

# MOLECULAR, CELLULAR AND DEVELOPMENTAL BIOLOGY - BACHELOR OF ARTS (BA)

The undergraduate degree in molecular, cellular and developmental biology emphasizes knowledge and awareness of:

- the biological sciences in general and a detailed understanding of currently important aspects of cellular biology, molecular biology, biochemistry, genetics and developmental biology; and
- the relationship of the specialty area to broader areas of science and to society in general, including ethical issues raised by current biological research and by the rapid growth of biotechnology as an important shaping force for the future.

In addition, students completing the degree in molecular, cellular and developmental biology are expected to acquire the ability and skills to:

- learn detailed laboratory procedures rapidly when the need arises;
- demonstrate a scientific vocabulary and an understanding of research methods that permits the comprehension of current journal articles, extraction of pertinent information and judgment of the quality of the work described;
- evaluate a biological problem, determine which aspects are understood and apply basic research methods and techniques to the unknown aspects; and
- communicate scientific concepts and analytical arguments clearly and concisely, both orally and in writing.

## Prerequisites

It is MCDB policy to enforce the course prerequisites listed in the course catalog. If you have not either taken and passed (C- or better) the prerequisites for a course, or obtained permission from the instructor or a departmental advisor to take the course based on equivalent preparatory coursework or experience here or elsewhere, you may be administratively dropped from the course.

## Course Requirements

Students must complete the general requirements of the College of Arts and Sciences and the required courses listed below. All required major courses and all required ancillary courses must be passed with a C- or better and cannot be taken pass/fail. Students must have a grade point average of at least 2.000 in the major in order to graduate.

It is strongly recommended that MCDB majors consult with a departmental advisor before applying AP, IB or CLEP credit. Students majoring in MCDB who transfer biology credit from other institutions also must consult a departmental advisor.

Students who plan to double major with biochemistry or chemistry are encouraged to meet with an academic advisor to understand how their chemistry courses will apply to the MCDB major.

Students who plan to also pursue a degree in engineering are encouraged to meet with an academic advisor to understand how their chemistry and calculus courses will apply to the MCDB major.

## Required Courses and Credits

Code	Title	Credit Hours
<b>Required Major Courses</b>		
<i>Introductory Coursework</i>		
Select one:		3
MCDB 1150	Introduction to Cellular and Molecular Biology (MCDB 1152 is a recommended coseminar for MCDB 1150) <sup>1</sup>	
MCDB 1111	Core Concepts in Biology I: Evolutionary, Molecular and Cell Biology (MCDB 1152 is not a recommended coseminar for MCDB 1111)	
<i>Genetics</i>		
Select one:		3
MCDB 2150	Principles of Genetics (MCDB 2152 is a recommended coseminar for MCDB 2150) <sup>2</sup>	
MCDB 2222	Core Concepts in Biology II: Genes, Genetics and Phenotypes (MCDB 2152 is not a recommended coseminar for MCDB 2222)	
<i>Research-Based Introductory Labs</i>		
Select one:		2
MCDB 1161	From Dirt to DNA: Phage Genomics Laboratory I	
MCDB 1171	Antibiotics Discovery Through Hands-on Screens I	
MCDB 1181	Biological Probiotic/Drug Discovery Through Hands-on Screens	
MCDB 2171	Chemotherapeutic Discovery Through Hands-On Screens 2	
<i>Cell Biology</i>		
		8
MCDB 3135	Molecular Biology	
MCDB 3140	Cell Biology Laboratory	
MCDB 3145	Cell Biology	
<i>Development Biology</i>		
		3
MCDB 4650	Developmental Biology	
<b>Upper-division capstone and scientific reasoning requirements</b>		
<i>Capstone</i>		
Select one:		3
MCDB 4300	Immunology	
MCDB 4777	Molecular Neurobiology	
MCDB 4150	Biology of Aging and Longevity	
<i>Scientific Reasoning</i>		
Select one (see department for full list of approved courses)		3
MCDB 4350	Microbial Diversity and the Biosphere	
MCDB 4361	Evolution and Development	
MCDB 4410	Human Molecular Genetics	
MCDB 4420	Genetics of Brain and Behavior	
MCDB 4422	Molecular Biology of Free Radicals: Role(s) in Oxidative Stress, Signaling, Disease, Aging	
MCDB 4425	Topics in Membrane Biology: Cell Biology, Physiology and Disease	

MCDB 4426	Cell Signaling and Developmental Regulation
MCDB 4427	Biology of the Visual System
MCDB 4444	Cellular Basis of Disease
MCDB 4471	Mechanisms of Gene Regulation in Eukaryotes
MCDB 4550	Cells, Molecules and Tissues: A Biophysical Approach
MCDB 4615	Biology of Stem Cells
MCDB 4680	Mechanisms of Aging
MCDB 4750	Animal Virology
MCDB 4810	Insane in the Membrane: The Biology and Biophysics of the Membrane
MCDB 4811	Teaching and Learning Biology

**Electives**

An additional 6 credit hours of upper-division electives (any MCDB 3000 or MCDB 4000 level)<sup>3</sup> 6

**Total Credit Hours** 31

Code	Title	Credit Hours
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**Required Ancillary Courses:**

Complete the following chemistry and biochemistry courses: 18

CHEM 1113 & CHEM 1114	General Chemistry 1 and Laboratory in General Chemistry 1	
CHEM 1133 & CHEM 1134	General Chemistry 2 and Laboratory in General Chemistry 2	
CHEM 3311 & CHEM 3321	Organic Chemistry 1 and Laboratory in Organic Chemistry 1	
BCHM 4611	Principles of Biochemistry	

Select one of the following calculus or statistics courses:<sup>4</sup> 3-5

Calculus:		
MATH 1300	Calculus 1	
MATH 1310	Calculus for Life Sciences	
APPM 1350	Calculus 1 for Engineers	
Statistics:		
MATH 2510	Introduction to Statistics	
EBIO 1010	Introduction to Statistics and Quantitative Thinking for Biologists	
EBIO 4410	Biological Statistics	
IPHY 3280	Intro to Data Science and Biostatistics	
PSYC 2111	Psychological Science I: Statistics	

**Total Credit Hours** 21-23

<sup>1</sup> EBIO 1210 is an acceptable alternative to MCDB 1150.

<sup>2</sup> EBIO 2070 is accepted in place of MCDB 2150.

<sup>3</sup> Up to 6 hours of MCDB 4840 Upper-Division Independent Study, MCDB 4980 Honors Research, MCDB 4990 Honors Thesis, or select courses from outside MCDB may be used. A minimum of 3 credit hours of MCDB upper-division electives must be taken on the Boulder campus. See department for details.

<sup>4</sup> Not all the courses in this category will also meet the QRMS component of the Gen Ed Skills Requirement.

**Graduating in Four Years**

Consult the Four-Year Guarantee Requirements for information on eligibility. The concept of "adequate progress" as it is used here only refers to maintaining eligibility for the four-year guarantee; it is not a requirement for the major. To maintain adequate progress in molecular, cellular and developmental biology, students should meet the following requirements:

- In the first semester, declare the MCDB major. (If the major is not started in the first year, the student must meet with an MCDB academic advisor to ensure that it is still possible to complete the major in four years.)
- During the first and second semesters, complete either general chemistry or the introductory MCDB sequence.
- By the end of the fourth semester, complete general chemistry and the introductory MCDB sequence with a C- or better.
- By the end of the eighth semester, complete the major.

**Recommended Four-Year Plan of Study**

Through the required coursework for the major, students will fulfill all 12 credits of the Natural Sciences area of the Gen Ed Distribution Requirement, including the Lab requirement, and, potentially, the QRMS component of the Gen Ed Skills Requirement.

**Year One**

Fall Semester		Credit Hours
MCDB 1150 or MCDB 1111	Introduction to Cellular and Molecular Biology or Core Concepts in Biology I: Evolutionary, Molecular and Cell Biology	3
MCDB 2 Credit Hour Lab		2
MCDB 1152	Problem Solving Co-Seminar for Introduction to Molecular and Cellular Biology (strongly recommended in conjunction with MCDB 1150, not required)	1
CHEM 1113 & CHEM 1114	General Chemistry 1 and Laboratory in General Chemistry 1	5
Gen. Ed. Skills course (example: Lower-division Written Communication)		3
<b>Credit Hours</b>		<b>14</b>
Spring Semester		Credit Hours
MCDB 2150 or MCDB 2222	Principles of Genetics or Core Concepts in Biology II: Genes, Genetics and Phenotypes	3
MCDB 2152	Problem Solving Co-Seminars for Genetics (strongly recommended in conjunction with MCDB 2150, not required)	1
CHEM 1133 & CHEM 1134	General Chemistry 2 and Laboratory in General Chemistry 2	5
Gen. Ed. Distribution course (example: Social Sciences)		3
Gen. Ed. Skills course (example: QRMS) or Elective if QRMS is fulfilled by major requirement.		3
<b>Credit Hours</b>		<b>15</b>

**Year Two****Fall Semester**

MCDB 3135 or MCDB 3145	Molecular Biology or Cell Biology	3
MCDB 3140 or MCDB 3145	Cell Biology Laboratory (MCDB 3140 may be taken at the same time as MCDB 3135 or MCDB3145) or Cell Biology	
CHEM 3311 & CHEM 3321	Organic Chemistry 1 and Laboratory in Organic Chemistry 1	5
Gen. Ed. Distribution/Diversity course (example: Social Sciences/Global Perspective)		3
Elective		3

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**Credit Hours** **14**

**Spring Semester**

MCDB 3145	Cell Biology	3
MATH 1300 OR Statistics: Calculus 1 or Statistics OR (some students may decide to take Organic Chemistry 2 as an approved out of department, upper division MCDB elective, in that case, taking stats or calc is advised for later semesters)		3-5
Gen. Ed. Distribution course (example: Social Sciences)		3
Gen. Ed. Distribution course (example: Arts & Humanities)		3
Elective (only if taking Statistics)		3

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**Credit Hours** **15-17**

**Year Three****Fall Semester**

MCDB 4650	Developmental Biology	3
BCHM 4611	Principles of Biochemistry	3
Gen. Ed. Skills course (example: Upper-division Written Communication)		3
Gen. Ed. Distribution course (example: Arts & Humanities)		3
Free Elective		3

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**Credit Hours** **15**

**Spring Semester**

Free elective		3
MCDB Science Reasoning		3
Gen. Ed. Distribution course (example: Social Sciences)		3
Upper-Division Elective		3
Upper-Division Elective		3

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**Credit Hours** **15**

**Year Four****Fall Semester**

MCDB Capstone		3
MCDB upper division elective		3
Gen. Ed. Distribution/Diversity course (example: Arts & Humanities/US Perspective)		3
Free Elective		3
Free Elective		3

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**Credit Hours** **15**

**Spring Semester**

MCDB Upper-division Elective		3
Gen. Ed. Distribution course (example: Arts & Humanities)		3
Upper-Division Elective		3
Free elective		3

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Free elective 3

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**Credit Hours** **15**

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**Total Credit Hours** **118-120**

## Learning Outcomes

Upon completing the program, students will be able to:

- Connect the principles of evolution to the cellular, molecular and genetic properties of organisms, including how genomes and allele frequencies change over time.
- Describe the assembly and properties of macromolecular complexes and membranes, the movement of molecules and macromolecules, and the chemical properties that underlie these functions.
- Describe how the genetic information in a cell is stored, replicated, transcribed and translated, and compare the different mechanisms and consequences of gene expression regulation.
- Describe the basic features of inter- and intra-cellular signaling systems and interpret the ways that they can influence, directly and indirectly, gene expression, cellular behaviors, and organismic phenotypes.
- Describe the mechanisms of inheritance, including deducing information about genes, alleles, mutations and gene functions from analyses of genetic crosses and patterns of inheritance.
- Distinguish between different experimental techniques, justify their use to test specific hypotheses and interpret conclusions from experimental data.
- Carry out basic research using standard cell and molecular biology techniques and communicate that research through both written and oral presentations.