

Pharmaceutical Sciences

College of Pharmacy

The Graduate Program in Pharmaceutical Sciences is a multidisciplinary program designed to prepare motivated individuals for academic, industrial, or government careers in pharmaceutical and biomedical research. It is a graduate training program that encompasses research in areas of pharmaceutical sciences that range from identifying fundamental mechanisms of human disease, to the design, development and formulation of new medicines, to understanding the impact of drug policies on health care systems. Within this broad scientific framework, students develop individually tailored programs of study to meet their particular research interests and career objectives.

Intense, laboratory-based and data and analysis driven research, using state-of-the-art techniques and instruments, forms the basis of a student's PhD dissertation or Master's thesis. Each student develops the skills and judgment to make a unique, scholarly contribution to our understanding of drugs and how these compounds impact human health and disease. These breakthroughs are published in top pharmaceutical journals and presented at national and international meetings. Students receive the training that will enable them to become independent scientists who can conduct front-line research in pharmaceutical sciences in industrial, academic or governmental settings.

The overall goal of the graduate program is to provide the graduate student with a comprehensive, structured, yet flexible educational experience comprised of both coursework and independent, highly creative, research. This goal is supported by additional components, such as research rotations for first-year students and a program-wide seminar series. The intent is to provide both depth and breadth of expertise in the Pharmaceutical Sciences along with developing the creative and critical approach to research that characterizes a PhD-level or Master's level scientist.

All students in the program will carry out hypothesis-driven laboratory investigations as the basis of a written dissertation or thesis for PharmD/MS students. The quality of the dissertation will be judged by the student's advisory committee, in accord with the requirements and regulations set forth by the Graduate School. It is expected that the dissertation or thesis work will be recognized as high quality by also being published in national and international scientific journals and presented in forums at national and international scientific meetings.

Admission Requirements

Admission to the graduate program is competitive and is based upon academic background, professional recommendations, performance on the Graduate Record Examination (GRE), experience and interviews. Students should have completed an undergraduate degree in biology, biochemistry, biomedical engineering, chemical engineering, chemistry, neurosciences, or pharmacy with a mastery of mathematics through calculus.

Training Options

Doctoral degrees in Pharmaceutical Sciences at the College of Pharmacy are obtained through one of five Tracks. The Traditional Pharmaceutical Science Tracks provide training that is based on advanced coursework in contemporary basic pharmaceutical sciences plus independent laboratory or computational research under the direction of a faculty mentor. In the Traditional Pharmaceutical Science Tracks the many research opportunities available are organized into three broad disciplinary areas: Medicinal, Bioorganic and Computational Chemistry, Pharmaceutical Chemistry and Engineering, and Pharmacology

and Experimental Therapeutics. The Clinical and Experimental Therapeutics Track requires a prior degree in an area of professional health care, and focuses on training in translational research at the interface between basic and clinical studies. The Pharmaceutical Outcomes and Policy Track trains scientists to conduct research on the safe, efficient, and effective use of pharmaceuticals to improve the health of individuals and populations.

Traditional Pharmaceutical Science Tracks

The goal of the Pharmaceutical Science Tracks is to develop scientists who possess a blend of contemporary basic science skills and an understanding of their role in the development of new drugs. Training begins with advanced coursework that is tailored to give each student a solid foundation across the breadth of pharmaceutical sciences, yet is individualized based on the student's academic background, and the research project that will be the basis for their dissertation. The many research opportunities available are organized into three broad disciplinary areas, built around the three Divisions within the Department of Pharmaceutical Sciences—the Medicinal, Bioorganic, & Computational Chemistry Division, The Pharmaceutical Chemistry and Engineering Division, and the Pharmacology & Experimental Therapeutics Division.

Medicinal, Bioorganic and Computational Chemistry Track

The Division of Medicinal, Bioorganic and Computational Chemistry is focused on small molecules as well as new protein and nucleic acid based therapies, and natural product drug discovery platforms and seeks to expand its expertise with interests in synthetic/biosynthetic approaches for drug discovery, development of novel computational tools for drug design, and evolution of biologics for specific therapies or drug delivery.

Pharmaceutical Chemistry and Engineering Track

The Division of Pharmaceutical Chemistry and Engineering focuses on drug formulation, development and delivery. Areas of emphasis include the application of physical, physical organic, and analytical chemistry to solve pharmaceutical problems; the design, development, and optimization of dosage forms for small and large molecules; and fundamental research into materials science and nanotechnology to advance drug delivery systems design. Collaborations with faculty in the UK College of Engineering provide additional opportunities for a combined pharmaceutical and engineering research program. In addition, faculty participate in preclinical and/or clinical projects through collaborative relationships within the College of Pharmacy and with investigators across the UK Medical Center Complex.

Pharmacology and Experimental Therapeutics Track

The Division of Pharmacology and Experimental Therapeutics draws upon campus-wide strengths in neurobiology, cardiovascular disease, oncology and infectious diseases. Strong collaborations exist with the Sanders-Brown Center on Aging, addiction/abuse consortia, and the Markey Cancer Center, which recently received NCI Cancer Center designation. Division faculty are skilled in pharmacokinetic and pharmacodynamics, systems biology, neurochemistry and neurophysiology. Translational research programs bridging preclinical and/or clinical projects through collaborative relationships within the College of Pharmacy and with investigators across the UK Medical Center Complex also exist.

Clinical and Experimental Therapeutics Track (CET)

The completion of a Pharm.D., D.D.S., D.V.M. or other professional health degree is required for admission into this training Track. The focus of the CET Track is translational research, and involves training in how to conduct studies that occur at the interface of basic and clinical research. Since all students admitted to the program will already have a clinical/health profession degree, the emphasis of the program will be training in the basic sciences. This breadth and balance of skills will improve the graduate's ability to successfully compete for extramural funding and job opportunities. There are required clinical components to assure competency in the foundations, principle and processes of clinical research.

The keystone of the training is the conduct of an integrated, combined laboratory-based and clinical dissertation.

Pharmaceutical Outcomes and Policy Track (POP)

The goal of the Pharmaceutical Outcomes and Policy Track is to train scientists to conduct research on the safe, efficient, and effective use of pharmaceuticals to improve the health of individuals and populations. The emphasis of the program will be on building a core set of analytical skills and tools to evaluate the impact of clinical interventions and clinical outcomes. Students complete core classes in five areas: pharmacoepidemiology, pharmacoconomics, statistics, biomedical informatics, and pharmaceutical policy. This breadth and balance of skills will improve the graduate's ability to successfully compete for extramural funding and contribute to the scholarly literature on pharmaceutical outcomes. Most students within the Pharmaceutical Outcomes & Policy Track have a prior professional health related degree (Pharm.D., B.S. Pharm.) Exceptional students without a pharmacy related degree may be admitted with the consent of the admissions committee. Students without appropriate prerequisite training may be required to complete additional course work.

Doctoral Program Core Coursework

Each Track has a distinct set of courses. These courses may be offered in the Graduate Program of Pharmaceutical Sciences, or available outside of the Program. The mentor and the Dissertation Advisory Committee are empowered to select those courses that fit best into the educational and career goals of the student and the scientific goals of the dissertation. The Track Coordinator (for first-year students) or mentor and the Dissertation Advisory Committee are empowered to petition the DGS, in writing, to waive courses of the Graduate Program Core if the student has demonstrated sufficient academic mastery of material in courses taken in other programs. The DGS will monitor the coursework of students and keep the Advisory Committee members apprised as to the student's grades and completion of courses. Coursework and grades are reviewed by the Advisory committee at each yearly meeting.

The student's Dissertation Advisory Committee is responsible for coursework recommendations that are in addition to the common coursework of the program and courses recommended by the Track faculty. Full descriptions of available graduate courses are described in the Bulletin of the University of Kentucky Graduate School (<http://www.uky.edu/Registrar/Bulletin.htm>).

Medicinal, Bioorganic, and Computational Chemistry Track

Core Courses

Students should complete these courses over 4-6 semesters

IBS/CHE 601/550	Biomolecules and Metabolism or Biological Chemistry I	(3)
IBS/CHE 602/552	Molecular Biology and Genetics Biological Chemistry II	(3)
PHS 760 00x	Introduction to Pharmaceutical Sciences	(1)
PHS 760 00x	Drug Discovery, Development, Commercialization, Outcomes	(3)
PHS 711	Fundamentals of Bioethics	(2)
PHS 778	Seminar (attendance required each semester until defense; officially register only until passing the qualifying exam)	(1)

Additional courses to be taken by an individual student depend on:

1. The lab and dissertation project the student selects
2. The academic preparation of the student (areas that need strengthening)

Elective courses

PHS 510	Modern Methods in Pharmaceutical Analysis	(5)
PHS 662	Bioorganic Mechanisms	(3)

PHS 660	Biosynthesis of Natural Products	(3)
BCH 401G	Fundamentals of Biochemistry	(3)
CHE 440G	Introductory Physical Chemistry	(4)
CHE 538	Principals of Physical Chemistry	(3)
IBS 606	Physiological Communication	(3)
MA 213	Calculus III	(4)
PGY 502	Principles of Systems, Cellular and Molecular Physiology	(5)
STA 570	Basic Statistical Analysis ⁴	(4)

Pharmaceutical Chemistry and Engineering Track

Core Courses

Students should complete these courses over 4-6 semesters

CHE 548	Principles of Physical Chemistry II	(3)
PHS 612	Quantitative PD/PK (Modules I and II listed under PHS 760)	(2)
PHS 630	Pharmaceutical Rate Process	(3)
PHS 631	Equilibrium Phenomena in Pharmaceutical Systems	(3)
PHS 760	Drug Discovery, Development, Commercialization and Outcomes	(3)
PHS 711	Fundamentals of Bioethics	(2)
PHS 778	Seminar (attendance required each semester until defense; officially register only until passing the qualifying exam)	(1)

Additional courses to be taken by an individual student depend on:

1. The lab and dissertation project the student selects
2. The academic preparation of the student (areas that need strengthening)

Highly Recommended Courses

Students must select 5 courses from this list

CHE 538	Principles of Organic Chemistry	(3)
CME 505	Analysis of Chemical Engineering Problems	(3)
CME 630	Transport I	(3)
IBS 601	Biomolecules and Metabolism (or CHE 550)	(3)
PGY 206 or 502	Elementary Physiology (no graduate credit) or Principles of Systems, Cellular and Molecular Physiology	(3-5)
PHS 76x	Drug Delivery Systems	(3)
PHS 76x	Solid State Stability and Formulation	(3)
PHS 76x	Techniques in Pharmaceutical Analysis (3)	(3)

Elective Courses

These courses may require additional prerequisites

CHE 532	Spectroscopic Identification of Organic Molecules	(2)
CHE/IBS 552/602	Biological Chemistry II or Molecular Biology and Genetics	(3)
CHE/ABT 553/495	Chemistry and Molecular Biotechnology or Experimental Methods in Biotechnology	(3-4)
MED 616	Biology and Therapy of Cancer	(3)
STA 673	Distribution-Free Statistical Inference and Analysis of Categorical Data	(2)
STA 677	Applied Multivariate Methods	(3)
STA 679	Design and Analysis of Experiments II	(3)

Pharmacology and Experimental Therapeutics

Core Courses

Students should complete these courses over 4-6 semesters

IBS/CHE 601/550	Biomolecules and Metabolism or Biological Chemistry I	(3)
IBS/CHE 602/603/552	Molecular Biology and Genetics/Cell Biology and Cell Signaling/ Biological Chemistry II	(3)
STA/IBS 570/580/611	Basic Statistical Analysis	(4)
	Biostatistics	(3)
	Practical Statistics	(1-4)
PHS 760 00x	Introduction to Pharmaceutical Sciences	(1)
PHS 760 00x	Drug Discovery, Development, Commercialization, Out-comes	(3)
PHS 711	Fundamentals of Bioethics	(2)
PHS 778	Seminar (attendance required each semester until de-fense; officially register only until passing the qualifying exam)	(1)

Clinical and Experimental Therapeutics

Core Courses

Students should complete these courses over 4-6 semesters

IBS 601	Biomolecules and Metabolism	(3)
IBS 602	Molecular Biology and Genetics	(3)
PHS 612	Quantitative Pharmacodynamics: Pharmacokinetics	(3)
PHS 711	Fundamentals of Bioethics	(2)
PHS 750	Journal Club (choice of journal club topic)	(1)
PHS 760 00x	Introduction to Pharmaceutical Sciences	(1)
PHS 760 00x	Drug Discovery, Development, Commercialization, Out-comes	(3)
PHS 760 00x	CET track lab rotations	Varies
PHS 778	Seminar (attendance required each semester until de-fense; officially register only until passing the qualifying exam)	(1)
PPS 764	Drug Development Regulation & Clinical Research	(3)

All students must become IRB and HIPPA certified

Strongly Recommended Courses

STA 671	Statistics: Regression and Correlation	(2)
STA 672	Statistics: Design and Analysis of Experiments	(2)

Possible Electives

PHS 760 00x	Techniques in Pharmaceutical Analysis	(3)
BIO 520	Bioinformatics	(3)
BIO 615	Molecular Biology	(3)
IBS 603	Cell Biology and Signaling	(3)
PGY 502	Principles of Systems, Cellular and Molecular Physiology	(5)
PGY 617	Physiological Genomics	(2)
PHA 621	Principles of Drug Action	(3)

Pharmaceutical Outcomes and Policy

The Doctor of Philosophy track focusing on Pharmaceutical Outcomes & Policy requires a minimum of 50 credit hours: including a 29 credit hour core curriculum, 12 hours in a specialization area de-signed by the Advisory Committee, and 9 hours of dissertation work. Students without appropriate pre-requisite training may be required to complete additional course work. Generally, students without a Master level degree will

be required to complete appropriate level courses designed to meet pre-requisite requirements to begin doctoral coursework. The student Advisory Committee may also require additional coursework to satisfy appropriate depth and breadth of training.

PPS 700	Introduction to Pharmaceutical Outcomes and Policy	(3)
PPS 701	Pharmacoepidemiology	(3)
PPS 704	Pharmacy Informatics	(3)
PPS 706	Intermediate Pharmacoeconomics and Decision Analysis	(3)
PPS 710	Techniques in Secondary Data Research	(3)
PPS 750	Pharmaceutical Outcomes and Policy Journal Club (attendance is required each semester until defense)	(1)
PPS 760	Special Topics in Pharmacy Practice & Science: Behavioral Economics in Pharmaceutical Outcomes & Policy (will be created as new course PPS 703)	(3)
PPS 778	Seminars in Pharmacy Practice & Science (attendance is required each semester until defense)	(1)
PHS 760	Topics in Pharmaceutical Sciences: Introduction to Pharmaceutical Sciences	(1)
PHS 760	Topics in Pharmaceutical Sciences: Drug Discovery, Development & Translation	(3)
PHS 711	Fundamentals of Bioethics	(2)
ECO 603*	Research Methods and Procedures in Economics OR (Alt. Statistics)	(3)
ECO 703*	Introduction to Econometrics I OR (Alt. Statistics)	(3)

All students must complete IRB and HIPAA training

* Prerequisites are required, including 6 hours of statistics or biostatistics, and introductory epidemiology and health economics.

In addition to the core courses, the student's Advisory Committee may recommend additional elective courses. A student's completion of these course requirements must be assured by the student's Mentor(s), Advisory Committee and PPS Track Coordinator. In addition, some students may need to complete prerequisite courses before beginning core class course work. Note at least 75% of the courses must be 600 level or higher and prerequisites for core courses cannot count as specialty electives.

Partial List of Elective Courses

These courses may require additional prerequisites.

PPS 605	Pharmacoeconomics and Decision Analysis	(2)
PPS 620	Substance Use Disorders: Health Implication, Policies, & Prevention Strategies	(3)
PPS 702	Pharmaceutical Health Policy	(2-3)
PPS 764	Drug Development Regulation and Clinical Research	(3)
BMI 633	Introduction to Bioinformatics	(3)
BMI 730	Principles of Clinical Informatics	(3)
BMI 732	Biomedical Ontologies and Semantic Web Techniques	(3)
BMI 734	Introduction to Biomedical Image Analysis	(3)
BMI 738	Big Data for Healthcare	(3)
BST 682	Generalized Linear Models	(3)
BST 761	Time to Event Analysis	(3)
BST 762	Longitudinal Data Analysis	(3)
CPH 664	Design and Analysis of Clinical Trials	(3)
CPH 711	Chronic Disease Epidemiology	(3)
CPH 712	Advanced Epidemiology	(3)

CS 405G	Introduction to Database Systems	(3)
CS 460G	Machine Learning	(3)
CS 515	Algorithm Design	(3)
ECO 751	Public Economics	(3)
PA 751	Public Policy Formulation & Implementation	(3)
PA 752	The Economics of Policy Analysis	(3)
PPA 784	Next Generation Sequencing and Bioinformatics	
STA 671	Regression and Correlation	(2)
STA 672	Design and Analysis of Experiments	(2)
STA 673	Distribution-Free Statistical Inference and Analysis of Categorical Data	(2)
STA 677	Applied Multivariate Methods	(3)