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See pages 12-13 for admission procedures.

Application fees: Domestic students in pharmacy: paper $55, online $45.
International students in pharmacy: paper $60, online $55.

KU is a member of the American Association of Colleges of Pharmacy and is accredited
by the American Council on Pharmaceutical Education.
Associate Professors: Barnes, Grauer, Henry
Clinical Professor: Generali
Kleoppel, Ragan, Woods, Yang
Clinical Assistant Professors: Davidow, Emerson, Eng, Jenkins,
Clinical Associate Professors: Backes, Moeller, Ruisinger

The School of Pharmacy offers graduate programs through the Departments of Medicinal Chemistry, Pharmaceutical Chemistry, Pharmacology and Toxicology, and Pharmacy Practice. The Department of Pharmacy Practice offers the M.S. with a major in hospital pharmacy. The other three departments offer both the M.S. and the Ph.D. with majors in their respective disciplines. Requirements for admission and baccalaureate preparation vary with each department and are discussed separately.

Address inquiries and correspondence about graduate studies to the program or department of interest.

See Admission in the General Information chapter of this catalog for information about application fees.

Hospital Pharmacy
Interim Chair and Graduate Adviser: Dennis W. Grauer
Malott Hall, 1251 Wescoe Hall Dr., Room 6050
Lawrence, KS 66045-7572 or
KU Medical Center, Mail Stop 4040
3910 Rainbow Blvd., Kansas City, KS 66160, (913) 588-5360
http://pharmpractice.ku.edu, (785) 864-4881
Professors: Godwin, Howard
Clinical Professor: Generali
Associate Professors: Barnes, Grauer, Henry
Clinical Associate Professors: Backes, Moeller, Ruisinger
Clinical Assistant Professors: Davidow, Emerson, Eng, Jenkins, Kleoppel, Ragan, Woods, Yang

Admission
In addition to meeting the general requirements for admission to graduate studies, applicants are considered for admission if they are graduates of a school of pharmacy accredited by the American Council on Pharmaceutical Education and are eligible for licensure as registered pharmacists by the Kansas State Board of Pharmacy. A Bachelor of Science degree or a Doctor of Pharmacy (Pharm.D.) degree with a major in pharmacy is required.

Submit your application online at www.graduate.ku.edu. Send transcripts of all completed college and university course work and all other requested application materials to

The University of Kansas
Department of Pharmacy Practice
Malott Hall, 1251 Wescoe Hall Dr., Room 6050
Lawrence, KS 66045-7572

M.S. Degree Requirements
A minimum of 30 credit hours, with a majority of hours in pharmacy, is required for the degree. These courses may be selected from related fields after approval by the department. Examples are hospital pharmacy, clinical pharmacy, nuclear pharmacy, computer science, business administration, health policy and management, and related fields. An approved project, representing 6 to 9 credit hours of original research, is required. It may be in pharmaceutical sciences, clinical pharmacy, pharmacy practice, pharmacotherapy, or hospital pharmacy.

To provide practical experience, an accredited specialty residency in pharmacy practice management in an approved hospital is required of each student. Requirements for the residency program include eligibility for licensure as a pharmacist in Kansas. The student must complete the residency concurrently with the academic portion of the program. Upon satisfactory completion of the residency, the student receives a certificate of residency from the cooperating hospital. The typical length of the program is two years. For students who have previously completed a residency accredited by the American Society of Health-System Pharmacists, this part of the program may be waived on approval of the department.

Facilities
Facilities of the pharmacy department at the University of Kansas Medical Center in Kansas City are used in the residency portion of the program.

Pharmacy Practice Courses
PHPR 502 Pharmacy Practice II Pharmaceutical Care Fundamentals (4).
PHPR 508 Oncology Elective (1).
PHPR 510 Medical Terminology Elective (1).
PHPR 511 Service-Learning Elective (1).
PHPR 512 Careers in Pharmacy Elective (4).
PHPR 513 Chemical Dependency Elective (1).
PHPR 514 Communication and Counseling (1).
PHPR 515 Pharmacy and the Arts (1).
PHPR 600 Community Practice (4).
PHPR 612 Pharmacoeconomics and Outcomes (3).
PHPR 614 Pharmacy Management (4).
PHPR 615 Nuclear Pharmacy Practice (2).
PHPR 619 Health Care Systems (3).
PHPR 620 Ethics and Introduction to Law (1).
PHPR 621 Pharmacy Law (2).
PHPR 622 Drug Information and Biostatistics (3).
PHPR 625 Pharmacotherapy I (3).
PHPR 626 Pharmacotherapy II (3).
PHPR 627 Pharmacotherapy III (3).
PHPR 628 Pharmacotherapy IV (3).
PHPR 630 Drug Information/Biostatistics and Med Lit Evaluation (4).
PHPR 631 General Clinical Clerkship (4).
PHPR 632 Compounding Clerkship (4).
PHPR 633 Ambulatory Community Practice Clerkship (4).
PHPR 634 Surgical ICU Clerkship (4).
PHPR 635 Problems in Pharmacy Practice (1-5).
PHPR 636 Law/Ethics (3).
PHPR 637 NTPD Rounding Clerkship I (4).
PHPR 638 NTPD Clerkship II (4).
PHPR 639 NTPD Clerkship III (4).
PHPR 640 NTPD Clerkship IV (4).
PHPR 641 NTPD Clerkship V (4).
PHPR 642 Medical ICU Clerkship (4).
PHPR 643 Nutrition Support Advanced Clerkship (4).
PHPR 646 Pharmacotherapy I (4).
PHPR 647 Pharmacotherapy II (4).

KU’s School of Pharmacy ranked third among the nation’s elite programs in fiscal year 2008 for securing funding from the National Institutes of Health. The school received more than $17.6 million in NIH funding.

The School of Pharmacy has been in the top five for NIH funding for eight consecutive years and in the top 10 since 1995.
PHPR 648 Pharmacotherapy III (4).
PHPR 649 Drug Information (3).
PHPR 650 Family Practice Advanced Clerkship (4).
PHPR 651 Biostatistics (3).
PHPR 652 Drug Information Advanced Clerkship (4).
PHPR 653 Home Health Care Advanced Clerkship (4).
PHPR 654 Neonatal Advanced Clerkship (4).
PHPR 655 Pediatrics Hematology, Oncology Advanced Clerkship (4).
PHPR 656 Internal Medicine Advanced Clerkship (4).
PHPR 657 Poison Control Center Advanced Clerkship (4).
PHPR 658 Infectious Disease Advanced Clerkship (4).
PHPR 659 Medication Safety/Reconciliation (4).
PHPR 660 Cardiology Advanced Clerkship (4).
PHPR 661 General Practice Advanced Clerkship (4).
PHPR 662 Research Laboratory Rotation (4).
PHPR 663 Critical Care Advanced Clerkship (4).
PHPR 664 Geriatrics Advanced Clerkship (4).
PHPR 665 Advanced Specialized Clerkship I (4).
PHPR 667 Advanced Specialized Clerkship II (4).
PHPR 668 OB-QYN Advanced Clerkship (4).
PHPR 669 Oncology Advanced Clerkship (4).
PHPR 670 Physical Assessment (1).
PHPR 671 Nuclear Pharmacy Advanced Clerkship (4).
PHPR 672 Managed Care Clerkship (4).
PHPR 673 Formulary Management/DUE (4).
PHPR 674 Ambulatory Care Advanced Clerkship I (4).
PHPR 675 Operating Room Clerkship (4).
PHPR 676 Clinical Clerkship (4).
PHPR 677 Ambulatory Care Advanced Clerkship II (4).
PHPR 678 Pharmaceutical Industry Clerkship (4).
PHPR 679 Pharmacy Association Clerkship (4).
PHPR 680 Advanced Specialized Extremity I (4).
PHPR 681 Pulmonary/Critical Care Advanced Clerkship (4).
PHPR 682 Public Health Service Clerkship (4).
PHPR 683 Hematology Advanced Clerkship (4).
PHPR 684 Neurology Advanced Clerkship (4).
PHPR 685 Hospital Pharmacy Administration (4).
PHPR 686 Hospital Extremity I (4).
PHPR 687 Hospital Extremity II (4).
PHPR 688 Long-Term Care Advanced Clerkship (4).
PHPR 689 Pediatric Critical Care Advanced Clerkship (4).
PHPR 690 Clinical Drug Research (4).
PHPR 691 Diabetes Advanced Clerkship (4).
PHPR 692 Veterinary Medicine Clerkship (4).
PHPR 693 Psychopharmacy Advanced Clerkship (4).
PHPR 694 Drug Utilization Review Clerkship (4).
PHPR 695 Investigational Drugs Clerkship (4).
PHPR 696 Community Extremity I (4).
PHPR 697 Community Extremity II (4).
PHPR 699 Seminar (1).

PHPR 845 Professional Communications (2). A course designed to give the graduate student a practical experience in areas of professional communications such as administrative proposals, grants, letters, memos, poster presentations, and written papers. The course focuses on the different kinds of communications required to relate to other health care professionals. Prerequisite: Consent of instructor. LEC

PHPR 855 Economic Evaluation of Health Care Programs and Services (3). The course will provide students with an overview and appraisal of the state of the art in the evaluation of health care programs and services. Prerequisite: CHEM 624 and 626 and CHEM 627. In all cases, general admission requirements must be met.

Admission
Graduate students are primarily admitted to the department to pursue the Ph.D. degree. The M.S. degree and postdoctoral training are also available. An applicant wishing to enter the graduate program must have earned a bachelor’s or master’s degree in pharmacy, medicinal chemistry, chemistry, biochemistry, or a closely related field, and must have completed one year of organic chemistry with laboratory (equivalent to CHEM 624, CHEM 625, CHEM 626, and CHEM 627). In all cases, general admission requirements must be met.

Applications are evaluated by the graduate selection committee. Applications must be supported by one copy of official transcripts of all previous college and university work, both undergraduate and graduate. In addition, three letters of recommendation from current or former teachers, advisers, or employers must be submitted. Students from non-English-speaking countries also must furnish proof of proficiency in English. Graduate Record
Examination general test scores are required, and applicants are strongly encouraged to take the subject test in chemistry as well. The graduate selection committee makes admission decisions based on grade-point averages for previous college work (particularly in the relevant science areas), letters of recommendation, previous research or employment experience relevant to the graduate training being sought, GRE scores, etc. The number of applicants who can be admitted at any time varies, depending on the availability of laboratory space, research facilities, and financial support for research activities, but it is usually about 10 a year.

Applications can be submitted online at www.graduate.ku.edu. All other requested application materials (transcripts, résumé, statement of purpose, recommendation letters, etc.) should be sent directly to the following address:

The University of Kansas Department of Medicinal Chemistry Malott Hall, 1251 Wescoe Hall Dr., Room 4070 Lawrence, KS 66045-7572

M.S. Degree Requirements
Candidates for this degree must satisfy general requirements as well as those of one of the following options:

Students who are proceeding toward the Ph.D. degree at KU receive the master’s degree after satisfactorily completing the course work requirement for the Ph.D. and passing a comprehensive examination.

Students who wish to earn only the M.S. degree must complete a prescribed subset of the course work requirements for the Ph.D. degree and a thesis representing at least 10 credit hours of research and pass a thesis defense.

Ph.D. Degree Requirements
If credit has not already been obtained in the courses below or their equivalents, students must complete the following courses as early as is practical in the graduate program: one semester of physical chemistry (CHEM 640 or CHEM 646), and biochemistry (MDCM 701). Satisfactory completion of qualifying examinations in organic chemistry and biochemistry also is required.

A series of monthly written cumulative examinations is used to assess students’ knowledge of medicinal chemistry, organic chemistry, and biochemistry. These examinations must be passed at an accelerating rate during the second and third years. After completing the cumulative examinations, the major part of the course work, and other requirements, the student takes an oral comprehensive examination. After completing this examination, the student prepares an original research proposal for presentation to the faculty. The final requirement for the Ph.D. is the preparation and defense of a dissertation based on original laboratory research conducted by the candidate.

General requirements, such as those related to the comprehensive oral examination, the dissertation, and the dissertation defense, are listed in the General Information chapter of this catalog.

Facilities
The department is well equipped for both chemical and biochemical research and has research facilities for about 70 graduate students, postdoctoral associates, and research technicians. Malott Hall, where most of the medicinal chemistry laboratories are located, also houses the Departments of Chemistry and Pharmacology and Toxicology; Anschutz Library is adjacent to the building. Much of the laboratory space in the department has recently undergone renovation and provides exceptional research laboratories for chemical synthesis and biochemical research. The department has an excellent complement of modern spectroscopic, biochemical, and chromatographic instrumentation, and other specialized research instrumentation is available through cooperative arrangements with other departments.

Advanced instrumentation and facilities are available through KU’s Molecular Structures Group (www.msg.ku.edu). MSG laboratories include the Biochemical Research Service Laboratory, the Mass Spectrometry Laboratory, the Nuclear Magnetic Resonance Laboratory, the Molecular Graphics and Modeling Laboratory, the X-ray Crystallography Laboratory, and the Protein Structure Laboratory (dedicated to macromolecular X-ray crystallography) with more than $10 million in instrumentation. The Structural Biology Center, on KU’s west campus, offers new research opportunities for medicinal chemists interested in protein and nucleic acid structure and combinatorial synthesis; it also houses the new 800-MHz NMR. The Analytical Proteomics Laboratory, which combines activities of the Mass Spectrometry Lab and BRSL to create a collaborative environment for protein handling, protein mass spectrometry, and bioinformatics, is in the Structural Biology Center. In the same building, the High Throughput Screening Laboratory has integrated and automated robotics equipment for carrying out biochemical and cell-based assays and a chemical library of more than 100,000 compounds with diverse structures and drug-like properties for biological screening. The service laboratories have professional staff that provides training in specialized research techniques in addition to their service functions.

Medicinal Chemistry Courses
MDCM 601 Medicinal Biochemistry I (4).
MDCM 602 Medicinal Biochemistry Laboratory (1).
MDCM 603 Medicinal Biochemistry II (3).
MDCM 606 Phytomedicinal Agents (1).
MDCM 607 Clinical Pharmacognosy (1).
MDCM 625 Medicinal Chemistry I: Neuroeffector Agents (3).
MDCM 626 Medicinal Chemistry II: Homeostatic Agents (3).
MDCM 627 Medicinal Chemistry III: Chemotherapeutic Agents (3).
MDCM 675 Introduction to Drug Design and Development (2-3).
MDCM 690 Undergraduate Research (1-5).
MDCM 691 Research Techniques in Medicinal Chemistry (1).
MDCM 692 Problems in Medicinal Chemistry (1-5).
MDCM 701 Biomedicinal Chemistry (3). A study of the principles of macromolecular structure and function, biosignaling, bioenergetics and metabolism, with an emphasis on the relationship between biochemistry and medicine. Prerequisite: Graduate standing or permission of instructor. LEC
MDCM 703 Advanced Biomedicinal Chemistry (3). A study of the principles of basic enzymology, including chemical reactions, biosynthesis, and metabolism. In addition, the course will cover hormones, vitamins, and minerals. Prerequisite: Graduate standing or permission of instructor. LEC
MDCM 710 Physiological Aspects of Medicinal Chemistry (1). The goal of this one-credit-hour course is to provide an overview of physiological mechanisms and disease processes as a background for intermediate level courses in medicinal chemistry, drug discovery and drug development. Prerequisite: One college-level course in biology. LEC
MDCM 721 Introduction to Medicinal Chemistry (1). An overview of the field of medicinal chemistry, including discussions of research techniques and the application of organic chemistry to medicinal chemistry problems. Prerequisite: Graduate standing or permission of instructor. LEC
MDCM 722 Principles of Organic Medicinal Chemistry (3). The discovery and properties of pharmaceutical agents, including a survey of the various drug classes important in clinical applications. The relationship between chemical structure and biological mechanism of action will be emphasized. Prerequisite: Graduate standing or permission of instructor. LEC
MDCM 742 Experimental Pharmacology (4). Experimental approaches to understanding mechanism of drug action. Use of drugs as tools to understand functioning of biological systems will also be stressed. Historically important experiments will be discussed along with experiments which are currently used to define drug mechanisms. Topics will include: dose-response, drug receptors, drug metabolism, chemotherapy as well as autonomic and CNS, cancer and renal pharmacology. (Same as P&TX 742.) Prerequisite: BIOL 600 and BIOL 646 or equivalent, or consent of instructor. LEC
MDCM 775 Chemistry of the Nervous System (5). A detailed study of the molecular aspects of nerve transmission will be covered with special emphasis on the uptake, storage, release, biosynthesis, and metabolism of specific neurotransmitters. Drugs affecting these processes and current research on receptor isolation and receptor mechanisms will be discussed from a chemical viewpoint. (Same as BIOL 775, CHEM 775, NURO 775, P&TX 775, and PHCH 775.) Prerequisite: Consent of instructor. LEC
MDCM 777 Advanced Laboratory Techniques in Medicinal Chemistry (2). A laboratory course designed to acquaint advanced undergraduate and beginning graduate
students with laboratory safety, the research notebook, use of advanced instrumen-
tal techniques for structural assignment and verification, methods of separation
and purification, and the use of advanced reagents and laboratory transformations rele-
vant to research in medicinal chemistry. Prerequisite: Consent of instructor. LAB
MDCM 785 Natural Products of Medicinal Significance (2). A discussion of bioas-
say-directed screening, the isolation, structure determination, biosynthesis, partial
synthesis and total chemical synthesis of organic natural products of medicinal
significance. Examples of the classes of compounds to be considered include
steroid hormones, cardiac glycosides, alkaloids, antibiotics, terpenes, and the like.
Prerequisite: Graduate standing or consent of instructor. LEC
MDCM 790 Principles of Drug Design (3). A discussion of the principles of contempo-
rary drug design with specific examples chosen from the original literature. Prodrugs;
biosossterees; Keat inhibitors; active site directed reversible and irreversible inhibitors;
quantitative SAR; modulation of drug absorption, distribution, metabolism and excre-
tion; molecular dissection; rigid analogs; pharmacophores; etc., will be treated. Prereq-
usite: Graduate standing or completion of MDCM 624 and MDCM 627. LEC
MDCM 791 Principles of Drug Disposition (1). An introduction to the chemical and
biochemical principles which govern the interaction of drugs and chemicals with
cells and organisms. Topics include absorption, distribution, metabolism, and
excretion; passive vs. active processes; pharmacokinetics; bioactivation vs.
detoxification; and applications in drug design and improvement. Prerequisite: One
year of organic chemistry and one course in biochemistry. LEC
MDCM 799 Seminar in Medicinal Chemistry (1). Reports by research students and
discussions of developments in the field not covered in formal courses. LEC
MDCM 801 Issues in Scientific Integrity (1). Lectures and discussion on ethical is-
sues in the conduct of scientific careers, with emphasis on the ethical conduct of scien-
tific careers, with emphasis on practical topics of special importance in molecular-
level research in the chemical, biological, and pharmaceutical sciences. Topics will
include the nature of ethics, the scientist in the laboratory, the scientist as author,
grantor, reviewer, employer/employee, teacher, student, and citizen. Discussions will
focus on case histories. Graded on a satisfactory/unsatisfactory basis. (Same as
MDCM 801, NURO 801, P&TX 801, PHCH 801 and PHCH 802.) LEC
MDCM 804 Interdisciplinary Seminar on Ethics in Science and Engineering (1-3).
The course will cover basic techniques of moral reasoning, especially as applied to
ethical issues in the physical sciences and engineering. Topics covered will include
the ethical conduct of research, the federal and professional guidelines for differ-
ent kinds of research, and the ethical dimensions of publication and professional
life. Emphasis will be on practical applications, cases and student involvement.
(Same as GS 804, NURO 804, P&TX 804, and PHCH 804.) Prerequisite: Must be
admitted to the program or division of Pharmacy to enroll in this class. LEC
MDCM 860 Drug Metabolism (2). An in-depth examination of the pathways, en-
zymes, and mechanisms of xenobiotic biotransformation in a combined lecture-
readings-discussion format. Emphasis will be on recent as well as classic methods of
findings. Prerequisite: MDCM 790 or MDCM 791 or consent of instructor. LEC
MDCM 881 Drug Metabolism Laboratory (1-3). A laboratory course exemplifying
various techniques used in studying the metabolism of foreign organic com-
pounds in mammalian systems. In addition, enzymatic reactions in other plant
and microbial systems are studied. Prerequisite: Consent of instructor. LAB
MDCM 895 Research in Medicinal Chemistry (1-12). Hours and credit to be arranged.
SH
MDCM 899 Master's Thesis (1-12). Hours and credit to be arranged. Independent inves-
tigation of a research problem of limited scope. Prerequisite: Consent of instructor. THE
MDCM 950 Advanced Topics: ______ (1-3). An in-depth discussion of topics of cur-
rent interest to medicinal chemists. Prerequisite: Consent of instructor. THE
MDCM 952 Introduction to Molecular Modeling (3). Theory and practice of contempo-
rary molecular modeling: real-time computer graphics, model-building routines, use of
structural databases, molecular mechanics and molecular dynamics calculations. The
laboratory section places emphasis on drug design; work on own problems is welcome.
(Same as BIOL 952.) Prerequisite: Graduate standing or consent of instructor. LAB
MDCM 980 Original Research Proposal (1). Preparation of an original research
proposal concerning contemporary problems in medicinal chemistry. Prerequisite:
Consent of instructor. LAB
MDCM 990 Postdoctoral Research in Medicinal Chemistry (1-12). Advanced level
research in collaboration with a faculty member, which may involve projects in one
or more of the following areas: organic synthesis, isolation and structure elucidation,
metabolism, biochemical mechanisms of drug action. Prerequisite: Doctoral degree or equivalent in an appropriate related area, and consent of instructor. SH
MDCM 999 Doctoral Dissertation (1-12). Hours and credit to be arranged. Original
chemical research in the synthesis and development of medicinal agents, elucidation of the chemical mechanisms of drug action, drug metabolism, and drug
toxicities. THE

Neurosciences
Co-director: Elias K. Michaelis, emichaelis@kku.edu
2099 Constant Avenue, Lawrence, KS 66047-3729,
(785) 864-4504 or (785) 864-7339
Co-director: Paul D. Cheney, pcheney@kumc.edu
KU Medical Center, 3011 Wahl Hall East (A), Mail Stop 3043
3901 Rainbow Blvd., Kansas City, KS 66160, (913) 588-7400
Participating Faculty Members: Brian Ackley (Molecular Biosciences), Aldrich (Medicinal Chemistry), P. Atchley (Psychology), R. Atchley (Psychology), Auer (Speech-Language-Hearing: Sciences and Disorders), Barlow (Speech-Language-Hearing: Sciences and Disorders), Belousov (Molecular and Integrative Physiology), Berman (Anatomy and Cell Biology), Brooks (Hoglund Brain Imaging Center), Bruns (Anatomy and Cell Biology), Burns (General Clinical Research Center, Alzheimer’s and Memory Center), Carrasco (Pharmacology and Toxicology), Cheney (Molecular and Integrative Physiology), Chertoff (Hearing and Speech), Choi (Hoglund Brain Imaging Center), Colombo (Psychology), Dobrowsky (Pharmacology and Toxicology), Durham (Tootaryngology), Enna (Pharmacology, Toxicology, and Therapeutics), Estoff (Neurology and Pharmacology, Toxicology, and Therapeutics), Fiorentino (Vestitciscs), Fowler (Pharmacology and Toxicology), Frost (Landon Center on Aging), Gamblin (Molecular Biosciences), Ilardi (Psychology), Imag (Molecular and Integrative Physiology), Johnson, D. (Psychology), Johnson, M. (Chemistry), Kelly (Molecular Biosciences), Klein (School of Medicine, Faculty Development, Anatomy and Cell Biology), Krumlauf (Anatomy and Cell Biology, Biochemistry and Molecular Biology), Lee (Hoglund Brain Imaging Center), Levant (Pharmacology, Toxicology, and Therapeutics), LeVine (Molecular and Integrative Physiology), Lundquist (Molecular Biosciences), Lunte (Pharmaceutical Chemistry), Lyons (Parkinson’s Disease and Movement Disorder Center), McCarson (Pharmacology, Toxicology, and Therapeutics), E. Michaelis (Pharmacology and Toxicology), M. Michaelis (Pharmacology and Toxicology), Moskovitz (Pharmacology and Toxicology), Muma (Pharmacology and Toxicology), Nishimune (Anatomy and Cell Biology), Nudo (Molecular and Integrative Physiology), Orr (Molecular Biosciences), Prisinzano (Medicinal Chemistry), Radel (Occupational Therapy), Rice (Speech-Language-Hearing: Sciences and Disorders), Shi (Pharmacology and Toxicology), Smith (Molecular and Integrative Physiology), Stanford (Molecular and Integrative Physiology), Steinmetz, (Psychology and Molecular Biosciences), Swerdlov (Neurology, Alzheimer’s Memory Program), Trainor (Anatomy and Cell Biology), Werle (Anatomy and Cell Biology), Wright (Anatomy and Cell Biology) The neurosciences program admits students directly for study on the Lawrence campus, with strengths in behavioral, biologi-
cal, chemical, and pharmaceutical sciences, and the Medical Center campus in Kansas City, with strengths in all the biomed-
cal and clinical sciences. Each student is asked which campus he or she would prefer. Students earn a Ph.D. degree in the neu-
sciences. In exceptional circumstances, the program also offers an M.S. degree in neurosciences.
Programs

Neuroscience is a truly multidisciplinary research field. All students are expected to be able to understand the fundamental principles and contributions of each of the major disciplines of the neurosciences core. New students receive training in biochemistry and molecular biology, cell biology, and physiology before proceeding with more focused courses.

Admission

All application materials are reviewed by faculty committees in Lawrence and Kansas City. Students should have B.A. or B.S. degrees in anthropology, behavioral sciences, biology, chemistry, engineering, neuroscience, or pharmacological sciences. Preference is given to students who have completed courses in introductory and organic chemistry, calculus, physics, introductory biology, and at least one course in advanced biology topics such as biochemistry, physiology, microbiology, or molecular biology. Students who do not have sufficient training complete appropriate courses before admission. The program requires standard Graduate Record Examination scores with all applications, three letters of recommendation, and an essay by the applicant about his or her career goals. Selection is based on grade-point average, GRE scores, letters of recommendation, and evidence of previous experience in research. The minimum standard is a grade-point average of 3.0 on a 4.0 scale.

Submit your application online at www.graduate.ku.edu. Forward all requested supporting application documents to:

The University of Kansas
Neuroscience Graduate Program, Malott Hall
1251 Wescoe Hall Drive, Room 5064
Lawrence, KS 66045-7572

M.S. Degree Requirements

The M.S. is offered in rare cases where attainment of the Ph.D. is inappropriate. A student may earn the M.S. by completing these minimum requirements:

• The courses in the curriculum of the first year of the Ph.D. training program.
• The course in advanced neuroscience.
• A thesis based on either original research or library research.
• The total credit hours of graduate-level courses required for the M.S. degree.

Ph.D. Degree Requirements

The neuroscience curriculum is subdivided into core courses that all students must complete and electives representing the two major specializations, Cell and Molecular Neuroscience and Cognitive and Systems Neuroscience. The core curriculum includes research rotations in two laboratories of the student’s choice during the first year. Laboratory rotations offer first-hand research experience. Students complete two rotations in faculty research laboratories in the first year. Laboratories are selected by the student and the co-directors. After the rotations, each student chooses a research adviser and begins an independent research project.

Students also receive training in the responsible conduct of research and teaching in the neurosciences. For the Ph.D., the student completes the core curriculum as well as research skills training, comprehensive oral examination, preparation of a dissertation, and final oral examination and defense of the dissertation.

Core Curriculum for the Ph.D. in Neurosciences

Year One, Fall Semester

BIOL 750 Advanced Biochemistry
Cognitive and Systems Neuroscience course
BIOL 752 Cell Biology
Lab rotations
NURO 799 Neuroscience Seminar Series

Year One, Spring Semester

PHSL 846 Advanced Neuroscience
BIOL 646 Mammalian Physiology
Lab rotations
NURO 800 Neuroscience Teaching Principles
Research Skill: One lecture course or one laboratory course
NURO 799 Neuroscience Seminar Series

Year Two, Fall Semester

NURO 801 Issues in Scientific Integrity
(Offered in the fall every odd-numbered year, 1 credit hour)
Cell and Molecular Neuroscience course
First Elective for Molecular and Cellular Neuroscience or
Cognitive and Systems Neuroscience
Second Elective for Molecular and Cellular Neuroscience or
Cognitive and Systems Neuroscience
NURO 799 Neuroscience Seminar Series

Year Two, Spring Semester

Completion of written and oral comprehensive examination

Year Three, Fall/Spring

NURO 999 Doctoral Dissertation

Year Four, Fall/Spring

NURO 999 Doctoral Dissertation

Students must complete one core course from Cognitive and Systems Neuroscience, one from Cell and Molecular Neuroscience, and one from General Neurobiology; take Bioethics or NURO 801 Issues in Scientific Integrity; and receive training in effective oral communication and teaching by enrolling in one semester of NURO 800 Neuroscience Teaching Principles, which includes a teaching experience.

Neuroscience Courses

Cognitive and Systems Neuroscience
BIOL 701 Topics in: Brain Disorders and Neurological Disorders (3)
NURO 544 Neurophysiology (3)
PSYC 961 Biological Foundations of Psychopathology (3)

Cell and Molecular Neuroscience
BIOL 673 Cellular and Molecular Neurobiology (3)
NURO 775 Chemistry of the Nervous System (3)
NURO 848 Molecular Mechanisms of Neurological Disorders (3)

General Neurobiology
NURO 846 Advanced Neuroscience (5)
NURO 710 Advanced Neurobiology (3)
NURO 847 Developmental Neurobiology (2)

Neuroscience Seminar
NURO 799 Neuroscience Seminar Series (2)

Scientific Integrity
NURO 801 Issues in Scientific Integrity (1)

Teaching Experience
NURO 800 Neuroscience Teaching Principles (2)

Continuous enrollment in the neuroscience seminar is required, and students present at least two seminars during their graduate careers. In consultation with a five-member faculty advisory committee including at least three members of the neuroscience program, each student chooses electives that provide training relevant to the research goals. All students must com-

The Interdisciplinary Neurosciences Program admits students for work on KU’s Lawrence campus or on the KU Medical Center campus in Kansas City.
Neurosciences | Pharmaceutical Chemistry

Pharmaceutical Chemistry

Chair: Christian Schöneich, schoneic@ku.edu
2095 Constant Ave., Room 236C
Lawrence, KS 66047-3729
www.pharmchem.ku.edu, (785) 864-4880, fax: (785) 864-5736
Graduate Adviser: Jeff Krise, krise@ku.edu,
236B Simons Laboratories, (785) 864-2626, fax: (785) 864-5736
Professors: Audus, Borchardt, Lunte, Middaugh, Munson, Schöneich, Siahaan, Stobaugh, Topp, Verkhivker, Wilson
Professor Emeritus: Schowen
Associate Professors: Berkland, Krise
Assistant Professors: Forrest, Laurence

The Department of Pharmaceutical Chemistry offers a number of core courses designed to hone the student’s skills in aspects of physical/organic chemistry, chemical kinetics, and equilibrium phenomena, which we consider essential in understanding problems of any origin, including biological processes, on a molecular level. Every student entering the program is expected to complete these core courses successfully during the first year.

Research has become increasingly multidisciplinary; students have the option to focus their didactic training in two unique areas of specialization or tracks: pharmaceutical biotechnology and physical/analytical pharmaceutical chemistry. In addition, students can choose from a variety of elective courses that allow them to gain knowledge and skills in areas specific to individual research project interests.

The department places emphasis on excellence in research, making every effort to ensure that students are able to commit as much time as possible to their research projects, which allows them to earn the Ph.D. degree in a timely fashion. The core courses are taught every quarter and can be completed in just two semesters. Students are fully supported by the department throughout their time in the program and are not burdened with time-consuming teaching responsibilities.

Admission

Students with bachelor’s or master’s degrees in chemistry, pharmacy, the biological sciences, material sciences, chemical engineering or related disciplines are encouraged to seek admission. Except under unusual circumstances, we review and accept candidates for admission to fall semester only. All required materials must be received before the department can begin to consider an application.

Required materials to be sent to the Department of Pharmaceutical Chemistry include the following:

1. Graduate Record Examination results (not more than five years old) forwarded directly to Graduate Studies/Department of Pharmaceutical Chemistry from the Educational Testing Service. Photocopies of results are not permissible. The institution code for the University of Kansas is R6871. The Department of Pharmaceutical Chemistry’s code is R0305.

2. Test of English as a Foreign Language results if applicable. These may not be required if you have completed a degree in an English-speaking country. The current list is limited to the U.S.,
England, Australia, and New Zealand. Contact the Office of Graduate Studies to learn if your institution is recognized.

3. Official transcripts from all universities/institutions in which the applicant has studied.

4. KU’s graduate application. This can be completed online at www.grad.ku.edu.

5. The application processing fee (amount varies).

6. A brief personal statement (about one page) that helps us understand why you are interested in graduate studies and specifically why KU’s department.

7. An updated copy of your résumé indicating relevant experience, including educational and research experience, if applicable.

8. Three letters of recommendation from people you believe are best qualified to comment on your potential to succeed in graduate studies. There is no template for letters of recommendation, but please make sure they are on official letterhead.

All of these items should be sent to the following address:

The University of Kansas
Department of Pharmaceutical Chemistry, Attn: Nancy Helm
Lawrence, KS 66047-3729

Although the department does not have a formal application deadline, the faculty begins evaluations of applications around January 15 each year. To ensure full consideration, it is highly recommended that complete applications be in the department far in advance of January 15.

Admitted students receive a competitive stipend, tuition, and basic health insurance. Students also can be selected to participate in the Takeru Higuchi and Nigel Manning Ph.D. Intersearch Program, allowing them to conduct a portion of their research at the Victorian College of Pharmacy (www.vcp.monash.edu.au) at Monash University in Melbourne, Australia. In addition, students are encouraged to participate in other industrial and/or academic internship programs the department offers.

A number of fellowship awards are offered to recognize academic superiority and to assist meritorious students in the timely completion of their degree programs. The number of fellowships awarded each year depends upon available funds. For a complete description of available fellowships and scholarships, visit the Graduate Studies Web site at www.grad.ku.edu. Students with particularly outstanding undergraduate records may be eligible for special awards. The Department of Pharmaceutical Chemistry has a Madison and Lila Self Graduate Fellowship Program (www2.ku.edu/~selfpro) partner at KU. The program provides a generous stipend and tuition to outstanding students for four years of graduate study. At the department level, the Takeru Higuchi and Siegfried Lindenbaum Fellowships are awarded each year to incoming graduate students with high promise.

### M.S. Degree Requirements

Except under unusual circumstances, the Department of Pharmaceutical Chemistry does not recruit students seeking the M.S. degree. However, all students who pass the comprehensive qualifying examinations for the Ph.D. degree receive a nonthesis M.S. degree. Students who wish to earn the terminal M.S. degree must complete satisfactorily at least one third of the courses recommended for the Ph.D. degree, present a thesis based on original research or a suitable technical report based on the review of published research in a particular area, and pass a final oral general examination.

### Distance Master’s Degree Program

The department also offers a distance master’s program. See the Web site for details (www.pharmchem.ku.edu/distance_masters.php). This program features the same high-quality lectures and courses offered in the Ph.D. program but allows students to complete the degree while working at a remote location. Students typically take one course a semester. Most of the courses offered by the department can be taken this way. For questions, contact the director of the distance master’s program, J. Howard Rytting, rytting@ku.edu, 785-864-3757.

### Ph.D. Degree Requirements

#### Entering Background

Students entering the program are expected to be competent in basic principles of physical/organic chemistry and mathematics. These requirements are typically satisfied by most degrees in the basic or pharmaceutical sciences.

#### Core Courses

Each student must complete seven core courses with grades of B or higher to be eligible to take the comprehensive core curriculum examination (offered after the spring semester of the first year in the program):

- **Fall Semester, Year One**
  - CHEM 740 Principles of Organic Reactions
  - PHCH 862 Pharmaceutical Equilibrium
  - PHCH 976 Advanced Topics in Biopharmaceutics and Pharmacokinetics

- **Spring Semester, Year One**
  - CHEM 742 Physical Organic Chemistry
  - PHCH 920 Chemical Kinetics
  - PHCH 972 Mechanisms of Drug Deterioration and Stabilization

#### Specialized Areas of Emphasis (Tracks)

Upon successful completion of the core curriculum, students should select a specialized area of emphasis or track. Students may select either the pharmaceutical biotechnology track or the physical/analytical pharmaceutical chemistry track. The student must take the two courses for each track listed below. With the consent of his or her adviser and the department graduate studies adviser, a student with a cross-disciplinary research project may be able to replace a required course from a track with a suitable alternative course.

- **Pharmaceutical Biotechnology Track — Required Courses**
  - PHCH 870 Advanced Pharmaceutical Biotechnology
  - PHCH 725 Molecular Cell Biology
  - PHCH 850 Solid State Stability and Formulation

- **Physical/Analytical Pharmaceutical Chemistry Track — Required Courses**
  - PHCH 864 Pharmaceutical Analysis
  - PHCH 979 Advanced Topics in Biopharmaceutics and Pharmacokinetics II
  - PHCH 715 Drug Delivery

#### Electives and Foreign Language or Other Research Skills Requirement

Graduate students must take one elective course in addition to the previously listed courses. This may be from the courses offered by the Department of Pharmaceutical Chemistry (see below) or from any other department on campus with prior approval from the student’s research adviser. Examples of additional courses offered by this department are

- PHCH 866 Pharmaceutical Mass Transport
- PHCH 979 Advanced Topics in Biopharmaceutics and Pharmacokinetics II
- PHCH 715 Drug Delivery
- PHCH 865 Pharmaceutical Analysis II

To complete the didactic component, the student must complete the FLORS (foreign language or other research skill) requirement. This may be met by successfully completing an acceptable skills development course. Courses that have been accepted to fulfill the FLORS requirement are as follows (other courses may be permissible upon approval of the pharmaceutical chemistry FLORS committee):

- BIOL 672 Gene Expression
- BIOL 688 The Molecular Biology of Cancer
- BIOL 702 Laboratory Practice: Radiation Safety Procedures
- BIOL 703 Radioisotopes in Radiation Safety in Research

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Biol. 481 Biometry I (5)
Biol. 918 Modern Biochemical and Biophysical Methods (4)
Chem 711 Applied Electronics for Scientists (4)
Chem 766 Spectroscopic Identification of Organic Compounds (3)
Chem 959 Advanced Topics in Analytical Chemistry: (3)
Chem 966 Physical Organic Chemistry II (3)
MDCM 860 Drug Metabolism (2)
CPE 121 Introduction to Computers in Engineering (3)
PFC 725 Molecular Cell Biology (3)

Seminar Requirements. All graduate students must attend the weekly departmental seminar. Seminars consist of presentations by guest speakers, faculty members, and students. Typically, graduate students are required to present at least two departmental seminars during their time in the program. The seminar may be based on progress in their research or on a literature review of work related to their research.

Dissertation. Each Ph.D. candidate must submit and defend a dissertation resulting from research of sufficient originality and quality for publication in peer-reviewed scientific journals. The research is conducted under the supervision and guidance of the student’s advisor, with input from the dissertation committee as needed. The median time for students to complete the Ph.D. degree is 5.3 years.

Facilities
The department is on KU’s west campus in Simons Biosciences Research Laboratories, a 30,000-square-foot, two-story research facility completed in 1996. There are 18 general laboratories and an experimental cancer chemotherapeutic-agent testing laboratory, a radiosotope handling room, a molecular biology laboratory, a natural products extraction laboratory, and a liquid chromatography mass spectrometry laboratory. The laboratories contain an extensive array of equipment and instrumentation. The department currently maintains five mass spectrometers. There are facilities for cell culture, several advanced fluorescence microscopes, NMRs (both solution state and solid state), and numerous components and software for proteomic analysis. In addition, an extensive array of instrumentation is available for the characterization of both small and macromolecules including a circular dichroism spectrophotometer, FTIR, and light-scattering instrumentation to name a few. An amazing array of equipment and service facilities help with nearly any aspect of research. For example, the Molecular Structures Group (www.msg.ku.edu) is a campuswide facility encompassing NMR, MS, X-ray Crystallography, Biochemical Research Service, and Molecular Graphics and Modeling Laboratories available to all campus members for a nominal fee. Near the Simons building, the structural biology wing of the MSG houses an 800-mHz NMR along with many other instruments and services. The recently completed Multidisciplinary Research Building houses researchers from a variety of disciplines to encourage interaction and collaboration. Professors Middaugh, Lunte, Berkland, and Laurence occupy space in this new facility.

Pharmaceutical Chemistry Courses

PHCH 510 Emerging Trends in Pharmaceutical Chemistry I (1).
PHCH 511 Emerging Trends in Pharmaceutical Chemistry II (1).
PHCH 512 Roadmap to Drug Development (1).
PHCH 513 Dispelling the Myths about Drug Discovery and Development: ___ (1).
PHCH 517 Pharmacy Calculations (2).

PHCH 518 Physical-Chemical Principles of Solution Dosage Forms (3).
PHCH 605 Vaccines (1).
PHCH 625 Pharmacokinetics (3).
PHCH 626 Biopharmaceutics and Drug Delivery (3).
PHCH 667 Introduction to Clinical Chemistry (2).
PHCH 686 Special Topics in Pharmaceutics (1-2).
PHCH 690 Undergraduate Research in Pharmaceutical Chemistry (1-5).
PHCH 694 Problems in Pharmaceutical Chemistry (1-5).
PHCH 700 Experimental Methods in Pharmaceutical Chemistry (1-5). Discussions, lectures, and laboratory work designed to acquaint and provide hands on experiences to advanced undergraduate and graduate students with experimental design, methods, and approaches relevant to modern research in pharmaceutical chemistry. Prerequisite: Consent of instructor. LEC

PHCH 701 Bioinformatics I (5). First semester of a two-semester course. The course is designed to introduce the most important and basic concepts, methods, and tools used in Bioinformatics. Topics include (but not limited to) bioinformatics databases, sequence and structure alignment, protein structure prediction, protein folding, protein-protein interaction, Monte Carlo simulation, and molecular dynamics. Emphasis will be on understanding and utilization of these concepts and algorithms. The objective is to help the students to reach rapidly the frontier of bioinformatics and be able to use the bioinformatics tools to solve the problems on their own research. (Same as BINF 701). LEC

PHCH 702 Bioinformatics II (5). Second semester of a two-semester course in bioinformatics. The course is designed to introduce the most important and basic concepts, methods, and tools used in Bioinformatics. Topics include (but not limited to) bioinformatics databases, sequence and structure alignment, protein structure prediction, protein folding, protein-protein interaction, Monte Carlo simulation, and molecular dynamics. Emphasis will be on the understanding and utilization of these concepts and algorithms. The objective is to help the students to reach rapidly the frontier of bioinformatics and be able to use the bioinformatics tools to solve the problems on their own research. (Same as BINF 702). LEC

PHCH 715 Drug Delivery (3). The course will survey the latest technology for delivering pharmaceuticals and biologicals to reduce side effects and enhance drug efficacy. The course will survey the latest research in this area and examine more classical delivery methods. A qualitative and quantitative understanding of drug delivery practice and theory is the goal. Prerequisite: Master’s or Ph.D. candidate in Engineering, Chemistry, Medicinal Chemistry, or Pharmaceutical Chemistry (by appointment for seniors or graduate students in departments not listed). LEC

PHCH 716 Drug Delivery (3). The course will survey the latest technology for delivering pharmaceuticals and biologicals to reduce side effects and enhance drug efficacy. The course will survey the latest research in this area and examine more classical delivery methods. A qualitative and quantitative understanding of drug delivery practice and theory is the goal. This course is only open to distance education students. Prerequisite: Master’s candidate in Pharmaceutical Chemistry. LEC

PHCH 720 Bibliography of Pharmaceutical Chemistry (1). A course on the use of the library as a research tool and the study of bibliographic techniques of literature searching. Emphasis on the literature of pharmaceutical chemistry and physical pharmacy. LEC

PHCH 725 Molecular Cell Biology (3). Fundamental and advanced concepts in cell biology and the molecular interactions responsible for cell function, homeostasis and disease will be presented. Current analytical methods for examining cells and their molecular components will be discussed. Emphasis will be placed on the chemical and physical properties of individual proteins, nucleic acids and lipids and their assembly into cellular and subcellular structures. (Same as CPE 725). LEC

PHCH 726 Molecular Cell Biology (3). Fundamental and advanced concepts in cell biology and the molecular interactions responsible for cell function, homeostasis and disease will be presented. Current analytical methods for examining cells and their molecular components will be discussed. Emphasis will be placed on the chemical and physical properties of individual proteins, nucleic acids and lipids and their assembly into cellular and subcellular structures. This course is only open to distance education students. LEC

PHCH 745 Advanced Drug Delivery (2). An advanced course focusing on current and future strategies for targeted drug delivery to specific tissue sites. The emphasis of lectures and discussions is on routes of drug administration across biological barriers; macromolecules, viruses, microparticulates, and cells as drug carriers; and drug delivery systems. Students are required to individually review selected topics. Prerequisite: Graduate standing or consent of the instructor. LEC

PHCH 775 Chemistry of the Nervous System (3). A detailed study of the molecular aspects of nerve transmission will be covered with special emphasis on the uptake, storage, release, biosynthesis, and metabolism of specific neurotransmitters. Drugs affecting these processes and current research on receptor isolation and receptor mechanisms will be discussed from a chemical viewpoint. (Same as P&T 775, BIOL 775, CHEM 775, MDCM 775 and NURO 775). Prerequisite: BIOL 600 or equivalent. LEC

The Center for Biomedical Research combines several biomedical research units that have brought KU to international prominence in this field.

The School of Pharmacy operates one of the most extensive programs of research and graduate education in the pharmaceutical sciences in the country.
PHCH 801 Issues in Scientific Integrity (1). Lectures and discussion on ethical issues in the conduct of a scientific career, with emphasis on practical techniques of special importance in molecular-level research in the chemical, biological, and pharmaceutical sciences. Topics will include the nature of ethics, the scientist in the laboratory, and chemical and ethical responsibilities of the scientist and the scientist as author, grantee, reviewer, employer/employee, teacher/student, and citizen. Discussions will focus on case histories. Graded on a satisfactory/unsatisfactory basis. (Same as MDCM 801, NURO 804, P&TX 801 and PHCH 802.) LEC

PHCH 802 Issues of Scientific Integrity (3). Lectures and discussion on ethical issues in the conduct of a scientific career, with emphasis on practical topics of special importance in molecular-level research in the chemical, biological, and pharmaceutical sciences. Topics will include the nature of ethics, the scientist in the laboratory, as author, grantee, reviewer, employer/employee, teacher/student, and citizen. Discussions will focus on case histories. Graded on a satisfactory/unsatisfactory basis. This course is only open to distance education students. (Same as PHCH 801, MDCM 801, NURO 804, and P&TX 801.) LEC

PHCH 804 Interdisciplinary Seminar on Ethics in Science and Engineering (1-3). The course will cover basic techniques of moral reasoning, especially as applied to ethical issues in the physical sciences and engineering. Topics covered will include the ethical conduct of research, the federal and professional guidelines for different kinds of research, and the ethical dimensions of publication and professional life. Emphasis will be on practical applications, cases and student involvement. (Same as GS 804, MDCM 804, NURO 804, and P&TX 804.) Prerequisite: Must be admitted to the program or division of Pharmacy to enroll in this class. LEC

PHCH 850 Solid State Stability and Formulation (1-3). This course is designed to provide an understanding of the thermodynamic stability of small and large drug candidates in the solid state. The first two-thirds of the course will focus on small molecules, with the last third being devoted to proteins. Prerequisite: Graduate standing in PHCH or consent of the instructor. LEC

PHCH 860 Chemical Equilibria I (3-4). A course on equilibria in aqueous and nonaqueous systems with emphasis on solutions of interest to pharmaceutical technology. Included are association-dissociation equilibria, complexation, protein binding, and chemical reactions in living systems. The emphasis will be on chromatographic techniques reflecting the prevalent position that those techniques occupy in the field of pharmaceutical and biomedical analysis. Prerequisite: Previous or concurrent enrollment in PHCH 684. LEC

PHCH 866 Pharmaceutical Mass Transport (2). A course on mass transport problems of pharmaceutical interest. Topics include physiological pharmacokinetic models, mass transport, and drug delivery systems. Prerequisite: MATH 320 or equivalent. LEC

PHCH 867 Pharmaceutical Mass Transport (3). A course on mass transport problems of pharmaceutical interest. Topics include physiological pharmacokinetic models, mass transport, and drug delivery systems. This course is only open to distance education students. Prerequisite: MATH 320 or equivalent. LEC

PHCH 868 Pharmaceutical Analysis (3). Advanced course on pharmaceutical analysis. This course is only open to distance education students. LEC

PHCH 870 Advanced Pharmaceutical Biotechnology (3). A course designed to emphasize the important facets of recombinant proteins as pharmaceutical agents. Basics of protein structure and analysis will be introduced, and methods for purification, isolation, and purification of recombinant proteins will be described. Potential chemical and physical degradation processes and strategies for circumventing these difficulties will be discussed. Prerequisite: BIOL 600 or consent of instructor. LEC

PHCH 871 Advanced Pharmaceutical Biotechnology (3). A course designed to emphasize the important facets of recombinant proteins as pharmaceutical agents. Basics of protein structure and analysis will be introduced, and methods for purification, isolation, and purification of recombinant proteins will be described. Potential chemical and physical degradation processes and strategies for circumventing these difficulties will be discussed. This course is only open to distance education students. Prerequisite: BIOL 600 or consent of instructor. LEC

PHCH 895 Research in Pharmaceutical Chemistry (1-11). Advanced level research in collaboration with a faculty member in pharmaceutical chemistry or related areas. This course is limited to students who are doing research, but not necessarily working toward a master’s or a doctoral degree. RSH

PHCH 898 Master’s Thesis (1-5). Master’s Thesis. This course is only open to distance education students. THE

PHCH 899 Master’s Thesis (1-11). Graded on a Satisfactory/Fail basis. THE

PHCH 920 Chemical Kinetics (2). This course provides the principles of kinetic data analysis as applied to problems in pharmaceutical chemistry. Topics include the setup and solution of rate equations related to chemical reactions; simplifications and approximations in complex chemical systems; and chemical and physical sciences, or the equivalent. Prerequisite: BIOL 600 or consent of instructor. LEC

PHCH 921 Chemical Kinetics (2). This course provides the principles of kinetic data analysis as applied to problems in pharmaceutical chemistry. Topics include
G R A D U A T E  C A T A L O G

Pharmacology & Toxicology

M.S. Degree Requirements
The department offers an M.S. degree in pharmacology and toxicology only in special cases where attainment of the Ph.D. is inappropriate. To obtain an M.S. degree, a student must take advanced courses in pharmacology and toxicology and related fields, including biotechnology. A thesis based on original research generally is required.

Ph.D. Degree Requirements
Course Work. Students must earn credit in the following courses or their equivalents:
P&TX 700 Professional Issues in the Biomedical Sciences
Students must complete 8 credit hours of Advanced Pharmacology (P&TX 730 and P&TX 735) consisting of four 2-credit-hour modules.
P&TX 730 Advanced Pharmacology I: Central Nervous System and Autonomic Nervous System (required)
P&TX 731 Advanced Pharmacology II: Cardiovascular and Renal System (required)
P&TX 732 Advanced Pharmacology III: Hematology and Cancer Biology (elective)
P&TX 733 Advanced Pharmacology IV: Infectious and Respiratory Diseases (required)
P&TX 754 Advanced Pharmacology V: Endocrinology (elective)
P&TX 725 Advanced Pharmacology VI: Metabolism and GI (elective)
P&TX 740 Advanced Biotechnology
P&TX 742 Experimental Pharmacology
P&TX 747 Molecular Toxicology
P&TX 799 Pharmacology and Toxicology Seminar
P&TX 800 Pharmacology and Toxicology Teaching Principles
P&TX 801 Issues in Scientific Integrity
P&TX 803 Pharmacology Literature Review I
P&TX 805 Pharmacology Literature Review II
BIOL 841 Biometry I

Students also must complete 3 credit hours of advanced graduate work in an elective course.

On passing the comprehensive oral examination, an aspirant for the Ph.D. degree becomes a candidate, and a dissertation committee is appointed, in accordance with KU general regulations. The dissertation committee normally consists of five members of the Graduate Faculty. Three members of the committee must be pharmacology and toxicology faculty members.

Research Skills Requirement. In consultation with the adviser, each student develops research skills relevant to the chosen research program. A great deal of flexibility is allowed in selecting the research skills. All graduate students must complete training in an area that can become useful in future research design and data analysis. Representative areas are computer science; statistical methodology; cellular imaging techniques; histochemistry and cytochemistry; tissue culture methods; radioisotope techniques; methods in immunology, molecular biology, or protein chemistry; bioinformatics; and molecular modeling procedures.

Comprehensive Examinations. The Ph.D. aspirant takes the comprehensive examination after completing most of the course work and fulfilling the research skills requirement. The comprehensive examination is composed of three parts:

1. Written Comprehensive Examination: Each student must complete two written examinations to complete P&TX 803 and P&TX 805.
2. Preparation of a Literature Review and Research Proposal: Each student must prepare a literature review and a research proposal on a current topic in pharmacology or toxicology.
3. Oral Comprehensive Examination: After approval of the literature review/research proposal by the student’s advisory committee, each student, in consultation with the adviser, takes an oral examination covering the student’s major field.

Dissertation. Shortly after entering the program, the student, with the adviser’s assistance, selects a dissertation project. After the oral comprehensive examination, the student presents the dissertation research project to the advisory committee and receives periodic advice from this committee throughout the project. Upon acceptance of the dissertation by the advisory committee, the candidate must pass a final oral examination, including a defense of the dissertation before the dissertation committee and any other interested members of the Graduate Faculty.

Facilities
Research facilities offer a range of modern instrumentation and many research support services. Major instruments include tissue culture rooms, ultra-centrifuges, flow cytometry, scintillation counters, high-pressure liquid chromatography systems, computer-driven fluorometers and spectrophotometers, and light and fluorescence microscopy systems. Several laboratory groups have more specialized equipment for molecular biology, protein purification and analysis, electrophysiology and calcium imaging, immunohemistry, and related techniques. All labs have current computer technology, including hardware and extensive software for imaging, data analysis, data reduction, protein and gene analysis, and statistical tests. Specialized research support labs include a confocal and an electron microscopy laboratory with both transmission and scanning scopes; a transgenic and knockout mouse facility; a gene-chip and microarray facility; a Biochemical Research Service Laboratory with DNA sequencing, DNA microarrays, peptide synthesis, fermentation, and MALDI-TOF instrumentation; a Molecular Graphics and Modeling Laboratory with extensive data bases for protein structures; an NMR facility; an X-ray Crystallography Laboratory; a Mass Spectrometry Laboratory; and an Instrumentation Design Laboratory.

Pharmacology and Toxicology Courses

P&TX 630 Pharmacology I (4).
P&TX 631 Pharmacology II (4).
P&TX 632 Pharmacology III (4).
P&TX 633 Pharmacology IV (3).
P&TX 640 Toxicology (2).
P&TX 641 Antibiotics: Benefits and Risks (1).
P&TX 642 Obesity, Diabetes, and Metabolic Syndrome: Current Concepts (1).
P&TX 643 Current Concepts of Neurodegenerative Disease (1).
P&TX 645 Neurobiological Basis of Addiction: Physiological, Biochemical, Pharmacological, and Treatment Conceptualization (1).
P&TX 694 Undergraduate Laboratory: Research in Pharmacology and Toxicology (1-5).
P&TX 698 Library Problems in Pharmacology and Toxicology (1-5).
P&TX 700 Professional Issues in the Biomedical Sciences (2).
P&TX 725 Biomedical Bibliography (1). The use of the library as a research tool and the study of bibliographic techniques of literature searching. Emphasis on pharmacological, physiological, biochemical, and medical literature. Graded on a satisfactory/unsatisfactory basis. Prerequisite: Graduate standing. LEC
P&TX 730 Advanced Pharmacology I (2). A detailed study of the fundamentals of autonomic nervous system, central nervous system, and their pharmacology. The student will attend P&TX 652 lectures and meet separately with the faculty for additional discussions of advanced material on the topics. The students will be examined on the advanced material. Prerequisite: Graduate standing in pharmacology and toxicology. LEC
P&TX 731 Advanced Pharmacology II (2). A detailed study of the fundamentals of cardiovascular system, renal system and their pharmacology. The student will attend P&TX 632 lectures and meet separately with the faculty for additional discussions of advanced material on the topics. The students will be examined on the advanced material. Prerequisite: Graduate standing in pharmacology and toxicology. LEC
P&TX 732 Advanced Pharmacology III (2). A detailed study of the fundamentals of hematology, cancer biology and their pharmacology. The student will attend P&TX 631 lectures and meet separately with the faculty for additional discussions of advanced material on the topics. The students will be examined on the advanced material. Prerequisite: Graduate standing in pharmacology and toxicology. LEC
P&TX 733 Advanced Pharmacology IV (2). A detailed study of the fundamentals of infectious diseases, respiratory diseases and their pharmacology. The student will attend P&TX 631 lectures and meet separately with the faculty for additional discussions of advanced material on the topics. The students will be examined on the advanced material. Prerequisite: Graduate standing in pharmacology and toxicology. LEC
P&TX 724 Advanced Pharmacology V: Endocrinology (1). A detailed study of the fundamentals of endocrinology and associated pharmacology. The student will attend P&TX 631 lectures and meet separately with the faculty for additional discussions of advanced material. Prerequisite: Graduate standing in Pharmacology and Toxicology Program. LEC

P&TX 735 Advanced Pharmacology VI: Metabolism and GI (1). A detailed study of the fundamentals of energy metabolism and obesity, gastrointestinal pharmacology, and vitamins. The student will attend P&TX 633 lectures and meet separately with the faculty for additional discussion of advanced material on the topic. The students will be examined on the advanced material. Prerequisite: Graduate standing in pharmacology and toxicology. LEC

P&TX 740 Advanced Biotechnology (3). An examination of basic principles of molecular biology, immunology, and protein chemistry as they apply to the identification, production, stability, delivery, and monitoring of new therapeutic agents provided by the expanding biotechnology industry. Students will attend lectures in P&TX 633 and meet separately with faculty for additional discussions of more advanced material on the topic. The students will function as a discussion leader on the advanced material. Prerequisite: Graduate standing in Pharmacology and Toxicology. LAB

P&TX 742 Experimental Pharmacology (4). Experimental approaches to understanding mechanism of drug action. Use of drugs as tools to understand functioning of biological systems will also be stressed. Historically important experiments will be discussed along with experiments which are currently used to define drug mechanisms. Topics will include: dose-response, drug receptors, drug metabolism, chemotherapy, as well as autonomic CNS, cardiovascular and renal pharmacology. (Same as MDCM 742.) Prerequisite: BIOL 726 or equivalent, or consent of instructor. LEC

P&TX 747 Molecular Toxicology (4). The molecular basis involved in the poisoning and detoxification process will be covered. Topics will include drug metabolism and disposition, chemical, genetic, and developmental toxicity. Prerequisite: BIOL 680, BIOL 762 or equivalent, or consent of instructor. LEC

P&TX 775 Chemistry of the Nervous System (3). A detailed study of the molecular aspects of nerve transmission will be covered with special emphasis on the uptake, storage, release, biosynthesis, and metabolism of specific neurotransmitters. Drugs affecting these processes and current research on receptor isolation and receptor mechanisms will be discussed from a chemical viewpoint. (Same as BIOL 775, CHEM 775, MDCM 775, NURO 775, and PHCH 775.) Prerequisite: BIOL 600 or equivalent. LEC

P&TX 799 Pharmacology and Toxicology Seminar (1-2). A review of current literature and research in pharmacology and toxicology. Required of all graduate students in the department every fall and spring semester. Graded on a satisfactory/unsatisfactory basis. Prerequisite: Graduate standing in P&TX. LEC

P&TX 800 Pharmacology and Toxicology Teaching Principles (2). This course is to be used by graduate students fulfilling the teaching requirement for the Ph.D. in pharmacology and toxicology. The student will function as a discussion leader and lecturer in a limited number of class sessions. Each student will meet with the faculty whom he or she is assisting. Prerequisite: Graduate standing in pharmacology and toxicology program. RSH

P&TX 801 Issues in Scientific Integrity (1). Lectures and discussion on ethical issues in the conduct of a scientific career, with emphasis on practical topics of special importance in molecular-level research in the chemical, biological, and pharmaceutical sciences. Topics will include the nature of ethics, the scientist in the laboratory, the scientist as author, grantee, reviewer, employer/employee, teacher, student, and citizen. Discussions will focus on case histories. Graded on a satisfactory/unsatisfactory basis. (Same as MDCM 801, NURO 801, PHCH 801 and PHCH 802.) LEC

P&TX 803 Pharmacology Literature Review I (1). This course is designed for graduate students and will fulfill the first written exam requirement for the Ph.D. in pharmacology and Toxicology. The student will research and write a six-page literature review by choosing a topic provided by the faculty. Prerequisite: Graduate standing in Pharmacology and Toxicology Program. LEC

P&TX 804 Interdisciplinary Seminar on Ethics in Science and Engineering (1-3). The course will cover basic techniques of moral reasoning, especially as applied to ethical issues in the physical sciences and engineering. Topics covered will include the ethical conduct of research, the federal and professional guidelines for different kinds of research, and the ethical dimensions of publication and professional life. Emphasis will be on practical applications, cases and student involvement. (Same as GS 804, MDCM 804, NURO 804, and PHCH 804.) Prerequisite: Must be admitted to the program or division of Pharmacy to enroll in this class. LEC

P&TX 805 Pharmacology Literature Review II (1). This course is designed for graduate students and will fulfill the second written exam requirement for the Ph.D. in pharmacology and Toxicology. The student will research and write a twelve-page literature review by choosing a topic provided by the faculty. Prerequisite: Graduate standing in Pharmacology and Toxicology Program. LEC

P&TX 825 Research in Pharmacology and Toxicology (1-10). Original investigations at an advanced level in the areas of pharmacology or toxicology or related fields. This research will be performed by graduate students in collaboration with a faculty member. Prerequisite: Graduate standing and consent of instructor. RSH

P&TX 899 Master’s Thesis (1-11). Hours and credit to be arranged. Independent investigation of a research problem of limited scope. Prerequisite: Graduate standing in P&TX and consent of instructor. THE

P&TX 901 Seminar: Psychotropic Drugs Across the Life Span (3). Through the use of both traditional didactic and student participatory instructional methods, the seminar will address basic pharmacological concepts (i.e., assimilation, distribution, elimination, dose effect analyses, kinetics, etc.), neuropharmacological principles (i.e., neuronal mechanisms of action of psychotropic drugs, animal models of human psychiatric disorders, etc.), and therapeutics (i.e., drug treatment of psychosis, depression, Alzheimer’s disease, etc.). Special attention will be devoted to the organism’s age (and history) as these may influence psychopharmacological outcomes. LEC

P&TX 902 Behavioral Neurobiology (3). This course will examine the bases for reciprocal dynamic interactions between central nervous system function and structure (“nature”) and experience (“nurture”). “Nature” will be explored using principles and methodologies derived from systems and molecular pharmacology, and neurochemistry. The effects of “nurture” on brain will involve issues derived from behavioral pharmacology, environmental, enrichment, and human brain imaging. During the course, with the help of the instructor, students will be expected to discuss and critically analyze research articles for subsequent presentation to the class. LEC

P&TX 950 Molecular Pharmacology (2). A study of drug effects at the cellular, subcellular, and molecular levels, and the correlation with tissue and organ reactions. Prerequisite: Graduate standing in P&TX and consent of instructor. LEC

P&TX 990 Postdoctoral Research (1-11). Advanced level research in collaboration with a faculty member in the department. Graded on a satisfactory/unsatisfactory basis. Prerequisite: Doctoral degree or equivalent in an appropriate related area, and consent of instructor. RSH

P&TX 999 Doctoral Dissertation (1-11). Hours and credit to be arranged. Original investigation in pharmacology and toxicology. Prerequisite: Consent of instructor. THE

Takeru Higuchi and Nigel Manning Intersearch Ph.D. Program

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2095 Constant Ave., Room 121B
Lawrence, KS 66047-3729
www.hbc.ku.edu/phch/takeru.htm, (785) 864-4820

Professors: Borchartd, Chapman (Australia), Grunewald, E. Michaelis, Fincham, Reed (Australia), Stella, Stewart (Australia)
The Takeru Higuchi and Nigel Manning Intersearch Program is an international pharmaceutical graduate research program conducted by the United States and Australia through the University of Kansas and the Victorian College of Pharmacy, Monash University, Melbourne, Australia. It is a cooperative program with the Departments of Medicinal Chemistry, Pharmaceutical Chemistry, and Pharmacology and Toxicology. Intersearch trains doctors of philosophy by teaching methods of research and offers a broadening international experience.

A joint degree is possible under the names of both institutions. Graduates receive training suitable to the needs of the pharmaceutical industry and institutions of higher learning in both countries.

The program admits students from either institution to either campus. Each student entering the program must study for at least 12 months on each campus. Round-trip tourist-class fares are provided, and additional financial support generally is available.

Pharmacologists and toxicologists work on the cutting edge of new developments in the biomedical sciences through jobs in academia, the biotechnology/pharmaceutical industry, and federal research institutes.