

Department of Pharmaceutical Chemistry

Pharmaceutical Chemistry Graduate Programs

Pharmaceutical Chemistry is a broad discipline that integrates diverse areas of science ranging from biological to chemical sciences. Students in the program will become familiar with aspects of physical, organic and analytical chemistry, chemical kinetics, biopharmaceutics and pharmacokinetics, and biotechnology including vaccines. To address these needs, the department offers a series of eight (8) core courses designed to hone the student's skills in these topical areas, which are considered essential in understanding problems of biological, biophysical and chemical processes at the molecular level. Refer to the website (<http://pharmchem.ku.edu/academics-overview> (<http://pharmchem.ku.edu/academics-overview/>)) then consult the links Coursework Research Overview and Department Graduate Student Handbook for details. Every student entering the program is expected to complete the core courses during the first three semesters of graduate study. 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 can maximize efforts on their research projects toward earning the Ph.D. degree in a timely fashion.

Currently, the department has 16 faculty members, about 35 graduate students, and a similar number of postdoctoral fellows and research scientists. The department is recognized nationally and internationally, with most graduates and researchers going on to successful careers in the pharmaceutical industry, government positions and academia. The department serves as the home department for the long-standing NIH training grant in pharmaceutical biotechnology.

Facilities

The department is located on KU's west campus in the Simons Biosciences Research Laboratories and the Multidisciplinary Research Building (MRB). Recently renovated and expanded, Simons is a modern, well-equipped research facility. MRB houses researchers from the pharmaceutical chemistry and a variety of other disciplines, thus encouraging interdisciplinary interaction and collaboration. The department is well equipped for biochemical, biophysical and chemical research, having state-of-the-art spectroscopic, physical characterization, chromatographic and mass spectrometry instrumentation. Within the department there are facilities for cell culture, several advanced fluorescence microscopes, and numerous components and software for proteomic analysis. Furthermore, the faculty has established the Macromolecule and Vaccine Stabilization Center (MVSC) and Kansas Vaccine Institute (KVI), which contain an extensive array of instrumentation for the characterization of both small and macromolecules. Examples of analytical instrumentation include circular dichroism spectrophotometers, FTIR, capillary LCQ-ToF mass spectrometry, and particulate analysis. Additionally the university offers state of the art equipment and service facilities to assist with many

aspects of research. For example, the Molecular Structures Group (MSG) is a campus-wide facility encompassing NMR, MS, X-ray Crystallography, Protein Production, Fragment-based Drug Discovery, 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.

Department of Pharmaceutical Chemistry

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Courses

PHCH 510. Emerging Trends in Pharmaceutical Chemistry I. 1 Credits.

This elective class will explore emerging areas of research currently impacting the pharmaceutical industry. Potential topics include; biologicals as therapeutics, drug targeting, prodrugs, nanotechnology, biological barriers, gene therapy, transporters, vaccines, intracellular drug trafficking, controlled release drug delivery, cancer therapy, analytical biotechnology and many others. The class will be team taught by PHCH faculty and guest speakers. Graded on a satisfactory/unsatisfactory basis. Prerequisite: Must be accepted to the Pharmacy Program.

PHCH 512. Road Map to the Development and Regulatory Approval of a New Drug. 1 Credits.

This special topics course will cover key steps in developing and bringing a new drug through pharmaceutical development and regulatory approval and into commercial use. Development of both traditional small-molecule chemical drugs and biotechnology-based protein drugs will be discussed. Example topics include: (1) how does a drug candidate move from its discovery at the lab bench into clinical trials? (2) what are the key hurdles in developing a new medicine that can be produced at large-scale in a manufacturing facility? (3) why are patents and venture capital so important in drug development? Guest lecturers will provide real world perspectives including case studies. This is two-hour class that meets 8 times during the semester. Prerequisite: 1st, 2nd or 3rd professional year standing in the School of Pharmacy.

PHCH 517. Pharmacy Calculations. 2 Credits.

An introduction to the mathematics involved in filling prescriptions and in manufacturing pharmaceuticals. Includes an introduction to standard prescription notation and familiarization with pharmaceutical weights and measures.

PHCH 518. Physical-Chemical Principles of Solution Dosage Forms. 3 Credits.

Physical properties of pharmaceutical solutions and their physiological compatibility will be discussed (intermolecular interactions, energetics, colligative properties, isotonicity, pH, buffers and drug solubility). Kinetics and mechanisms of drug degradation in solution will also be introduced.

Prerequisite: Students must have first year professional standing in the School of Pharmacy. Students must have successfully completed PHCH 517.

PHCH 605. Vaccines. 1 Credits.

Vaccines are currently the most powerful therapeutic approach available for infectious disease and promise to become of increasing importance for a wide variety of other pathologies including cancer. This course discusses the immunological basis of vaccinology, types of vaccines currently available and in development and the process by which vaccines are made from the basic research stage through their pharmaceutical development and marketing. Ethical aspects of vaccine use will also be considered. Prerequisite: Students must have first, second or third year professional standing in the School of Pharmacy.

PHCH 625. Pharmacokinetics. 3 Credits.

A discussion of the basic concepts, and some clinical applications, of pharmacokinetics, clearance concepts, extravascular dosing, and the use of pharmacokinetics in dosage regimen design and adjustment. Prerequisite: Students must be admitted to the school of Pharmacy to enroll in this course. Students must have successfully completed PHCH 517 and PHCH 518.

PHCH 626. Biopharmaceutics and Drug Delivery. 3 Credits.

A study of biological barriers to drug delivery, conventional dosage forms, and new and future drug delivery strategies. Prerequisite: Students must have second year professional standing in the School of Pharmacy. Students must have successfully completed PHCH 517, PHCH 518, and PHCH 625.

PHCH 667. Introduction to Clinical Chemistry. 2 Credits.

A lecture-discussion course concerned with identification of the contents of physiological fluids, changes in physiological fluid content induced by disease and drugs, and therapeutic drug monitoring: case studies are presented. Prerequisite: Must be accepted to the Pharmacy Program.

PHCH 690. Undergraduate Research in Pharmaceutical Chemistry. 1-5 Credits.

Student will be assigned a suitable research project in the area of pharmaceutical analysis or pharmaceutics. Prerequisite: Consent of instructor.

PHCH 693. Clinical Pharmacokinetics. 2 Credits.

This course presents discussions on physiological and disease state variables in pharmacokinetics for selected drugs and drug classes, and instructs students in the use of physiological and disease state pharmacokinetic information to develop individualized therapeutic regimens. Prerequisite: Students must be admitted to the school of Pharmacy to enroll in this course. Students must have successfully completed PHCH 625 and PHCH 626.

PHCH 694. Problems in Pharmaceutical Chemistry. 1-5 Credits.

A student will be assigned a suitable research project in an area of pharmaceutical analysis or pharmaceutics. This course is offered regularly by the Department of Pharmaceutical Chemistry to meet the special needs of selected students, usually for one of the following two situations: (1) This course may be taken when a student has a special interest in a problem or area of limited scope and desires to pursue that study in depth under supervision of a member of the faculty. (2) This course is sometimes used as a remedial class to provide a mechanism of intensive review and study in an area of weakness. Prerequisite: Consent of instructor.

PHCH 700. Experimental Methods in Pharmaceutical Chemistry. 1-5 Credits.

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.

PHCH 705. Writing and Communicating Science for Graduate Students. 3 Credits.

Communicating research proposals and experimental findings is a critical skill for scientists. Successful communication depends on clarity of thought and careful use of language. This course will use class discussions with examples and homework assignments to help prepare the graduate student to successfully communicate in both academia and industry settings. Graded on a satisfactory/unsatisfactory basis. Prerequisite: Graduate standing in PHCH or consent of the instructor.

PHCH 706. Writing and Communicating Science for Graduate Students. 3 Credits.

Communicating research proposals and experimental findings is a critical skill for scientists. Successful communication depends on clarity of thought and careful use of language. This course will use class discussions with examples and homework assignments to help prepare the graduate student to successfully communicate in both academia and industry settings. Graded on a satisfactory/unsatisfactory basis. Prerequisite: This course is only open to distance education students.

PHCH 712. Road Map to the Development and Regulatory Approval of a New Drug. 1 Credits.

This special topics course will cover key steps in developing and bringing a new drug through pharmaceutical development and regulatory approval and into commercial use. Development of both traditional small-molecule chemical drugs and biotechnology-based protein drugs will be discussed. Example topics include: (1) how does a drug candidate move from its discovery at the lab bench into clinical trials? (2) what are the key hurdles in developing a new medicine that can be produced at large-scale in a manufacturing facility? (3) why are patents and venture capital so important in drug development? Guest lecturers will provide real world perspectives including case studies. This is two-hour class that meets 8 times during the semester. Prerequisite: Graduate standing in Pharmaceutical Chemistry or a trainee of the NIH Biotech Training Grant.

PHCH 715. Drug Delivery. 3 Credits.

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 PhD candidate in Engineering, Chemistry, Medicinal Chemistry, or Pharmaceutical Chemistry (by appointment for seniors or graduate students in departments not listed).

PHCH 716. Drug Delivery. 3 Credits.

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: This course is only open to distance education students.

PHCH 717. Drug Delivery. 3 Credits.

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 external non-degree seeking students. Offered in spring semesters. Prerequisite: PHCH 732.

PHCH 718. Physical-Chemical Principles of Solution Dosage Forms. 3 Credits.

Physical properties of pharmaceutical solutions and their physiological compatibility will be discussed (intermolecular interactions, energetics, colligative properties, isotonicity, pH, buffers and drug solubility). Kinetics and mechanisms of drug degradation in solution will also be introduced. Prerequisite: Graduate standing.

PHCH 719. Physical-Chemical Principles of Solution Dosage Forms. 3 Credits.

Physical properties of pharmaceutical solutions and their physiological compatibility will be discussed (intermolecular interactions, energetics, colligative properties, isotonicity, pH, buffers and drug solubility). Kinetics and mechanisms of drug degradation in solution will also be introduced. This course is only open to distance education students. Prerequisite: Graduate standing.

PHCH 721. Physical-Chemical Principles of Solution Dosage Forms. 3 Credits.

Physical properties of pharmaceutical solutions and their physiological compatibility will be discussed (intermolecular interactions, energetics, colligative properties, isotonicity, pH, buffers and drug solubility). Kinetics and mechanisms of drug degradation in solution will also be introduced. This course is only open to external non-degree seeking students. Offered in spring semesters.

PHCH 725. Cellular and Molecular Pharmaceutics. 3 Credits.

The pharmaceutical relevance of fundamental and advanced concepts in cell biology and the molecular interactions responsible for cell and tissue functions, homeostasis in health and disease will be presented. Current analytical methods for examining cells and tissues, and molecular components important in understanding drug and protein biodistribution and metabolism will be discussed. Discussion topics will include the chemical and physical properties of small molecules, proteins, nucleic acids and lipids and their impact on cellular and subcellular structures and ultimately of either adverse or therapeutic benefit. (Same as C&PE 725.) Prerequisite: Graduate standing or consent of instructor.

PHCH 726. Cellular and Molecular Pharmaceutics. 3 Credits.

The pharmaceutical relevance of fundamental and advanced concepts in cell biology and the molecular interactions responsible for cell and tissue functions, homeostasis in health and disease will be presented. Current analytical methods for examining cells and tissues, and molecular components important in understanding drug and protein biodistribution and metabolism will be discussed. Discussion topics will include the chemical and physical properties of small molecules, proteins, nucleic acids and lipids and their impact on cellular and subcellular structures and ultimately of either adverse or therapeutic benefit. Prerequisite: Graduate standing or consent of instructor.

PHCH 730. Biopharmaceutics and Pharmacokinetics. 3 Credits.

A quantitative treatment of the processes involved with drug absorption, distribution, metabolism, and excretion in living systems.

PHCH 731. Biopharmaceutics and Pharmacokinetics. 3 Credits.

A quantitative treatment of the processes involved with drug absorption, distribution, metabolism, and excretion in living systems. This course open only to distance education students.

PHCH 732. Biopharmaceutics and Pharmacokinetics. 3 Credits.

A quantitative treatment of the processes involved with drug absorption, distribution, metabolism, and excretion in living systems. This course is only open to external non-degree seeking students. Offered in fall semesters.

PHCH 744. Organic Chemistry for Pharmaceutical Scientists. 3 Credits.

A consideration of the structural features and driving forces that control the course of chemical reactions. Topics will include functional group chemistry: electronic structure, acid/base properties: molecular structure and properties (dipole, strain, and steric effects, inductive and resonance effects); dynamics of reactions (the major organic reaction mechanism, kinetics, energy profiles, isotope effects, linear free energy relationships), solvent effects, stereochemistry and conformation, an introduction to orbital symmetry control; basic thermodynamic and kinetic concepts; and an overview of important classes of mechanisms. This course is only open to distance education students. Prerequisite: CHEM 624 and CHEM 626.

PHCH 801. Issues in Scientific Integrity. 1 Credits.

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. This course is open only to distance education students. Graded on a satisfactory/unsatisfactory basis. (Same as MDCM 801, NURO 801, P&TX 801 and PHCH 802.)

PHCH 802. Issues in Scientific Integrity. 1 Credits.

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. This course is open only to distance education students. Graded on a satisfactory/unsatisfactory basis. (Same as PHCH 801, MDCM 801, NURO 801, and P&TX 801.)

PHCH 816. Careers in the Biomedical Sciences. 1 Credits.

Advanced course examining career options open to PhD scientists in the biomedical sciences, and providing preparation for the different career paths. Extensive student/faculty interaction is emphasized utilizing lectures, class discussion of assigned readings, and oral presentations. Graded on a satisfactory/unsatisfactory basis. (Same as BIOL 816 and CHEM 816.) Prerequisite: Permission of instructor.

PHCH 817. Rigor, Reproducibility and Responsible Conduct in Research. 3 Credits.

This class addresses the recognized problems in rigor, reproducibility, and transparency that are plaguing modern science. Students will learn the fundamentals of hypothesis design, avoiding bias, randomization, sampling, and appropriate statistical analyses, reagent validation, among other key topics. This course also introduces principles for being an ethical, responsible, and professional research scientist. Topics include: plagiarism, fabrication and falsification of data, record keeping and data sharing, mentor/mentee and collaborative relationships, among others. The class will include a mixture of lecture, case studies and discussion. (Same as BIOL 817/CHEM 817/MDCM 817.) Prerequisite: Graduate student.

PHCH 850. Formulation Design: Solid Dosage Forms. 1 Credits.

This course is designed to provide an understanding of the formulation and 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. Graded on a satisfactory/fail basis. Prerequisite: Graduate standing in PHCH or consent of the instructor.

PHCH 851. Solid State Stability and Formulation. 2 Credits.

This course is designed to provide an understanding of the formulation and 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. This course is open only to distance education students. Prerequisite: Graduate standing in Pharmaceutical Chemistry or consent of the instructor.

PHCH 860. Principles and Practice of Chemical Biology. 3 Credits.

A survey of topics investigated by chemical biology methods including: transcription and translation, cell signaling, genetic and genomics, biochemical pathways, macromolecular structure, and the biosynthesis of peptides, carbohydrates, natural products, and nucleic acids. Concepts of thermodynamics and kinetics, bioconjugations and bioorthogonal chemistry will also be presented. (Same as BIOL 860, CHEM 860 and MDCM 860.) Prerequisite: Permission of instructor.

PHCH 862. Physical Chemistry of Solutions, Solids and Surfaces. 3 Credits.

A course on equilibria in aqueous and non-aqueous systems with emphasis on solutions of interest to pharmaceutical technology. Included are association-dissociation equilibria, complexation, protein binding calculation of species concentrations, estimation of solubility and ionization constants. Methods for the determination of chemical potential in solution are presented.

PHCH 863. Physical Chemistry of Solutions, Solids and Surfaces. 3 Credits.

A course on equilibria in aqueous and non-aqueous systems with emphasis on solutions of interest to pharmaceutical technology. Included are association-dissociation equilibria, complexation, protein binding calculation of species concentrations, estimation of solubility and ionization constants. Methods for the determination of chemical potential in solution are presented. This course is open only to distance education students.

PHCH 864. Pharmaceutical Analysis. 4 Credits.

This course is intended to be a comprehensive treatment of contemporary techniques used to validate analytical methods for the determination of drugs in the bulk form, pharmaceutical formulations, biological samples and other relevant media. The emphasis will be on chromatographic techniques reflecting the preeminent position that those techniques occupy in the field of pharmaceutical and biomedical analysis. Prerequisite: Previous or concurrent enrollment in PHCH 684.

PHCH 865. Pharmaceutical Analysis. 4 Credits.

Advanced course on pharmaceutical analysis. This course is only open to distance education students.

PHCH 870. Advanced Pharmaceutical Biotechnology. 4 Credits.

A course designed to emphasize the important facets of recombinant proteins and vaccines as pharmaceutical agents. Basics of protein structure and analysis will be introduced, and methods for production, isolation, and purification of recombinant proteins will be described. Potential chemical and physical degradation processes and strategies for circumventing these difficulties will be discussed. An overview of the development and formulation of vaccines and their immunological basis will be presented. Prerequisite: BIOL 600 or consent of instructor.

PHCH 871. Advanced Pharmaceutical Biotechnology. 4 Credits.

A course designed to emphasize the important facets of recombinant proteins and vaccines as pharmaceutical agents. Basics of protein structure and analysis will be introduced, and methods for production, 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. An overview of the development and formulation of vaccines and their immunological basis will be presented. Prerequisite: BIOL 600 or consent of instructor.

PHCH 895. Research in Pharmaceutical Chemistry. 1-11 Credits.

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 either a master's or a doctoral degree.

PHCH 898. Master's Thesis. 1-10 Credits.

Master's Thesis. This course is open only to distance education students.

PHCH 899. Master's Thesis. 1-11 Credits.

Graded on a satisfactory/fail basis.

PHCH 920. Chemical Kinetics. 2 Credits.

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 equation systems; isotope, solvent and salt rate effects; and diffusion and activation controlled reactions.

PHCH 921. Chemical Kinetics. 2 Credits.

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 equation systems; isotope, solvent and salt rate effects; and diffusion and activation controlled reactions. This course is only open to distance education students.

PHCH 972. Mechanisms of Drug Deterioration and Stabilization. 3 Credits.

A course dealing with mechanisms and chemical kinetics of drug deterioration and stabilization.

PHCH 973. Mechanisms of Drug Deterioration and Stabilization. 3 Credits.

A course dealing with mechanisms and chemical kinetics of drug deterioration and stabilization. This course is only open to distance education students.

PHCH 974. Advanced Special Topics in Pharmaceutical Chemistry. 1-3 Credits.

Various topics pertinent to the area of pharmaceutical chemistry will be explored. Graded on a satisfactory/unsatisfactory basis.

PHCH 978. Pharmaceutical Chemistry Seminar. 1 Credits.

A seminar on the chemistry of pharmaceutical systems.

PHCH 998. Doctoral Dissertation in Pharmaceutical Chemistry. 1-11 Credits.

This course is open only to distance education students.

PHCH 999. Doctoral Dissertation in Pharmaceutical Chemistry. 1-11 Credits.