

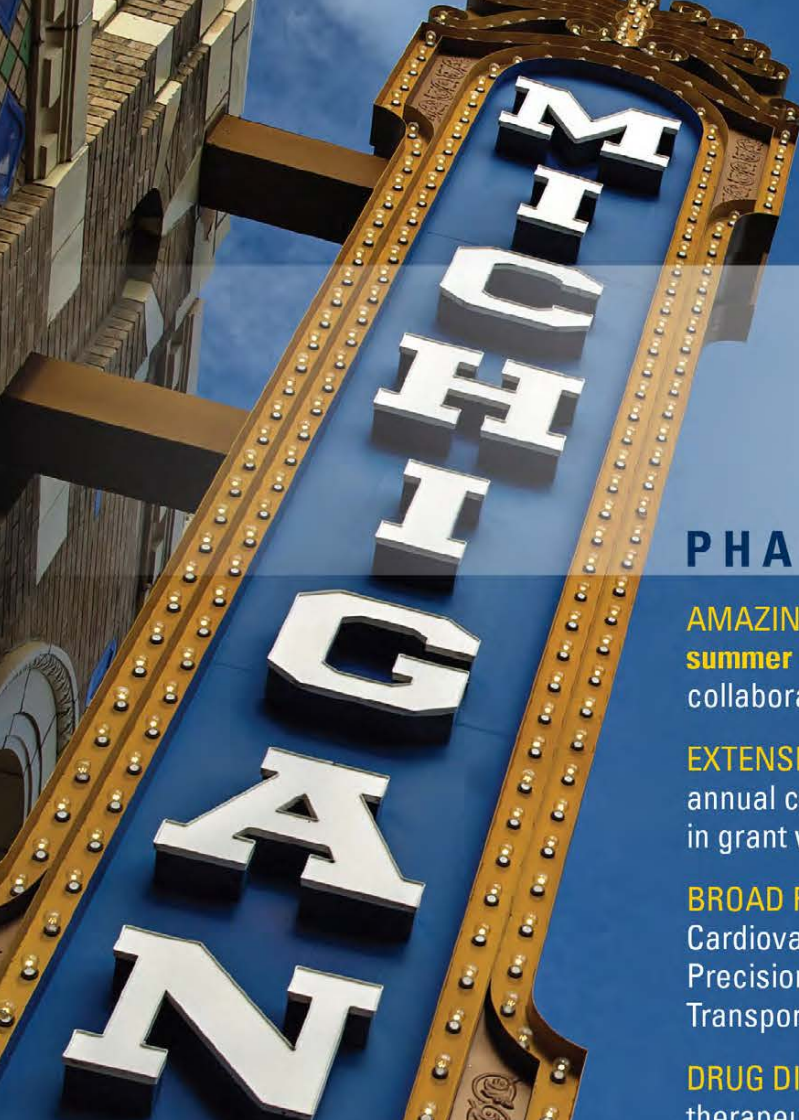
# Explore Pharmacology

A Resource for Undergraduate Students



American Society for Pharmacology and Experimental Therapeutics  
2022 Edition





**MICHIGAN MEDICINE**  
UNIVERSITY OF MICHIGAN

**DEPARTMENT OF  
PHARMACOLOGY**  
HEALING THROUGH DISCOVERY

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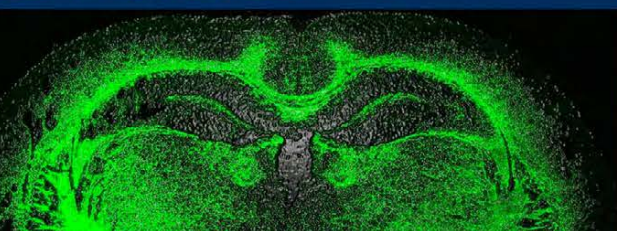
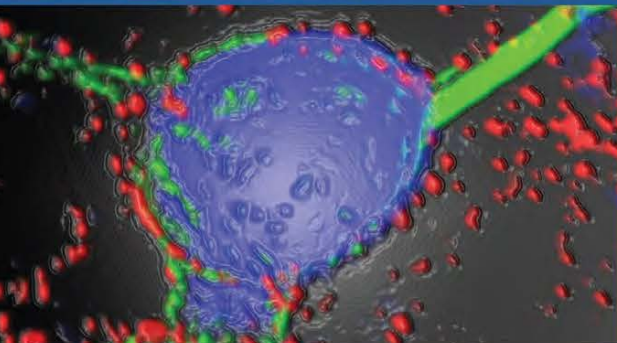
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# What is Pharmacology?

Often confused with pharmacy, **pharmacology** is a **separate discipline** in the health sciences.

## Pharmacology

is the science of **how drugs act on biological systems and how the body responds to the drug**. The study of pharmacology encompasses the sources, chemical properties, biological effects and therapeutic uses of drugs.

## Pharmacy

uses the knowledge derived from pharmacology to achieve optimal therapeutic outcomes through the appropriate **preparation and dispensing of medicines**.

If you:

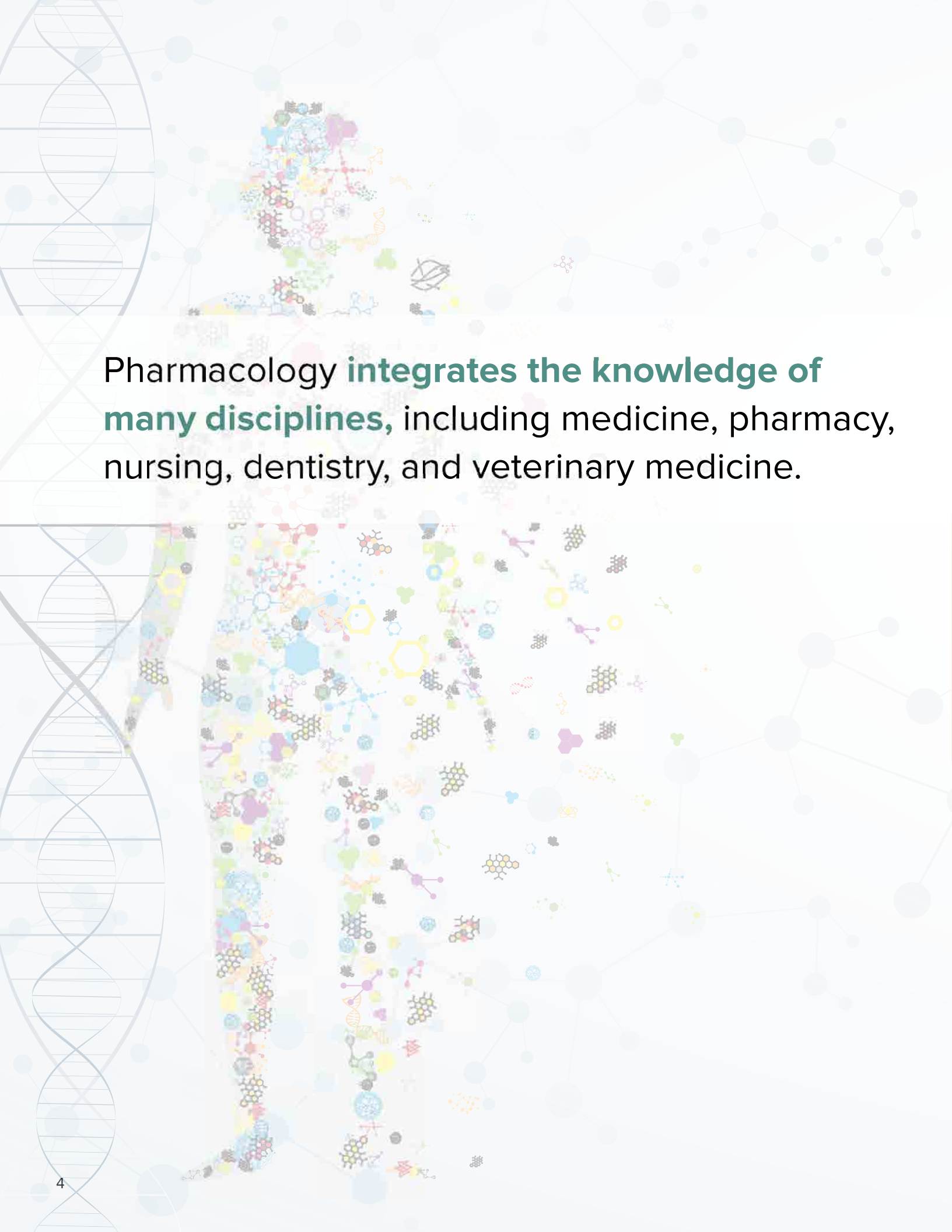
- are a highly motivated student seeking a **career in the biomedical sciences**,
- have a strong interest in making a major contribution to the **understanding** of both novel and current **disease processes**,
- would like to be involved in the **development of new therapies** used in the clinic,

then you should:

## Explore Pharmacology!

Learning more is the first step to a challenging, productive, and rewarding career.





Pharmacology **integrates the knowledge of many disciplines**, including medicine, pharmacy, nursing, dentistry, and veterinary medicine.

This integrative nature allows pharmacology to have a **unique perspective for solving** drug, hormone, and chemical-related **problems** as they impinge on human health.

Since pharmacology can be studied at so many different levels, it has a **broad range of applications**, including:

- Focusing on **treatment and prevention** of major **diseases**
- Examining the **effects of chemical agents** on subcellular mechanisms
- Dealing with the potential **hazards of pesticides** and herbicides

Some of the **new and exciting areas in pharmacology** are:

- **Personalized precision medicine and gene therapy** through genomic and proteomic approaches
- **Regenerative pharmacology** to optimize development of bioengineered and regenerating tissues
- **Computational and modeling approaches** as both design and drug discovery tools to understand cell function
- **Nanotechnology**-based approaches to fighting disease

While remarkable progress has been made in developing new drugs and in understanding how they act,

**the opportunities that remain are endless!**

Ongoing discoveries regarding fundamental life processes will continue to raise **new and intriguing questions** that stimulate further research and evoke the **need for fresh scientific insight.**

This booklet provides a broad **overview of the discipline** of pharmacology and describes the many employment opportunities that await graduates in the pharmacological sciences, as well as outlines the academic path that they can follow for a promising career in pharmacology.

“My interest in pharmacology developed from my mother, herself a medical professional, and my many visits to her hospital opened my eyes to the reality of suffering due to various diseases. As a kid, I used to wonder how a small pill could cure complex diseases. With my perpetual interest in pharmacology, I opted to pursue a PhD in cardiovascular pharmacology. Cardiovascular diseases, being the leading cause of death, always have many exciting research opportunities. For example, my PhD dissertation work is focused on deciphering vasoactive effects of the novel adipokine ‘apelin’. This research has broad implications on currently on-going clinical trials and will enhance knowledge about the apelinergic system in health and disease.”

*Amreen Mughal, Graduate Research Assistant, PhD Candidate,  
North Dakota State University; Fargo, ND*

# What Do Pharmacologists Study?

Pharmacology is the study of **how a drug affects a biological system**. These effects can be therapeutic or toxic, depending on many factors. Pharmacologists are often interested in *therapeutics*, which focuses on the effects of drugs and other chemical agents that minimize disease, or *toxicology* which involves

the study of the adverse, or toxic, effects of drugs and other chemical agents. Toxicology can refer to both drugs used in the treatment of disease and with chemicals that may be present in household, environmental, or industrial hazards.

Pharmacology has two major branches: **pharmacodynamics** and **pharmacokinetics**.

## Pharmacokinetics

Absorption, Distribution, Metabolism, and Excretion of Drugs

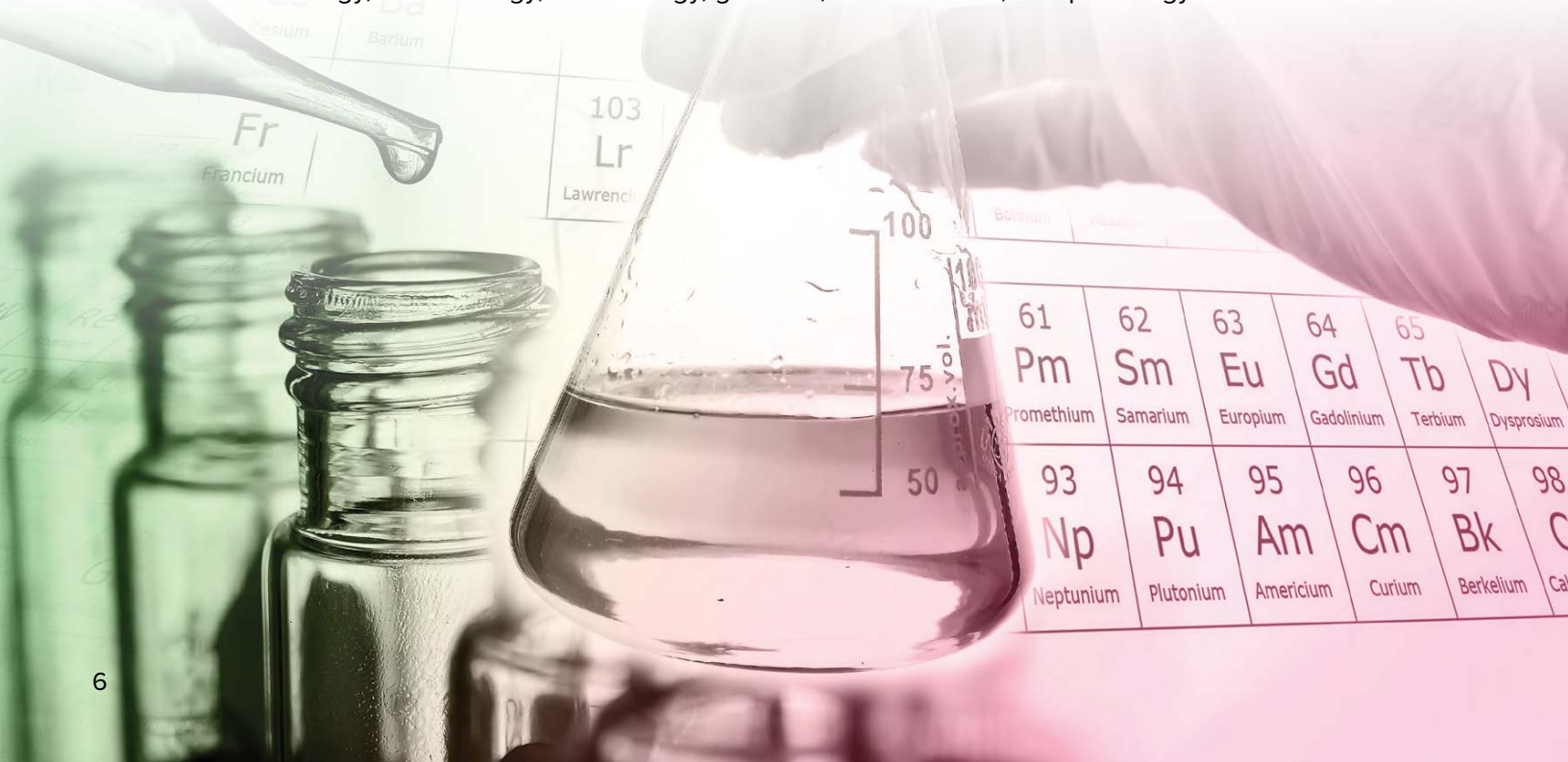
## Pharmacodynamics

Molecular, Biochemical, and Physiological Effects of Drugs, Including Drug Mechanism of Action

The pharmacokinetics and pharmacodynamics of a drug will change with disease states, leading to decreased therapeutic effect and increased toxicity. Age, sex, liver and kidney function can also change drug response!

**Pharmacodynamics is what the drug does to the body and pharmacokinetics is what the body does to the drug.**

Pharmacology is closely interwoven with other bioscience disciplines including physiology, biochemistry, cellular and molecular biology, microbiology, immunology, genetics, neuroscience, and pathology.





## Pharmacology can be divided into a variety of topical areas:

### **Focus: Behavioral Pharmacology**

**Purpose:** Investigate effects of drugs on behavior and of how behaviors can influence drug effects

**Examples of Research Areas:** Study the effects of psychoactive drugs on learning, memory, wakefulness, sleep, and drug addiction; understand behavioral consequences of experimental intervention on enzyme activity or brain neurotransmitters and metabolism; study how behaviors influence drug-taking

### **Focus: Biochemical Pharmacology**

**Purpose:** Investigate how drugs interact with, and influence, the chemical “machinery” of the organism

**Examples of Research Areas:** Study biosynthetic pathways and their kinetics; investigate how drugs can correct the biochemical abnormalities that are responsible for human illness

### **Focus: Cardiovascular Pharmacology**

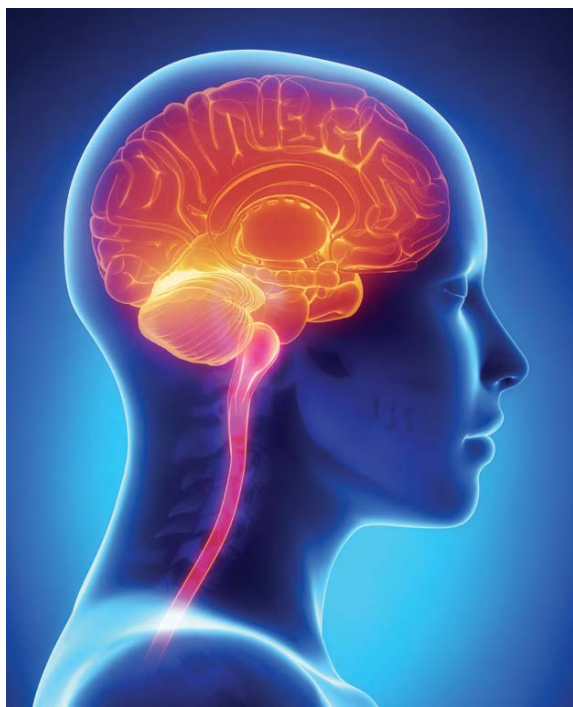
**Purpose:** Investigate effects of drugs on the heart, the vascular system, and those parts of the nervous and endocrine systems that participate in regulating cardiovascular function

**Examples of Research Areas:** Study the effects of drugs on arterial pressure, blood flow in specific vascular beds, release of physiological mediators, and neural activity arising from central nervous system structures

### **Focus: Chemotherapy**

**Purpose:** Investigate drugs used for treatment of microbial infections and malignancies

**Examples of Research Areas:** Study and develop chemotherapeutic drugs that will selectively inhibit the growth of, or kill, the infectious agent or cancer cell without seriously impairing the normal functions of the host



### **Focus: Clinical Pharmacology**

**Purpose:** Investigate the application of pharmacodynamics and pharmacokinetics to patients with diseases; this discipline now has a significant pharmacogenetic component

**Examples of Research Areas:** Study how drugs work, how they interact with the genome and with other drugs, how their effects can alter disease processes, and how disease can alter the effects of drugs

### **Focus: Drug Metabolism**

**Purpose:** Investigate the metabolic breakdown of drugs and how they are changed by the body

**Examples of Research Areas:** Study ways to control how drugs are altered by the body in order to maximize their therapeutic effects and minimize their undesirable side effects

**Focus: Endocrine Pharmacology**

**Purpose:** Investigate drugs that are either hormones, hormone derivatives, or drugs that may modify the actions of hormones normally secreted by the body

**Examples of Research Areas:** Study the nature of diseases of metabolic origin; understand use of drugs to help regulate and control endocrine function

**Focus: Ethnopharmacology**

**Purpose:** Investigate the use of traditional remedies (plants, fungi, or animals) for medicinal and/or health purposes

**Examples of Research Areas:** Study and document indigenous medical knowledge; contribute to improved health outcomes in regions of study; search for pharmacologically unique principles from existing indigenous medicines

**Focus: Molecular Pharmacology**

**Purpose:** Investigate the biochemical and biophysical characteristics of interactions between drug molecules and those of the cell

**Examples of Research Areas:** Study how cells respond to hormones or pharmacologic agents, and how chemical structure correlates with biological activity

**Focus: Neuropharmacology**

**Purpose:** Investigate effects of drugs on components of the nervous system, including the brain, spinal cord, and the nerves that communicate with all parts of the body

**Examples of Research Areas:** Study ways to use drugs in the treatment of specific disease states of the nervous system; determine functions of the nervous system that are modified by drug action; elucidate the neurobiological nature of disease processes

**Focus: Pharmacogenomics**

**Purpose:** Investigate how a person's genetic makeup affects their response to drugs

**Examples of Research Areas:** Study drug-gene interactions; investigate novel therapeutics tailored specifically to a person's genetic makeup

**Focus: Toxicology**

**Purpose:** Investigate the toxic effects of drugs and other chemicals

**Examples of Research Areas:** Study the adverse effects of drugs on development, organ systems, and molecular and cellular processes

**Focus: Translational Pharmacology**

**Purpose:** Investigate the efficacy and usefulness of new treatment modalities in human experiments

**Examples of Research Areas:** Study and predict human drug response on the basis of mathematical models; support drug development and safe and effective dosing





# A Brief History of Pharmacology

**Distinctions between the useful actions of drugs and their toxic effects were recognized thousands of years ago.** As people tried plant, animal, and mineral materials for possible use as foods, they noted both the toxic and the therapeutic actions of some of these materials.



Past civilizations contributed to our present knowledge of drugs and drug preparations. Ancient Chinese writings and Egyptian medical papyri represent the earliest documented compilations of pharmacological knowledge. They included classifications of diseases to be treated and recommended prescriptions for such diseases.

The introduction of many drugs from the New World in the 17th century stimulated experimentation on crude preparations. These experiments were conducted chiefly to get some ideas about the possible toxic dosage for such drugs as tobacco, ipecac, cinchona bark, and coca leaves. By the 18th century, many such descriptive studies were being conducted. **How drugs produced their effects was, however, still a mystery.**



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The term pharmacology comes from the Greek words *pharmakon*, meaning a drug or medicine, and *logos*, meaning study.

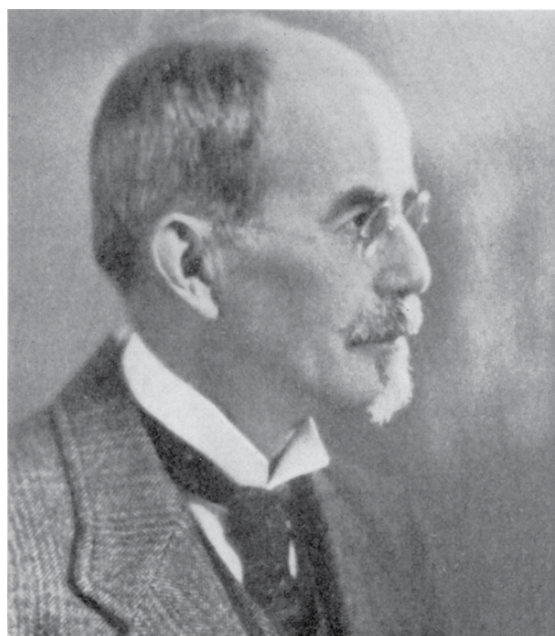


**The birth of modern experimental pharmacology** is generally associated with the work of the French physiologist Francois Magendie (1783 – 1855) in the early 19th century. Magendie’s research on strychnine-containing plants clearly established the site of action of these substances as being the spinal cord and provided evidence for the view that drugs and poisons must be absorbed into the bloodstream and carried to the site of action before producing their effects. The work of Magendie and his pupil, Claude Bernard, on curare-induced muscle relaxation and carbon monoxide poisoning **helped to establish some of the techniques and principles of the science of pharmacology.**

During the second half of the 19th century, pharmacology emerged as a well-defined discipline when Rudolf Buchheim (1820 – 1879) established the first institute of pharmacology at the University of Dorpat in Estonia (then a part of Russia) in 1847.

Among the notable students who received research training in Buchheim’s laboratory was Oswald Schmiedeberg (1838 – 1921), sometimes referred to as the **“father of modern pharmacology”**. In his 46 years at the University of Strassburg, Schmiedeberg trained some 120 students, many of whom later occupied academic chairs in pharmacology departments throughout the world.

One of the most eminent of Schmiedeberg’s students was John Jacob Abel (1857 – 1938), who brought the new science of experimental pharmacology from Germany to the USA and became the first American full-time professor of pharmacology. He co-founded the **American Society for Pharmacology and Experimental Therapeutics** in 1908.



The progress and contributions of 20th century pharmacology were immense, with over **twenty pharmacologists having received Nobel prizes.** Their contributions include discoveries of many important drugs, neurotransmitters, and second messengers, as well as an understanding of a number of physiological and biochemical processes.

Did you know that 22 ASPET members and pharmacologists have won the Nobel Prize?  
Learn more about them at [www.aspet.org/nobel](http://www.aspet.org/nobel)



# Achievements and New Frontiers

Pharmacology in the 21st century continues to build on previous discoveries. **Current research in pharmacology extends across a wide frontier that includes:**

- developing **new drugs**
- discovering **new druggable targets**
- learning more about the properties and **novel indications** of drugs already in use
- investigating the effects of **environmental pollutants**
- using drugs as probes to study **cell and organ system functions**
- exploring how genetic variation impacts **drug disposition and efficacy**

A major contribution of pharmacology has been the advancement of knowledge about cellular receptors with which hormones and chemical agents interact. **New drug development** has focused on steps in this process that are sensitive to modulation. Identifying the structure of receptors **will allow scientists to develop highly selective drugs with fewer undesirable side effects.**

Many significant discoveries have resulted from this research. For example, advances in antibacterial and anticancer chemotherapy have played a major role in **reducing infectious diseases and producing cures** for certain types of cancers. Other research has led to the development of drugs for the treatment of hypertension, congestive heart failure, and cardiac



arrhythmias, as well as more effective treatments for asthma, pain, anxiety, and chronic psychiatric disorders with far fewer unpleasant side effects.

**Clinical and quantitative pharmacology methods were instrumental in the development of COVID-19 therapies and vaccines.** Advances in clinical trials, scientific collaboration, and integrative approaches allowed for the fastest vaccine rollout in history in order to respond to the global pandemic.

Obtaining the sequence of the human genome greatly expanded the study of pharmacogenetics/pharmacogenomics, i.e., how variation in genetic information impacts how a particular drug is absorbed, metabolized, and/or eliminated, as well as how the particular drug interacts with its cellular targets. This field offers considerable promise for **development of novel therapeutics, optimized drug trials, and medicine tailored to each person's response.**

Over the next several decades, the knowledge emerging from pharmacological studies will have an immeasurable impact on society. **There are still many diseases that we don't know how to cure** or manage adequately – cancer, autism, depression, and drug use disorder, to name just a few.

Major challenges include developing better drugs for treating severe infections like AIDS and other viral diseases, cancer, drug-resistant bacteria, and preventing rejection of organ transplants. Research on drug addiction holds the promise of developing

new treatments for drug dependence and withdrawal as well as identifying individual differences that may influence a person's susceptibility to addiction.

**Gene therapy** opens the possibility of developing gene products that could alter the course of a disease. The emergence of **tissue engineering** to treat failing organs demands drugs that can facilitate



the process. **Nanotechnology** approaches to drug discovery open the door for site-selective delivery and more accurate dosing.

Pharmacology is such an integral part of our lives that we often aren't even aware of it. Aspirin, antibiotics, and antiseptics are so common in our lives that we forget there was a time when they did not exist. As a pharmacologist, there are so many ways that you can help improve human health. It is an exciting time to

**Explore Pharmacology!**



# Why Choose Pharmacology?

## Perspectives from the field



“Pharmacology appealed to me because of the highly translational component. It also offered me interdisciplinary training, which really provided me with multiple theoretical and technical skill sets to make me competitive for a career in science. Think cross-fit training. By identifying novel mechanisms of action of toxicants I hope to decrease the risk that these compounds pose to humans.”

*Brian Cummings, PhD, Professor and Director, Interdisciplinary Toxicology Program, Pharmaceutical and Biomedical Sciences, University of Georgia, College of Pharmacy; Athens, GA*

“In my role at Pfizer, I integrate knowledge from different disciplines including: chemistry, biology, safety, and clinical pharmacology to predict/estimate efficacious dose and dosing regimens. The success of these predictions and benefit to patients really demands that we understand the target pharmacology. What excites me most about my career is that one of these molecules may become a successful drug and may make a difference in the quality of lives of our patients! I find that hope extremely rewarding.”

*Aarti Sawant-Basak, PhD, Senior Principal Scientist, Pharmacokinetics, Dynamics and Metabolism, Pfizer Inc.; Cambridge, MA*



“One exciting aspect of being a pharmacologist is that pharmacology encompasses so many fields that impact drug development, therapy and safety. Pharmacologists have the opportunity to contribute to our understanding of all major diseases and their treatments, as well as determining why drugs produce unwanted side effects and how to eliminate many of these issues. Becoming a pharmacologist was a natural career choice for me with my background in medicinal chemistry (drug design) and toxicology, and I believe that pharmacologists are in the perfect position to make major advances to improve human health and well-being.”

*Gary O. Rankin, PhD, Vice Dean for Basic Sciences, Professor and Chair, Marshall University, Joan C. Edwards School of Medicine, Huntington, WV*

“For pharmacologists, the first challenge is to understand the molecular defects that cause disease. That requires an appreciation of human genetics, biochemistry and physiology, and also a willingness to learn from the simplest model organisms. To eventually “fix the machine” we need to be thinking about chemical pharmaceuticals but also about emerging technologies like biologics and gene therapy. Being a pharmacologist requires both a broad perspective and a focused research strategy.”

*Henrik Dohlman, PhD, Professor and Chair, Department of Pharmacology, University of North Carolina at Chapel Hill; Chapel Hill, NC*



“As an educator of medical students, I thrive on the “lightbulb” moments when the mechanism of how a drug works suddenly comes alive for the students.”

*Kelly Karpa, PhD, Professor, Department of Pharmacology, Penn State College of Medicine; Hershey, PA*



“What drew me to pharmacology was the integrative nature of pharmacological research. My research directly impacts the health and well-being of animals in extensive grazing systems. Grazing livestock are continuously exposed to a variety of bioactive molecules from plants and some of them can be toxic. I use pharmacology to investigate the mechanism of toxin action, and work as part of a scientific team to formulate evidence-based management plans to prevent livestock poisoning from occurring. What I like most about my career is that my work directly contributes to improving animal health and welfare.”

*Benedict (Ben) Green, PhD, Research Pharmacologist, United States Department of Agriculture (USDA), Agricultural Research Service; North Logan, UT*

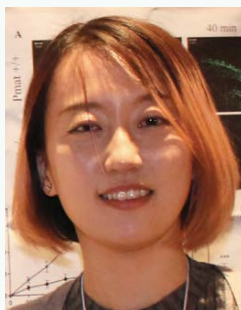
“I chose pharmacology because it is a dynamic, interdisciplinary field that positively impacts lives. In addition to new medications, I am always learning new concepts and making new connections. Being a pharmacology educator means that I help students respect the use of medications as a powerful part of their arsenal to help improve the lives of their patients.”

*Jayne Reuben, PhD, Instructional Associate Professor/Director, Texas A & M University, College of Dentistry; Dallas, TX*



“I realized my passion for the field of pharmacology and toxicology when I was undergoing the training to become a pharmacist. It was exciting to learn about delicate mechanisms by which various drugs work to affect our body. The more I learned about the intricacy of medicine, I wanted to dive deeper into this field so I decided to go to graduate school. With the increasing need for personalized medicine, I expect that pharmacology will be a key discipline to lead the next generation of patient therapy.”

*Dahea You, PharmD, PhD Candidate, Rutgers University, Ernest Mario School of Pharmacy; Piscataway, NJ*



“Pharmacology is the most fundamental way to fight diseases. It is all about understanding what drugs do to our body and what our body does to the drugs. Without this understanding we couldn’t move anywhere in modern medicine.”

*Katharina Brandl, PhD, Assistant Professor, University of California – San Diego, Skaggs School of Pharmacy and Pharmaceutical Sciences; San Diego, CA*



“Imagine knowing that your research directly contributed to finding a new treatment which helps patients! That gives me the day-to-day excitement I feel in applying pharmacology to discover drug targets that can modify or prevent disease. Understanding the principles of drug action in physiological systems opens the door for a universe of careers. These principles guide testing of ideas through bench research to understand effectiveness of the novel molecule. Toxicologists assess its safety and clinical pharmacologists design trials in humans. Regulatory scientists evaluate all this to enable the US Food and Drug Administration’s decision on approval. It is never, ever boring to come to work each day.”

*Pamela Hornby, PhD, Senior Scientific Director & Fellow, Cardiovascular & Metabolic Disease Therapeutics, Janssen, Pharmaceutical Companies of Johnson & Johnson; Spring House, PA*



# Career Opportunities

Pharmacology knowledge is necessary in just about all biomedical and veterinary related fields. There is also an increasing need for experts who can study, comprehend, and translate pharmacology in a number of related fields. The **diverse career opportunities** in pharmacology reflect the integrative nature of the field.



## What career options are available for those with training in pharmacology?

Field	Example Job Titles/Areas
Academia	Professor, Instructor, Educator, Lab Manager, Administrator, Research Associate
Foundations and Non-profits	Program Manager or Director, Grants Officer, Executive Director, Communications Specialist, Project Manager
Government	Investigator, Staff Scientist, Director of Regulatory Affairs, Advisor, Administrator
Industry	Staff Scientist, Director of Research, Project Manager, Medical Science Liaison, Field Application Specialist
Law	Tech Transfer Specialist, Patent Lawyer
Science Policy and Outreach	Policy Analyst or Advisor, Public Affairs Director, Outreach Director, Government Affairs Specialist, Consultant
Science Writing	Author, Editor, Freelance Writer, Medical Writer

Pharmacologists who wish to pursue **teaching and/or research careers** in academic institutions can join university faculties in all areas of the health sciences, including medicine, dentistry, veterinary medicine, pharmacy, pharmaceutical sciences, and nursing. Universities also offer research opportunities in virtually every pharmacology specialty.

**Government organizations** employ pharmacologists in research centers such as the National Institutes of Health, the Environmental Protection Agency, the Food and Drug Administration, and the Centers for Disease Control. Opportunities range from basic research to study the actions and effects of pharmacological agents to drug safety and regulatory responsibilities.

The applications of pharmacology to health and agriculture have resulted in phenomenal growth of the drug manufacturing industry. **Pharmaceutical corporations** employ pharmacologists to develop products and to determine molecular or biochemical actions of various chemicals; toxicologists determine the safety of drugs with therapeutic potential.

**Private research foundations** involved in addressing vital questions in health and disease also draw from the research expertise of pharmacologists. Some pharmacologists hold administrative positions in government or private industry. Working in this capacity, they may direct or oversee research programs or administer drug-related programs.

The need to communicate science effectively with policymakers and the public has yielded opportunities in **science writing, science policy, and outreach**. The biotechnology field requires **tech transfer and patent professionals** who can help translate and advance discoveries for wider use.

Regardless of the setting, pharmacologists often work as members of multidisciplinary groups. Collaborating with professionals from many backgrounds contributes to the thrill of entering unexplored realms and participating in discoveries that have an impact on life and health.



# Preparing for a Career in Pharmacology

## Suggested bachelor's degrees for pharmacology:

For students who attend schools that may not offer pharmacology courses or degrees, students are advised to earn a bachelor's degree (either a B.S. or a B.A.) in one of the biological sciences, chemistry, or biochemistry.

## Suggested coursework to prepare for a degree in pharmacology:

- Writing and Language
- Literature
- Biochemistry
- Molecular biology
- Organic chemistry
- Physics
- Calculus
- Statistics
- Pharmacology
- Toxicology
- Pathology
- Anatomy and Physiology

## Research experience is invaluable

Hands-on research experience will help you learn how to solve problems and think like a scientist. Get acquainted with professors who have active research programs and inquire about working as a laboratory assistant, either during the academic year or during the summer. There are also many formal undergraduate research programs available, including the **Summer Undergraduate Research Fellowship (SURF) program offered through the American Society for Pharmacology and Experimental Therapeutics.** Information on this program can be obtained at <https://www.aspet.org/awards/SURF/>.





## Post-baccalaureate programs

Some students find that post-baccalaureate (“post-bac”) programs are a useful additional step to improve their skills after the bachelor’s degree. Post-bac programs may help with additional research experience or in completing coursework required to apply to graduate programs. They may be formal programs or involve more independent study. Students interested in these opportunities should seek programs that match their career goals.

## Graduate study

Depending on your chosen career field, a master’s, PhD, or other professional doctoral degree (MD/DO or PharmD) may be required. PhD programs in pharmacology can also be found in schools that offer medical, pharmacy, and veterinary medicine degrees, and in graduate schools of biomedical sciences. Many programs offer assistantships and fellowships that will provide a stipend, tuition, and health insurance while you are enrolled. If you would like to obtain a medical or pharmacy degree as well, look into combined MD/PhD, DO/PhD, PharmD/PhD, or DVM/PhD programs. Earning a PhD degree generally requires four to six years. Earning a dual degree takes about two to three years longer.

## What courses are typically offered in a pharmacology PhD program?

- Physiology
- Cell and molecular biology
- Biochemistry
- Statistics
- Research design and methods
- Pharmacology
- Toxicology
- Immunology
- Pharmacokinetics and pharmacodynamics (PK/PD)
- Discipline-specific courses (e.g., cardiovascular pharmacology, neuropharmacology, immunotoxicology)

The major portion of the graduate degree program is devoted to laboratory research. The primary goal is to complete an original and creative research study that yields new information and withstands peer review. Because each program has different areas of emphasis,

it is important to consider several programs, keeping in mind how they relate to your own areas of interest.

## What should you consider when deciding on a pharmacology PhD program?

- Areas of research expertise among faculty
- Publications of faculty
- Research funding of faculty
- Student flexibility in choosing research projects
- Availability of training grants and stipends designated for graduate student support
- Extent to which research efforts are independent or linked by interdisciplinary team approaches
- Current positions held by previous graduates



## Post-doctoral research

PhD graduates have the option to complete two to four years of additional training in a post-doctoral (“post-doc”) position to expand their research skills and experience and to mature as an independent scientist. The combination of graduate and post-doctoral experiences enables young investigators to contribute new perspectives on unique areas of research. It is important to note that not all careers require the completion of post-doctoral training. Typically, those who wish to enter research and teaching fields will need some post-doctoral experience. If your interests lie outside the lab, a post-doc may not be necessary.

**No matter what training you pursue, you should focus on gaining transferable skills, such as writing, public speaking, collaboration and teamwork, critical thinking and problem-solving, and project management.**

# How Professional Societies Can Help You

Navigating through the steps required for the career you want can sometimes feel overwhelming. Joining a professional society like the **American Society for Pharmacology and Experimental Therapeutics (ASPET)** can help provide guidance with benefits such as:



## Fellowships and Awards

ASPET's Summer Undergraduate Research Fellowship (SURF) program provides stipend support for undergraduates to conduct summer research in pharmacology. See <https://www.aspet.org/awards/SURF/> for more information. Travel awards and poster awards are also available for undergraduate members to attend and present their research at the ASPET Annual Meeting. See <https://www.aspet.org/awards/> for more information.

## Networking

As a member, you can learn from the expertise of more senior scientists as well as make connections with peers. Networking opportunities are available in person at our Annual Meeting and chapter meetings, and virtually through a variety of online member groups.



## Career Center

ASPET's Career Center is constantly posting new jobs in pharmacology and related health science fields, including post-doctoral positions.

“Being at the forefront of developing new treatments for patients is what drew me to pharmacology. My lab possesses the expertise to collaborate directly with pharmaceutical and biotechnology companies from around the world to understand how specific compounds work to treat pain.”

*Beverly Greenwood-Van Meerveld, PhD, Professor of Physiology,  
Director Oklahoma Center for Neuroscience, Oklahoma University  
Health Science Center; Oklahoma City, OK*



## News and Perspectives

ASPET’s monthly newsletter, quarterly membership magazine, social media presence, and website all provide news from the field, career opportunities, and other updates relevant to members. *PharmTalk*, a blog by and for young scientists, provides perspectives on careers and leadership opportunities.

## Publications

Stay up to date with the latest research and publish your own findings in ASPET’s journals, *Drug Metabolism and Disposition*, *The Journal of Pharmacology and Experimental Therapeutics*, *Molecular Pharmacology*, and *Pharmacological Reviews*.

**For more information on becoming a member of ASPET, please visit:**  
<https://www.aspet.org/membership/> – we look forward to welcoming you!

“Pharmacology has opened so many doors for me because of its breadth and depth – meaning the study of therapeutics in disease can involve so many disciplines from molecular biology to whole animal physiology – to me that is the beauty of modern pharmacology!”

*Walter J. Koch, PhD, Professor and Chair, Department of Pharmacology, Temple University School of Medicine; Philadelphia, PA*

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# FOCUS ON PHARMACOLOGY

ASPET Virtual Series



ASPET is pleased to present Focus on Pharmacology – a virtual series presenting high quality, innovative science in pharmacology and experimental therapeutics. Sessions focus on important and timely areas of pharmacology and feature pre-meeting community discussions on *ASPETConnect*, live and interactive webinars on Zoom, and post-meeting Q&A with the presenters.

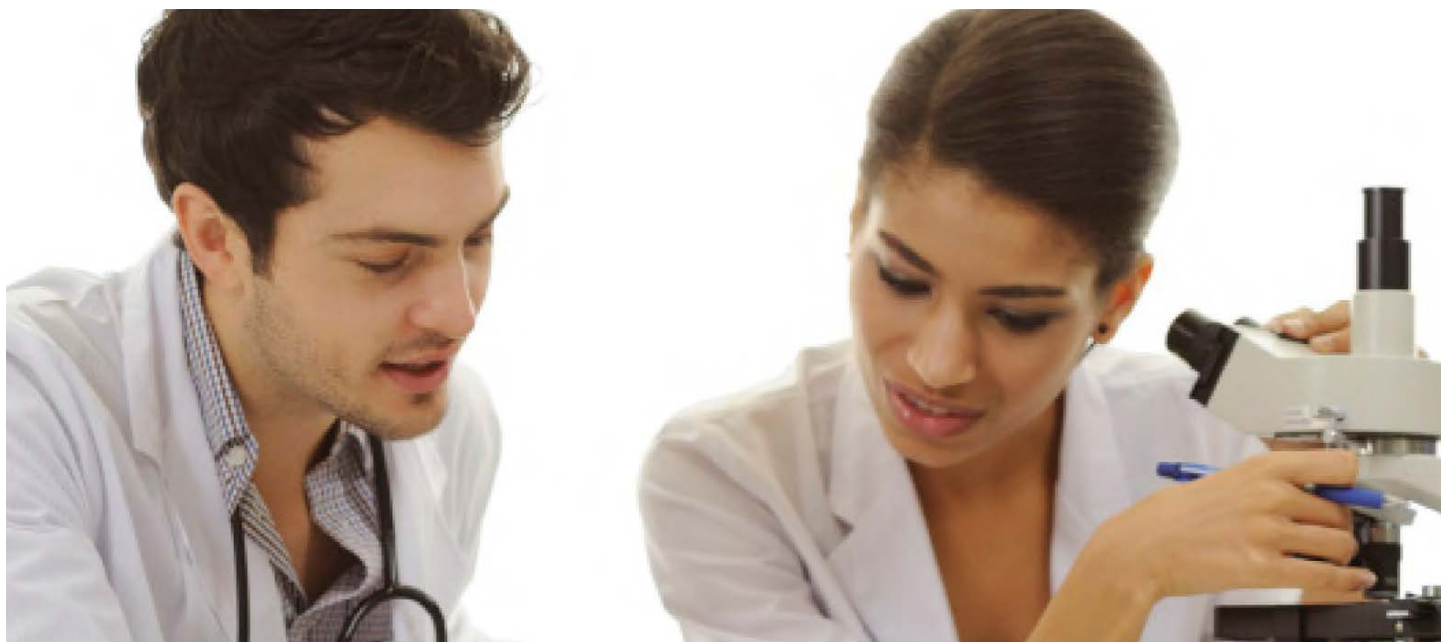
New virtual sessions are planned throughout the year.

View the schedule and learn more at [www.aspet.org/focus](http://www.aspet.org/focus).

Check out past recorded sessions on the ASPET Focus on Pharmacology community on *ASPETConnect*.

The Focus on Pharmacology virtual series is free for all ASPET members. Not a member yet? Sign up for membership at [www.aspet.org/membership](http://www.aspet.org/membership).

VISIT THE **ASPET CAREER CENTER** TODAY!  
**WWW.ASPET.ORG/CAREERCENTER/**



## WHAT YOU NEED: **ASPET'S CAREER CENTER** HAS IT

### Jobseekers:

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- Free & confidential résumé posting
- Access to jobs posted on the National Healthcare Career Network (NHCN)
- Career management resources including career tips, coaching, résumé writing, online profile development, and much more

### Employers:

- Searchable résumé database
- Hassle-free posting; online account management tools
- Reach ASPET's Twitter followers (almost 2,000), LinkedIn Members (over 2,000), and email subscribers (over 4,000)
- Post to just ASPET or to the entire NHCN network
- Sign up for automatic email notifications of new résumés that match your criteria
- Job activity tracking

### ASPET is committed to your success:

The ASPET Career Center is the best resource for matching job seekers and employers in pharmacology and related health science fields. Our vast range of resources and tools will help you look for jobs, find great employees, and proactively manage your career goals.



1801 Rockville Pike, Suite 210, Rockville, MD 20852-1633  
Main Office: 301.634.7060  
[www.aspet.org](http://www.aspet.org)



# Make ASPET your professional home.

Join ASPET as an undergraduate student for \$10/yr or graduate student for \$40/yr and take advantage of tools and resources available to advance your career, promote your research and discipline, and build lasting relationships with fellow scientists.



**A growing ASPET means greater recognition for the field of pharmacology, more resources and support for our members, and a louder voice with policy makers.**

**Some benefits include:**


- **Awards and recognition opportunities**
- **Networking and mentoring opportunities**
- **Free membership in ASPET Divisions**
- **Free or reduced registration fees for ASPET webinars or meetings**
- **Free full-text access to ASPET journals**

**For a full listing of our benefits visit [www.aspet.org](http://www.aspet.org) or contact the membership department at [membership@aspnet.org](mailto:membership@aspnet.org).**



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Cardiovascular Biology, &  
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**PROGRAM HIGHLIGHTS**

**CAREER PATHS**

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**FINANCIAL SUPPORT**

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**ENVIRONMENT AND ACTIVITIES**



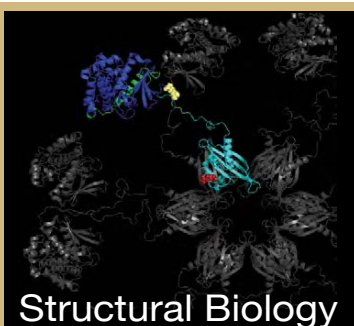
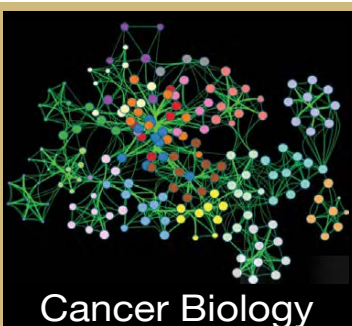
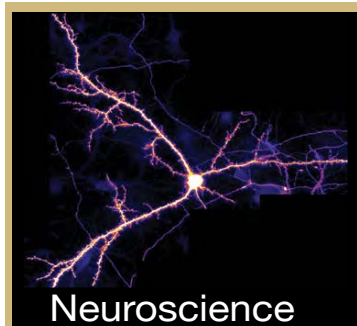
**APPLICATIONS**

Accepted: **Sept. 1st to Dec. 1st**.  
On-campus interviews: During Feb.


**DIVERSITY AND INCLUSION**

We are committed to diversity and inclusion. Students from all backgrounds will find resources and support on campus.

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[ucdenver.edu/pharmphd](http://ucdenver.edu/pharmphd)







## Summer Undergraduate Research Fellow Awards (SURF)

Gain valuable research experience through ASPET's SURF program

The ASPET Summer Undergraduate Research Fellow (SURF) Awards introduce undergraduate students to pharmacology research. Our goal is to use authentic, mentored research experiences in pharmacology to heighten student interest in careers in research and related health care disciplines.


Since 1992, over 2,200 students have conducted research in faculty labs through the SURF program.

**Fellows have opportunities to:**

- Investigate the latest issues in biomedical research
- Get hands-on experience with laboratory techniques
- Collaborate with faculty and other students
- Build and expand their professional networks
- Learn about careers in research and related health care disciplines

Fellows receive stipend support to conduct 10 weeks of summer research.

For more info and to apply, visit us online at:  
[www.aspet.org/awards/SURF](http://www.aspet.org/awards/SURF)



American Society for Pharmacology and Experimental Therapeutics



## PhD Program in Pharmacology

Pharmacology is the most multidisciplinary field in the biomedical sciences. It draws from anatomy, physiology, molecular and cellular biology, biochemistry and many other fields...We study the way in which drugs interact with the body to treat diseases and how the body interacts with the drugs.

**Great prospects for jobs after graduation with a PhD in Pharmacology in academia, industry, and government.**

**Areas of Specialization:**

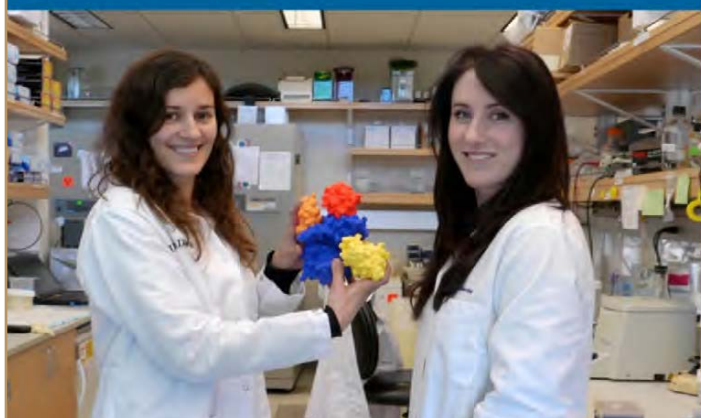
- ❖ Behavioral Pharmacology
- ❖ Cancer Pharmacology
- ❖ Cardiovascular Pharmacology
- ❖ Reproductive Pharmacology
- ❖ Endocrine Pharmacology
- ❖ Neuropharmacology



For inquiries: (202)352-6862 [mdavila-garcia@howard.edu](mailto:mdavila-garcia@howard.edu)  
 To apply: <https://gradcas2023.liaisoncas.com/applicant-ux/#/login>  
 For more information: <https://gs.howard.edu/graduate-programs/pharmacology>

The Pharmacological Sciences Ph.D. program at UC San Diego is recognized by **U.S. News & World Report** as the **3rd leading center worldwide** for research and training in the disciplines of pharmacology and toxicology. Our program faculty provide Ph.D. training in all aspects of molecular pharmacology, from basic mechanisms of signal transduction to disease and therapeutics, and rational drug design. The program has been supported for more than 40 years by the nation's largest NIH-funded Pharmacological Sciences pre-doctoral training grant which supports 15 trainees in affiliated labs annually.

*A Defining Future Starts Here!!*



# Department of Pharmacology

**Areas of Graduate Studies include:**

- Cancer Biology
- Cardiovascular and Metabolic Diseases
- Immunology, Inflammation, and Infectious Diseases
- Neuropharmacology and Neurological Disorders
- Biochemical, Biophysical, and Structural Pharmacology
- Integrative -Omics and Data Science
- Signaling and Molecular Pharmacology
- Systems and Computational Biology

For more information visit: <http://pharmacology.ucsd.edu>

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- ♦ quantitative systems pharmacology
- ♦ computational genomics
- ♦ molecular pharmacology
- ♦ drug development sciences
- ♦ therapeutic bioengineering

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*UCSF is a founding member of the Coalition for Disability Access in Health Science & Medical Education. The PSPG program is actively recruiting qualified students with disabilities.*

[pspg.ucsf.edu](http://pspg.ucsf.edu)

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- \*Multiple sclerosis
- \*Drug addiction
- \*Circadian rhythm disorders
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# Pharmacology

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## Graduate Programs in Cellular and Molecular Pharmacology and Physiology



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The Cellular and Molecular Pharmacology and Physiology graduate program at Rochester leads to **M.S. and Ph.D. degrees in Pharmacology or Physiology**. While completing core courses, students embark on independent research utilizing the latest molecular, cellular, and behavioral approaches in a highly collaborative and supportive environment.

**Application Deadlines: Ph.D. - December 15<sup>th</sup>; M.S. - May 1<sup>st</sup>**

For more information on the application process and to check out current research opportunities, visit: [www.cmpp.urmc.edu](http://www.cmpp.urmc.edu)



## Premed Master's Degree Program in Medical Pharmacology

- Two-semester **M.S. degree program** aimed at helping students gain entry into and excel in medical school, dental school & other professional health programs
- Advanced instruction in pharmacology, cell physiology, and anatomy (human cadaver dissection lab) led by the same faculty who teach UR's 1<sup>st</sup>-year medical students
- Professional development training & clinical experiences that align with career goals

**Applications due June 15<sup>th</sup>**

For more information, visit [www.medpharm.urmc.edu](http://www.medpharm.urmc.edu)



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# Choose your path to make your impact!



## Our Impact

*An outstanding graduate program is our priority!*

*We rank in the top tier in NIH funding and #2 globally in pharmacology research*

*We offer dynamic, cutting edge research and training programs*

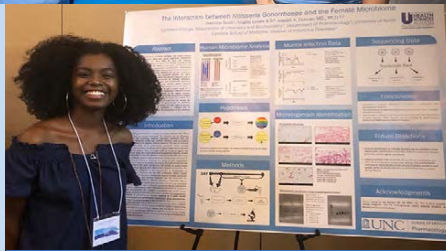
*State of the art core facilities*

*Award winning discoveries in cancer and addiction research*

*Career and networking opportunities*

*Carolina Summer Fellowship Program: Outstanding summer sciences career and research prep program for undergrad students*

*Chapel Hill ranked in Top Ten Best Places to Live in the US*



## Training



## Research



## Community



## Outreach

## Make your impact in these areas

- Cancer Biology
- Cardiovascular Pharmacology
- Chemical Biology
- Computational Bioinformatics
- DNA Repair/Cell Cycle
- Drug Discovery
- Epigenetics
- Gene Therapy
- Nanotechnology
- Neuroscience
- Proteomics
- Signal Transduction
- Structural Biology
- Stem Cells
- Systems Biology
- Translational Medicine



**Take your next step by contacting us**

phcograd@med.unc.edu

Department of Pharmacology

University of North Carolina at Chapel Hill

<http://med.unc.edu/pharm/>



## UNC Ph.D. Program in Pharmacology



# Ph.D. Program in Physiology & Pharmacology

## Areas of Excellence:

- Addiction
- Aging
- Behavioral Pharmacology
- Cardiovascular function in health and disease
- Neurological diseases of aging
- Neuropharmacology
- Neurophysiology
- Metabolism and regulation of energy homeostasis
- Pain Physiology and Pharmacology
- Pharmacology of Anticancer Drugs

UT Health San Antonio, Graduate School of Biomedical Sciences  
Physiology & Pharmacology Discipline

## Details:

- Stipend \$30,000 - Check website for information about stipend increases
- Tuition, fees, and basic student health benefits are included
- GRE scores are not required for applications



*Choose Your own Adventure!*

For more information: [davilat3@uthscsa.edu](mailto:davilat3@uthscsa.edu)  
<https://physiology.uthscsa.edu/education/phd/>  
<https://pharmacology.uthscsa.edu/programs/physiology-pharmacology/>





# Weill Cornell Medicine Pharmacology

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## PHD GRADUATE PROGRAM IN PHARMACOLOGY

The Pharmacology PhD Program at Weill Cornell Medicine (WCMGS) of Cornell University, a joint graduate program with Sloan Kettering, is located in New York City, and trains students in the scientific foundations that underlie modern pharmacology. These include chemistry and chemical biology, molecular biology, receptor biology, neurosciences, and cell and organ physiology.

The program's mission is to provide students with the necessary skills for pursuing research in cancer biology, neurosciences, physiology, toxicology, clinical pharmacology, proteomics, drug development, and translational research.

The research activities of the Weill Cornell Pharmacology Program faculty cover broad areas of modern pharmacological science. Faculty carry out research in cancer pharmacology, neuropharmacology, cardiovascular pharmacology, drug metabolism, toxicology, proteomics, molecular pharmacology, receptors and signal transduction, and drug design.

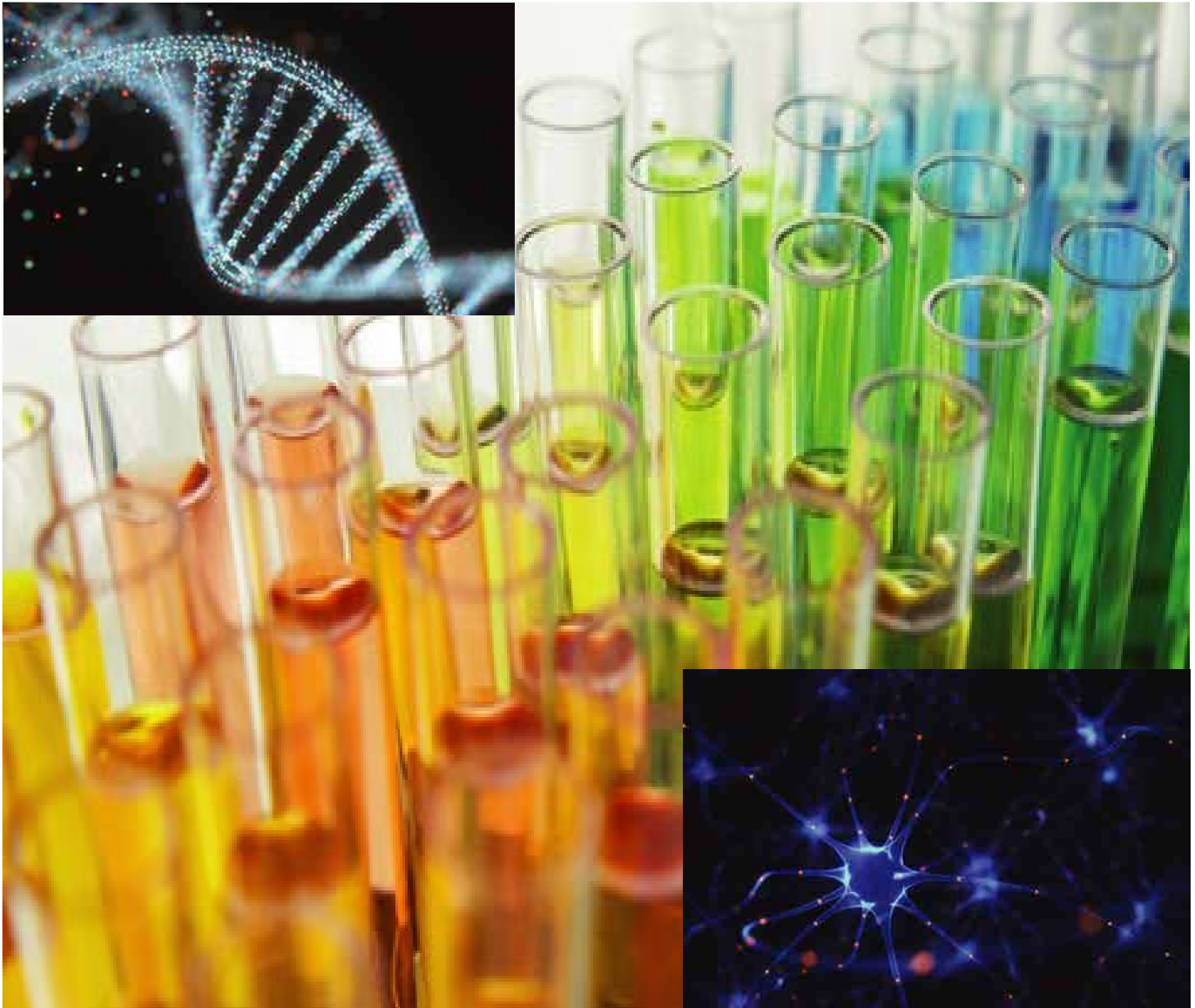


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[HTTPS://PHARMACOLOGY.WEILL.CORNELL.EDU/PH-D-PROGRAM-PHARMACOLOGY](https://pharmacology.weill.cornell.edu/ph-d-program-pharmacology)

## ***Pharmacology, Addiction Science, and Toxicology Track***



The Pharmacology, Addiction Science, and Toxicology Track provides multidisciplinary training leading to a PhD, as part of the Integrated Biomedical Sciences Program. Faculty within the track have expertise in a variety of research areas of pharmacology and toxicology related to addiction, cerebrovascular regulation, neurodegenerative disorders, cardiovascular disease, metabolic disorders, cancer biology, and signal transduction.

Program information:

<https://www.uthsc.edu/graduate-health-sciences/ibs/research-tracks/pharmacology.php>

Track Director: Steve Tavalin, Ph.D. [stavalin@uthsc.edu](mailto:stavalin@uthsc.edu)



I N T E R D I S C I P L I N A R Y   S T U D I E S   I N  
**MOLECULAR AND CELLULAR PHARMACOLOGY**

A T T H E   U N I V E R S I T Y   O F   W I S C O N S I N   -   M A D I S O N

The objective of the Graduate Program in Molecular and Cellular Pharmacology is to equip students with advanced skills applied to a variety of basic, translational, and discovery-based research projects. Students emerge as independent scientists ready for a variety of career paths in academia, industry, and government.

Molecular and Cellular Pharmacology faculty and students work in a diverse array of schools and departments across the University of Wisconsin — one of the largest graduate training institutions in the country. **AREAS OF RESEARCH EXPERTISE INCLUDE:**

Molecular Structure and Function • Cellular Signal Transduction  
Biochemistry and Chemistry • Biomedical Engineering • Cancer  
Neuroscience • Cardiovascular Biology • Virology • Drug Discovery  
Epigenetics • Metabolism • Proteomics • Genomics • Stem Cell Fate

Contact: Dr. Nathan Sherer, Program Director: [nsherer@wisc.edu](mailto:nsherer@wisc.edu) or Kristin Cooper, Administrator : [kgcooper@wisc.edu](mailto:kgcooper@wisc.edu)

[molpharm.wisc.edu](http://molpharm.wisc.edu)