

Graduate Program in Pharmacology

Course Requirements for the Program in Biochemistry and Cancer Biology

DR: Departmental Required Course

DE: Departmental Elective Course

First Year: Core Curriculum

Second Year:

Semester	Name of Course	Number of Credit Hours
Fall Semester		
	General Pharmacology (DR)	5
	Neuropharmacology (DE)	3
	Research in Pharmacology (DR)	1-12
	Pharmacology Seminar (DR)	2
	Carcinogenesis & Cancer Therapeutics (DE)	3
Spring Semester		
	Cell Surface Receptors (DR)	2
	Drug Metabolism (DR)	2
	Pharmacokinetics (DR)	2
	Research in Pharmacology (DR)	1-12
	Pharmacology Seminar Course (DR)	2
	Cardiovascular Pharmacology (DE)	2
Summer Semester		
		2

Third Year:

Semester	Name of Course	Number of Credit Hours
Fall Semester		
	Research in Pharmacology (DR)	1-12
	Pharmacology Seminar (DR)	2
	Preparation of PhD Candidacy Proposal	
	General Electives	
Spring Semester		
	Research in Pharmacology (DR)	1-12
	Pharmacology Seminar (DR)	2
	PhD Candidacy Exam	
Summer Semester		
	Research in Pharmacology (DR)	6
	PhD Candidacy Exam	

Subsequent Years:

Semester	Name of Course	Number of Credit Hours
Fall Semester		
	Research in Pharmacology (DR)	1-12
	Pharmacology Seminar (DR)	2
Spring Semester		
	Research in Pharmacology (DR)	1-12
	Pharmacology Seminar (DR)	2
Summer Semester		
	Research in Pharmacology(DR)	6

Students are expected to complete the requirements for the Ph.D. degree in 5-6 years.

COURSE REQUIREMENTS FOR THE PROGRAM in PHARMACOLOGY

Elective Pharmacology Courses

Courses offered at Meharry Medical College:

PHARM 705	Cardiovascular Pharmacology
PHARM 722	Neuropharmacology
PHARM 723	Toxicology
PHARM 735	Research Problems in Pharmacology
PHARM 736	Current Topics in Pharmacology
PHARM 738	Carcinogenesis & Cancer Therapeutics

Courses offered at Vanderbilt University

PHAR 324	Receptor Theory, Cell-Surface Receptors and Signal Transduction Pathways
PHAR 320	Pharmacological Targets and Mechanisms
PHAR 322	Scientific Communication Skills
PHAR 321	Principles of Drug Action
PHAR 325	Cardiovascular Pharmacology
PHAR 329	Pharmacology of Psychotropic Drugs
PHAR 345	Cellular and Molecular Neuroscience
PHAR 346	Molecular Neurobiology

COURSE DESCRIPTIONS FOR COURSES IN THE PHARMACOLOGY EMPHASIS AREA

PHARM 705. CARDIOVASCULAR PHARMACOLOGY. The pharmacology of drug agents exerting major effects on the cardiovascular system will be presented in lectures, discussions, and demonstrations. Mechanism of action, basis for therapeutic application and limiting side effects of the drug agents will be discussed. Research methodology utilized in studying these agents will also be covered. 3 credit hours (Drs. Maleque & Barnett)

PHARM 706. GENERAL PHARMACOLOGY. The pharmacological basis of therapeutics is presented by means of lectures, conferences and demonstrations. Emphasis is placed on the factors governing drug action, dose-response relationships, the relationship between chemical structure and pharmacological action, the problems associated with absorption, distribution metabolism and elimination, and the mechanism of action of the common classes of drugs. Attention is also given to contra-indications, side effects and toxic effects of these compounds. 5 credit hours (Staff)

FUNDAMENTALS OF PHARMACOLOGY (3 modules). General principles and introductory considerations of the pharmacological basis of therapeutics will be presented in this course. Course will be offered in modular format, consisting of three modules: Receptor Theory (Dr. Limbird), Drug Metabolism (Dr. Eltom), Pharmacokinetics (Dr. Nyanda). Areas to be covered include: receptor theory & kinetics, dose-response relationships, and mechanism of drug action; Phase I and phase II of drug metabolism, diversity of cytochromes P450(CYPs), CYP polymorphism (SNPs) & drug efficacy; pharmacokinetics concepts, Pharmacodynamic-Pharmacokinetic modeling, therapeutic drug monitoring, clinical correlates. 6 credit hours (2h for each module) (Drs. Limbird, Eltom & Nyanda)

PHARM 710. CELL SURFACE RECEPTORS. The course consists of interactive but lecture-like sessions. Exams are take home, open book, and focus on critical thinking and using what is taught in a new experimental setting. The course will begin with studies of receptor identification and characterization in simple cellular settings, and then extend those studies to *in vivo* formats, using classical methodology. 2 credits hours (Dr. Limbird)

PHARM 715. DRUG METABOLISM. This course will cover in depth the concepts involved in metabolism of lipophilic molecules - identifying Phase I & Phase II enzymes; their location, mechanism, typical substrates, genetic variation, species variation, inhibition and drug interaction and drug design. 2 credit hours (Dr. Eltom)

PHARM 722. NEUROPHARMACOLOGY. This course presents an overview of neuropharmacology, including fundamentals of receptor theory, Neurotoxicology, neurophysiology and drug abuse. Mechanisms and problems concerned with neurotransmission will be discussed. Emphasis is given to the neurochemical basis of CNS disorders and drug intervention. Lecturers, current literature, discussions are included. 3 credit hours (Dr. Charlton & Staff)

PHARM 723. TOXICOLOGY. Principles involved in toxicity of drug and chemical agents will be presented. Topics include xenobiotic biotransformation, toxicokinetics, chemical carcinogenesis, neurotoxicology, metal toxicity, toxic response of skin & respiratory system & occupational toxicology. Toxicological mechanisms of action, rationale for therapeutic measures against effects of toxic chemical agents, and the basis for toxicological pathology, Current issues in toxicology (Toxicogenomics) will also be covered. Course format includes lectures, and student involvement in critical review of current literature. 3 credit hours (Dr. Hood & Staff).

PHARM 735. RESEARCH PROBLEMS IN PHARMACOLOGY. This is essentially an independent study, qualified students work with individual staff members in areas not covered in other available courses. 1-6 credit hours (Staff)

PHARM 736. CURRENT TOPICS IN PHARMACOLOGY. By means of lectures and/or discussion sessions, this course will offer opportunity to evaluate current advances in the field of pharmacology. Each

student enrolled will be required to write and submit a critical evaluation of an assigned, current, published research article. 3 credit hours (Staff)

PHARM 737. PHARMACOKINETICS. Offered as a module in Fundamentals of Pharmacology. This course module is designed to understand the pharmacokinetics principles that govern the absorption, distribution, metabolism, and elimination of drugs. Basic pharmacokinetics parameters are examined using one- and two-compartment modeling. In addition, applications of pharmacokinetics are examined with respect to clinical situations, and students will be introduced to the use of computer programs in pharmacokinetics. 2 credit hours (Dr. Nyanda & Staff)

PHARM 738. CARCINOGENESIS & CANCER THERAPEUTICS (cross-listing with Cancer biology). This course will cover the mechanisms underlying the carcinogenic process induced by chemical, viral or physical agents. Major emphasis will be focused on the mechanisms exploited in developing therapeutic targets for cancer treatment. Lectures on clinical correlates will be presented by clinical oncologists. 3 credit hours (Drs. Eltom& Ochieng)

Courses at Vanderbilt University that may be taken as electives in the Pharmacology emphasis program

PHAR 324. RECEPTOR THEORY, CELL-SURFACE RECEPTORS AND SIGNAL TRANSDUCTION PATHWAYS. Course covering structure and function of cell-surface receptors and the molecular bases by which they activate cellular function. Topics include receptor identification; quantitation of simple and complex binding phenomena; molecular bases for receptor coupling to GTP-binding proteins; the structure and function of ligand-operated ion channels, receptor tyrosine kinases and receptor-induced signal transduction cascades receptors as oncogenes and proto-oncogenes. (Summer)

PHAR 320. PHARMACOLOGICAL TARGETS AND MECHANISMS. Introduction to *in vivo* physiological mechanisms, anatomical structure of organ systems, and regulatory feedback pathways responsible for drug metabolism and physiological homeostasis. Classical studies that shifted the paradigm in a particular area and contemporary research will be discussed to demonstrate clarity of thinking, focused experimental strategies leading to genuine discovery, as well as potential difficulties in interpretation of results of experiments. (Fall)

PHAR 321. PRINCIPLES OF DRUG ACTION. The mechanisms of drug action are taken up in a systematic manner. Course includes didactic lectures and parallel, guided readings on drug discovery and design, based on current advances in basic science and clinical research. (Spring)

PHAR 322. SCIENTIFIC COMMUNICATION SKILLS. Techniques in effective oral communication of scientific research as well as practical experience in research and literature presentation and in the preparation of grant proposals. (Fall)

PHAR 323. EXCITABLE MEMBRANES IN NERVE AND MUSCLE. Recent findings concerning the structure, function, and pharmacology of ion channels. Topics will include the relationship between amino acid sequence, protein subunit structure, and function of both voltage- and ligand-gated channels; the relationship between channel structure and pharmacology; the interaction of drugs with channels and receptor/channel proteins, with special emphasis on the

interaction of compounds with different functional channel states; indirect coupling between ion channels and neurotransmitter and hormone receptors. Classes will include both presentations by the instructors and discussion of recent publications by students. (Dr. DeFelice)

PHAR 325. CARDIOVASCULAR PHARMACOLOGY. Cardiovascular physiology and pharmacology from the molecular to the organismal level. Classic experimental studies, molecular studies, and clinical observations will be presented to demonstrate the power of interdisciplinary approaches in answering complex questions in biology. Students will have the opportunity to identify specific areas or pathophysiologic states for emphasis. Topics covered: development of the cardiovascular system, regulation of cardiac contractility and electrophysiology, blood pressure regulation, coagulation, and select cardiovascular pathophysiologies. (Dr. Barnett)

PHAR 329. PHARMACOLOGY OF PSYCHOTROPIC DRUGS. An advanced course that focuses on the mechanism of action of CNS-active drugs, with extensive literature reading and student presentations. (Dr. Sanders-Bush)

PHAR 345. CELLULAR AND MOLECULAR NEUROSCIENCE. An overview of major neural networks, including examples from motor and sensory systems, as well as higher cognitive and affective functions. Studies of neural development move from an examination of neurogenesis, cell fate, and phenotype development to an analysis of invertebrate models and how they have advanced our understanding of mechanisms involved in axonal guidance, synapse formation and apoptosis. Additional lectures covering synaptic and systems plasticity, and models of neural networks and learning and memory will also be provided. Emphasis is placed on the integration of anatomical, biochemical and physiological information. (Dr. Blakely)

PHAR 346. MOLECULAR NEUROBIOLOGY. Molecular components and interactions that regulate neuronal development, signaling and disease. Classic molecular analysis of neurobiological processes will be coupled with detailed studies of contemporary literature to provide students with a sound foundation for understanding the molecular bases underlying the development and function of the nervous system. Topics to be covered include: development of neuronal identity, axonal transport, growth factors and cell death, axon guidance and synapse formation, electrical and chemical neurotransmission, regulation of neuronal excitability, and genetic analysis of signaling and neural disorders. (Dr. Emeson)

Special Programmatic Features of the Pharmacology Program

Pharmacology Retreat

Each fall, the Department of Pharmacology at Vanderbilt University holds a retreat in conjunction with the Pharmacology graduate program at Meharry Medical College at a nearby state park. Attendance at and full participation in the Retreat is required for all graduate students who are in the Pharmacology program at Meharry Medical College. The speakers at the retreat are students and postdoctoral fellows. Each of the talks by the students is ten minutes in length, and focuses on future research plans rather than past accomplishments. Although a few minutes of the presentation are used to explain the research problem under study, its importance, and what has been learned to date, the students are expected to spend the majority of the ten minute presentation explaining what they want

to accomplish or learn in the coming year and what strategies they will employ to do so. This emphasis on the future tense encourages a great deal of input, discussion, and critical consideration of the project at a level of intensity that would not necessarily occur following presentations of already-completed work. Furthermore, by learning the methodologies being established in different laboratories, participants in the training program can more readily learn from one another, rather than "reinventing the wheel." Important collaboration and "crash courses" in different technologies have emerged because of this retreat, and this mode of scientific exchange has fostered an acceleration of the productivity of graduate students and participating mentors alike.

Pharmacology Graduate Students Enrichment Club

This club is run by Meharry Medical College students, mentored by Dr. Eltom, and meets every two weeks in the West Basic Science Building 3rd floor conference room. The major activity of the club involves reading of books or articles and their thorough discussion to lead to an in depth understanding of concepts in pharmacological sciences or relevant biological sciences. In the past, books have included a Textbook of Receptor Pharmacology; a Workshop for Reference Manager and its application in citation management for writing fellowships, thesis and manuscripts: PowerPoint Presentation Skills; Ask The Expert sessions, to discuss a technique by somebody who does the assay routinely, either graduate student or invited guest; and other topics. As some of these topics and workshops are integrated into required elements of the Core Curriculum for the PhD, graduate students in the Pharmacology program will identify the needs to be addressed in this enrichment club, on an annual basis.