

# Graduate School of Biomedical Sciences

Luis Reuss, M.D., Dean

## About the Program

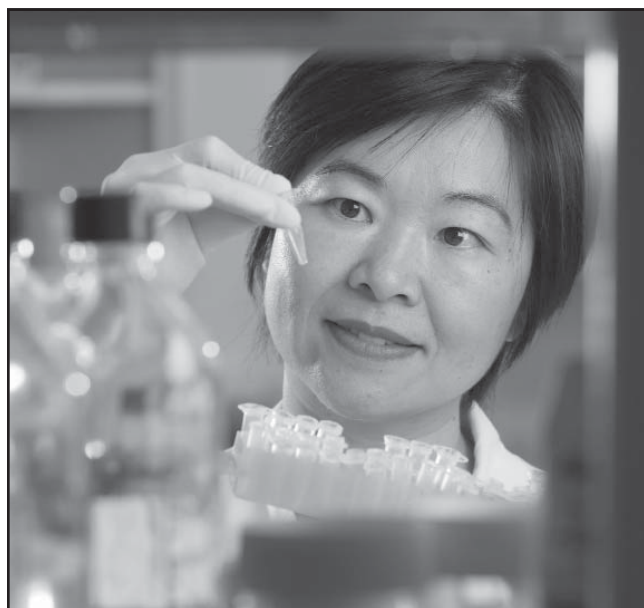
Development of a strong program of graduate education in the basic biomedical and related health sciences is one of the responsibilities and goals of the Texas Tech University Health Sciences Center. Present-day medicine cannot exist outside the academic framework and intellectual discipline which the biological, chemical, and medical sciences provide. Graduate training in these areas, an integral component of the overall program of the Health Sciences Center, is provided by the Graduate School of Biomedical Sciences.

Opportunities are offered for study and research leading to the following degrees:

- Master of Science in Biotechnology
- Master of Science in Cell and Molecular Biology
- Master of Science in Biochemistry and Molecular Genetics
- Master of Science in Medical Microbiology
- Master of Science in Pharmaceutical Sciences
- Master of Science in Pharmacology and Neuroscience
- Master of Science in Physiology
- Doctor of Philosophy in Cell and Molecular Biology
- Doctor of Philosophy in Biochemistry and Molecular Genetics
- Doctor of Philosophy in Medical Microbiology
- Doctor of Philosophy in Pharmaceutical Sciences
- Doctor of Philosophy in Pharmacology and Neuroscience
- Doctor of Philosophy in Physiology

Individual program descriptions can be found within the specific department or program sections in this catalog.

Students interested in pursuing a career in academic medicine as a physician-scientist may apply to the M.D.–Ph.D. program. The M.D.–Ph.D. program permits a student to complete the requirements of both the degrees in one of the approved graduate programs. M.D.–Ph.D. students may receive a stipend, tuition scholarships for both the medical and graduate portions of the program, and health insurance for the duration of the stipend. This program is designed to be completed in seven years and will provide the student with rigorous training in both clinical medicine and biomedical research. Students interested in this program should indicate their interest on the application forms submitted to the Texas Medical and Dental Schools Application Service (TMDAS) at [www.utsystem.edu/tmdas](http://www.utsystem.edu/tmdas).



The graduate courses listed in this section are available to graduate students at Texas Tech University or other qualified applicants as a graduate interdisciplinary student (GIDS). Applications must be made to the Graduate School of Biomedical Sciences.

Further information about graduate programs offered through the Health Sciences Center Graduate School of Biomedical Sciences may be obtained by contacting the Graduate School of Biomedical Sciences, Texas Tech University Health Sciences Center, Lubbock, Texas 79430, 806.743.2556, 800.528.5391, FAX 806.743.2656, or e-mail [graduate.school@ttuhsc.edu](mailto:graduate.school@ttuhsc.edu). For more information and to apply online, visit [www.ttuhsc.edu/gsbbs](http://www.ttuhsc.edu/gsbbs).

The policies and procedures for the Graduate School of Biomedical Sciences differ from those established by Texas Tech University Graduate School. Policy information is available on the Web site at [www.ttuhsc.edu/gsbbs](http://www.ttuhsc.edu/gsbbs). Programs are subject to change, depending on availability of resources and educational goals.

## Interdisciplinary Courses

The following interdisciplinary courses are available in addition to course offerings in the individual departments and divisions throughout the Graduate School of Biomedical Sciences.

### Graduate School of Biomedical Sciences (GSBS)

5101. Responsible Conduct of Research (1:1:0). This course will address the regulatory and ethical environment of today's biomedical research using lectures and case discussions. Course is required for all GSBS students.
5310. Introduction to Statistical Methods (3:3:0). This course provides an introduction to the interpretation and calculation of descriptive and inferential statistics. In addition to statistical analysis methods, this course provides some instruction in research methods and in the use of statistical analysis software.

### Neuroscience (GIDN)

5910. Integrated Neurosciences (9:8:1). This cooperative, interdepartmental effort offers a detailed study of the nervous system. Students examine both gross and fine structure and function from the subcellular through the behavioral level.

### Health Communications (GIHC)

5319. Seminar in Current Topics of Information Sciences (3:3:0). Prerequisite: Must be enrolled or accepted in a graduate program. Course varies each semester emphasizing information science topics including Internet training. (Writing Intensive)

### Preventive Medicine (GIPM)

6303. Principles of Epidemiology (3:3:0). Considers the variety, behavior, and distribution of both infectious and noninfectious diseases in populations. It will show how an understanding of the etiology, transmission, and pathogenesis of disease can lead to methods of disease prevention. Emphasis will be placed on the principles and methods of epidemiologic investigation. Arranged.
6304. Topics in Community Health (3:3:0). Considers various topics in epidemiology, preventive medicine, and community health not normally included in other courses. Emphasis on the interactions of various agencies in the community to abate hazards and promote health. May be repeated for credit with change in content. Arranged.

# Department of Cell Biology and Biochemistry

Harry M. Weitlauf, M.D., Chairperson

Professors: Chilton, Everse, Faust, Hutson, Reid, Stocco, Weitlauf  
Associate Professors: Beale, Coates, Cornwall, Coué, Hardy, Lee, Little, MacDonald, Pelley, Pfarr, Sridhara, Whelly, Schneider Williams, Wright

Assistant Professors: Dufour, Thomas, Urbatsch, Webster

## About the Program

This department offers study in the following graduate degree programs:

- Master of Science in Cell and Molecular Biology
- Master of Science in Biotechnology
- Master of Science in Biochemistry and Molecular Genetics
- Doctor of Philosophy in Cell and Molecular Biology
- Doctor of Philosophy in Biochemistry and Molecular Genetics

**Cell and Molecular Biology.** The purpose of the Ph.D. program is to prepare students for careers in cellular, developmental, and molecular biology. Employment opportunities for graduates of this program include traditional university professorships, positions in the biotechnology industry, and governmental appointments. The curriculum centers around three courses: Cell Function and Structure, Advanced Cell Biology, and Biochemistry. During the first year of study, the student will progress through a minimum of three laboratory rotations in order to determine his or her research interest. Dissertation topics can be pursued in the following areas: Regulation of gene expression, RNA processing, the role of transcription factors in cellular transformation and differentiation, cell cycle, cell and molecular biology of intercellular communication, control of microtubular function, embryo implantation, molecular mechanisms of epididymal sperm function, proliferation and differentiation of gonadal cells, molecular basis of gamete interactions, molecular regulation of ovarian development and function, development and regeneration of the nervous system, genetics of human cancer and congenital human disorders, diagnosis and treatment of human cancer, molecular basis of sex differences in maintenance and repair of connective tissues, morphogenesis, developmental genetics, actin cytoskeleton, embryonic development, cellular genetics, cell biology of epithelia, immune privilege and transplantation, molecular mechanisms of ABC transporters in cholesterol homeostasis and multidrug resistance of cancer cells.

The Master of Science program in Cell and Molecular Biology offers two instructional tracks. The research track is designed for students who need extra preparation for the Ph.D. program or whose career track is geared toward technical or staff level positions in industry or universities. Students undertake study and research in similar areas as that of the Ph.D. program. The education-medical track is designed for students whose eventual goal is towards a teaching career in the anatomical sciences. Students in the education-medical track take courses in the anatomical sciences and in modern instructional methods and design, and will participate in the teaching mission of the medical school as teaching assistants.

Students with undergraduate degrees in biology and chemistry are well suited for this program. Please contact Terri Lloyd at 806.743.2701 for more information concerning admission to this program.

**Biochemistry and Molecular Genetics.** The biochemistry and molecular genetics program is designed to prepare students for research and teaching careers in biochemistry and molecular biology as related to the medical and life sciences. Admission to the program requires prior coursework in mathematics, general physics, organic chemistry, analytical chemistry, and biological science. Students with deficiencies in any of these areas may be conditionally admitted pending successful completion of leveling courses prescribed by the program. Students are required to take GBCH 5421, 6323, 6333, and 6441 or their equivalents as determined by the department. In addition,

students are urged to take or to have successfully completed courses in physical chemistry, statistics, and computer programming.

After a major portion of the required coursework has been completed, the student must pass a qualifying examination that consists of two parts: a written portion in the form of an original research proposition designed to demonstrate the student's comprehension of some field of study related to biochemistry, ability to develop hypotheses, and competence in the design and conduct of promising and significant experiments; and an oral portion in which the student is expected to defend the proposition and demonstrate an understanding of the fundamental concepts and principles of biochemistry that relate to the proposition.

During the first year in the program, students will rotate through at least three different laboratories to broaden their education and research experience and to help them identify a field of specialization for their dissertation research. Major areas of current research include studies of the regulation of gene expression in a variety of eukaryotic tissues, biochemistry of development, mechanisms of hormone action, biochemistry of neoplasia, genetics of somatic cells in culture, biochemistry of membranes, mechanisms of enzyme action, and recombinant DNA.

Information covering specific requirements for degree programs is contained in the departmental Graduate Student Handbook. For more information, contact Dr. Sandra Whelly, the program advisor, at 806.743.2503.

**Biotechnology Master of Science Biomedical Track.** Although this program is listed among degrees offered by the Department of Cell Biology and Biochemistry, it is an interdisciplinary degree supported by all basic science departments in the Health Sciences Center. The Texas Tech University general academic campus administers a complementary track in Applied Science Biotechnology.

The biomedical track is a 21-month curriculum consisting of two terms (nine months) of coursework and 12 months of full-time laboratory research. It is typically a nonthesis degree with an optional thesis at the end of the second year by arrangement with the advisor. The research component may be completed either at the HSC campus or at a biotechnology industry laboratory. Students who choose to do their research at the HSC campus will work with a member of the biotechnology graduate faculty. All biotechnology graduate faculty have active research programs that emphasize use of molecular biology methods.

Prerequisites for the program include a bachelor's degree in science with at least one semester of organic chemistry. Please contact Dr. Daniel Hardy at p806.743.2053 for more information regarding admission to the program.

## Cell and Molecular Biology (GANM)

5112, 5212, 5312. Laboratory Methods (1:0:2, 2:0:4, 3:0:6). Prerequisite: Consent of instructor. Taken as (1) a hands-on introduction to the laboratories in which a student may wish to do dissertation research or (2) after a student is well established in his or her dissertation research, additional rotations can be done to gain expertise in techniques applicable to the student's research but not available in the faculty advisor's laboratory. Repeatable if different methods are covered for each registration.

5113, 5213, 5313. Selected Topics in Cell and Developmental Biology (1:1:0, 2:2:0, 3:3:0). Topics vary from semester to semester and reflect the research interests of the faculty. Recent offerings have included oncogenes and molecular biology of hormone action. May be repeated provided that different topics are covered for each registration.

5121. Surgical Gross Anatomy (1:1:0). This block will provide an introduction and overview to surgical approaches to different regions of the human body from a clinical perspective. Students will observe and assist surgeons with surgical dissections of

cadavers. The experience in surgical anatomy will provide students with a relevant correlation of anatomy to applied surgical procedures.

5331. Advanced Training in Histology (3:0:3). Students will participate in the histology laboratories as teaching assistants and attend all pre-laboratory meetings in preparation for the laboratory sessions. The students will also assist in preparing the practical exams. Prerequisites include successful completion of the first year course work of the Masters Track Program in Anatomy.
5332. Advanced Training in Anatomy (3:0:3). Students will participate in the gross anatomy laboratories as teaching assistants and attend all pre-laboratory meetings in preparation for the laboratory sessions. The students will also assist in preparing the practical exams. Prerequisites include successful completion of the first year course work of the Masters Track Program in Anatomy.
5340. Educational Project in Biomedical Sciences (3:0:0). A requirement of the Masters Track in Anatomy, students will design and carry out an educational project in either Anatomy or Histology. The project will be designed according to the needs of these courses and matched to the interest of the student. Examples of project might include self-directed learning units/sessions, or upgrading or creation of educational materials as presented on WebCT.
5510. Biology of Cells and Tissues (5:5:5). Biology of Cells and Tissues is designed to provide students with fundamental information concerning the traditional areas of biochemistry, genetics, and cell biology. The principles presented in this course will proceed from molecules to cells and then to tissues integrating structure and function.
5611. Gross Anatomy (6:2:10). A highly integrated introductory course of anatomical study (including human prosection) which embodies the gross morphology of the body and coordinates it with the clinical, developmental, and microscopic aspects of the human body.
6000. Master's Thesis (V1-6).
6340. Cell Function and Structure (3:3:0). Topics include structure/function relationships involved in DNA replication, transcription, protein tracking, cytoskeletal organization and function, cell division, and adhesion.
6620. Advanced Cell Biology (6:6:0). Prerequisite: GANM5321. This course will cover advanced topics in cell biology and is designed for senior students who have completed introductory cell biology courses. The topics covered will include regulatory mechanisms that control the development of metazoan organisms, cell cycle regulation, cancer, and reproductive and stem cell biology.
7000. Research (V1-12).
7101. Seminar (1:1:0). Students will attend and participate in departmental seminars.
8000. Doctoral Dissertation (V1-12).

### Biochemistry and Molecular Genetics (GBCH)

5421. General Biochemistry (4:4:0). Human life processes at the molecular level with emphasis on biochemical homeostasis and control mechanisms.
6000. Master's Thesis (V1-6).
6101. Biochemistry Conference (1:1:0). Informal conferences between faculty and students considering topics of current interest in biochemistry not normally included in other courses. Literature search, evaluation, organization, writing, and oral presentation by the student are emphasized. Different topic each semester. May be repeated for credit.
- 6135, 6235, 6335, 6535. Topics in Biochemistry (1:1:0, 2:2:0, 3:3:0, 5:5:0). Prerequisite: Consent of instructor. Lectures in specific areas of biochemistry not normally included in other courses. May be repeated for credit with change of content.
6441. Cell Signaling (4:4:0). Topics include structure and function of membranes and organelles, mechanisms of transcription and translation, and regulation of cellular processes including both the endocrine and nonendocrine aspects.
6323. Molecular Genetics and Nucleic Acids (3:3:0). This course will be based on readings and discussions of primary literature in the areas of nucleic acid biology. As such, the students will read and discuss a single historic or illustrative peer-reviewed paper during each session for each of the topics listed below. Successful completion of this course will give the student a firm

foundation in nucleic acid biology and prepare the student to read, discuss, and understand literature from the disciplines of DNA and RNA structure and function, gene expression, molecular biology, molecular genetics, and genomics.

6333. Advanced Protein Biochemistry (3:3:0). Teaches advanced concepts in the field of protein biochemistry with emphasis on the fundamentals of protein biosynthesis, structure, and folding; methods of characterizing protein structural properties and conformation; and techniques for purifying proteins with diverse properties. Prerequisite: Successful completion of the GSBS common first year curriculum or consent of the course director.
7000. Research (V1-12).
7101. Biochemistry Seminar (1:1:0).
8000. Doctor's Dissertation (V1-12).

### Biotechnology, Medical (GBTC)

5338. Biochemical Methods (3:1:6). Provides integrated approach to modern biochemical techniques. Present methods used to manipulate a gene, purify and characterize the enzymatic properties of the encoded protein.
6000. Master's Thesis (V1-6).
6001. Biotechnology Internship (V1-9). Research and training in a private-sector or government biotechnology laboratory (by prior arrangement with program director).
6101. Biotechnology Seminar (1:1:0).
6103. Biomedical Informatics (1:0:2). Prerequisite: GBTC 6301. Provides a broad introduction to the field of bioinformatics in medical research. Emphasizes use of modern software packages and internet-based genomic and other databases to solve research problems.
6301. Introduction to Biotechnology (3:3:0). Broad coverage of topics with high current interest and utility to the medical and agricultural biotechnology industries. Emphasizes application of technologies.
7000. Research (V1-12).



## Department of Microbiology and Immunology

Ronald C. Kennedy, Ph.D., Chairperson

Professors: Chaffin, Fralick, Hamood, Kennedy, Rolfe, Siddiqui Straus  
Associate Professors: Bright, San Francisco

Assistant Professors: Chiriva-Internati, Filleur, Reilly

Research Assistant Professors: Colmer-Hamood

Joint Faculty: Cobos, Frezza, Griswold, Jumper, Lampe, Lyte, Pence, Schneider, Williams

### About the Program

This department offers study in the following graduate degree programs:

- Master of Science in Medical Microbiology
- Doctor of Philosophy in Medical Microbiology

The coursework and information presented below describe those aspects of the programs of particular interest to students choosing to study and conduct research in the areas of medical microbiology which are traditionally found in a medical center.

Students seeking information concerning admission to the graduate program in medical microbiology, training, and research opportunities or teaching and research assistantships in the department should contact the chairperson of the department. For further information, see [www.ttuhscc.edu/som/microbiology](http://www.ttuhscc.edu/som/microbiology).

### Microbiology (GMIB)

- 5181, 5281, 5381. Selected Topics in Microbiology (1:1:0; 2:2:0; 3:3:0). Prerequisite: Consent of instructor. Specific areas in microbiology and immunology or related research not normally included in other sources. May be repeated for credit.
5340. Cellular and Molecular Immunology (3:0:3). Core curriculum course. Consent of instructor. Cellular and Molecular Immunology is a study of the development of the immune system, and immunity against microbes and tumors, and diseases caused by inappropriate immune responses.
5350. Introduction to Microbiology (3:0:3). Core curriculum course. Consent of instructor. A study of the classification, structure, virulence and pathogenesis of the microorganisms that cause human disease and the ways to control these organisms.
5399. Introduction to Microbiological Research (3:0:3). Exposure to experimental design, research methodology and data analysis in the laboratories of three faculty members.
6000. Master's Thesis (V1-6).
6323. Genetics and Molecular Biology of Prokaryotes (3:3:0). Prerequisite: Biochemistry and general microbiology. Current concepts on the molecular biology and genetics of prokaryotes with emphasis on regulation of gene expression.
6324. The Molecular Biology of Pathogenic Bacteria (3:3:0). Prerequisite: Medical microbiology, biochemistry. Lectures and discussions concerning the molecular analysis of mechanisms by which pathogenic bacteria produce infections. The regulation and expression of virulence factors are emphasized.
6325. The Biology of Animal Viruses (3:3:0). Prerequisite: General biochemistry and general microbiology. Emphasis will be placed on DNA and RNA tumor viruses, tumor suppressor genes and human immunodeficiency virus.
6329. Advances in Immunology (3:3:0). Prerequisite: GMIB 6345, 6346, 6347 or consent of instructor. Current knowledge of the immune system with emphasis on molecular and cellular interactions.
6335. The Pathogenesis of Infectious Disease (3:3:0). Prerequisite: Medical or pathogenic microbiology or consent of the instructor. A study of the processes by which microorganisms produce disease in humans and how the host responds.
6345. Cellular and Molecular Immunology (3:3:0). Beginning student. A study of the development of the immune system and immunity, including defenses against microbes and tumors and diseases caused by inappropriate immune responses.
6346. Medical Bacteriology (3:3:0). Beginning student. A study of bacterial classification, structure, virulence and pathogenesis of

the bacteria that cause human disease and the ways to control these organisms.

6347. Medical Mycology, Parasitology, and Virology (3:3:0). Beginning student. A study of the classification, structure, and pathogenesis of fungi, parasites, and viruses that cause human disease and the ways used to control these organisms.
7000. Research (V1-12).
7101. Microbiology Seminar (1:1:0).
8000. Doctoral Dissertation (V1-12).

## Department of Pharmaceutical Sciences

Quentin R. Smith, Ph.D., Chairperson

Professors: Bickel, Mehvar, Smith, Thekkumkara, Wang  
Associate Professors: Abbruscato, Ahsan, Gunaje, Rao, Siddiqui, Srivastava, Srivenugopal, Stoll, Weidanz, Weis, Wright  
Assistant Professors: Arumugam, Borges, Liu, Lockman, Moridani, Shek

### About the Program

This department offers study in the following graduate degree programs:

- Master of Science in Pharmaceutical Sciences
- Doctor of Philosophy in Pharmaceutical Sciences

The department is housed in the Texas Tech School of Pharmacy at Amarillo. Pharmaceutical sciences encompass all those areas of pharmacy research that pertain to drug design, delivery, formulations, and therapeutics. The faculty members of the department exhibit research interests and expertise in drug design and delivery, pharmacology, pharmaceuticals (including formulations and industrial pharmacy), pharmacokinetics, drug receptor modeling, molecular and reproductive biology, biochemistry, pathophysiology, immunology and cancer therapy, toxicology, and pharmacy administration. The graduate program in pharmaceutical sciences is designed to educate students for careers in pharmaceutical industry, academia, and federal agencies including the FDA. Admissions requirements include a degree in pharmacy, chemistry, biology, or related areas, acceptable GRE scores, and a TOEFL score of at least 550 (written), 213 (electronic), or 79 (internet-based) for international students. Teaching and research assistantships are awarded on a competitive basis. The departmental courses are listed below. For more information contact Teresa Carlisle, graduate program coordinator, 806.356.4015 ext. 287 or email [pharmsci.gradadv@ttuhscc.edu](mailto:pharmsci.gradadv@ttuhscc.edu).

### Pharmaceutical Sciences (GPSC)

5101. Topics in Pharmaceutical Sciences (1:1:0). Special topics in pharmaceutical sciences that are not normally included in other courses. May be repeated for credit with change in content.
5201. Topics in Pharmaceutical Sciences (2:2:0). Special topics in pharmaceutical sciences that are not normally included in other courses. May be repeated for credit with change in content.
5210. Graduate Pharmaceutics Part 1 (2:3:0). This course will cover various pharmaceutical dosage forms and drug delivery systems.
5211. Graduate Pharmaceutics Part 2 (2:3:0). This course will cover the basic principles of pharmaceuticals for the development of formulations that are stable and therapeutically effective.
5301. Topics in Pharmaceutical Sciences (3:3:0). Special topics in pharmaceutical sciences that are not normally included in other courses. May be repeated for credit with change in content.
5304. Principles of Drug Action (3:3:0). Principles that govern drug action within the body (pharmacodynamics) as well as drug absorption, distribution, metabolism, and excretion (pharmacokinetics).
5307. Pharmaceutical Sciences Research Methods (3:3:3). A lecture and laboratory course designed to provide an overview of

- current research methods in pharmaceutical sciences under direct guidance of a faculty member.
5310. Drug Design and Discovery (3:3:0). Prerequisite: GPSC 5304. Overview of new methods for quantitative SAR, computer-aided drug design, mass screening, and combinatorial chemistry.
5320. Drug Metabolism (3:3:0). Analysis of primary metabolic enzymatic systems involved in the clearance of drugs from the body and the mechanisms that regulate their activity.
5325. Medicinal Chemistry (3:3:0). A comprehensive study of the chemistry molecules and their interactions to aid in the understanding of concepts such as drug discovery and design.
5326. Cancer Biology and Therapeutics (3:3:0). This course is designed for graduate students studying molecular and cellular basis of cancer. It offers principles of cancer biology from origin of cancer to therapeutic intervention principles. Admission to the Pharmaceutical Sciences Graduate Program and basic knowledge of biochemistry and cell biology are required. Permission from the advisor and the team leader are also required.
5330. Pharmacokinetics (3:3:0). A quantitative treatment at the graduate level of the dynamics of drug disposition in the body and the national design of drug dosage regimens.
5335. Physiology-based Pharmacology Part 1. (3:3:0). Drug classes and mechanisms of action. Drugs acting on chemical mediators. Drugs affecting major organ systems including the cardiovascular, peripheral and central nervous systems.
5336. Physiology-based Pharmacology Part 2. (3:3:0). Drug classes and mechanisms of action. Drugs acting on chemical mediators. Drugs affecting major organ systems including the cardiovascular, peripheral and central nervous systems.
5340. Molecular Drug Action (3:3:0). Analysis of drug action at the molecular level, including molecular biology and signal transduction.
5350. Advanced Pharmaceutics (3:3:0). Prerequisite: Drug Delivery Systems 3 or equivalent. Quantitative treatment of reactions of pharmaceutical interest. Drug decomposition, approaches to stabilization and preservation, accelerated stability analysis, complexation, and micromeritics.
5356. Advanced Principles of Disease (3:3:0). Pathophysiological mechanisms at the molecular and cellular level. Lecture and discussion will cover the etiology, pathogenesis, functional changes, and clinical significance of general diseases.
5360. Industrial Pharmacy (3:3:0). Principles of formulation of powders, capsules, and compressed and coated tablets for conventional and controlled drug delivery.
5370. Biotechnology (3:3:0). An introduction to the area of molecular biology, genomics, and protein chemistry.
5380. Special Topics in Drug Design—Immunopharmacology (3:3:0). Principles of disease treatment with focus on the immunological system and new advances in immunotherapy.
5390. Pharmaceutical Science Research Design and Analysis (3:3:0). Overview of experimental design implementation and data analysis, including biostatistics for pharmaceutical science investigations.
5430. Graduate Immunology (4:4:0). The student will be required to express complicated immunological concepts in written and oral form. It is expected that the student will make significant intellectual contributions to the development of the specific aims of the team members' grants and will demonstrate independent thinking in regards to several focused areas in immunology.
5440. Biopharmaceutics (4:4:0). Prerequisite: DDS3 and kinetics or equivalent. Advanced treatment of the influence of dosage forms, route of administration, and dosage regimen on drug availability and newer technologies for targeting drug delivery to specific organs and cell types.
5610. General Biochemistry (6:6:0). Human life processes at the molecular level with emphasis on biochemical homeostasis and control mechanisms.
6000. Master's Thesis (V1-6).
7000. Pharmaceutical Sciences Research (V1-12).
7101. Pharmaceutical Sciences Seminar (1:1:0). Weekly seminar series designed to provide training in research data presentation and analysis.
8000. Doctoral Dissertation (V1-12).

## Department of Pharmacology and Neuroscience

Reid L. Norman, Ph.D., Chairperson

Professors: Lombardini, Norman, Strahlendorf, Syapin, Tenner, Young  
Associate Professors: Bergeson, Blanton, Dickerson, Freeman, McMahon, Roghani  
Assistant Professors: Frame, Popp

### About the Program

This department offers study in the following graduate degree programs:

- Master of Science in Pharmacology and Neuroscience
- Doctor of Philosophy in Pharmacology and Neuroscience

The objective is to prepare students for careers in research and teaching. The faculty of the program seeks to foster a creative and productive research atmosphere, to provide encouragement and positive challenge, and to equip students with the intellectual tools they will need to be effective teachers and investigators. Specialized research training is available in the areas of biochemical pharmacology, circadian pharmacology, autonomic pharmacology, cardiovascular pharmacology, neuropharmacology, and molecular pharmacology.

### Pharmacology (GPHM)

- 5101, 5201, 5301. Topics in Pharmacology (1:1:0, 2:2:0, 3:3:0). Prerequisite: Consent of instructor. Specific areas of pharmacology not normally included in other courses. May be repeated for credit with change in content.
5225. Techniques in Pharmacological Research (2:2:6). Prerequisite: Consent of instructor. Standard experimental techniques used in pharmacological research are explored through a series of hands-on laboratory exercises. Numerous techniques common to research in many fields will be introduced.
5303. Principles of Pharmacology (3:3:0). Prerequisite: Biochemistry and physiology or consent of instructor. A study of the principles and theories of pharmacokinetics and pharmacodynamics of chemicals in relationship to dose and time. The course will consist of lectures, discussions, and oral presentations of original papers by the class and is oriented for both pharmacology and nonpharmacology majors.
5312. Medical Pharmacology I (3:8:0). A study of pharmacology with emphasis on mechanisms of drug action, interaction, and therapeutics.
5326. Pharmacology of the Autonomic Nervous System (3:3:0). Prerequisite: GBCH 5921, GPHY 5803, GPHM 5613 or equivalent. A conceptual study of drugs which alter the function of the autonomic nervous system. Emphasis will be on mechanisms by which drugs affect transmitter synthesis, release, uptake, and metabolism as well as receptor function.
5336. Molecular and Cellular Pharmacology (3:3:0). Prerequisite: Consent of instructor. Course focuses on experimental methods employed in pharmacological research. Topics include expression cloning, photo-affinity labeling, gene microarrays, patch clamp recording, etc. This course will consist of selected topics, lectures, and student discussions.
5337. Neuropsychopharmacology (3:3:0). Prerequisite: Consent of instructor. A structured in-depth study of specific topics concerning neurochemical pharmacology, behavioral pharmacology, and neuropsychopharmacology. Topics to be studied will vary each semester. The course will consist of lectures, discussions, and oral presentations of original papers by the class.
6000. Master's Thesis (V1-6).
6331. Principles of Toxicology I (3:3:0). Prerequisite: Graduate standing in the department or consent of instructor. First half of a two-semester course. Examines the foundations of toxicological sciences. Covers principles, disposition, and first half of toxicological mechanisms.

6332. Principles of Toxicology II (3:3:0). Prerequisite: GPHM 6331. Second half of a two-semester course. Covers remaining toxicological mechanisms, toxic agents, and applied toxicology.
7000. Research (V1-12).
7101. Pharmacology Seminar (1:1:0). Prerequisite: Consent of instructor. This weekly seminar is designed to provide training in research data presentation and analysis. A required course for pharmacology and neuroscience graduate students, it is taken during the fall and spring semesters. Students present seminars to the entire department. Seminar topics vary but the two primary formats are journal club and presentation of data involving the student's research. Part of the grade is determined by class participation.
8000. Doctoral Dissertation (V1-12).

## Department of Cell Physiology and Molecular Biophysics

Luis Reuss, M.D., Chairperson

Professors: Davies, Janssen, Kurtzman, Laski, Lutherer, Orem, Pressley, Reuss, Strahlendorf  
Associate Professors: Altenberg, Fowler, Martinez-Zaguilan

### About the Program

This department offers study in the following graduate degree programs:

- Master of Science in Physiology
- Doctor of Philosophy in Physiology

The program is designed primarily to train persons for careers in biomedical research in medical institutions or industry, but can accommodate those interested in alternative careers in physiology. Faculty research programs are diverse, encompassing the general areas of cellular and systemic physiology. Specific areas include membrane channels and transporters, pH and Ca<sup>++</sup> homeostasis, excitation-contraction coupling, apoptosis, neuronal protective mechanisms, hypertension, shock, and mechanisms of rhythm generation such as sleep and control of respiratory and cardiovascular function.

Advanced courses in specialized areas are taught under the topics course and are designed to fit a student's specific needs.

Applicants should have a demonstrated interest in research and preferably have identified an area for their dissertation research. All candidates for graduate degrees who hold assistantships must fulfill certain requirements while appointed as assistants.

GPHY 5302 is normally a prerequisite for all courses in or above the 6000 level but may be waived for students in other programs with approval of the instructor. Enrollment in GPHY 5302 is limited to students admitted to degree programs and requires approval by the course director.

### Physiology (GPHY)

5302. Human Physiology (3:2:0). This introductory graduate course provides the student with a basic understanding of the organ systems of the human body, including their functions, regulation and interactions. No prerequisites are required.
5350. Laboratory Methods in Physiology (3:0:3). Fundamental principles of physiology are explored through a series of hands-on laboratory exercises. Numerous techniques common to research in many fields will be introduced.
5360. Laboratory Rotations as an Introduction to Modern Physiological Research (3:3:0). Prerequisite: Consent of instructor. Students work in a specific laboratory assisting an ongoing research project or conducting an independent research effort.
5400. General Physiology (4:4:0). An introduction to the physical properties that underlie physiology at the molecular and cellular level. Lecture material will be supplemented by readings from the textbook, as well as discussion of seminal papers. There are no prerequisites; completion of an undergraduate course in physical chemistry or thermodynamics is recommended.

5904. Systems Physiology (9:4:0). An introduction to the organ systems of the body, with emphasis on their regulations and interactions. The course material is presented in the context of a larger medical school course, thus individual lectures, small group conferences, and computer exercises are provided at regular intervals during the semester.
6000. Master's Thesis (V1-6).
- 6105, 6205, 6305. Topics in Physiology (1:1:0; 2:2:0; 3:3:0). Prerequisite: Consent of instructor. Advanced training in a specialized area of physiology. May be repeated for credit with change in content.
6311. Cellular and Molecular Physiology (3:3:0). Prerequisite: GPHY 5302 or consent of instructor. The study of the structure and function of ion channels and transporters, excitation-contraction coupling, and mechanisms of cell damage and death.
6314. Membrane Biophysics (3:3:0). Students are introduced to the mechanisms of ion transport through membrane channels; models of membrane excitability; molecular structures of ion channels and their physiological functions.
6318. Physiology of the Neuron (3:3:0). Prerequisite: Consent of the instructor. A contemporary and comprehensive coverage of the biology of nerve cells.
7000. Research (V1-12).
7101. Physiology Seminar (1:1:0). This weekly seminar series provides invited speakers from this and other departments as well as other universities and laboratories with the opportunity to present their current research in some area of physiology.
7102. Readings in Physiology (1:1:0). Students review literature on special topics of research. (Students may be assigned or may select these topics.) May be repeated for credit.
7103. Supervised Teaching in Physiology (1:1:0). Supervised teaching experience including leading laboratory groups and small-group discussions and presenting lectures in some departmental courses (all under faculty supervision).
8000. Doctoral Dissertation (V1-12).

