MOLECULAR AND CELLULAR PHARMACOLOGY

http://biomed.med.miami.edu/graduate-programs/molecular-and-cellular-pharmacology

Overview

Scientists in the Molecular and Cellular Pharmacology Ph. D. Program apply knowledge and techniques from diverse areas of biology, chemistry, physics, and informatics to study the action of drugs on fundamental processes in living systems.

The goals of the research in this GRADUATE PROGRAM are:

- to identify new targets, mechanisms and pathways for development of therapeutics
- to use drugs and other bioactive molecules as tools in the study of basic biological processes
- to develop and study agents that may be beneficial in the treatment of disease

Research in this program is highly multidisciplinary, encompassing diverse fields, including genetics, biochemistry, biophysics, molecular and cell biology, imaging, computational modeling, bioinformatics and genetically engineered yeast, fly, and mouse models. The faculty are a mixture of senior scientists who are recognized leaders in their respective fields and more junior faculty with recent training in state-of-the-art approaches to important biomedical problems. **Research interests of the faculty include:**

Drug Discovery and Computational Pharmacology:
Investigators in this area focus on the use of bioinformatics, high-throughput assay development, medicinal chemistry, *in vivo* animal testing, and other tools to identify and develop novel molecular probes and possible lead candidates to address various therapeutic needs of interest including cancer, diabetes, cardiovascular, kidney and neurodegenerative diseases. Current research is focused on G-protein coupled receptors (GPCRs), protein kinases, regulation of gene expression, protein-protein interactions, and other post-translational modifications.

Cardiovascular Pharmacology / Muscle Contraction
Studies of cardiac muscle contraction and the effect of disease-causing mutations in the contractile apparatus of the heart on heart performance are being pursued. Current research areas include structure/function relationships in the proteins in health and disease, cardiotoxicity of chemotherapy agents, the role of microRNAs in cholesterol biosynthesis and smooth muscle cell plasticity, and the stem cell-based therapy for cardiac disease. In addition to cardiac myocytes, researchers investigate fibroblasts, endothelial and smooth and skeletal muscle cells.

Neuroscience / Endocrinology
Investigators in this area study the function, pharmacology, development and diseases of the nervous system. Current research interests include neuronal signaling, control of physiological functions by neurons, endocrine pancreas and kidney; the genetic and cellular basis of neural development and degeneration using the fruit fly *Drosophila melanogaster* as a model system.

Cell Biology / Cancer
Investigators in this area study cell cycle control and cancer, gene expression, mechanisms of hormone action, signal transduction, cytoskeleton, posttranslational modification and degradation of proteins, stem cells, and novel therapeutics targeting receptors and protein kinases.

Current research interests include steroid hormone regulation of gene expression and cell proliferation; cell cycle checkpoints during DNA replication; control of cell polarity and morphogenesis; molecular basis of human lymphoma; endocrine-related cancers including prostate and breast; stem cell maintenance and therapy; and physiochemical and metabolic aspects of drug design.

Model Systems
Model organisms used in these studies include transgenic and knock-out/knock-in mouse, fly (*Drosophila*), and yeast models. Yeast and Drosophila are important models because of the powerful molecular and genetic approaches and tools available. These systems are being used to study fundamental processes such as apoptosis, cell cycle, signal transduction, membrane dynamics, cytoskeleton, cell polarity and development. Because most of these processes are conserved in evolution, investigators are using these systems to screen for therapeutic agents and to identify targets of pharmacologically relevant compounds.

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Admission Requirements

Applicants to biomedical programs should have a bachelor degree in a biological or related discipline (e.g., psychology, chemistry, engineering, physics). Although there are no prerequisite requirements, courses in general biology, cell/molecular biology, calculus, general physics, organic chemistry, physical chemistry, and biochemistry are encouraged. Applications are generally accepted from September to December for fall entry only. Select applicants will be offered an interview.

COMPETITIVE CANDIDATES WILL HAVE THE FOLLOWING:

- Excellent academic record
- Research experience in a laboratory setting
- Publications of abstract and / or papers
- Co-authorship in a peer-reviewed journal is recommended
- Strong letters of recommendation from research scientists who know the candidate well
- Motivation to pursue state-of-the-art biomedical research

APPLICANTS MUST SUBMIT THE FOLLOWING:

- Online Application
- Application Fee
- Official Academic Transcripts
- English Proficiency Exam (non-native speakers)
- Statement of Purpose
- Resume / CV

Full application instructions can be found here (http://biomed.med.miami.edu/apply/).

Curriculum Requirements

Code	Title	Credit Hours
Biomedical Science Core		
Journal Club [1]		2
PIB 700	Journal Club	1
PIB 701	Introduction to Biomedical Sciences	5
PIB 702	Scientific Reasoning	3
PIB 705	Biostatistics for the Biosciences	3
PIB 731	Laboratory Research	3-5
PIB 780	Research Ethics	1
PIB 782	Professional Development: Skills for Success I	1
PIB 783	Professional Development: Skills for Success II	1
PIB 785	PIBS Bioinformatics Workshop	1
PIB 830	Doctoral Dissertation [1]	1
Molecular and Cellular Pharmacology Required Courses		
MCP 701	Seminar [2]	2
MCP 743	Introductory Python Programming for Bioscientists [4]	3
MCP 704	Mechanisms of Drug Action	3
MCP 732	Cardiovascular Pharmacology	3
MCP 752	Systems Biology and Approaches in Pharmacology	3
MCP 753	Computational Pharmacology and Fundamentals of Drug Design	3
MCP 768	Neuropharmacology	3
Research Credits		**23**
MCP 830	Dissertation Research-Pre-Candidacy [3]	
MCP 840	Doctoral Dissertation- Post Candidacy [3]	

MCP 850	Research in Residence [3]	
Total Credit Hours		**65**

1 Students in this program take PIB 700 twice for a total of 2 credits. Please see the Plan of Study for more information.
2 Students in this program take MCP 701 four times for a total of 8 credits. Please see the Plan of Study for more information.
3 The student should be working in the laboratory where he/she intends to do his/her thesis research by the summer, first year. Nearly all of the student's time is spent on original laboratory research – with a minimum total of 24 credit hours of research for graduation
4 MCP 743 is a pre-requisite requirement which must be completed prior to enrolling in MCP 704 & MCP 753.

Plan of Study

In the first year, students receive a solid foundation in biomedical science. The core coursework ranges from molecules to cells to systems of human physiology. Lectures are balanced by breakout sessions, in which faculty members discuss the primary literature with students in small groups. The core curriculum also offers critical learning opportunities in biostatistics and in using genomic and other databases, as well as education in ethics. Students also meet several times in small groups with experienced faculty mentors to discuss important issues of student development. In subsequent semesters, students take core courses encompassing Mechanisms of Drug Action MCP 704, Neuropharmacology MCP 768, Cardiovascular Pharmacology MCP 732, Python Programming for Bioscientists MCP 743, Systems Biology and Approaches in Pharmacology MCP 752, and Computational Pharmacology and Fundamentals of Drug Design MCP 753. A variety of elective courses are offered by this program and other basic science programs at the Miller School of Medicine.

Minimum credit requirements for the PhD degree are set by the University at 36 course credits (including specific required courses) and 24 credit hours of research (for a total of 60 credits). The course credits must be earned in graduate level (600 and above) courses. Students may elect to take any of the graduate courses offered by the MCP program, in addition to the mandatory courses, or choose from a large variety of advanced courses offered by other basic science programs at the University of Miami Miller School of Medicine.

The student should be working in the laboratory where he/she intends to do his/her thesis research by the summer, first year. By the beginning of the spring semester of the second year, students are required to take the Qualifying Exam (QE). The goals of the QE are (1) to assess the scientific proficiency of the student, especially his/her ability to design experiments and to write a competitive grant application; and (2) to aid the student and mentor in the process of obtaining extramural funds to support the student's stipend.

The thesis proposal is expected to be passed during the third year, Fall semester. It is important to note that in the MCP program this is not the Qualifying Exam. Rather, it is a collegial meeting with the thesis committee where the student discusses his/her preliminary data and plans for the thesis. Students normally meet with the committee for progress meetings every 9 months.

The thesis is defended in front of the entire program and also in a meeting with the committee. The average time-to-completion is 5.5 years.

Please note that the following is a sample curriculum plan. Current students must discuss their plan with their program coordinator to make adjustments as needed.

Year One		
Fall		**Credit Hours**
PIB 700	Journal Club	1
PIB 701	Introduction to Biomedical Sciences	5
PIB 702	Scientific Reasoning	3
PIB 731	Laboratory Research (1 credit per lab rotation)	2
PIB 780	Research Ethics	1
PIB 782	Professional Development: Skills for Success I	1
	Credit Hours	**13**
Spring		
PIB 700	Journal Club	1
PIB 705	Biostatistics for the Biosciences	3
PIB 731	Laboratory Research (1 credit per rotation)	1
PIB 783	Professional Development: Skills for Success II	1
MCP 752	Systems Biology and Approaches in Pharmacology (Spring B)	3
MCP 704	Mechanisms of Drug Action (Spring A)	3
MCP 753	Computational Pharmacology and Fundamentals of Drug Design (Spring B)	3
MCP 743	Introductory Python Programming for Bioscientists (Spring A)	3
	Credit Hours	**18**

Summer		
PIB 830	Doctoral Dissertation	1
PIB 785	PIBS Bioinformatics Workshop	1
	Credit Hours	**2**
Year Two		
Fall		
MCP 701	Seminar	2
MCP 732 or 768	Cardiovascular Pharmacology or Neuropharmacology	3
MCP 830	Dissertation Research-Pre-Candidacy	3
	Credit Hours	**8**
Spring		
MCP 701	Seminar	2
MCP 830	Dissertation Research-Pre-Candidacy	3
Students may elect to take additional basic science courses.		
	Credit Hours	**5**
Summer		
MCP 830	Dissertation Research-Pre-Candidacy	1
	Credit Hours	**1**
Year Three		
Fall		
MCP 701	Seminar	2
MCP 732 or 768	Cardiovascular Pharmacology or Neuropharmacology	3
MCP 830	Dissertation Research-Pre-Candidacy	3
	Credit Hours	**8**
Spring		
MCP 701	Seminar	2
MCP 840	Doctoral Dissertation- Post Candidacy	3
Students may elect to take additional basic science courses.		
	Credit Hours	**5**
Summer		
MCP 840	Doctoral Dissertation- Post Candidacy	1
	Credit Hours	**1**
Year Four		
Fall		
MCP 840	Doctoral Dissertation- Post Candidacy	3
	Credit Hours	**3**
Spring		
MCP 840	Doctoral Dissertation- Post Candidacy	3
	Credit Hours	**3**
Summer		
MCP 840	Doctoral Dissertation- Post Candidacy	1
	Credit Hours	**1**
Year Five		
Fall		
MCP 840	Doctoral Dissertation- Post Candidacy	1
	Credit Hours	**1**

Spring		
MCP 850	Research in Residence	1
	Credit Hours	**1**
	Total Credit Hours	**70**

Mission

The Graduate Program in Molecular and Cellular Pharmacology (MCP) offers graduate training leading to a Ph.D. in Pharmacology. The mission of the program is to endow our students with the skills for research work in the area of life science.

Goals

Our students learn:

- To understand central concepts in pharmacology and basic biomedical science;
- To identify existing gaps in current knowledge about molecular and cellular pharmacology and formulate scientific hypotheses; and
- To design sound research plans, perform original laboratory or computational research, analyze data and effectively disseminate the results.

Student Learning Outcomes

- Students demonstrate the ability to produce original research data, and publish it in peer-reviewed international scientific journals.
- Students learn to be flexible in applying their knowledge base to the rapidly changing employment environment.

MCP 701. Seminar. 2 Credit Hours.
Review of related literature, discussion of special topics, student presentations and attendance of faculty/department seminars. Course may be repeated for a total of eight credits.
Components: SEM.
Grading: GRD.
Typically Offered: Fall & Spring.

MCP 704. Mechanisms of Drug Action. 3 Credit Hours.
This course focuses on a basic scientific understanding of the main processes underlying drug action. It briefly covers all important aspects of both the pharmacodynamic and pharmacokinetic phases including (i) a review of the receptor concept and related general principles; (ii) a detailed discussion of quantitative models of receptor occupancy, agonism, and antagonism; (iii) basic concepts related to absorption, distribution, metabolism, and elimination (ADME) processes and pharmacokinetics; (iv) illustrative molecular mechanisms of action for a few representative drug classes; and (v) an overview of the drug design and discovery process
Components: LEC.
Grading: GRD.
Typically Offered: Spring.

MCP 731. Special Topics. 1-6 Credit Hours.
Directed readings on subjects not ordinarily treated in depth in specific courses. Course may also consist of special laboratory problems.
Components: LEC.
Grading: GRD.
Typically Offered: Fall, Spring, & Summer.

MCP 732. Cardiovascular Pharmacology. 2-3 Credit Hours.
The course covers cardiovascular pharmacology, necessary cardiovascular physiology and anatomy and the function and pharmacology of the autonomic nervous system. The students learn about the function and energetics of the heart and how it is changed in cardiac disease.
Components: LEC.
Grading: GRD.
Typically Offered: Fall Even Years.

MCP 733. Research & Development in Pharmacology. 1-6 Credit Hours.
Presentations are a huge part of scientific life. They are very important for advancing students' careers. Furthermore, a presentation (verbal or written) is the only way you can let others know about your results. This ability will be earned by observing and discussing seminar presentations given by faculty and fellow students, and by practicing your own scientific presentation and receiving feedback from the instructors and other students. Draft your individual development plans (IDP) for successful graduate training and career The class will discuss the significance and the basic elements of an individual development plan. Discuss important issues of Responsible Conduct of Research and Professionalism Responsible conduct of research (RCR) is the practice of scientific investigation with integrity and is an important component of your research training. It involves the awareness and application of established professional norms and ethical principles in the performance of all activities related to scientific research. In MCP731, we actively incorporate the RCR education in the seminar series by using real-life materials and situations as examples for in-depth analyses and discussions, in addition to other teaching materials as recommended by the relevant NIH guidelines. By these mechanisms, the MCP731 will cover all the RCR issues as recommended by the NIH guidelines with a focus on topics related to pharmacological sciences.
Components: LEC.
Grading: GRD.
Typically Offered: Fall, Spring, & Summer.

MCP 743. Introductory Python Programming for Bioscientists. 3 Credit Hours.
This course is designed to teach problem solving using the Python programming language. No prior programming knowledge is needed. Students will learn to write their own original Python programs to parse, manipulate, and analyze big data sets containing genomic, proteomic, and structural information. As the course progresses, students will be encouraged to apply their emerging programming knowledge to tackle scientific problems of their interest. The course culminates with each student designing a final project related to their research. This is a hands-on course with in-class interactive programming. Therefore, students are required to have their own Mac or PC laptop in good working condition for every class.
Components: DIS.
Grading: SUS.
Typically Offered: Spring.

MCP 752. Systems Biology and Approaches in Pharmacology. 2 Credit Hours.
In this course students will discuss the biochemical structure and function of signaling pathways that are most frequently targeted by the pharmaceutical industry. Students will be exposed to novel concepts and findings, in particular with regards to innovative therapeutic applications. Each week will address a different pathway or signaling network, its biological targets and functions, and specific drugs that target it. Each week includes one lecture and one class where students and instructor convene to discuss articles, technical approaches or fundamental questions in the field.
Components: LEC.
Grading: GRD.
Typically Offered: Spring.

MCP 753. Computational Pharmacology and Fundamentals of Drug Design. 2 Credit Hours.
In pharmacology, the importance of computation and bio- and chemo-informatics cannot be overestimated. This course is collectively taught by the MCP faculty and addresses the following four distinct areas. (1) Computer-based analysis of drug-receptor interactions. Students learn principles and specific software packages for in silico docking of drugs to proteins, predict structure-activity relationships and become familiar with programming tools required for such tasks. (2) Using on-line databases to study biological activity, therapeutic indexes, toxicity and other characteristics of drugs and other chemicals. Similarly, they learn to analyze the vast information available for drug targets such as receptor proteins and enzymes. (3) Students learn about pharmacogenomics, an area essential for personalized medicine. Here, they learn, for example, how to predict the reaction of certain populations to particular treatments. (4) Students learn about the drug development pipeline, starting with the design, through screening chemical libraries and to the basics of FDA approval.
Components: LEC.
Grading: GRD.
Typically Offered: Spring.

MCP 754. Identification and validation of pharmacological targets. 2 Credit Hours.
Pharmacological treatment of many diseases is based on inhibiting or stimulating certain enzymes, receptors, and channels, generally referred to as "drug targets." Pathological events can be triggered by mutations, changes in gene expression, and activity of various proteins. The crucial step in devising a therapeutic strategy is to decide which target to select for manipulation by a pharmacological agent. What makes a target successful, i.e. amenable to pharmacological intervention? How does one discover and validate such a novel drug target? This course will analyze examples of cellular pathways that have been successfully targeted by FDA-approved drugs or are currently under investigation. The classes are taught by several MCP faculty who are experts in signal transduction, gene expression, cell proliferation, cancer biology, and other cellular processes. One important aspect of this class is that the students will learn to apply general principles of target identification and validation to their areas of interest and/or ongoing research projects in their labs. The knowledge gained from the lectures and critical discussions in this course will help students design their dissertation research and aid in their future careers.
Components: LEC.
Grading: GRD.
Typically Offered: Spring.

MCP 755. Strategies and methodologies of modern drug discovery campaigns. 2 Credit Hours.
This course will address the current state of the art in general principles, technologies, and available resources used in the process of drug discovery. It will be taught collectively by MCP faculty who have expertise and are currently involved in drug discovery projects. The presentations and faculty-led discussions will cover topics such as assay development, the criteria for suitability of an assay for high-throughput screening (HTS), and the necessary controls to validate the "hits." Pharmacological characterization of novel compounds (EC50, stability, toxicity, etc.) will also be covered. Students will also learn about the fundamentals of the current in silico drug design methods and virtual screening based on the structure of the protein target and structure-activity relationships (SAR) in the ligands. In addition to traditional small molecule chemicals, the faculty will also discuss other types of therapeutics, such as engineered growth factors, gene therapy agents, and innovative approaches like targeted protein degradation. The technical knowledge about the principles of the drug discovery "pipeline" will be complemented with relevant economic, translational, and regulatory aspects. In this class, students will propose designing a drug (a small molecule or biological agent) discovery project applied to their area of interest.
Components: LEC.
Grading: GRD.
Typically Offered: Spring.

MCP 768. Neuropharmacology. 2-3 Credit Hours.
An intensive course covering the regulation of neural processes by drugs that target neurotransmitter signaling at the level of GPCRs, G proteins, second-messengers and ion channels.
Components: LEC.
Grading: GRD.
Typically Offered: Fall Odd Years.

MCP 810. Master's Thesis. 1-6 Credit Hours.
The student working on his/her master's thesis enrolls for credit, in most departments not to exceed six, as determined by his/her advisor. Credit is not awarded until the thesis has been accepted.
Components: THI.
Grading: SUS.
Typically Offered: Fall, Spring, & Summer.

MCP 820. Research in Residence. 1 Credit Hour.
Used to establish research in residence for the thesis for the master's degree after the student has enrolled for the permissible cumulative total in MCP 710 (usually six credits). Credit not granted. May be regarded as full time residence.
Components: LEC.
Grading: GRD.
Typically Offered: Fall, Spring, & Summer.

MCP 830. Dissertation Research-Pre-Candidacy. 1-12 Credit Hours.
Required for all PhD candidates. The student will enroll for credits as determined by their advisor/Office of Graduate and Postdoctoral Studies. No more than 12 hours of research may be taken in a regular semester, and no more than six in a summer session.
Components: THI.
Grading: SUS.
Typically Offered: Fall, Spring, & Summer.

MCP 840. Doctoral Dissertation- Post Candidacy. 1-12 Credit Hours.
Required for all PhD candidates. The student will enroll for credits as determined by their advisor/ Office of Graduate and Postdoctoral Studies but not less than a total of 24. No more than 12 hours of research may be taken in a regular semester, and no more than six in a summer session.
Components: THI.
Grading: SUS.
Typically Offered: Fall, Spring, & Summer.

MCP 850. Research in Residence. 1-12 Credit Hours.
Student must be registered in the semester they plan to defend. Used to establish research in residence for the PhD after the student has been enrolled for the permissible cumulative total in appropriate doctoral research. Student may be regarded as full-time residence as determined by the Dean of the Graduate School.
Components: THI.
Grading: SUS.
Typically Offered: Fall, Spring, & Summer.