MOLECULAR PHARMACOLOGY AND EXPERIMENTAL THERAPEUTICS

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Ph.D. Degree

Course Work

CORE Courses (12 credits, all required courses)

CORE 6000  Responsible Conduct of Research ................................................. 1 cr.
CORE 6100  Chemical Principles of Biological Systems ......................................... 3 cr.
CORE 6150  Genome Biology .................................................................................. 3 cr.
CORE 6250  Molecular Cell Biology ....................................................................... 3 cr.
CORE 6450  Molecular Pharmacology and Receptor Signaling ............................. 2 cr.

Lab Rotations (6 credits maximum, a minimum of 3 rotations)

MGS 5102  Lab Rotations (8 weeks)... ................................................................. 2 cr.

M.D.-Ph.D. students satisfy this requirement with three one-month full-time rotations.

Track Requirements (12 credits required)

MPET 5100  Pharmacology Seminar Series (required attendance; no credit)
*MPET 5808  Introduction to Molecular Pharmacology ......................................... 4 cr.
MPET 6800  Research Seminars in Pharmacology (1 cr./yr.) ................................. 4 cr.
MPET 6805  Drug Metabolism and Pharmacogenomics ....................................... 2 cr.
CTSC 5600  Statistics in Clinical Research ........................................................... 2 cr.

*MPET M.D.-Ph.D. students may exclude these in accordance with M.D.-Ph.D. requirements.

Track Tutorials (6 credits required, 3 tutorials required)

MPET 6000  Essentials in Patch Clamp Technique ............................................... 2 cr.
MPET 6400  Introduction to Principles of Pharmacokinetics ................................ 2 cr.
MPET 6655  Mechanisms of Cell Growth and Death .............................................. 2 cr.
MPET 6811  Tutorial in Cardiovascular Pharmacology .......................................... 2 cr.
MPET 6812  Tutorial in Receptor Biology ............................................................... 2 cr.
MPET 6813  Tutorial in Systems Pharmacology ...................................................... 2 cr.
MPET 6814  Cellular Pharmacology of Agents that Target Cancer ....................... 2 cr.
MPET 6815  Neurobehavioral Pharmacology ......................................................... 2 cr.
MPET 6820  Regenerative Medicine .................................................................... 2 cr.
Electives (6 credits required)

Any courses approved for graduate credit; select in consultation with your thesis advisor.

Research

MPET 6890    Research in Pharmacology
Directed research projects under the supervision of a faculty advisor, must enroll every quarter once a thesis laboratory is selected.

Qualifying Exams and Thesis Research

Written qualifying exam: Ph.D. students can take the written qualifying exam at the end of the first or second year, but no later than September 30 of the third year. M.D.-Ph.D. students must take the written qualifying exam before December 31 of the second year. The written exam covers the fundamentals of pharmacology, including the material covered in Molecular Pharmacology and Receptor Signaling (CORE 6450), Introduction to Molecular Pharmacology (MPET 5808), Drug Metabolism and Pharmacogenomics (MPET 6805) as applied in a laboratory setting. In addition, each student is asked to write an “NIH-style grant” based on data in a recent research article in one of the fields of molecular pharmacology. The exam is prepared and graded by the faculty.

Oral qualifying exam: The oral qualifying exam must be taken by December 31 of the student’s third year. In this exam, students orally present a preliminary thesis proposal, which serves as a springboard for faculty to probe the student’s background knowledge, ability to propose hypotheses, and design experiments to test hypotheses. The oral qualifying exam committee must conform to the Mayo Graduate School requirements and be approved by the Program Director.

Thesis proposal: A written thesis proposal in the format of an NIH R01 grant must be presented to your Thesis Advisory Committee within two months of completing the oral qualifying exam.

The proposal should be divided into the following sections:

- **Abstract**: Summary of your project.
- **Specific Aims**: Describe briefly the aims of your project and hypotheses.
- **Significance and Innovation**: Put your project into context with what is known about this area of biology and show the importance of the questions you are asking.
- **Approach**:
  A. **Background and Preliminary Data**: Describe the results you (and others) have obtained, in your host laboratory (and in collaboration), that set the scene for your proposal and support your hypotheses.
  B. **Rationale**: Here, you summarize AGAIN your key background and preliminary data facts, and say why they support your hypothesis and approach. Explain why in general you chose your particular specific aims/experiments/approach to test your hypothesis.
  C. **Research Plan**: Describe what you plan to do and how you plan to do it. Break this down by specific aims. Include expected outcomes and potential pitfalls for each aim.
INTRODUCTION TO MOLECULAR PHARMACOLOGY. (4 cr; A-F) Sun-Hee Lee
This course covers the effects of drugs and other therapeutic agents on biological systems, with particular emphasis on how drugs interact with their receptors, are metabolized by humans, affect the functions of organ systems, and are used to treat diseases.

ESSENTIALS IN PATCH CLAMP TECHNIQUE. (2 cr; S-N) Reyes Ramirez, Terzic
An introduction to patch clamp electronics and ion channel measurements. A limited number of students pursuing research with patch clamp techniques will be accepted.

MASTER’S SCHOLARLY REVIEW ARTICLE (FINAL PROJECT). (3 cr; S-N) Staff
The Employee Master’s project will consist of a scholarly written review of a topical area in pharmacology. The review will describe the current state of understanding of the topic, identify an important question related to the topic, and describe potential future directions and experimental strategies to address the question. The topic will be chosen by the student in consultation with a faculty advisor with full or associate graduate privileges and the student’s Advisory Committee. The student’s committee will evaluate the scope and content of the Employee Master’s Project. Register in the quarter in which you present your final project to the advisory committee; and register with your advisor as course director.

CLINICAL PHARMACOLOGY JOURNAL CLUB. (1 cr; S-N) Weinshilboum
This journal club meets once monthly. At each meeting, one participant chooses, along with his/her mentor, an original research article and leads the discussion. Articles deal with any aspect of the interactions between xenobiotics and man, spanning articles of fundamental laboratory-based science to clinical trials. This journal club will be of interest to graduate students in pharmacology, post-doctoral students in pharmacology, and trainees in clinical pharmacology. Register in fall quarter only (1 cr./yr.). Attendance required fall, winter and spring.

INTRODUCTION TO PRINCIPLES OF PHARMACOKINETICS. (2 cr; A-F) Reid
This 12-week course will focus on the qualitative and quantitative description of the kinetics of drug absorption, distribution and elimination. Learners will gain a basic and practical understanding of the physiological factors that influence these processes and will develop the skills necessary to fine
tune dosing regimens for the purpose of optimizing drug levels. Rigorous mathematical derivation of important concepts will be minimized. This course will prepare learners to work in the pharmaceutical industry or take the board examination in clinical pharmacology.

MPET 6655f. MECHANISMS OF CELL GROWTH AND DEATH. (2 cr; A-F; offered even years; prereq CORE 6100, 6150 and 6250 or consent of instructor) Karnitz, Kaufmann
This tutorial provides in-depth coverage of a series of cellular signaling pathways including those activated by receptor tyrosine kinases, cell death receptors, and DNA damage. Specific topics include receptor tyrosine kinases and the Ras and phosphatidylinositol 3-kinase pathways, cell death receptors and caspase activation, and the ATM/ATR-dependent signaling pathways. Alterations in the signaling pathways in disease states are discussed.

MPET 6700f. APOPTOSIS JOURNAL CLUB. (1 cr; S-N) Kaufmann
The course is a journal club reviewing recent articles on the cellular mechanisms of apoptosis. An emphasis is placed on reviewing articles describing new, universal molecular and biochemical pathways of apoptosis. The course meets monthly throughout the year. No prerequisites are required. Register in fall quarter only (1 cr./yr.). Attendance required fall, winter and spring.

MPET 6800f. RESEARCH SEMINARS IN PHARMACOLOGY. (1 cr; S-N) Machida
The purpose of this course is to provide a forum for development of graduate speaking skills in a seminar setting. Students prepare talks presented to students, faculty, fellows, and research technicians. Register in fall quarter only (1 cr./yr.) Attendance required fall, winter and spring.

MPET 6805w. DRUG METABOLISM AND PHARMACOGENOMICS. (2 cr; A-F) Weinshilboum
Principles of disposition of drugs in biological systems. Lectures on absorption, distribution, excretion, and metabolic transformation of drugs; descriptions of enzyme systems and factors affecting them.

MPET 6811w. TUTORIAL IN CARDIOVASCULAR PHARMACOLOGY. (2 cr; A-F; offered even years) Landry, Behfar
Advances in physiology, pharmacology, genomics and regenerative medicine are in the process of creating new therapeutic opportunities in cardiovascular medicine. The present course will examine recent literature to explore advanced topics related to understanding innovative pharmacological approaches to treating cardiovascular disease. Previous completion of the Principles of Pharmacology course in the Medical School or Graduate School is required.
MPET 6812s. TUTORIAL IN RECEPTOR BIOLOGY. (2 cr; S-N) Brimijoin
Student-led discussions and presentations on current topics in receptor biology (runs concurrently with CORE 6450).

MPET 6813f. TUTORIAL IN SYSTEMS PHARMACOLOGY (2 cr; A-F; prereq MPET 6805, MPET 5808 strongly recommended) Hu Li, Keith Robertson
Changes in biomedical research have greatly increased the opportunities for clinical impact. These new opportunities were born in large part through the emergence of large-scale genomics, transcriptomics, epigenomics, proteomics, and metabolomics research efforts that have yielded huge databases from large patient cohorts and laboratory studies. This explosion of data now necessitates use of quantitative and systems approaches more broadly and deeply than ever before in biomedicine. This course will cover how these large multi-layer datasets can be creatively analyzed and more importantly, how they can be integrated to yield new information on disease and drug response mechanisms, deregulated pathways, and biomarkers of disease and drug response. The class format will be part didactic lecture and part group discussion using recent illustrative papers that will help advanced graduate students and postdoctoral fellows learn how to generate and analyze ‘omics’ data and what the pitfalls and limitations are in this field. Students who have not taken these courses should discuss enrollment with one of the course directors first.

MPET 6814w. CELLULAR PHARMACOLOGY OF AGENTS THAT TARGET CANCER. (2 cr; A-F; offered even years) Kaufmann
This tutorial will examine the mechanisms of action of selected pharmacological agents of the cellular and subcellular level. Drug targets to be examined during the quarter will include plasma membrane receptors, enzymes involved in signal transduction, cell cycle regulation, chromatin modification and DNA repair, selected pathways in intermediary metabolism, and/or regulators of apoptosis. Emphasis will be placed on: 1) understanding the variety of experimental approaches that are applicable to the study of drug action in different subcellular compartments and, 2) developing an ability to critically evaluate recent literature.

MPET 6815s. NEUROBEHAVIORAL PHARMACOLOGY. (2 cr; A-F) Choi
This course will cover the most recent neuropharmacological aspects of behavior disorders. The emphasis will be on understanding the advancement of neurogenetics, neurobiology, neuroimaging, and human genomics, which are enabling us to decipher behavioral disorders in molecular levels, and thereby to develop more precise pharmacological treatment methods.

MPET 6820s. REGENERATIVE MEDICINE. (2 cr; A-F) Terzic
This graduate course is designed to introduce principles and practice of stem cell biology and regenerative medicine. Particular emphasis is placed on state-of-the-art derivation of stem cell population lineages, analysis of
respective genomic, proteomic, and metabolomic traits, and applications in therapy in diagnosis. Prerequisites for this course include proficiency in fundamental cell biology, genomics, and pharmacology. This is a shared course with the Clinical and Translational Sciences track.

Research

MPET 6890f,w,s,su. RESEARCH IN MOLECULAR PHARMACOLOGY AND EXPERIMENTAL THERAPEUTICS. (S-N) Staff Directed research projects for Ph.D. students under the supervision of a faculty advisor.