MOLECULAR AND CELLULAR PHARMACOLOGY

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

Overview
Scientists in the Molecular and Cellular Pharmacology Program make use of the knowledge and techniques of biology, chemistry and physics to study the action of drugs, hormones and neurotransmitters on living systems and, more generally, the mechanisms through which signals are recognized and transduced by cells.

The goals of the research in this department are:
• to identify new targets and pathways for development of pharmaceuticals
• to use drugs as tools in the study of basic biological processes
• to develop and study agents that may be beneficial in the treatment of disease

A variety of technical approaches is used, including genetics, molecular biology, protein biochemistry and biophysics, fluorescence microscopy, immunology, computer modeling, cell culture, imaging, gene expression profiling, proteomics and whole animal studies including transgenic and genetically engineered 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:
Cardiovascular Pharmacology / Signaling / Muscle Contraction
Investigators in this area study transcriptional regulation of gene expression and intracellular signals associated with the growth and function of the heart. They study ion channels, membrane events, blood vessels, etc. Studies of cardiac muscle contraction and the effect of disease causing mutations in the contractile apparatus of the heart on heart performance and morphology are also being pursued.

Current research areas include structure/function relationships in the proteins of the thin (troponin complex) and thick (myosin) filaments in health and disease, the role of specific ion channels in ventricular hypertrophy and its alleviation, excitation-contraction coupling in skeletal and cardiac muscle, proto-oncogene regulation of cardiac-specific genes, signaling in cardiac myocytes including the characterization of multimolecular enzyme complexes, apoptosis during myocardial ischemia, the role of microRNAs in cholesterol biosynthesis and smooth muscle cell plasticity, and the potential of stem cell based therapy for cardiac disease. A new study has been launched to investigate the effect of bone marrow stem cells in cardiac repair.

Neuropharmacology / Neuroscience
Investigators in this area study the development, function, pharmacology, and diseases of the nervous system.

Current research interests include neuronal signaling through G-proteins, Ca²⁺, and cyclic nucleotides, growth and guidance of axons during development and regeneration after injury, molecular control of dendrite development, control of physiological functions by the nervous system; molecular mechanisms and cell biology of olfaction and phototransduction; 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, membrane transport, stem cells, and novel therapeutics.

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

Model Systems
Many investigators are using model organisms for their studies. These include transgenic and knock-out/knock-in mouse models Xenopus, Drosophila and yeast models. Yeast and Drosophila are important models because of the powerful molecular and genetic approaches and tools available. Xenopus provides a unique system for studying development and for protein expression and analysis. These systems are being used to study fundamental processes such as apoptosis, cell cycle, signal transduction, membrane dynamics, cytoskeleton, cell polarity, olfaction, development of the cardiovascular system, neurogenesis and neuronal degeneration. All of these processes are conserved in humans, so these systems serve as important models of human diseases. Investigators are also using these systems to screen for therapeutic agents and to identify targets of toxins and other natural, synthetic or 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
• Competitive GRE exam scores
• 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
• GRE General Test
• 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

### Biomedical Science Core

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credit Hours</th>
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</thead>
<tbody>
<tr>
<td>PIB 700</td>
<td>Journal Club</td>
<td>2</td>
</tr>
<tr>
<td>PIB 701</td>
<td>Introduction to Biomedical Sciences</td>
<td>5</td>
</tr>
<tr>
<td>PIB 702</td>
<td>Scientific Reasoning</td>
<td>3</td>
</tr>
<tr>
<td>PIB 705</td>
<td>Biostatistics for the Biosciences</td>
<td>3</td>
</tr>
<tr>
<td>PIB 731</td>
<td>Laboratory Research</td>
<td>3-5</td>
</tr>
<tr>
<td>PIB 780</td>
<td>Research Ethics</td>
<td>1</td>
</tr>
<tr>
<td>PIB 782</td>
<td>Professional Development: Skills for Success I</td>
<td>1</td>
</tr>
<tr>
<td>PIB 783</td>
<td>Professional Development: Skills for Success II</td>
<td>1</td>
</tr>
<tr>
<td>PIB 785</td>
<td>PIBS Bioinformatics Workshop</td>
<td>1</td>
</tr>
<tr>
<td>PIB 830</td>
<td>Doctoral Dissertation</td>
<td>1</td>
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### Molecular and Cellular Pharmacology Required Courses

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credit Hours</th>
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<tbody>
<tr>
<td>MCP 701</td>
<td>Seminar</td>
<td>8</td>
</tr>
<tr>
<td>MCP 704</td>
<td>Mechanisms of Drug Action</td>
<td>3</td>
</tr>
<tr>
<td>MCP 732</td>
<td>Cardiovascular Pharmacology</td>
<td>3</td>
</tr>
<tr>
<td>MCP 752</td>
<td>Systems Biology and Approaches in Pharmacology</td>
<td>3</td>
</tr>
<tr>
<td>MCP 753</td>
<td>Computational Pharmacology and Fundamentals of Drug Design</td>
<td>3</td>
</tr>
<tr>
<td>MCP 768</td>
<td>Neuropharmacology</td>
<td>3</td>
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### Research Credits

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<th>Credit Hours</th>
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<tbody>
<tr>
<td>MCP 830</td>
<td>Dissertation Research-Pre- Candidacy</td>
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</tr>
<tr>
<td>MCP 840</td>
<td>Doctoral Dissertation- Post Candidacy</td>
<td>1</td>
</tr>
<tr>
<td>MCP 850</td>
<td>Research in Residence</td>
<td>1</td>
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</table>

Total Credit Hours: 67-69

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1 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.

### 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 and Computational Pharmacology and Fundamentals of Drug Design.

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. At the end of the Fall 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

<table>
<thead>
<tr>
<th>Course</th>
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<th>Credit Hours</th>
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<tbody>
<tr>
<td>Fall</td>
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<tr>
<td>PIB 700</td>
<td>Journal Club</td>
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</tr>
<tr>
<td>PIB 701</td>
<td>Introduction to Biomedical Sciences</td>
<td>5</td>
</tr>
<tr>
<td>PIB 702</td>
<td>Scientific Reasoning</td>
<td>3</td>
</tr>
</tbody>
</table>

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1 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.
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 consists of a combination of lectures, problem sessions and student presentations. Students will be given in-depth exposure to the fundamental principles of Pharmacology. The mechanism of action of some specific drug classes will be examined in detail.

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.

MCP 743. Introductory Python Programming for Bioscientists. 3 Credit Hours.
The course is designed to teach the basic of the Python programming language. Students will learn to use code to solve problems related to biological datasets such as genomes, proteomes, and molecular structures.
Components: DIS.
Grading: SUS.
Typically Offered: Spring.

MCP 752. Systems Biology and Approaches in Pharmacology. 3 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. 3 Credit Hours.
Like physics and chemistry in the 20th century, computers are transforming biology and medicine at a rapid pace. 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. In addition to lectures, they visit a UM robotic drug screening facility and UM pharmacy. Overall, this course emphasizes a hands-on approach with students performing computation tasks on their laptops. Laptops and gaining access to certain on-line resources are required.
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.

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 Credit Hour.
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.