DEPARTMENT OF PHARMACOLOGY (GRAD)

The Department of Pharmacology offers a program of study that leads to the degree of doctor of philosophy in pharmacology. The curriculum is individualized in recognition of the diverse backgrounds and interests of students and the broad scope of the discipline of pharmacology.

The department offers a variety of research areas including

1. Receptors and signal transduction
2. Ion channels
3. Neuropharmacology
4. Cancer pharmacology
5. Gene therapy
6. Pharmacology of alcohol and drugs of abuse

The student is expected to begin independent research early in his or her training and to participate in an intensive program of research seminars. Close personal contact between preceptor and trainee is encouraged.

Research Facilities

Laboratory facilities and a variety of research equipment are available in the department, which is located primarily in the Genetic Medicine Building, where it occupies approximately 30,000 square feet (exclusive of classrooms and animal facilities). In addition, several faculty members are located in the Lineberger Comprehensive Cancer Center, the Thurston Bowles Alcohol Center, and the Neurosciences Building.

Assistantships and Other Student Aid

All graduate students in pharmacology are provided a competitive stipend. UNC–Chapel Hill tuition and fees and health insurance are also covered.

Requirements for Admission

All students in the basic science departments in the Medical School and the biological sciences divisions in biology and chemistry enter graduate school through the Biological and Biomedical Sciences Program (http://bbsp.unc.edu/). During the first year students take courses and complete three rotations in laboratories from any of the participating departments or curricula.

After identifying a research mentor, if that faculty member is affiliated with the Pharmacology Department (http://www.med.unc.edu/pharm/people/primaryfaculty/), students can choose to join the pharmacology graduate program. Once in the program, students complete required coursework and qualifying examinations, propose a research topic, choose a dissertation committee, and engage in dissertation research. The anticipated duration of training is five years.

The pharmacology graduate program is dedicated to the training of outstanding scientists in the pharmacological sciences. An outstanding graduate program is a high priority of the department, and the training faculty participate fully at all levels. The department has the highest level of NIH funding of all pharmacology departments and a great diversity of research areas is available to trainees. These areas include cell surface receptors, G proteins, protein kinases, and signal transduction mechanisms; neuropharmacology; nucleic acids, cancer, and antimicrobial pharmacology; and experimental therapeutics. Cell and molecular approaches are particularly strong, but systems-level research such as behavioral pharmacology and analysis of knock-in and knock-out mice is also well-represented. Excellent physical facilities are available for all research areas.

Students completing the training program will have acquired basic knowledge of pharmacology and related fields, in-depth knowledge in their dissertation research area, the ability to evaluate scientific literature, mastery of a variety of laboratory procedures, skill in planning and executing an important research project in pharmacology, and the ability to communicate results, analysis, and interpretation. These skills provide a sound basis for successful scientific careers in academia, government, or industry.

To apply to BBSP, students must use The Graduate School's online application form (http://gradschool.unc.edu/admissions/). They should read carefully the information for domestic or international applicants before beginning the application. For Question 2 of the application, applicants should scroll down to School of Medicine and select "Biological and Biomedical Sciences" from the dropdown list.

The following materials are required for an application to be considered complete:

1. Nonrefundable application fee (the department cannot review the application until this is paid)
2. Copies of each of the student's transcripts
3. Letters of recommendation (submit online)
4. Personal statement (submit online)
5. GRE scores (must be less than five years old; UNC–Chapel Hill institution code is 5816)
6. TOEFL score (must be less than two years old and is necessary only if the student is an international applicant who does not have an undergraduate degree from a United States university)

For Graduate School information and submission of application materials, please consult the Graduate School Admissions Office Web site (http://gradschool.unc.edu/admissions/).

For program information and submission of application materials, prospective applicants may write to the following address:

BBSP Admissions
130 Mason Farm Road
1125 Bioinformatics Bldg.
CB#7108
University of North Carolina
Chapel Hill, NC 27599-7108
Telephone: (919) 843-6960
Email: bbsp@unc.edu

The basic course requirements for the Ph.D. degree include introductory and advanced courses in pharmacology and related programs in accord with the principal interest of the students in molecular pharmacology, neuropharmacology, or toxicology. In addition, in order to satisfy the requirements of the department and The Graduate School, the student must pass written and oral doctoral examinations, write a dissertation based on original research, and submit to a final oral examination. Under special circumstances the department will offer a program leading to the M.S. degree. The requirements are appropriate coursework, a written comprehensive examination, a thesis based on original research, and a final oral examination.

Following the faculty member's name is a section number that students should use when registering for independent studies, reading, research, and thesis and dissertation courses with that particular professor.

Professors

James Bear, Cell Motility, Migration, and Cancer Metastasis[1]
Jean Cook (144), Cell Cycle Control in Human Cells
Adrienne D. Cox (90), Ras Family Oncogenes, Lipid Modification and Protein Function[1]
Fulton T. Crews (88), Excitotoxicity, Gene Delivery, Neuroprogenetor Stem Cells and Addiction
Channing Der (74), Ras Protein Superfamily, Signal Transduction and Oncogenesis
H.G. Dohlman (127), Receptor and Signal Transduction: Mechanisms of Drug Desensitization[1]
H. Shelton Earp (63), Growth Regulation, Growth Factor and Protein Kinases[1]
Timothy Elston (129), Mathematical Modeling of G-Protein and MAP Kinase Signaling
Lee M. Graves (89), Kinome Proteomics and Signal Transduction, Cancer Drug Resistance
Klaus Hahn (126), Development of Fluorophores for Site-Specific Protein Labeling, Live Cell Biosensors and Their Biological Applications, Motility, Apoptosis, and Crosstalk in Signaling
Clyde Hodge (123), Molecular Mechanisms Mediating the Reinforcing/Pleasurable Subjective Effects of Alcohol and Other Drugs[1]
Gary L. Johnson (124), Receptors/G-Proteins, Defining the Signal Relay Systems Initiated by Various Cellular Stimuli (Including Cytokines), Growth Factors, Antigens, and Drugs Used to Treat Human Disease
Alan Jones (138), Heterotrimeric G-Protein Signaling in Model Systems[1]
Terrance Kenakin, Drug Discovery and Development for Seven Transmembrane Receptors, Protein Allosteric Mechanisms/Signal Efficacy
David Lawrence (139), Chemical Biology of Signal Transduction[1]
Nigel Mackman (150), Role of Tissue Factor in Hemostasis, Thrombosis and Ischemia-Reperfusion (I/R), Injury[1]
Leslie Morrow (105), Molecular Neuropharmacology of GABA Receptors and Alcohol
Robert A. Nicholas (68), G-Protein-Coupled P2Y Receptors, Mechanisms of Antibiotic Resistance[1]
Leslie V. Parise (70), Adhesion Receptors and Signal Transduction in Platelets, Sickle Cell Disease, and Cancer[1]
Bryan Roth (130), Regulation of Signaling and Trafficking, Drug Discovery
Janet Rubin (142), Mechanical and Hormonal Control of Bone Remodeling, Mesenchymal Stem Cell Differentiation, and Osteoporosis[1]
R. Jude Samulski (77), Development of Efficient Viral Vectors for Gene Delivery into Eukaryotic Genes
John Sondek (100), X-Ray Crystallography and Transmembrane Signaling
Juan Song (147), Adult Neurogenesis Function and Regulation
Yanping Zhang (143), Molecular Basis of Cancer[1]

Associate Professors

Michael Emanuele (148), Cell Cycle, Mitosis, Protein Stability, Ubiquitin, Cancer, Genetics, Cell Biology
J. Alex Duncan (145), Inflammation and Immune Response and Host Pathogen Interactions[1]
Shawn Gomez (149), Computational Biology, Systems Biology, Cancer[1]
Thomas Kash (134), Neurophysiological Alterations Underlying Dysregulated Emotional Behavior
Jen Jen Yeh (151), Gene Expression Profiling of Human Tumors; Study, Development, and Evaluation of Novel Therapeutics; Pancreatic and Colorectal Cancer[1]
Qisheng Zhang (153), Lipid Signaling in Development and Disease[1]
C. Ryan Miller, Genomics of Glioma
Ben Major, Proteomics, Mass Spectrometry, Signal Transduction
William Kim, Cancer Genetics

Assistant Professors

Nicholas G. Brown, Cell Cycle, Mitosis, Ubiquitin Ligases, Anaphase Promoting Complex
J. Mauro Calabrese (146), Epigenetic Control by Long Noncoding RNAs, Genomics, Stem Cells, Cancer, Human Genetic Disorders
Melissa Herman, How Structural Changes of Inhibitory Neuronal Networks Contribute to Addiction and Stress
Brian Jensen (154), Transthoracic and Transesophageal Echocardiography, Heart Failure, Myocardial Biology, Adrenergic Receptor Biology[1]
Wesley R. Legant, Microscopy, 3D Image Analysis, Biomaterials, Cell Migration, Cancer Metastasis, Tissue Engineering
Zoe McElligott, Substance Abuse, Anxiety and Depression
Jonathan C. Schisler, Cardiovascular Genomics, Proteinopathies, and Cellular Metabolism in Neuronal and Cardiovascular Disease
Qing Zhang, Hypoxia, VHL Signaling in Cancer

Adjunct Professors

Cam Patterson (115), Angiogenesis, Vascular Biology Endothelium, Atherosclerosis[1]
James W. Putney (84), Second Messenger Signaling
Robert L. Rosenberg (69), Regulation of Ion Channels
David Siderovski (111), Regulator of G-Protein Signaling (RGS), Family of Proteins

Adjunct Associate Professors

Kenneth S. Korach (85), Biochemistry and Biology of Steroid Hormone Receptors
Sommath Mukhopadhyay (143), Cannabinoid and G-Protein Coupled Receptor-Mediated Regulation of Neurogenesis and Angiogenesis

Professors Emeriti

Kenneth H. Dudley
Barry Goz
T. Kendall Harden
Rudolph L. Juliano
Gene A. Scarborough

[1] *joint faculty members*

PHCO

Graduate-level Courses

PHCO 701. Introduction to Molecular Pharmacology. 3 Credits.
Permission of the instructor. A first-year pharmacology course outlining the basics of molecular pharmacology, including molecular biology, drug and receptor interactions, receptors and ion channels, regulation of second messengers, and drug metabolism. Three lecture hours a week.

Rules & Requirements
Grading Status: Letter grade.

PHCO 702. Principles of Pharmacology and Physiology. 3 Credits.
Introduces students to the major areas of pharmacology and physiology and serves as a basis for more advanced courses. Three lecture hours a week.

Rules & Requirements
Requisites: Prerequisite, CHEM 430; permission of the instructor for students lacking the prerequisite.
Grading Status: Letter grade.
Same as: TOXC 702.

PHCO 705. Behavioral Pharmacology. 3 Credits.
Basic principles of pharmacology and behavior analysis are considered in relation to drugs that affect the central nervous system.

Rules & Requirements
Requisites: Prerequisite, PSYC 404; permission of the instructor for students lacking the prerequisite.
Grading Status: Letter grade.
Same as: PSYC 705, NBIO 705.

PHCO 707. Advanced Toxicology. 3 Credits.
Cellular and physiological basis of toxicity of environmental chemicals, with emphasis on inhalation toxicology, developmental toxicology, immunotoxicology, radiation toxicology, renal toxicology, and neurotoxicology. Three lecture hours per week.

Rules & Requirements
Requisites: Prerequisite, PHCO 702; permission of the instructor for students lacking the prerequisite.
Grading Status: Letter grade.
Same as: TOXC 707, ENVR 707.

PHCO 710. Cell Membranes. 2 Credits.
Rules & Requirements
Grading Status: Letter grade.

PHCO 715. The Molecular Pharmacology of Cancer. 2 Credits.
Required preparation, advanced graduate or advanced undergraduate courses in biochemistry and molecular biology. This course deals with the molecular and cellular basis of anticancer and antiviral chemotherapy, with emphasis on novel approaches including immunotherapy, antisense oligonucleotides, and gene therapy. The course includes faculty lectures and student presentations.

Rules & Requirements
Grading Status: Letter grade.

PHCO 721. Seminar Courses in Pharmacology. 1-3 Credits.
This is a series of seminar courses dealing with advanced topics in modern molecular pharmacology based mainly on discussion of current literature.

Rules & Requirements
Grading Status: Letter grade.

PHCO 722. Cellular and Molecular Neurobiology I. 2-6 Credits.
Lecture/discussion course on the physiology, pharmacology, biochemistry, and molecular biology of the nervous system. Topics include function and structure of ion channels, neurotransmitter biosynthesis and release mechanisms, neurotransmitter receptors, and intracellular signaling pathways.

Rules & Requirements
Grading Status: Letter grade.

PHCO 722A. Cellular and Molecular Neurobiology: Introduction and Electrical Signaling. 2 Credits.
Permission of the department. This course explores the experimental and theoretical function of the nervous system. Typically, the first hour is fundamental material presentation and the second hour may be a presentation led by the students. Topics covered include: cellular diversity in the CNS, gross brain anatomy, human and rodent brain imaging, neuromolecular genetics, behavioral methods, membrane potentials/resistance/capacitance, ion channel structure, electrophysiology and propagation of electrical signals in neurons. Basic undergraduate biology, chemistry, physics and intro calculus is assumed.

Rules & Requirements
Grading Status: Letter grade.
Same as: NBIO 722A, BIOC 722A.

PHCO 722B. Cellular and Molecular Neurobiology: Postsynaptic Mechanisms-Receptors. 2 Credits.
Permission of the department. Consideration of membrane receptor molecules activated by neurotransmitters in the nervous system with emphasis on ligand binding behavior and molecular and functional properties of different classes of receptors. Course meets for four weeks with six lecture hours per week.

Rules & Requirements
Grading Status: Letter grade.
Same as: NBIO 722B, BIOC 722B.

PHCO 724. Ras Superfamily Proteins and Signal Transduction. 2 Credits.
Seminar/discussion course covering recent advances in the role of these proteins in signaling and growth.

Rules & Requirements
Grading Status: Letter grade.

PHCO 725. Signal Transduction. 2 Credits.
Seminar/discussion course on molecular aspects of the receptors, G-proteins, effector proteins, kinases, and phosphatases that mediate hormone, neurotransmitter, growth factor, and sensory signaling.

Rules & Requirements
Grading Status: Letter grade.
Same as: BIOC 725.

PHCO 726. Adhesion Receptors and Signaling in Cancer and CV Disease. 2 Credits.
Examines the growing number of families of cell adhesion receptors and their role in biological processes including signal transduction, control of gene expression, hemostasis, cancer, neuronal development, immunobiology, and embryologic development.

Rules & Requirements
Grading Status: Letter grade.

PHCO 727. Structure and Function of Ion Channels. 2 Credits.
Seminar/discussion course on the physiology, pharmacology, biochemistry, and molecular biology of ion channel proteins.

Rules & Requirements
Grading Status: Letter grade.

PHCO 728. Neuropharmacology of Alcohol and Substance Use. 3 Credits.
A lecture/discussion course on the biological bases of alcohol and substance abuse.

Rules & Requirements
Grading Status: Letter grade.

PHCO 729. Gene Therapy: Medicine for the 21st Century. 2 Credits.
A seminar/discussion course on recent advances in targeted gene delivery and gene therapy.

Rules & Requirements
Grading Status: Letter grade.

PHCO 730. Seminar in Recent Advances in Pharmacology. 1 Credits.
Students meet as a group with faculty members to develop skills in critical reading and to summarize and discuss selected aspects of current pharmacological literature. Two hours a week. Fall and spring.

Rules & Requirements
Grading Status: Letter grade.

PHCO 731. Recent Advances in the Pharmacological Sciences. 1 Credits.
This graduate-level course encompasses both seminars presented by distinguished faculty from UNC, Duke, and other high-level research institutions, and seminars presented by students in the Pharmacological Sciences Training Program (PSTP) to other PSTP students and faculty. Students are required to attend at least 80% of these seminars each semester.

Rules & Requirements
Repeat Rules: May be repeated for credit.
Grading Status: Letter grade.

PHCO 732. Grant Writing. 2 Credits.
A discussion course covering the elements of successful grant proposals and scientific ethics.

Rules & Requirements
Requisites: Prerequisite, PHCO 701; Permission of the instructor for students lacking the prerequisite.
Grading Status: Letter grade.

PHCO 733. Drug Discovery and Development. 2 Credits.
A seminar/discussion course on the research, development, and regulatory processes involved in bringing new drugs to clinical use.

Rules & Requirements
Grading Status: Letter grade.

PHCO 734. Pain and Analgesia. 2 Credits.
A lecture/discussion course on pain transmission and pain measurement. The neuropharmacological basis of pain modulation will be discussed.

Rules & Requirements
Grading Status: Letter grade.

PHCO 735. Discovery Biology and Pharmacogenomics. 2 Credits.
Lecture/discussion course covering a variety of aspects of new biological and computational technologies. The course is predominantly in a lecture format with computer-based and literature assignments.

Rules & Requirements
Grading Status: Letter grade.

PHCO 736. Protein Kinases as Targets for Novel Pharmacological Inhibitors. 2 Credits.
A seminar/discussion course to evaluate the use of small molecule inhibitors of protein kinases from a structural and signal transduction perspective.

Rules & Requirements
Grading Status: Letter grade.

PHCO 737. Target-Based Drug Discovery and Cancer Treatment. 2 Credits.
A lecture/discussion course that emphasizes preclinical and clinical studies for the development of anti-cancer drugs that target signal transduction. Topics include: target identification and validation, drug discovery, the process of government approval for clinical trials, design of clinical trials, and new genetic-based technologies to foster drug development.

Rules & Requirements
Grading Status: Letter grade.

PHCO 738. Nanomedicine. 2 Credits.
This course offers an introduction to the nascent interdisciplinary field of nanomedicine for students with physical/biological science backgrounds; course will be based on student led discussions of current literature.

Rules & Requirements
Requisites: Prerequisite, completion of undergraduate major in physical or biological science or permission of the instructor.
Grading Status: Letter grade.

PHCO 739. Reprogramming of Somatic and Stem Cells and Its Applications in Pharmacology. 2 Credits.
The objective of this new elective is to provide graduate students with an overview of stem cell biology with a unique emphasis on the applications of stem cells in pharmacology, particularly in areas of cancer and tissue regeneration.

Rules & Requirements
Grading Status: Letter grade.

PHCO 740. Contemporary Topics in Cell Signaling: Phosphorylation Control. 1 Credits.
Required preparation, coursework in biochemistry, pharmacology and/or cell & molecular biology. Permission of the instructor. This graduate-level course is an in-depth analysis of how protein kinases and protein phosphorylation regulates key aspects of cell signaling. This class is one of the "Contemporary Topics in Cell Signaling" modules.

Rules & Requirements
Grading Status: Letter grade.

PHCO 741. Contemporary Topics in Cell Signaling: GTPases. 1 Credits.
Required preparation, coursework in biochemistry, pharmacology, and/or cell & molecular biology. Permission of the instructor. This graduate-level course conveys principles of signal transduction controlled by GTPases and emphasizes in-depth discussion of current literature and unanswered questions. This class is one of the "Contemporary Topics in Cell Signaling" modules.

Rules & Requirements
Grading Status: Letter grade.

PHCO 742. Contemporary Topics in Cell Signaling: Cell Cycle Control. 1 Credits.
Permission of the instructor. Required preparation, coursework in biochemistry and/or cell & molecular biology. This graduate-level course conveys principles of eukaryotic cell proliferation control emphasizing in-depth discussion of current literature and unanswered questions. This class is one of the Contemporary Topics in Cell Signaling modules.

Rules & Requirements
Grading Status: Letter grade.

PHCO 743. Contemporary Topics in Cell Signaling: Signaling Networks. 1 Credits.
Acquire the scientific vocabulary of the signaling network field. Master key concepts from mathematical characterization of signaling circuits. Develop and apply critical analysis skills.

Rules & Requirements
Grading Status: Letter grade.
Same as: BIOC 743.

PHCO 744. Topics on Stem Cells and Development. 2 Credits.
Required preparation, coursework in genetics, cell biology, and molecular biology. Permission of the instructor. Course addresses key issues in developmental biology focused on the role of stem cells and emphasizes in-depth discussion of current literature and unanswered questions. One of the Contemporary Topics in Cell Signaling modules.

Rules & Requirements
Grading Status: Letter grade.
Same as: BIOC 744.

PHCO 745. Intercellular Signaling in Development and Disease. 1 Credits.
This graduate-level course concentrates on up-to-date views of intercellular signal processing, with emphasis on signal transduction mechanisms as they relate to cellular/physiological responses in both normal development and disease. Signaling mechanisms that will be discussed include autocrine, paracrine, juxtacrine signaling and cell-matrix interactions.

Rules & Requirements
Grading Status: Letter grade.
Same as: BIOC 745.

PHCO 746. Introduction to Computer Vision Tools for Modern Microscopy. 1 Credits.
This course will introduce computer vision methods for cell biology. Each topic will be motivated with an explanation of a computational challenge, followed by a discussion of available techniques to address the need and practical examples for how to apply the techniques.

Rules & Requirements
Grading Status: Letter grade.

PHCO 747. Biological Concepts. 1.5 Credits.
Overview of structures and biological determinants of conditions and diseases of the oral cavity. Both growth and development and pathophysiology will be introduced in the context of three areas of oral biology: biology of extracellular matrices, host-pathogens interactions, and orofacial neurobiology.

Rules & Requirements
Grading Status: Letter grade.
Same as: OCBM 732, NBIO 732.

PHCO 748. Translational Pain Medicine. 1.5 Credits.
This is a clinician-taught course that advances students' understanding of chronic pain (e.g., head/face pain, pelvic pain, back pain, cancer pain, surgical pain) in both the classroom and the clinic.

Rules & Requirements
Requisites: Prerequisite, OBIO 732; Permission of the instructor for students lacking the prerequisite.
Grading Status: Letter grade.
Same as: OCBM 733.

PHCO 749. Practical RNA-Seq. 2 Credits.
This course is designed to familiarize students with everything needed to run an RNA-Seq experiment. There will be minimal emphasis on theory and heavy focus on practical aspects. There are no formal prerequisites required for this course and no prior experience with UNIX or the command line interface is expected.

Rules & Requirements
Grading Status: Letter grade.
Same as: GNET 749.

PHCO 750. Proteomics Methods and Applications. 1 Credits.
This course will familiarize graduate students with the fundamental concepts of mass spectrometry-based proteomics with emphasis on its applications (expression proteomics, post-translational modification identification, and interactomics) and practical aspects of these applications, such as experimental design, sample preparation and data interpretation. This course is intended for 2nd year students and above who currently use or plan to use proteomics in their research.

Rules & Requirements
Grading Status: Letter grade.

PHCO 767. Macromolecular Crystallographic Methods. 2 Credits.
A combined lecture/laboratory workshop for serious students of protein crystallography. Course intended primarily for graduate students.

Rules & Requirements
Grading Status: Letter grade.

PHCO 900. Special Pharmacology Research. 3-6 Credits.
Rules & Requirements
Grading Status: Letter grade.

PHCO 901. Research in Pharmacology. 1-15 Credits.
Permission of the department.

Rules & Requirements
Grading Status: Letter grade.

PHCO 951. Research in Neurobiology. 3-12 Credits.
Permission of the department. Research in various aspects of neurobiology. Six to 24 hours a week.

Rules & Requirements
Grading Status: Letter grade.
Same as: NBIO 951, BIOL 951.

PHCO 989. Special Pharmacology Research. 3-6 Credits.
Rules & Requirements
Grading Status: Letter grade.

PHCO 993. Master's Research and Thesis. 3 Credits.
Permission of the department.

Rules & Requirements
Repeat Rules: May be repeated for credit.

PHCO 994. Doctoral Research and Dissertation. 3 Credits.
Permission of the department.

Rules & Requirements
Repeat Rules: May be repeated for credit.

Contact Information

Department of Pharmacology
Visit Program Website (http://www.med.unc.edu/pharm/)

Chair
Henrik Dohlman