

# PHARMACOLOGY AND MOLECULAR MEDICINE (PHD)

## Overview

The Pharmacology and Molecular Medicine Training Program has a long and well-established history of training Ph.D. students in the biomedical sciences. The NIH funded Pharmacology pre-doctoral Training Grant (T32), is one of the longest standing grants of its type in existence. Students enter the Training Program either directly, via the Biomedical Sciences (umbrella) Program, or the Medical Scientist Training Program (MSTP). Currently, there are ~35 students and ~55 training faculty associated with the Program.

The Pharmacology and Molecular Medicine Training Program is truly both interdisciplinary and interdepartmental with faculty members having primary appointments in Anesthesiology, Biochemistry & Molecular Genetics, Immunology, Medicine, Neurology, Pathology, Pediatrics, Pharmaceutical Sciences, Pharmacology, and Physiology & Biophysics. Training Program faculty are internationally renowned in the areas of neuroscience, cancer biology, cardiovascular biology, signal transduction, structural biology, and bioinformatics.

One of the defining features of the Pharmacology and Molecular Medicine Program training faculty is the highly collaborative and interdisciplinary approach to their work. Laboratories frequently use multiple parallel approaches including molecular biology, structural biology, genomics, and informatics and cutting-edge methodologies employing high powered imaging techniques including optogenetics. Another defining feature of the Program is the focus on personalized medicine and translating fundamental benchtop discoveries to clinical practice.

Students admitted to the Pharmacology and Molecular Medicine Program are fully funded. In addition to the current stipend (\$38,110/yr subject to update), trainee support includes coverage of tuition & fees, health insurance, access to mental health resources, and free public transportation.

During their 1<sup>st</sup> year, Program students complete a set of core courses common to all biomedical science programs as well as core courses central to the discipline of Pharmacology. Students also complete 3 ten-week research rotations with Program faculty. The year wraps up with the Program's Preliminary Exam and the subsequent transfer of the student into their chosen thesis lab. A substantial proportion of our students are successful in obtaining external funding from entities such as the NIH, AHA, HHMI, NSF, etc. The average time to completion of a Ph.D. is 5.4 years. Please visit our Program's website to get a better feel for our current cohort of students and to see the progress of our recent alumni.

The University of Colorado Anschutz Medical Campus is the largest academic medical center in the region. Our graduate students are integral members of a community whose collective goal is to push the boundaries of science and healthcare, to improve lives, and to make a difference. At CU Anschutz, we are not training our graduate students to fit a certain academic mold. We are training thought-leaders who are equipped with the skills and knowledge to make an impact in all aspects of science.

## Admissions Requirements

To apply for admission applicants must submit the following:

- Online Graduate School application.
- A \$50.00 domestic and \$75.00 international non-refundable application fee [credit card (on-line only), check, or money order]. No application will be processed unless this fee is paid.
- One (1) official transcript of all academic work completed to date. To be considered "official", the transcripts must come from the issuing institution directly to the University of Colorado Denver Graduate Admissions.

Electronic Transcripts should be sent to:  
graduate.school@cuanschutz.edu

If sending a physical transcript, please mail to:

University of Colorado Denver  
Graduate School  
Mail Stop C296  
Fitzsimons Building, W5107  
13001 E. 17th Place  
Aurora, CO 80045

- Four (4) letters of recommendation.
- TOEFL or IELTS scores and financial support verification (international students only).

## Degree Requirements

### First Year

Year 1		Hours
<b>Fall</b>		
BMSC 7806	Core I: Foundations in Biomedical Sciences	6
BMSC 7810	Core Topics in Biomedical Science	2
BMSC 7810	Core Topics in Biomedical Science	2
PHCL 7600	Frontiers in Pharmacology	1
PHCL 7605	Responsible Conduct of Research	1
PHCL 7650	Research in Pharmacology <sup>Section 001</sup>	1-5
PHCL 7650	Research in Pharmacology <sup>Section 002</sup>	1-5
<b>Hours</b>		<b>14-22</b>
<b>Spring</b>		
PHCL 7606	Receptors and Cell Signaling	3
PHCL 7620	Principles of Pharmacology <sup>Section 001</sup>	6
PHCL 7650	Research in Pharmacology <sup>Section 003</sup>	1-5
<b>Hours</b>		<b>10-14</b>
<b>Summer</b>		
PHCL 8990	Doctoral Thesis <sup>Section 0V1</sup>	1-10
<b>Hours</b>		<b>1-10</b>
<b>Total Hours</b>		<b>25-46</b>

### Second Year

Second Year		Hours
<b>Fall</b>		
BIOS 6606	Statistics for the Basic Sciences	3
PHCL 7613	Pharmacology Journal Club <sup>Section 001</sup>	1
PHCL 7615	Grant Proposals in Pharmacology <sup>Section 001</sup>	1
<b>Elective</b>		
<b>Hours</b>		<b>5</b>

**Spring**

PHCL 7613	Pharmacology Journal Club <sup>Section 001</sup>	1
PHCL 7615	Grant Proposals in Pharmacology <sup>Section 001</sup>	1
PHCL 8990	Doctoral Thesis <sup>Section 0V1</sup>	1-10
Elective		

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**Hours** **3-12**

**Summer**

PHCL 8990	Doctoral Thesis <sup>Section 0V1</sup>	1-10
	<b>Hours</b>	<b>1-10</b>
	<b>Total Hours</b>	<b>9-27</b>

**Third Year****Year 3**

		<b>Hours</b>
<b>Fall</b>		
PHCL 7613	Pharmacology Journal Club <sup>Section 001</sup>	1
PHCL 8990	Doctoral Thesis <sup>Section 0V1</sup>	1-10
	<b>Hours</b>	<b>2-11</b>

**Spring**

PHCL 7613	Pharmacology Journal Club <sup>Section 001</sup>	1
PHCL 8990	Doctoral Thesis <sup>Section 0V1</sup>	1-10
	<b>Hours</b>	<b>2-11</b>

**Summer**

PHCL 8990	Doctoral Thesis <sup>Section 0V1</sup>	1-10
	<b>Hours</b>	<b>1-10</b>
	<b>Total Hours</b>	<b>5-32</b>

**Fourth Year & Beyond****Year 4**

		<b>Hours</b>
<b>Fall</b>		
PHCL 8990	Doctoral Thesis <sup>Section 0V1</sup>	1-10
	<b>Hours</b>	<b>1-10</b>

**Spring**

PHCL 8990	Doctoral Thesis <sup>Section 0V1</sup>	1-10
	<b>Hours</b>	<b>1-10</b>

**Summer**

PHCL 8990	Doctoral Thesis <sup>Section 0V1</sup>	1-10
	<b>Hours</b>	<b>1-10</b>
	<b>Total Hours</b>	<b>3-30</b>

**Learning Objectives**

**1A. Graduate education in general** | Doctoral education is the foundation of future scholarship and the primary “engine” driving the research enterprise. It prepares future faculty and leaders in the academy as well as in many other areas of industry, government, and society in general.

**1B. Pharmacology program in specific** | The excellence of our Graduate Program in Pharmacology is best illustrated by the fact that our NIH-sponsored pre-doctoral T32 Training Grant has been continuously funded since 1978, making it one of the longest standing pharmacology training programs of this type.

The philosophy of our graduate program is to emphasize state-of-the-art research approaches at all stages; and that begins with the recruitment phase. We identify candidates with excellent undergraduate academic

credentials, with a strong preference for those who have participated in independent research. During the first year in the program, students must complete three formal laboratory-based research rotations. Each research rotation is intended to examine testable hypotheses, as well as to provide exposure to new laboratory techniques. At the conclusion of each rotation, a post-rotational seminar is presented to the Department. To enhance research exposure further, the Department offers a special course on Frontiers in Pharmacology to our first-year students.

During the first two years in the program, students are required to take a number of courses to prepare them for research careers in pharmacology. These include a core course in molecular and cellular biology overseen by the Graduate School, and Program core courses in Cell and Molecular Signaling and Principles in Pharmacology. Additional requirements include courses in Ethics, Biostatistics, and Reproducibility & Rigor. During the second year, a number of electives are also available emphasizing topics such as: neuropharmacology/neurobiology and cancer biology, bioinformatics, and structural biology.

The Ph.D. program in pharmacology trains graduate students to become proficient and successful investigators who are able to:

- Demonstrate a basic knowledge of central concepts of the biomedical sciences.
- Understand the historical basis as well as current concepts in the scientific discipline of pharmacology.
- Read and critically evaluate scientific literature relevant to pharmacology, in specific, and the basic and clinical biomedical sciences, in general.
- Formulate hypotheses based on current concepts in the field and design, conduct, and interpret their own research projects.
- Writing: Present research results in peer-reviewed publications and in their doctoral dissertation.
- Speaking: Communicate research results effectively through oral presentations at scientific seminars, conferences, and other venues.
- Understand the basis of writing and submitting competitive applications for research funding.
- Develop ancillary skills, where necessary, to obtain positions outside of scientific research.
- Be competent in self-evaluation of acquired skills and understand how those skills may be perceived by external peers.
- Develop a mature and meaningful Personal Development Plan (PDP) that will facilitate attainment of career objectives.

**Courses**

BIOS 6606 - Statistics for the Basic Sciences (3 Credits)

This course is designed for those wishing to obtain a basic understanding of statistics and its application in biological research. Students will develop statistical literacy and an ability to perform basic statistical analyses, basic graphical statistics, data summarizations, and estimation and inference using statistical software. Restrictions: Enrollment in UCD-AMC graduate program or permission of the instructor. Grading Basis: Letter Grade  
A-PUBH1 Graduate students and public health certificate students only.  
Typically Offered: Fall.

**BMSC 7806 - Core I: Foundations in Biomedical Sciences (6 Credits)**  
 Course will focus on the fundamental principles of biomedical sciences. Lectures and recitations/discussions will primarily address the basics of molecular biology, biochemistry, genetics, cell biology and energetic principles. Course is typically limited to biomedical science PhD and BSBT MS students. Previously offered as IDPT 7806  
 Grading Basis: Letter Grade  
 Repeatable. Max Credits: 6.  
 Typically Offered: Fall.

**BMSC 7810 - Core Topics in Biomedical Science (2 Credits)**  
 Sections focus on different core topics in biomedical science, and will address subject areas such as protein structure and function, neurobiology, embryology, stem cell research, and cancer biology. Students can enroll in multiple Core Topic Courses topics in one semester. Previously offered as IDPT 7810.  
 Grading Basis: Letter Grade  
 Repeatable. Max Credits: 20.  
 AMC-PHD PhD Students only  
 Typically Offered: Fall.

**PHCL 7600 - Frontiers in Pharmacology (1 Credit)**  
 Course is intended to introduce students to cutting-edge pharmacology research and to the range of research opportunities available within the Pharmacology Training Program. Pharmacology Department faculty presentations will focus on cellular signaling, molecular mechanisms of drug actions, structure-based drug design.  
 Grading Basis: Letter Grade  
 A-GRAD Restricted to graduate students only.  
 Typically Offered: Fall.

**PHCL 7605 - Responsible Conduct of Research (1 Credit)**  
 The Department of Pharmacology in the University of Colorado School of Medicine organizes and offers an interactive course during the fall semester entitled "Responsible Conduct of Research". The course is designed to inform students, trainees and faculty to the NIH requirements for ethical and responsible research.  
 Grading Basis: Letter Grade  
 A-GRAD Restricted to graduate students only.  
 Typically Offered: Fall.

**PHCL 7613 - Pharmacology Journal Club (1 Credit)**  
 The overall goal of the course is to teach the students to read and discuss current literature in their field and to gain a comprehensive view of the directions that lead to high-impact research. Students will present and discuss papers.  
 Grading Basis: Satisfactory/Unsatisfactory w/IP  
 Repeatable. Max Credits: 1.  
 Typically Offered: Fall, Spring.

**PHCL 7615 - Grant Proposals in Pharmacology (1 Credit)**  
 We will learn principles of good grants(wo)manship and hone our skills in homework assignments and discussions. Our goal is to enable a better learning experience during comps proposal writing, by gaining the tools for optimized self-assessment. Prereq: IDPT 7811, IDPT 7812, IDPT 7813, IDPT 7814, IDPT 7815.  
 Grading Basis: Letter Grade  
 A-GRAD Restricted to graduate students only.  
 Typically Offered: Fall.

**PHCL 7620 - Principles of Pharmacology (6 Credits)**  
 Lectures are provided in the general areas of pharmacokinetics, receptor theory, structure-activity relationships, drug metabolism, basic pharmacological mechanisms with a particular emphasis on systems such as the nervous system and cardiovascular system, as well as cancer and microbial chemotherapy. Prereq: IDPT 7811, 7812, 7813, 7814, 7815.  
 Restriction: Consent of Course Directors.  
 Grading Basis: Letter Grade  
 A-GRAD Restricted to graduate students only.  
 Typically Offered: Spring.

**PHCL 7650 - Research in Pharmacology (1-5 Credits)**  
 Research work in pharmacology. Prereq: Consent of Instructor.  
 Grading Basis: Letter Grade with IP  
 Repeatable. Max Credits: 99.  
 A-GRAD Restricted to graduate students only.  
 Typically Offered: Fall, Spring, Summer.

**PHCL 8990 - Doctoral Thesis (1-10 Credits)**  
 Doctoral thesis work in pharmacology. Prereq: Consent of Instructor.  
 Grading Basis: Letter Grade with IP  
 Repeatable. Max Credits: 10.  
 A-GRAD Restricted to graduate students only.  
 Additional Information: Report as Full Time.  
 Typically Offered: Fall, Spring, Summer.

## Policies

Please refer to the Graduate School Policies page (<http://catalog.ucdenver.edu/cu-anschutz/schools-colleges-programs/graduate-school/#policiestext>).

## Contact Us

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