorado.edu/display/fisid_142883)
Professor; PhD, Univ of Basel (Switzerland)

Jones, Kevin Robert (https://experts.colorado.edu/display/fisid_102094)
Associate Professor; PhD, University of California-Berkeley

Junge, Harald Jobst (https://experts.colorado.edu/display/fisid_148593)
Assistant Professor; PhD, Philipps University Marburg (Germany)

Klymkowsky, Michael W (https://experts.colorado.edu/display/fisid_101226)
Professor; PhD, California Institute of Technology

Knight, Jennifer Kirsten (https://experts.colorado.edu/display/fisid_101933)
Associate Professor; PhD, University of Michigan Ann Arbor
Kralj, Joel M (https://experts.colorado.edu/display/fisid_153055)
Assistant Professor; PhD, Boston University

Krauter, Kenneth S (https://experts.colorado.edu/display/fisid_107978)
Professor; PhD, Yeshiva University

Kuempel, Peter L.
Professor Emeritus

Leinwand, Leslie Anne (https://experts.colorado.edu/display/fisid_107104)
Distinguished Professor; PhD, Yale University

Martin, Jennifer Mary (https://experts.colorado.edu/display/fisid_110125)
Senior Instructor; PhD, University of Washington

Mastronarde, David
Professor Attendant Rank; PhD, University of Colorado

McConkey, Edwin H.
Professor Emeritus

McHenry, Charles
Distinguished Professor Emeritus; PhD, University of California, Santa Barbara

McIntosh, J. Richard
Distinguished Professor Emeritus

Niswander, Lee
Professor; PhD, Case Western Reserve University

Odorizzi, Charles Gregory (https://experts.colorado.edu/display/fisid_118429)
Professor; PhD, University of California-San Diego

Old, William (https://experts.colorado.edu/display/fisid_103039)
Assistant Professor; PhD, University of Colorado Boulder

Olwin, Bradley Bruce (https://experts.colorado.edu/display/fisid_109888)
Professor; PhD, University of Washington

Orth, James D (https://experts.colorado.edu/display/fisid_152017)
Asst Research Professor; PhD, Mayo Graduate School of Medicine

Pace, Norman R.
Distinguished Professor Emeritus

Park, Soyeon (https://experts.colorado.edu/display/fisid_151944)
Assistant Professor; PhD, Mayo Graduate School of Medicine

Parker, Roy Robert (https://experts.colorado.edu/display/fisid_151440)
Professor; PhD, University of California-San Francisco

Runner, Meredith
Professor Emeritus

Sawyer, Sara Lea (https://experts.colorado.edu/display/fisid_155218)
Associate Professor; PhD, Cornell University

Shen, Jingshi (https://experts.colorado.edu/display/fisid_146414)
Associate Professor; PhD, Columbia University In the City of New York

Singh, Ravinder (https://experts.colorado.edu/display/fisid_112067)
Associate Professor; PhD, Baylor College of Medicine

Staehelin, L. Andrew
Professor Emeritus

Stowell, Michael (https://experts.colorado.edu/display/fisid_124136)
Associate Professor; PhD, California Institute of Technology

Su, Tin Tin (https://experts.colorado.edu/display/fisid_113847)
Professor; PhD, Carnegie Mellon University

Sueoka, Noboru
Professor Emeritus

Van Blerkom, Jonathan (https://experts.colorado.edu/display/fisid_100545)
Research Professor; PhD, University of Colorado Boulder

Voeltz, Gia Kaarina (https://experts.colorado.edu/display/fisid_143587)
Professor; PhD, Yale University

Weaver, Benjamin
Assistant Professor; PhD, University of Kansas

Wood, William B. III
Distinguished Professor Emeritus

Xue, Ding (https://experts.colorado.edu/display/fisid_112336)
Professor; PhD, Columbia University In the City of New York

Yarus, Michael J.
Professor Emeritus

Yi, Rui (https://experts.colorado.edu/display/fisid_146697)
Associate Professor; PhD, Duke University

Courses

MCDB 1030 (3) Introduction to Molecular Biology
Introduces the foundation of molecular, cell, developmental and evolutionary biology in the context of human development and disease. Including how the immune system works to protect us from infections and technologies being developed towards the goal of better health around the world. For nonmajors.

Additional Information: GT Pathways: GT-SC2 -Natural Physical Sci:Lec Crse w/o Req Lab
Arts Sci Core Curr: Natural Science Sequence
Arts Sci Gen Ed: Distribution-Natural Sciences

MCDB 1041 (3) Fundamentals of Human Genetics
Covers the basic principles of genetics, human pedigree analysis, and how genetic diseases affect DNA, RNA, and proteins. Considers implications of this research for medicine and society. For nonmajors.

Recommended: Requisite good background in high school chemistry and biology.

Additional Information: GT Pathways: GT-SC2 -Natural Physical Sci:Lec Crse w/o Req Lab
Arts Sci Core Curr: Natural Science Sequence
Arts Sci Gen Ed: Distribution-Natural Sciences
MCDB 1043 (1) Exploring Genetics Laboratory
Provides hands-on experience with fundamental genetic principles. Topics include scientific method, experimental design, mitosis, meiosis, classical genetics, molecular genetics, mutagenesis, DNA analysis, and transgenic organisms. Wherever possible, the focus of the lab will be on integrating science process skills with human-relevant experiments to encourage students to learn and apply science skills while seeing the application to humans.
Requisites: Restricted to Biological Sciences (MCDB) non-majors only.
Recommended: Corequisite MCDB 1041.
Additional Information: Arts Sci Core Curr: Natural Science Lab
Arts Sci Gen Ed: Distribution-Natural Sciences
Arts Sci Gen Ed: Distribution-Natural Sci Lab

MCDB 1111 (3) Core Concepts in Biology I: Evolutionary, Molecular and Cell Biology
Web-based, in-class discussion course covering the fundamental properties shaping living things. Uses evolutionary (including social) and physical-chemical mechanisms to frame molecular, cellular and organismic processes. Interpreting and answering questions scientifically as well as quantitative reasoning skills are stressed. Fulfills the MCDB major's requirement for MCDB 1150.
Equivalent - Duplicate Degree Credit Not Granted: MCDB 1150
Additional Information: Arts Sci Core Curr: Natural Science Sequence
Arts Sci Gen Ed: Distribution-Natural Sciences

MCDB 1150 (3) Introduction to Cellular and Molecular Biology
Covers biologically important macromolecules and biological processes, together with an introduction to cell structure, function, and physiology. Provides the foundation for advanced MCDB courses to majors, and a rigorous overview of modern biology to nonmajors. MCDB 1150 must be taken concurrently by MCDB and biochemistry majors and prehealth science students.
Equivalent - Duplicate Degree Credit Not Granted: MCDB 1111
Recommended: Prerequisite high school chemistry and algebra, and recommended corequisites of MCDB 1151 and MCDB 1152.
Additional Information: GT Pathways: GT-SC1 - Natural Physical Sci:Lec
Crse w/o Req Lab
Arts Sci Core Curr: Natural Science Sequence
Arts Sci Gen Ed: Distribution-Natural Sciences
MAPS Course: Natural Science Lab or Lab/Lec

MCDB 1151 (1) Introduction to Cell and Molecular Biology Lab
Offers one two-hour lab per week designed to acquaint students with research techniques and concepts in molecular and cellular biology. Topics include cell structure, function, physiology, and recombinant DNA.
Equivalent - Duplicate Degree Credit Not Granted: MCDB 1111
Recommended: Corequisite MCDB 1150 or CHEN 2810 or EBIO 1210.
Alternative Information: GT Pathways: GT-SC1 - Natural Physical Sci:Lec
Crse w/ Req Lab
Arts Sci Core Curr: Natural Science Lab
Arts Sci Gen Ed: Distribution-Natural Sciences
MAPS Course: Natural Science Lab or Lab/Lec

MCDB 1152 (1) Problem Solving Co-Seminar for Introduction to Molecular and Cellular Biology
Uses problem solving and other interactive group work to aid student learning in a corequisite course, MCDB 1150. Students will work in small groups on learning and practicing how to solve difficult conceptual problems, as well as using hands-on activities and concept mapping to help learn content.
Recommended: Corequisite MCDB 1150.
Grading Basis: Pass/Fail

MCDB 1161 (2) From Dirt to DNA: Phage Genomics Laboratory
Provides laboratory experience working on a bacteriophage genomics research project. Students will study novel bacteriophage they isolate from the environment. Topics covered include phage biology, bacteria and phage culturing and amplification, DNA isolation, restriction digest analysis, agarose gel electrophoresis, and electron microscopy.
Additional Information: Arts Sci Core Curr: Natural Science Lab
Arts Sci Gen Ed: Distribution-Natural Sciences
Arts Sci Gen Ed: Distribution-Natural Sci Lab

MCDB 1171 (2) Drug Discovery Through Hands-on Screens
Provides introductory research and laboratory experience. Students will work in teams to screen small molecule libraries for novel antibiotics using the bacterium Salmonella as a model system. Topics covered include the basic biology of the model system, genetics, approaches to screening for new therapeutics, statistical analysis of the data, compound verification and lead compound development.
Requisites: Requires corequisite course of MCDB 1150.
Grading Basis: Letter Grade
Additional Information: Arts Sci Core Curr: Natural Science Lab
Arts Sci Gen Ed: Distribution-Natural Sciences
Arts Sci Gen Ed: Distribution-Natural Sciences

MCDB 2150 (3) Principles of Genetics
Introduces the behavior of genes and chromosomes in eukaryotic and prokaryotic organisms. Covers three areas: transmission genetics, molecular genetics, and population genetics. Attention is given to genetic mapping, recombinant DNA procedures, and gene expression.
Equivalent - Duplicate Degree Credit Not Granted: MCDB 2222
Recommended: Prerequisite MCDB 1150 or EBIO 1210 or CHEN 2810 (minimum grade C-) and recommended corequisites of MCDB 2151 and MCDB 2152.
Additional Information: GT Pathways: GT-SC2 - Natural Physical Sci:Lec
Crse w/o Req Lab
Arts Sci Core Curr: Natural Science Sequence
Arts Sci Gen Ed: Distribution-Natural Sciences

MCDB 2151 (1) Principles of Genetics Laboratory
One two-hour lab per week. Provides hands-on experience with principles introduced in MCDB 2150. Topics include mitosis, meiosis, classical genetics, complementation, mutagenesis, DNA replication, natural selection, and evolution.
Recommended: Prerequisites MCDB 1150 and MCDB 1151 (all minimum grade D), and recommended corequisite of MCDB 2150.
Additional Information: GT Pathways: GT-SC1 - Natural Physical Sci:Lec
Crse w/ Req Lab
Arts Sci Core Curr: Natural Science Lab
Arts Sci Gen Ed: Distribution-Natural Sciences
Arts Sci Gen Ed: Distribution-Natural Sci Lab

MCDB 2152 (1) Problem Solving Co-Seminars for Genetics
Uses problem solving and other interactive group work to aid student learning in MCDB 2150. Students will work in small groups on learning and practicing how to solve difficult conceptual problems, as well as using hands-on activities and concept mapping to help learn content.
Recommended: Corequisite MCDB 2150.
Grading Basis: Pass/Fail
MCDB 2161 (2) From DNA to Genes, Phage Genomics Laboratory II
Provides laboratory experience working on a bacteriophage isolated during the previous semester. Topics include bioinformatics, genome annotation, open reading frame and RNA identification, BLAST analysis, phylogenetics and submission to a genomic database. 
**Requisites:** Requires prerequisite course of MCDB 1161 (minimum grade C-).
**Additional Information:** Arts Sci Gen Ed: Distribution-Natural Sciences

MCDB 2171 (2) Drug Discovery Through Hands-On Screens 2
Provides introductory research and laboratory experience. Students will work in teams to screen molecule libraries using fruit flies as a model system. Topics covered include the basic biology of the model system, genetics, approaches to screening for new therapeutics, statistical analysis of the data, compound verification and lead compound development.
**Requisites:** Requires a corequisite of MCDB 2150.
**Grading Basis:** Letter Grade
**Additional Information:** Arts Sci Core Curr: Natural Science Lab
Arts Sci Gen Ed: Distribution-Natural Sciences
Arts Sci Gen Ed: Distribution-Natural Sci Lab

MCDB 2222 (3) Core Concepts in Biology II: Genes, Genetics and Phenotypes
Web-based, in-class discussion course focused on the origins of genetic variation and inheritance, genome dynamics and gene expression and their relationship to phenotype(s). Interpreting, explaining and answering questions scientifically as well as quantitative reasoning are stress. Course fulfills the departmental requirement for MCDB 2150.
** Equivalent - Duplicate Degree Credit Not Granted:** MCDB 2150
**Requisites:** Requires a prerequisite course of MCDB 1111 or MCDB 1150 (minimum grade C-).
**Grading Basis:** Letter Grade
**Additional Information:** Arts Sci Core Curr: Natural Science Sequence
Arts Sci Gen Ed: Distribution-Natural Sciences

MCDB 2840 (1-3) Lower-Division Independent Study
Students with adequate prerequisites should take MCDB 4840.
**Repeatable:** Repeatable for up to 8.00 total credit hours.

MCDB 3010 (2) Undergraduate Teaching in Course-Based Undergraduate Research Experiences
To address the need for more advanced and continued participation in course-based research, MCDB 3010 is designed to train students who have taken MCDB 1171 or MCDB 2171 or MCBDB 4202 as teaching assistants. The aim is to enhance the students’ experience and responsibilities in course-based research and to prepare them for research and mentorship in a departmental or graduate laboratory.
**Repeatable:** Repeatable for up to 4.00 total credit hours.
**Requisites:** Requires prerequisite course of MCDB 1171 or MCDB 2171 or MCBDB 4202 (minimum grade B).
**Grading Basis:** Letter Grade
**Additional Information:** Arts Sci Core Curr: Natural Science Sequence
Arts Sci Gen Ed: Distribution-Natural Sciences

MCDB 3135 (3) Molecular Cell Biology I
Examines the central dogma of biology by discussing the most important molecules in cells (DNA, RNA and protein) and how their synthesis (DNA replication, transcription, RNA processing and translation) is regulated. Incorporated into the discussion is how recombinant DNA techniques are used to discover and dissect cellular processes, how to design and interpret experiments, and understanding the limits of experiments to draw conclusions. These principles are the foundation for subsequent examination of intracellular mechanisms in MCDB 3145.
**Requisites:** Requires prerequisite courses of MCDB 2150 or EBIO 2070 and CHEM 1113 or CHEM 1400 or CHEN 1211 (all minimum grade C-).
**Additional Information:** Arts Sci Gen Ed: Distribution-Natural Sciences

MCDB 3140 (2) Cell Biology Laboratory
One four-hour lab per week. Provides experience with and exposure to modern cell biology laboratory techniques. Topics include microscopy, immunocytochemistry, Western blotting, Southern blotting, and flow cytometry. This course does not use vertebrate animals.
**Recommended:** Corequisite MCDB 3135 or MCDB 3145.
**Additional Information:** Arts Sci Gen Ed: Distribution-Natural Sciences
Arts Sci Gen Ed: Distribution-Natural Sci Lab

MCDB 3145 (3) Molecular Cell Biology II
Examines intracellular mechanisms, including transport of ions and small molecules across membranes; protein targeting to organelles; membrane trafficking between organelles; signal transduction; the cytoskeleton; and the cell cycle. Analysis of these activities is from the experimental perspective established in MCDB 3135.
**Recommended:** Prerequisite MCDB 3135 (minimum grade C-), and recommended prerequisite or corequisite of MCDB 3140 concurrent with either this class or MCDB 3135.
**Additional Information:** Arts Sci Gen Ed: Distribution-Natural Sciences

MCDB 3150 (3) Biology of the Cancer Cell
Highlights dimensions of the cancer problem; cancer as a genetic/cellular disease; chemicals, viruses, and radiation as causes of cancer; cancer and diet; cancer epidemiology; cancer risk factors; proto-oncogenes, oncogenes, and cancer suppressor genes; and prevention of cancer.
**Recommended:** Prerequisite MCDB 2150 or EBIO 2070 (minimum grade C-).
**Additional Information:** Arts Sci Core Curr: Natural Science Non-Sequence
Arts Sci Gen Ed: Distribution-Natural Sciences

MCDB 3160 (3) Infectious Disease
Illustrate how cutting edge tools in genomics can be used to study, monitor and cure disease caused by new and re-emerging human pathogens such as SARS/MERS, Ebola virus, Neisseria meningitides, influenza virus and malaria parasites. Technologies covered will include genome sequencing, annotation, transcriptomics, phylogenetics and genotyping of microbial populations. An integrated approach to this topic will be presented, with these concepts threaded throughout: natural history and evolution of pathogens, molecular biology, immunology, epidemiology, public health and clinical diagnosis. There may be some overlap with material covered in MCDB 1030 and MCDB 4750.
**Requisites:** Requires prerequisite course of MCDB 2150 or EBIO 2070 (minimum grade C-).
**Grading Basis:** Letter Grade
**Additional Information:** Arts Sci Core Curr: Natural Science Non-Sequence
Arts Sci Gen Ed: Distribution-Natural Sciences

MCDB 3330 (3) Evolution and Creationism
Intensive lecture/discussion course on the interrelationships among science, religion, and social policy. Includes historical and scientific development of evolution theory, social Darwinism/sociobiology, and the public perception of science.
**Recommended:** Prerequisite MCDB 1150 or EBIO 1210 (minimum grade C-).
**Additional Information:** Arts Sci Core Curr: Natural Science Non-Sequence
Arts Sci Gen Ed: Distribution-Natural Sciences
MCDB 3332 (1) Scientific Ethics
A reading/discussion course on the implications of modern biologically-based technologies, from in vitro fertilization and its variants and issues surrounding these techniques, to genomic testing of embryos and adults, the genetic engineering of organisms, including humans, to issues surrounding communicable diseases and vaccination. Discussion will include a serious consideration of various philosophical and non-scientific perspectives.

**Requisites:** Requires prerequisite course of MCDB 1150 or EBIO 1210 (minimum grade C). Restricted to students with 57-180 credits (Juniors or Seniors).

**Grading Basis:** Letter Grade

**Additional Information:** Arts Sci Gen Ed: Distribution-Natural Sciences

MCDB 3333 (3) Biomedical Innovations and Discoveries
Discusses how biological inventions and discoveries fuel biomedical innovations, how important techniques in molecular biology have advanced our understanding of cellular processes and contributed to biotechnology revolution and biomedical sciences to benefit our society. Guest lectures from experts in industry and site visits will enhance the course by providing a non-academic perspective, networking opportunities, and unexpected avenues for career paths for our graduates. Department enforced prerequisite: MCDB 2150 or EBIO 2070 or instructor consent.

**Grading Basis:** Letter Grade

**Additional Information:** Arts Sci Gen Ed: Distribution-Natural Sciences

MCDB 3350 (3) Fertility, Sterility, and Early Mammalian Development
Describes the production of germ cells, ovulation, fertilization, reproductive cycles, controls of reproduction, early development of the embryo, methods of contraception, and causes and treatments of sterility. Recommended for students planning careers in the health sciences.

**Recommended:** Prerequisite MCDB 1150 or EBIO 1210 (minimum grade C).

**Additional Information:** Arts Sci Gen Ed: Distribution-Natural Sciences

MCDB 3501 (3) Structural Methods for Biological Macromolecules
Teaches fundamental knowledge about protein structures, protein interactions and protein folding. Discusses in detail the most common methods on how proteins and macromolecular complexes are studied, such as X-ray crystallography, NMR-spectroscopy and electron microscopy. Offers about 50 percent direct teaching, 40 percent discussion of papers in a journal club style and 10 percent hands-on practicals on software packages relevant to structural biology. Formerly MCDB 4501.

**Recommended:** Prerequisite MCDB 2150 or EBIO 2070 (minimum grade C).

**Additional Information:** Arts Sci Gen Ed: Distribution-Natural Sciences

MCDB 3650 (3) The Brain - From Molecules to Behavior
Examines the molecular basis of the brain's role in thought, action, and consciousness by exploring issues such as relationship of cognition and localized brain function, sensory systems and their role in cognition, learning and memory, and behavioral neurochemistry.

**Recommended:** Prerequisite MCDB 2150 or EBIO 2070 (minimum grade C).

**Additional Information:** Arts Sci Gen Ed: Distribution-Natural Sciences

MCDB 3651 (3) The Brain: Dysfunction to Disease
Misregulation of synaptic function results in abnormal brain function and behavior that is manifested in numerous neurological and psychiatric diseases. Explores the molecular mechanisms responsible for altered synaptic plasticity in neurological diseases such as frontotemporal dementia (FTD), Parkinson's disease, Huntington's disease, Creutzfeldt-Jakob disease, Down syndrome, epilepsy, autism, and Alzheimer's disease.

**Recommended:** Prerequisites MCDB 3650 or NRSC 2100 (minimum grade C- or instructor consent required.

**Grading Basis:** Letter Grade

**Additional Information:** Arts Sci Gen Ed: Distribution-Natural Sciences

MCDB 3700 (3) Poisons in Cell Biology and Society
Investigate the inner workings of our cells by studying how poisons disrupt these processes. We will learn how selected poisons affect critical processes inside the cell to cause death or destruction. The scientific aspects of the poison will be discussed in the context of its historical significance or impact on society and popular culture. Department enforced prerequisites: MCDB 1150 or EBIO 1210 and MCDB 2150.

**Additional Information:** Arts Sci Gen Ed: Distribution-Natural Sciences

MCDB 3990 (3) Introduction to Systems Biology for Biologists
Introduces majors with relatively little mathematical experience to the major concepts in systems biology, in the context of key processes (cell growth, division, adaptation, development, and disease). Designed to help students master the necessary mathematical tools involved.

**Recommended:** Prerequisites MCDB 3135 and MCDB 3145 and MATH 1310 (minimum grade C-).

**Grading Basis:** Letter Grade

**Additional Information:** Arts Sci Gen Ed: Distribution-Natural Sciences

MCDB 4100 (1-6) Special Topics
Repeatable: Repeatable for up to 6.00 total credit hours. Allows multiple enrollment in term.

**Recommended:** Prerequisites MCDB 3135 and MCDB 3145 (minimum grade C-).

**Additional Information:** Arts Sci Gen Ed: Distribution-Natural Sciences

MCDB 4101 (3) Editing Genomes with CRISPR-Cas9 Discovering Gene Function
Discover novel gene function in vertebrate embryonic development using the latest gene-editing technology, CRISPR-Cas9. Pick your gene of interest and design experiments to mutate the gene, confirm the mutation and characterize the phenotype. Search scientific databases to learn more about the gene and formulate a hypothesis about the gene function. Discuss and present your findings to your peer and faculty.

**Recommended:** Prerequisites MCDB 3135 and MCDB 3145.

**Grading Basis:** Letter Grade

MCDB 4111 (3) Experimental Design and Research in Cell and Molecular Biology
Learning molecular and cell biology experimental design and approaches through independent research projects. Students, working in pairs, will explore the research process and gain extensive first-hand experience in: hypothesis formation; experimental design; solution preparation and experimental methodology; proposal presentation and defense (oral and written); formal presentation of results and conclusions (oral and written in a publication-style format); the publication process; critical reading and evaluation of primary scientific literature.

**Recommended:** Prerequisite MCDB 1150 or EBIO 1210 (minimum grade C) and recommended corequisite of MCDB 3135.

**Additional Information:** Arts Sci Gen Ed: Distribution-Natural Sciences
MCDB 4201 (3) From Bench to Bedside: The Role of Science in Medicine
Demonstrates the breadth of research in the life sciences and how such research (not just in medical schools) can lead to medical applications. Lecturers from life sciences, the medical school and biotechnology, discuss drug development and the transfer of research into the clinical arena. Students also prepare a paper and presentation on the development of a commercial drug.
Recommended: Prerequisites MCDB 3135 and MCDB 3145 (minimum grade C).
Additional Information: Arts Sci Gen Ed: Distribution-Natural Sciences

MCDB 4202 (3) The Python Project
Studies how python hearts grow after they consume a meal. Understanding the molecular processes of growth and regression in the python heart could lead to development of therapeutics for heart disease. Students work in groups in the laboratory and generate novel data by using modern molecular biology and bioinformatic techniques to clone and sequence candidate molecules of the python genome. May be repeated once.
Repeatable: Repeatable for up to 6.00 total credit hours.
Recommended: Prerequisites MCDB 3135 and MCDB 3145 (minimum grade C).
Additional Information: Arts Sci Gen Ed: Distribution-Natural Sciences

MCDB 4234 (3) Research Methods
Presents a rigorous and pedagogically coherent introduction into the experimental process used to collect data, formulate hypotheses, and answer scientific questions in general, and biological questions in particular. Includes a detailed consideration of the elements of experimental design, data collection and analysis, and the interpretation of results in the context of effective science teaching. Part of the CU Teach course sequence for teacher certification in science and mathematics.
Requisites: Restricted to Biological Sciences (MCDB) majors or School of Education (EDUC) undergraduate students only.
Recommended: Prerequisites MCDB 3135 and MCDB 3145 (minimum grade C).
Additional Information: Arts Sci Gen Ed: Distribution-Natural Sciences

MCDB 4300 (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 5301
Recommended: Prerequisites MCDB 3135 and MCDB 3145 (minimum grade C).
Additional Information: Arts Sci Gen Ed: Distribution-Natural Sciences

MCDB 4310 (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 5310
Recommended: Prerequisites MCDB 3135 and MCDB 3145 (minimum grade C) and recommended corequisite of CHEM 4611.
Additional Information: Arts Sci Gen Ed: Distribution-Natural Sciences

MCDB 4312 (3-4) Quantitative Optical Imaging
Explores the fundamentals of optical imaging in biology. Covered topics include an introduction to optics and microscopes, fluorescence microscopy and image analysis. MATLAB will be taught throughout the course and used for image processing.
Equivalent - Duplicate Degree Credit Not Granted: MCDB 5312
Grading Basis: Letter Grade
Additional Information: Arts Sci Gen Ed: Distribution-Natural Sciences

MCDB 4350 (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. Fulfills MCDB scientific reasoning requirement.
Equivalent - Duplicate Degree Credit Not Granted: MCDB 5350
Recommended: Prerequisites MCDB 1150 or EBIO 1210 and CHEM 1133 and EBIO 3400 and/or CHEM 3311 (minimum grade C).
Additional Information: Arts Sci Gen Ed: Distribution-Natural Sciences

MCDB 4361 (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). Fulfills MCDB scientific reasoning requirement.
Equivalent - Duplicate Degree Credit Not Granted: MCDB 5361
Recommended: Prerequisites MCDB 3135 and MCDB 3145 (minimum grade C).
Additional Information: Arts Sci Gen Ed: Distribution-Natural Sciences

MCDB 4410 (3) Human Molecular Genetics
Studies the human organism as a genetic system, including effect of mutation on protein structure and function, biochemical basis of human genetic disease, polymorphic gene loci, gene mapping and identification, gene cloning and characterization, and impact of human genetics on medicine and society. Fulfills MCDB scientific reasoning requirement.
Recommended: Prerequisite MCDB 3135 (minimum grade C).
Additional Information: Arts Sci Gen Ed: Distribution-Natural Sciences

MCDB 4422 (3) Molecular Biology of Free Radicals: Role(s) in Oxidative Stress, Signaling, Disease, Aging
Examines how free radicals are formed in biological systems and their roles in oxidative stress, cell signalling, aging, and disease. Emphasis will be placed on the recent literature. Fulfills MCDB scientific reasoning requirement.
Recommended: Prerequisites MCDB 3135 and MCDB 3145 and CHEM 3311 (minimum grade C).
Additional Information: Arts Sci Gen Ed: Distribution-Natural Sciences

MCDB 4425 (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. Fulfills MCDB scientific reasoning requirement.
Equivalent - Duplicate Degree Credit Not Granted: MCDB 5425
Recommended: Prerequisites MCDB 3135 and MCDB 3145 (minimum grade C) or instructor consent required.
Additional Information: Arts Sci Gen Ed: Distribution-Natural Sciences
MCDB 4426 (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. Fulfills MCDB scientific reasoning requirement.
Equivalent - Duplicate Degree Credit Not Granted: MCDB 5426
Recommended: Prerequisites MCDB 3135 and MCDB 3145 and CHEM 4700 (minimum grade C-).
Additional Information: Arts Sci Gen Ed: Distribution-Natural Sciences

MCDB 4427 (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. Fulfills MCDB scientific reasoning requirement.
Equivalent - Duplicate Degree Credit Not Granted: MCDB 5427
Recommended: Prerequisites MCDB 3135 and MCDB 3145 (minimum grade C-) or instructor consent required.
Additional Information: Arts Sci Gen Ed: Distribution-Natural Sciences

MCDB 4441 (4) Animal Developmental Diversity
Surveys development in a range of vertebrate and invertebrate systems to reconstruct the common bilatarian 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 5441 and EBIIO 4440 and EBIIO 5440
Recommended: Prerequisites MCDB 1150 or EBIIO 1210 and MCDB 2150 or EBIIO 2070 (minimum grade C-).

MCDB 4444 (3) Cellular Basis of Disease
Explores the cellular basis of disease. Discusses diseases arising from defects in intracellular targeting, cytoskeletal function, intracellular signaling, genomic instability, gene regulation, cell proliferation, and cell death. Involves student-organized presentations and classroom discussion. Fulfills MCDB scientific reasoning requirement.
Recommended: Prerequisites MCDB 3135 and MCDB 3145 (minimum grade C-).
Additional Information: Arts Sci Gen Ed: Distribution-Natural Sciences

MCDB 4471 (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. Fulfills MCDB scientific reasoning requirement.
Equivalent - Duplicate Degree Credit Not Granted: MCDB 5471
Recommended: Prerequisite MCDB 3135 (minimum grade C-) or instructor consent required.
Additional Information: Arts Sci Gen Ed: Distribution-Natural Sciences

MCDB 4520 (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 5520
Recommended: Prerequisites MCDB 3135 or CHEM 4700 (minimum grade C-).
Additional Information: Arts Sci Gen Ed: Distribution-Natural Sciences

MCDB 4521 (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 5521
Grading Basis: Letter Grade

MCDB 4550 (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. Fulfills MCDB scientific reasoning requirement.
Equivalent - Duplicate Degree Credit Not Granted: MCDB 5550 and PHYS 4550 and PHYS 5550
Recommended: Prerequisites MCDB 3135 and MCDB 3145 and PHYS 2210 and PHYS 2220 and PHYS 4230 and CHEM 3311 and MATH 1300 and/or CHEM 3311 (minimum grade C-) or instructor consent required.
Additional Information: Arts Sci Gen Ed: Distribution-Natural Sciences

MCDB 4560 (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 5560 and PHYS 4560 and PHYS 5560
Requisites: Requires a prerequisites course of PHYS 2210 (minimum grade C-).
Recommended: Prerequisite PHYS 4230.
Grading Basis: Letter Grade
Additional Information: Arts Sci Gen Ed: Distribution-Natural Sciences

MCDB 4615 (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 5615
Recommended: Prerequisite MCDB 3135 or MCDB 3145 or instructor consent required.
Additional Information: Arts Sci Gen Ed: Distribution-Natural Sciences
MCDB 4621 (3) Genome Databases: Mining and Management
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: CHEM 4621 or CHEM 5621 MCDB 5621
Recommended: Prerequisite MCDB 3135 or CSCI 3104 or CHEM 4700 and recommended corequisite of CSCI 2270.
Additional Information: Arts Sci Gen Ed: Distribution-Natural Sciences

MCDB 4650 (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 5651
Recommended: Prerequisites MCDB 3135 and MCDB 3145 (minimum grade C-).
Additional Information: Arts Sci Gen Ed: Distribution-Natural Sciences

MCDB 4680 (3) Mechanisms of Aging
Studies aging as a developmental process emphasizing genetic, cellular and molecular mechanisms. Fulfills MCDB scientific reasoning requirement.
Equivalent - Duplicate Degree Credit Not Granted: MCDB 5680
Recommended: Prerequisites MCDB 3135 and MCDB 3145 (minimum grade C-).
Additional Information: Arts Sci Gen Ed: Distribution-Natural Sciences

MCDB 4750 (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.
Equivalent - Duplicate Degree Credit Not Granted: MCDB 5750
Recommended: Prerequisite MCDB 3135 (minimum grade C-) or instructor consent required.
Additional Information: Arts Sci Gen Ed: Distribution-Natural Sciences

MCDB 4777 (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 5777
Recommended: Prerequisites MCDB 3135 and MCDB 3145 (minimum grade C-).
Additional Information: Arts Sci Gen Ed: Distribution-Natural Sciences

MCDB 4790 (3) Oocytes, Stem Cells, Organisms: Experiments to Discoveries
Develop critical thinking, scientific reasoning and communication skills by reading and presenting primary research articles and Nobel Prize winning research on patterning, stem cells, cell death, genetic and epigenetic mechanisms that regulate embryonic development. Learn about experimental approaches from a historical and present view, while discussing their ethical implications.
Grading Basis: Letter Grade
Additional Information: Arts Sci Gen Ed: Distribution-Natural Sciences

MCDB 4810 (3) Insane in the Membrane: The Biology and Biophysics of the Membrane
Studies the biology and physics of the biomembrane. Topics include structure and mechanism of membrane proteins; membrane biogenesis; membrane protein folding and stability; membrane homeostasis; mechanisms of membrane fusion and fission; lipid trafficking. Fulfills MCDB scientific reasoning requirement.
Equivalent - Duplicate Degree Credit Not Granted: MCDB 5810 and EDUC 4811 and EDUC 6811
Recommended: Prerequisites MCDB 1150 or EBIO 1210 and MCDB 2150 and MCDB 3145.
Additional Information: Arts Sci Gen Ed: Distribution-Natural Sciences

MCDB 4840 (1-6) Upper-Division Independent Study
An independent study contract is required.
Repeatable: Repeatable for up to 8.00 total credit hours.
Recommended: Prerequisite MCDB 2150.

MCDB 4980 (3) Honors Research
Provides faculty-supervised research for students who have been approved by the departmental honors committee. Normally taken during the semester before completion of the honors thesis.
Recommended: Prerequisite MCDB 4840 or comparable research experience, and minimum GPA of 3.20.
Additional Information: Arts Sciences Honors Course

MCDB 4990 (3) Honors Thesis
Involves the preparation and defense of an honors thesis, based on faculty-supervised original research, including final phases of the research project.
Recommended: Prerequisites MCDB 4840 or MCDB 4980 or comparable research experience, and minimum GPA of 3.3 and approval by the MCDB Honors Committee.
Additional Information: Arts Sciences Honors Course