

# PH.D. IN CELL AND MOLECULAR BIOLOGY

The graduate program in Cell and Molecular Biology is an interdisciplinary degree-granting program that involves over 100 faculty members from 17 departments and 6 colleges who share common interests in cell and molecular biology. The PhD program includes core coursework in molecular genetics and cell biology and rigorous and reproducible research. Elective courses cover specialized areas, including grant writing, ethical conduct of research and statistics. Two alternating graduate seminar series allow students to present their research and to attend presentations by CSU faculty and nationally prominent scientists. Core courses typically are completed during the first year and most students advance to candidacy by the end of their 5th semester. The PhD degree can generally be completed within five years. There is an option to include a Cancer Biology Specialization (<https://catalog.colostate.edu/general-catalog/university-wide-programs/interdisciplinary-studies/cell-molecular-biology/phd-cell-molecular-cancer-biology-specialization/>).

Most students admitted to the PhD program rotate through three laboratories in their first year to identify a PhD advisor. Current focus areas of research include, but are not limited to, Cancer Biology; Gene Expression; Genome Structure, Evolution & Repair; Infectious Disease; Metabolism & Physiology; Microbiomes; Plant Molecular Biology; Prions & Neurobiology; Stem Cells & Development; Synthetic Biology and STEM Communication. Students are encouraged to complete coursework in computational/quantitative approaches, and an emphasis is placed on effective communication with various audiences. The CMB program supports a student association and aims to create a welcoming culture for all.

Students interested in this program should refer to the Graduate and Professional Bulletin (<https://catalog.colostate.edu/general-catalog/graduate-bulletin/>) or visit the Cell and Molecular Biology website (<http://www.cmb.colostate.edu/>) for further details.

## Learning Objectives

Graduates from our program will have strong foundations in core cell and molecular biology principles, state-of-the-art training in technical laboratory and computational skills, and leadership and communication skills necessary for professional achievement.

Upon successful completion of the Ph.D. program, students will be able to:

1. Demonstrate and apply detailed knowledge of the molecular processes by which genetic material is replicated, expressed, and regulated and/or the cellular processes involved in membrane formation, organelle biogenesis, cell communication/shape/motility and how these are linked with growth, aging, and death.
2. Evaluate primary research papers in the field of cell and molecular biology, including discerning the major questions/hypotheses being addressed, critically interpreting the data presented, assessing whether the conclusions are adequately supported by evidence, and relating the findings to the broader context and significance in the field.
3. Apply appropriate, ethical, and technically competent research practices to generate and analyze data and determine statistical and biological relevance.

4. Write publication-quality scientific manuscripts in the field of cell and molecular biology based on research findings.
5. Formulate new hypotheses based on the literature in the field of cell and molecular biology and design appropriate experimental and analytical approaches to test them and refine those approaches/hypotheses based on initial findings.

## Requirements Effective Fall 2024

Code	Title	Credits
CM 510	Introduction to Cell and Molecular Biology	1
CM 544/MIP 544	Reproducible Biomedical Research Methods	3
CM 792	Cell and Molecular Biology Seminar <sup>1, 2</sup>	4-10
CM 793	Seminar <sup>1, 2</sup>	4-10
<b>Select one course from the following:</b>		<b>4</b>
BC 563	Molecular Genetics	
BC 565	Molecular Regulation of Cell Function	
<b>Independent Study and Dissertation (select a minimum of 6 credits):</b>		<b>6-30</b>
CM 795	Independent Study <sup>2</sup>	
CM 799	Dissertation <sup>2</sup>	
Ethics Elective (see list below)		1-3
Statistics Elective (see list below)		3
Topics Elective (see list below)		1
Writing Elective (see list below)		1
Cell & Molecular Biology Elective <sup>3</sup>		3
<b>Master's Degree Credit (a maximum of 30 credits may be accepted from a master's degree)</b>		<b>30</b>
<b>Program Total Credits:</b>		<b>72</b>

A minimum of 72 credits are required to complete this program.

### Ethics Electives

Code	Title	Credits
Select at least one course from the following:		
BC 601	Responsible Conduct in Biochemistry	1
GRAD 544	Ethical Conduct of Research	1
MIP 554	Research Policies and Regulations	1
NSCI 575/GRAD 575	Ethical Issues in Big Data Research (preferred course)	1

### Statistics Electives

A minimum of 3 credits are required. This list is not exhaustive.

Code	Title	Credits
ERHS 535	R Programming for Research	3
ERHS 537A	R Programming: Research I	1
ERHS 537B	R Programming: Research II	2
ERHS 544/STAT 544	Biostatistical Methods for Quantitative Data	3
STAR 501	Data Wrangling/Visualization for Researchers	2
STAR 502	Multivariate Analysis for Researchers	2
STAR 511	Design and Data Analysis for Researchers I	4

STAR 512	Design and Data Analysis for Researchers II	4
STAR 513	Regression Models for Researchers	2
STAR 514	Experimental Design/Analysis for Researchers	2
STAR 531	Generalized Regression Models for Researchers	2
STAR 532	Mixed Models for Researchers	2
STAR 534	Machine Learning for Researchers	2
STAT 540	Data Analysis and Regression	3
VS 562	Clinical Research Design and Data Analysis	3
VS 733	Advanced Veterinary Epidemiology	4

## Topics Electives

Topics Electives provide guided practice in reading, interpreting, and critiquing scientific literature relevant to the field of Cell & Molecular Biology. A minimum of 1 credit is required.

Code	Title	Credits
<b>Preferred Course:</b>		
CM 700	Critical Analysis of Scientific Literature	1
Courses that may substitute for CM 700 (select in consultation with advisor:		
BMS 796A/NB 796C	Group Study: Topics in Neuroscience	1-4
BMS 796B	Group Study: Cardiopulmonary Physiology	1-18
BMS 796C	Group Study: Reproductive Physiology	1-18
BSPM 502B	Topics in Plant Pathology: Plant Bacteriology	1
CHEM 651B	Special Topics in Chemistry: Inorganic Chemistry	1-4
FSHN 650A	Recent Developments in Human Nutrition: Topics in Community Nutrition	2
FSHN 650B	Recent Developments in Human Nutrition: Carbohydrates, Lipids, and Energy	2
FSHN 650C	Recent Developments in Human Nutrition: Genomic, Proteomics, and Metabolomics	2
MIP 700	Topics in Microbiology	1
SOCR 730	Topics in Plant Breeding and Genetics	1

## Writing Electives

A minimum of 1 credit is required.

Code	Title	Credits
BC 701	Grant Proposal Writing and Reviewing	1
BSPM 530/SOCR 530	Scientific Writing	1
BZ 544	Presenting Research in Biology	2
HES 700	Professional Skills in Bioenergetics	3
MIP 643	Grant Writing for Microbiology/Pathology	1
MIP 666	Writing Scientific Manuscripts	3
NB 771	Writing, Submitting, and Reviewing Grants	1

## Cell & Molecular Biology Electives

A minimum of 3 credits of electives related to the student's research area are required. Some possible options are listed, but this list is not exhaustive.

Code	Title	Credits
AB 511	Microbiome of Plant Systems	3
ANEQ 505	Microbiome of Animal Systems	3
ANEQ 545	Molecular Methods in Animal Genetics	3
ANEQ 575	Computational Biology in Animal Breeding	3
BC 511	Structural Biology I	4
BC 563	Molecular Genetics	4
BC 565	Molecular Regulation of Cell Function	4
BC 571	Quantitative Biochemistry	1
BC 611	Structural Biology II	2
BC 663	Gene Expression	2
BC 665A	Advanced Topics in Cell Regulation: Microscopic Methods	2
BZ 565/MIP 565	Next Generation Sequencing Platform/ Libraries	1
BIOM 525/MECH 525	Cell and Tissue Engineering	3
BIOM 533/CIVE 533	Biomolecular Tools for Engineers	3
BMS 500	Mammalian Physiology I	4
BMS 501	Mammalian Physiology II	4
BZ 570	Molecular Aspects of Plant Development	3
BZ 576/BZ 476	Genetics of Model Organisms	4
CBE 560	Engineering of Protein Expression Systems	3
DSCI 511	Genomics Data Analysis in Python	2
DSCI 512	RNA-Sequencing Data Analysis	1
MIP 530	Advanced Molecular Virology	4
MIP 543	RNA Biology	3
MIP 545	Microbial Metagenomics/Genomics Data Analysis	2
MIP 670	Molecular Immunology and Immunogenetics	3
MIP 730/ERHS 730	Principles of Flow Cytometry & Cell Sorting	2
NB 503/BMS 503	Developmental Neurobiology	3
NB 501	Cellular and Molecular Neurophysiology	2

<sup>1</sup> CM 792 and CM 793 must be taken every year.

<sup>2</sup> Students must complete at least one credit from each CM 795 and CM 799, and select enough independent study, dissertation, seminar, and other elective course credits to bring the program total to a minimum of 72 credits, with approval of graduate advisory committee.

<sup>3</sup> Course selection depends on each student's focus within Cell & Molecular Biology and must be approved by the student's graduate advisory committee.

## Requirements for All Graduate Degrees

For more information, please visit Requirements for All Graduate Degrees (<https://catalog.colostate.edu/general-catalog/graduate-bulletin/graduate-study/procedures-requirements-all-degrees/>) in the Graduate and Professional Bulletin (<https://catalog.colostate.edu/general-catalog/graduate-bulletin/>).

## Summary of Procedures for the Master's and Doctoral Degrees

NOTE: Each semester the Graduate School publishes a schedule of deadlines. Deadlines are available on the Graduate School website

(<https://graduateschool.colostate.edu/deadline-dates/>). Students should consult this schedule whenever they approach important steps in their careers.

Forms (<https://graduateschool.colostate.edu/forms/>) are available online.

Step	Due Date
1. Application for admission (online)	Six months before first registration
2. Diagnostic examination when required	Before first registration
3. Appointment of advisor	Before first registration
4. Selection of graduate committee	Before the time of fourth regular semester registration
5. Filing of program of study (GS Form 6)	Before the time of fourth regular semester registration
6. Preliminary examination (Ph.D. and PD)	Two terms prior to final examination
7. Report of preliminary examination (GS Form 16) - (Ph.D. and PD)	Within two working days after results are known
8. Changes in committee (GS Form 9A)	When change is made
9. Application for Graduation (GS Form 25)	Refer to published deadlines from the Graduate School Website
9a. Reapplication for Graduation (online)	Failure to graduate requires Reapplication for Graduation (online) for the next time term for which you are applying
10. Submit thesis or dissertation to committee	At least two weeks prior to the examination or at the discretion of the graduate committee
11. Final examination	Refer to published deadlines from the Graduate School Website
12. Report of final examination (GS Form 24)	Within two working days after results are known; refer to published deadlines from the Graduate School website
13. Submit a signed Thesis/ Dissertation Submission Form (GS Form 30) to the Graduate School and Submit the Survey of Earned Doctorates (Ph.D. only) prior to submitting the electronic thesis/ dissertation	Refer to published deadlines from the Graduate School website.
14. Submit the thesis/dissertation electronically	Refer to published deadlines from the Graduate School website
15. Graduation	Ceremony information is available from the Graduate School website