**PHARMACOLOGY (PHRM)**

**PHRM 495 High Throughput discovery: A multidisciplinary approach to cancer**

The newly developed massively parallel technologies have enabled the simultaneous analysis of many pathways. There are several large scale international efforts to probe the genetics and drug sensitivity of cancer cell lines. However, there are some rare cancers that have not been analyzed in depth. One of these rare cancers is malignant peripheral nerve sheet tumors (MPNST). MPNST, although a rare cancer, are common in patients with neurofibromatosis type 1. In the course, students will take part in a high throughput discovery effort in two phases. Phase 1 is a training phase, which will consist of quantitative profiling the sensitivity of MPNST cell lines to a library of 130 common and experimental cancer drugs. Phase 2 is an independent research project. We expect the course to be a hypothesis engine that generates ideas for further research.

Taught by: Staff Dr. Jeffrey Field; Dr. David Schultz; Dr. Simon Berritt
Course usually offered in spring term
Also Offered As: CHEM 495
Prerequisites: Prerequisites include a strong foundation in biology and chemistry. Students will prepare an abstract proposal by week four on their phase 2 projects, and a report in scientific paper style, due on the last day of the semester. In addition to attending the class lecture, an estimated 10 hours a week Independent Laboratory Research is expected.

Activity: Laboratory
1.0 Course Unit

**PHRM 510 Neurotransmitter Signaling & Neuropsychopharmacology**

The goals of this course are three-fold: 1) Provide an overview of major psychiatric disorders. 2) Provide in-depth information on neurotransmitters, emphasizing the wealth of new molecular information on how neurons function and communicate, as well as the basis for psychotherapeutics (one class per week). 3) Develop skills to appreciate, present and critically evaluate the the current literature in neurotransmitter signaling and neuropsychopharmacology (one class per week).

Taught by: Staff Dr. Steve Thomas; Dr. Chris Pierce; Dr. Wade Berrettini; Dr. Liz Heller
Course offered spring; even-numbered years
Also Offered As: NGG 510
Prerequisite: Permission of course director
Activity: Lecture
1.0 Course Unit

Notes: Meets two times per week.
PHRM 535 Introduction to Bioinformatics
This course provides overview of bioinformatics and computational biology as applied to biomedical research. A primary objective of the course is to enable students to integrate modern bioinformatics tools into their research activities. Course material is aimed at addressing biological questions using computational approaches and the analysis of data. A basic primer in programming and operating in a UNIX environment will be presented and students will also be introduced to Python R and tools for reproducible research. This course emphasizes direct hands-on experience with applications to current biological research problems. Areas include DNA sequence alignment genetic variation and analysis motif discovery study design for high-throughput sequencing RNA and gene expression single gene and whole-genome analysis machine learning and topics in systems biology. The relevant principles underlying methods used for analysis in these areas will be introduced and discussed at a level appropriate for biologists without a background in computer science.
Taught by: B Voight, C Greene
Course usually offered in spring term
Also Offered As: GCB 535, MTR 535
Prerequisites: The course will assume a solid knowledge of modern biology. An advanced undergraduate course such as BIOL 421 or a graduate course in biology such as BIOL 526 (Experimental Principles in Cell and Molecular Biology) BIOL 527 (Advanced Molecular Biology and Genetics) BIOL 528 (Advanced Molecular Genetics) BIOL 540 (Genetic Systems or equivalent is a prerequisite.
Activity: Lecture
1.0 Course Unit
Notes: All students are required to bring a laptop to the lab sessions (Fridays). TAs will provide help with the material but students should be computer-capable with their own laptop and should be willing/capable to download and install free software from the internet.

PHRM 542 Topics in Molecular Medicine
TiMM is planned as a once-weekly seminar course whose goal is to introduce students to the ways in which biomedical research can provide new insights into clinical medicine and, conversely, how knowledge of clinical disease impacts scientific discovery.
Taught by: Skip Brass, MD, PhD; Gary Koretzky, MD, PhD; Mark Kahn, MD
Course usually offered in fall term
Also Offered As: CAMB 542
Prerequisite: Permission of the course directors
Activity: Seminar
1.0 Course Unit
Notes: The course is designed primarily for combined degree (MD/PhD) students, but will be available to all medical and graduate students as space permits. Priority will be given to 2st and 2nd year combined degree students. The optimal class size will be 14. Tentatively, the course will meet for one hour from 4 - 5 pm on Wednesday afternoons with occasional double sessions that will be two hours long.

PHRM 564 DRUG DELIVERY
In this course, students will learn about drug delivery systems with emphasis on targeted therapeutics and translational nanomedicine. The course will be directed and taught by Miriam Wattenbarger (CBE) and Vladimir Muzykantov (PHRM). Lectures will also be given by other faculty from the Penn School of Engineering and Applied Science and the School of Medicine. The four main topics for the course are traditional drug delivery, drug delivery systems and nanocarriers, targeted and smart drug delivery systems, and translational aspects of drug delivery systems. There will be a midterm, final, and a group project for the course. Students will form small groups for the project and research a drug delivery topic to propose an extension of a current research area. An oral and written proposal will be given by each group to the class at the end of the semester. The course is open to SEAS seniors and graduate students, SAS college pre-med, pre-BE and pre-BGS seniors, biotechnology MS students, PGG and BGS graduate students, Wharton and Dental School students.
Also Offered As: CBE 564
Activity: Lecture
1.0 Course Unit

PHRM 570 Principles of Cardiovascular Biology: Vascular biology, medicine and engineering
Lectures to be presented by various Medical School faculty members. Topics covered include: general principles of vascular biology and hemodynamics, endothelial cells and integral vascular functions, signaling in the cardiovascular system, angiogenesis, hemostasis and thrombosis, platelets, platelet vascular interactions, vascular integrins and adhesion molecules, vascular inflammation and oxidative stress, white blood cells, vasoactive compounds and drugs, mechanisms of atherosclerosis, cholesterol and lipid metabolism, hypertension, novel vascular directed gene and enzyme therapies.
Taught by: Drs. Vladimir Muzykantov and Tilo Grosser
Course usually offered in spring term
Prerequisite: Permission of course director
Activity: Lecture
1.0 Course Unit
PHRM 590 Molecular Toxicology: Chemical and Biological Mechanisms
Course Goals: Exposures to foreign compounds (drugs, carcinogens, and pollutants) can disrupt normal cellular processes leading to toxicity. This course will focus on the molecular mechanisms by which environmental exposures lead to end-organ injury and to diseases of environmental etiology (neurodegenerative and lung diseases, reproduction disruption and cardiovascular injury). Students will learn the difficulties in modeling response to low-dose chronic exposures, how these exposures are influenced by metabolism and disposition, and how reactive intermediates alter the function of biomolecules. Mechanisms responsible for cellular damage, aberrant repair, and end-organ injury will be discussed. Students will learn about modern predictive molecular toxicology to classify toxicants, predict individual susceptibility and response to environmental triggers, and how to develop and validate biomarkers for diseases of environmental etiology. Students are expected to write a term paper on risk assessment on an environmental exposure using available TOXNET information.
Taught by: Dr. Trevor M. Penning
Course usually offered in spring term
Also Offered As: REG 590
Prerequisites: Pre-requisites: Must have taken or will take Fundamentals of Pharmacology concurrently. Undergraduate course work in biochemistry and chemistry essential. Exceptions allowed based on past course work. Please consult with Course Director. Students: All 1st and 2nd year GGPS, CAMB, Neuro and BSTA students with required prerequisites; residents in Environmental and Occupational Health, and professional masters students (MPH and MTR).
Activity: Lecture
1.0 Course Unit

PHRM 599 Pharmacology Graduate Group Journal Club
The major goals of this journal club are 1) to gain experience presenting recent original research articles from the primary scientific literature, and 2) to learn to critically evaluate the research contained in these articles with respect to their context, documentation, authentication, presentation, scientific rigor, reproducibility, inferences, and any other factors that contribute to the quality of the research and its communication.
Taught by: Steven Thomas, Julie Blendy
Two terms. student may enter either term.
Activity: Seminar
0.5 Course Units

PHRM 605 Drug Discovery and Dev
Course usually offered in spring term
Also Offered As: BMB 605, CAMB 710
Activity: Lecture
1.0 Course Unit

PHRM 623 Fundamentals of Pharmacology
This course is designed to introduce students to basic pharmacological concepts with special emphasis on the molecular actions of drugs. Subject matter includes use of microcomputers to analyze pharmacological data.
Taught by: Dr. Jeffrey Field and staff
Course usually offered in fall term
Also Offered As: REG 623
Prerequisite: Permission of course director
Activity: Lecture
1.0 Course Unit
Notes: Meets three times per week

PHRM 624 Medical Pharmacology
This course surveys the major classes of drugs used to treat human conditions, and focuses in the detail on their molecular mechanisms of action. It consists of two 2-hour lectures per week and problem sets. Student evaluation is based 50% on exams and 50% on problem sets.
PHRM 624 is required of all 2nd year PGG students. PGG students must co-enroll in PHRM 532/CAMB 532 (Human Physiology).
Taught by: Course Directors: Paul H. Axelsen, Park Cho Park, Akiva Cohen, Steve Whitehead
Prerequisites: PHRM 623 - Fundamentals of Pharmacology; BIOM 600 - Cell Biology and Biochemistry Non-PGG students must have permission from course director to enroll.
Activity: Lecture
2.0 Course Units

PHRM 632 Cell Control by Signal Transduction Pathways
This course, "Targeting the cancer cell: from mechanism to precision medicine", will examine how various signal transduction mechanisms influence cell functions including replication, growth, transcription, translation and intracellular trafficking. We will also consider how non-cell autonomous mechanisms, such as the tumor microenvironment and the immune system influence cancer cell signaling. We will consider how important signaling pathways, such as Ras, Raf, Notch, Wnt, TGF beta, and various kinases/phosphatases become dysregulated in cancer, as well as delve into how the DNA damage response, immune system, and tumor microenvironment exert important influences on oncogenic signaling. In the first half of the course, invited faculty members will pick 2 relatively recent papers from their field that highlight important areas. Each paper will be assigned to a student, who will meet with the faculty mentor prior to the class to discuss the paper and their presentation. During the class, students will present each paper for approximately 45 minutes with time for discussion. Students will present the important background, break down the paper, look for strengths and weaknesses and come up with a plan of what the next set of experiments could or should be. In the second half of the course, students will independently pick a relevant paper for in class presentation and will also write a short "News and Views" style article based on the paper they have chosen. The goal of the course is to provide students with a view of the cancer cell that integrates both cell autonomous and non-cell autonomous signals and to use this information to consider how to successfully treat cancer.
Taught by: X. Hua, J. Field, A. Resnick, and W. Pear
Course usually offered in spring term
Also Offered As: CAMB 632
Prerequisites: BIOM 600, Molecular and Cell Biology Courses
Activity: Seminar
1.0 Course Unit

PHRM 650 Current Biochemical Topics
Participation in the "Dr. George W. Raiziss Biochemical Rounds", a weekly seminar program sponsored by the Department of Biochemistry and Biophysics. Program deals with a wide range of modern biochemical and biophysical topics presented by established investigators selected from our faculty, and by leading scientists from other institutions.
Taught by: Black, B. & Shorter, J.
Also Offered As: BMB 650, CAMB 702
Prerequisites: Course is limited to BGS graduate students and undergrads from the Vagelos Scholars Program.
Activity: Seminar
1.0 Course Unit
PHRM 657 Introduction to Superfund Sites and Health Effects of Hazardous Waste
Superfund hazardous waste sites are prevalent in our nation and the exposures to toxicants from these sites raise immediate health concerns. The aims of this course are to educate students about such sites and provide a scientific basis for hazard identification, hazard characterization, risk communication and risk management. The course will describe the effect of these hazardous chemicals on the ecosystem and vice-versa, and remediation and mitigation approaches. These environmental science issues will lead into the environmental health aspects of exposures including: biomonitoring (external and internal dose, biomarkers and the exposome), toxicological properties of contaminants and mode-of-action. The course will be complemented with visits to two Superfund sites in the region: Ambler (asbestos) and Palmerton (heavy metals).
Taught by: Jane Willenbring, Richard Pepino, Trevor Penning
Also Offered As: ENVS 657
Prerequisites: 400 level course in Biology/Chemistry and Biochemistry
Activity: Lecture
1.0 Course Unit

PHRM 699 Laboratory Rotation
Activity: Laboratory
1.0 Course Unit

PHRM 799 Independent Study
One-term course offered either term
Activity: Independent Study
0.5 Course Units

PHRM 899 Pre-Dissertation Lab Rotation
Activity: Laboratory
0.5 Course Units

PHRM 970 Candidacy Examination
One-term course offered either term
Activity: Lecture
2.0 Course Units

PHRM 995 Dissertation
Activity: Dissertation
1.0 Course Unit

PHRM 999 Research in Pharmacology
Independent or collaborative research in various fields of pharmacology arranged individually with members of the staff.
One-term course offered either term
Prerequisite: Permission of staff member
Activity: Independent Study
1.0 Course Unit