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 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.

**Pharmacology and Experimental Therapeutics Track**

The Division of Pharmacology and Experimental Therapeutics draws upon campus-wide strengths in pharmacodynamics, systems biology, neurochemistry and neurophysiology. Translational research 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.

**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, pharmacoeconomics, 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 co-reef 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)
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)
Biostatics          (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)

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 508 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)

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 (3)
STA 677 Applied Multivariate Methods (3)
STA 679 Design and Analysis of Experiments II (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 (3)
STA 677 Applied Multivariate Methods (3)

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)

All students must become IRB and HIPPA certified

Strongly 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)

Possible Electives
PES 500 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 (3)
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 Pharmacoconomics 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 Pharmacoconomics 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 Formation & Implementation (3)
PA 752 The Economics of Policy Analysis (3)
PAA 784 Next Generation Sequencing and Bioinformatics (3)
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)