

Graduate School of Biomedical Sciences

Brandt L. Schneider, Ph.D., Dean, Graduate School of Biomedical Sciences

About the School

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 (GSBS).

Opportunities for study and research lead to the following degrees:

Biotechnology Program

- Master of Science in Biotechnology

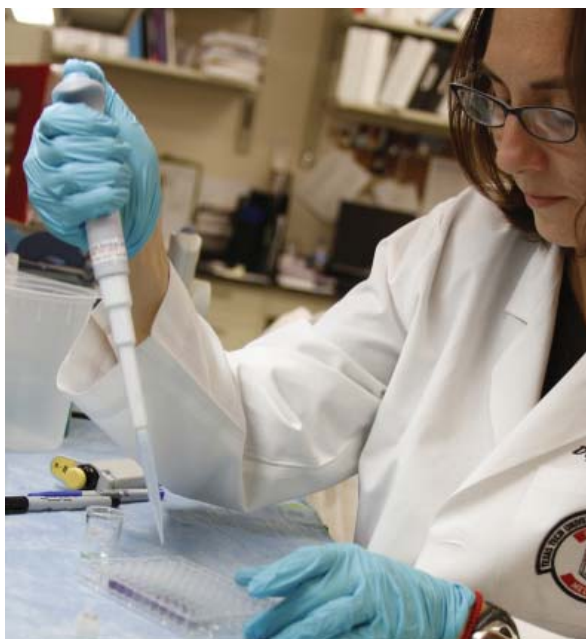
Biomedical Sciences Program

- Master of Science in Biomedical Sciences
Concentration Areas:
 - Biomedical Studies - El Paso
 - Cell and Molecular Biology
 - Cell Physiology and Molecular Biophysics
 - Immunology and Infectious Diseases
 - Pharmacology and Neuroscience
 - Pre-Medical Sciences
- Doctor of Philosophy in Biomedical Sciences
Concentration Areas:
 - Biochemistry and Molecular Genetics
 - Cell and Molecular Biology
 - Cell Physiology and Molecular Biophysics
 - Immunology and Infectious Diseases
 - Pharmacology and Neuroscience

Pharmaceutical Sciences Program

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

Courses and descriptions of the various programs and concentrations can be found in this course listing.



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 the Ph.D. degree in one of the approved Biomedical Sciences concentrations. M.D./Ph.D. students may receive a stipend, tuition scholarships for both the medical and graduate portions of the program, and health benefits 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 form submitted to the American Medical College Application Service at www.aamc.org/students/amcas/start.htm.

GSBS graduate courses are available to graduate students at Texas Tech University as a non-degree student (NDGD).

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, 3601 4th Street, Lubbock, Texas 79430-6206, 806.743.2556, 800.528.5391, FAX 806.743.2656, or e-mail graduate.school@ttuhsc.edu. For more information and to apply online, visit 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. Policies relating to curriculum can be found in the GSBS catalog which is located at: <http://www.ttuhsc.edu/gsbbs/catalogs.aspx>. 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 within each research area throughout the Graduate School of Biomedical Sciences.

Graduate School of Biomedical Sciences (GSBS)

- 5099. Topics in Biomedical Sciences (V1-6).** Specific areas in biomedical sciences or related research not normally included in other courses. May be repeated for credit.
- 5101. Responsible Conduct of Research (1:1:0).** This course will address the regulatory and ethical environment of today's biomedical research as well as such topics as authorship and data management. The class format is lectures and case discussions. Course is required for all GSBS students.
- 5102. How to be a Scientist: Professional Skills for the Biomedical Sciences Graduate Student (1:1:0).** Teaches useful concepts in the scientific professionalism that might not be learned elsewhere: how science is conducted in the United States and at TTUHSC, the importance of oral communication in science and tips for teaching in a science classroom.
- 5174. Core IV: Biomedical Seminar Series (1:1:0).** Students will attend and participate in seminars.
- 5201. Scientific Writing in the Biomedical Sciences (2:2:0).** Tactics for effective writing and communication in the biomedical sciences. Instruction will focus on the process of writing and publishing scientific manuscripts and writing fellowship applications. Students will complete short writing and editing exercises that focus on tactics of effective, clear, and concise writing, and prepare a manuscript or application in their area of study.
- 5275. Core V: Introduction to Biomedical Research (2:0:0).** Introduces the first-year graduate student to the funda-

Biochemistry and Molecular Genetics (GBMG)

Douglas M. Stocco, Ph.D., Interim Chairperson for the School of Medicine Department of Cell Biology & Biochemistry
Sandra Whelley, Ph.D., Graduate Advisor

Primary Faculty: Faust, Hardy, MacDonald, Miller, Pelley, Schneider, Stocco, Urbatsch, Whelley, Williams
Associate Faculty: Chilton, Cornwall, Coué, Dufour, Kang, Lee, Maurer, Pence, Reynolds, Thomas, Webster

About the Concentration

Biochemistry and Molecular Genetics is designed to prepare students for research and teaching careers in biochemistry and molecular biology as related to the medical and life sciences. Admission 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. Students are required to take GSBS core curriculum or their equivalent. In addition, students are urged to take or to have successfully completed courses in physical chemistry, statistics, and computer programming.

Students 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 protein amyloidogenesis.

For more information on Biochemistry and Molecular Genetics, contact Dr. Sandra Whelley, Graduate Advisor, at 806.743.2700, Ext. 247.

GBMG Courses:

5130. Research Presentation Skills (1:0:0). A comprehensive coverage of the most widely used research presentation methods used at national and international meetings. The course is offered at the request of a faculty member or the request of a student or group of students. May be repeated with credit. Prerequisite: Successful completion of GSBS core curriculum or consent of course director.

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).

6055. Research Methods (V1-6). 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 dissertation research, additional rotations can be done to gain expertise in techniques applicable to research. May be repeated with change of content.

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.

mental principles and techniques in basic biomedical research.

5303. Introduction to Clinical Research (3:2:3). Students will be involved in all aspects of preparation for and execution of prospective human studies and retrospective chart reviews. The didactic training deals with the regulations and ethical considerations related to research in humans, the process of obtaining approval for a study and the requirements associated with conducting a study. Prerequisites include the required courses in the first year GSBS Curriculum and preferably at least one laboratory rotation.

5310. Introduction to Statistical Methods in the Biomedical Sciences (3:3:0). Provide students explanation and application of classical test theory involving univariate statistics. The course will include discussion about classical test theory (p values, scales of measurement, assumptions of analyses, etc.) and application of this theory for various statistical analyses, such as t tests, anova, correlation. There will be a small introduction to non-parametric analyses.

5350. Laboratory Methods in Biomedical Sciences (3:3:0). Introduces the first-year graduate student to the fundamental principles and techniques in basic science research. Following a lecture and/or a laboratory demonstration, students conduct a well-defined laboratory exercise and provide a written report on the results.

5372. Core II: Cells (3:3:0). The structure/function relationships that underlie basic cellular processes, including translation, protein trafficking, cytoskeletal organization and motility, cell adhesion, and cell division. Required for first year students.

5373. Core III: Genes (3:3:0). Teaches essential scientific concepts underlying the field of Molecular Biology and Molecular Genetics. Required for first year students.

5399. Topics in Biomedical Sciences (3:0:0). Specific areas in biomedical sciences or related research not normally included in other courses. May be repeated for credit.

5471. Core I: Molecules (4:4:0). This course offers a broad coverage of biochemistry with an emphasis on structure and function of macromolecules, biosynthesis of small molecule precursors of macromolecules, and the pathways of intermediary metabolism. Required for first year students.

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 and includes searching relevant scientific databases. (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.

- 6121. History of Biochemistry (1:1:0).** Discussion of highlights in the advancement of biochemical knowledge.
- 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.
- 6323. Advanced Molecular Genetics (3:3:0).** Based on readings and discussions of primary literature in the areas of molecular genetics and nucleic acid biology. This course will give the student a firm foundation in molecular genetics 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, and cancer biology.
- 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).**
- 5103. Responsible Conduct of Research (1:1:0).** Addresses the regulatory and ethical environment of today's biomedical research as well as such topics as authorship and data management.
- 5104. Biomedical Sciences Seminar (1:1:0).** Students are required to attend all seminars sponsored by the Biomedical Studies Program. Students will present a seminar in their first year and a final seminar at the end of their internship (Spring semester) of the second year. Deviation from the yearly seminar presentation requirement requires approval of the Biomedical Studies graduate program committee.
- 5201. Laboratory Methods in Biomedical Science (2:0:2).** Introduces the first-year graduate students to the fundamental principles and techniques in basic science research.)
- 5202. CORE V: Introduction to Biomedical Research (2:2:0).** Introduces the first-year graduate student to the fundamental principles and techniques in basic biomedical research through laboratory rotations.
- 5220. Cancer Biology and Therapeutics (2:2:0).** This course offers an advanced level understanding of molecular and cellular basis of cancer. The principles of cancer biology from origin of cancer to therapeutic intervention are addressed.
- 5221. Microbial Genetics (2:2:0).** This course provides coverage of current techniques of genetic analysis, molecular biology, and gene regulation in microorganisms, with an emphasis on bacteria and bacteriophages.
- 5222. Advanced Human Genetics (2:2:0).** This course will cover detailed consideration of population genetics, cytogenetics, molecular biology, and biochemistry as related to human heredity and genetic disorders. Includes discussion of research papers from the current literature.
- 5223. The Cell Cycle and Human Diseases (2:2:0).** Advanced mechanisms of DNA replication repair, meiosis and recombination, and mitosis and the genetics of cell cycle control. Defects in DNA replication and repair and human diseases.
- 5224. Cellular and Molecular Neuroscience (2:2:0).** This course addresses molecular mechanisms of neurodegeneration associated with neurodegenerative disorders, including spinal muscular atrophy, Parkinson's disease, Alzheimer's disease, Amyotrophic Lateral Sclerosis and Huntington's disease. The course will consist of lectures and critical discussions of recent research papers.
- 5225. Immunology (2:2:0).** This course will cover basic and advanced concepts in immunology including a survey of immunology as a host response to foreign agents, covering the nature of antigens and antibodies, effector and memory T cell responses, innate and adaptive immunity to microbial infections, allergic reactions and tumor immunology.
- 5301. CORE I: BIOCHEMISTRY (3:3:0).** This course will teach structure, biosynthesis and functions of the major classes of organic compounds with particular reference to organic molecules and their relationship to polymers, such as carbohydrates, lipids, proteins, and nucleic acids.
- 5302. CORE II: CELL BIOLOGY (3:3:0).** This course will teach structural details and the molecular functions of the different parts of the cell. The course will also deal with signal transduction processes and cellular functions that are required for cell growth and death.
- 5303. CORE III: GENES and FUNCTION (3:3:0).** This course will teach the principles of molecular genetics. The main topics that will be covered by this course include gene structure and function at the molecular level, regulation of gene expression, organization of genetic information in prokaryotes and eukaryotes, genetic rearrangements and genetic engineering.
- 5306. Introduction to Biomedical Sciences (3:3:0).** This course will teach the basics of principles of biochemistry, cell biology and genetics. It will introduce the

Biomedical Studies - El Paso (GBSE)

Charles Miller, Ph.D., Director
Rajkumar Lakshmanaswamy, Ph.D., Graduate Advisor

Primary Faculty: Bryan, Gangwani, Garg, Joshi, Lakshmanaswamy, Miller, Nyakeriga, Perez, Shokar, Sundin, Tarwater, Trott, Watts, Wu, Zeng, Zu
Associate Faculty: Beale

About the Concentration

The Biomedical Studies MS program will provide foundational coursework and laboratory training in the areas of biochemistry, cell biology, and genetics in addition to elective courses that explore specialized topics, recent advances, and current literature within the field. The program is designed to provide a superior and competitive training environment in four state-of-the-art Center of Excellence research laboratory areas established at the Paul L. Foster School of Medicine / El Paso Health Sciences Center GSBS campus (Cancer, Diabetes and Obesity, Infectious Disease, and Neuroscience).

Students will be expected to engage in a mentored research project that culminates in the generation of a written thesis, as well as publication(s) within prominent peer-reviewed scientific journals. Students graduating from this program will be prepared for work at the forefront of biomedical research and will be highly competitive for positions in academia and industry that meet their individual interests.

GBSE Courses:

- 5101. Core IV: Biomedical Seminar (1:1:0).** This course will offer presentations, journal articles, etc in biomedical sciences presented by faculty and special guests for group discussion.
- 5102. Biochemical Methods (1:1:0).** Provides integrated approach to modern biochemical techniques biochemistry, cell and molecular biology, and genetics, including RNA interference and recombinant DNA techniques.
- 5103. Responsible Conduct of Research (1:1:0).** Addresses the regulatory and ethical environment of today's biomedical research as well as such topics as authorship and data management.
- 5104. Biomedical Sciences Seminar (1:1:0).** Students are required to attend all seminars sponsored by the Biomedical Studies Program. Students will present a seminar in their first year and a final seminar at the end of their internship (Spring semester) of the second year. Deviation from the yearly seminar presentation requirement requires approval of the Biomedical Studies graduate program committee.
- 5201. Laboratory Methods in Biomedical Science (2:0:2).** Introduces the first-year graduate students to the fundamental principles and techniques in basic science research.)
- 5202. CORE V: Introduction to Biomedical Research (2:2:0).** Introduces the first-year graduate student to the fundamental principles and techniques in basic biomedical research through laboratory rotations.
- 5220. Cancer Biology and Therapeutics (2:2:0).** This course offers an advanced level understanding of molecular and cellular basis of cancer. The principles of cancer biology from origin of cancer to therapeutic intervention are addressed.
- 5221. Microbial Genetics (2:2:0).** This course provides coverage of current techniques of genetic analysis, molecular biology, and gene regulation in microorganisms, with an emphasis on bacteria and bacteriophages.
- 5222. Advanced Human Genetics (2:2:0).** This course will cover detailed consideration of population genetics, cytogenetics, molecular biology, and biochemistry as related to human heredity and genetic disorders. Includes discussion of research papers from the current literature.
- 5223. The Cell Cycle and Human Diseases (2:2:0).** Advanced mechanisms of DNA replication repair, meiosis and recombination, and mitosis and the genetics of cell cycle control. Defects in DNA replication and repair and human diseases.
- 5224. Cellular and Molecular Neuroscience (2:2:0).** This course addresses molecular mechanisms of neurodegeneration associated with neurodegenerative disorders, including spinal muscular atrophy, Parkinson's disease, Alzheimer's disease, Amyotrophic Lateral Sclerosis and Huntington's disease. The course will consist of lectures and critical discussions of recent research papers.
- 5225. Immunology (2:2:0).** This course will cover basic and advanced concepts in immunology including a survey of immunology as a host response to foreign agents, covering the nature of antigens and antibodies, effector and memory T cell responses, innate and adaptive immunity to microbial infections, allergic reactions and tumor immunology.
- 5301. CORE I: BIOCHEMISTRY (3:3:0).** This course will teach structure, biosynthesis and functions of the major classes of organic compounds with particular reference to organic molecules and their relationship to polymers, such as carbohydrates, lipids, proteins, and nucleic acids.
- 5302. CORE II: CELL BIOLOGY (3:3:0).** This course will teach structural details and the molecular functions of the different parts of the cell. The course will also deal with signal transduction processes and cellular functions that are required for cell growth and death.
- 5303. CORE III: GENES and FUNCTION (3:3:0).** This course will teach the principles of molecular genetics. The main topics that will be covered by this course include gene structure and function at the molecular level, regulation of gene expression, organization of genetic information in prokaryotes and eukaryotes, genetic rearrangements and genetic engineering.
- 5306. Introduction to Biomedical Sciences (3:3:0).** This course will teach the basics of principles of biochemistry, cell biology and genetics. It will introduce the

students to the basic concepts about carbohydrates, lipids, proteins, nucleic acids, genes and cell structure and cellular components.

6000. Master's Thesis (V1-6).

7000. Research in Biomedical Studies (V1-9).

Biotechnology (GBTC)

Jon Weidanz, Ph.D., Associate Dean of the Graduate School of Biomedical Sciences; Director
Ted Reid, Ph.D., Co-Director

Primary Faculty: Filleur, Reid, Rumbaugh
Joint Faculty: Bergeson, Blanton, Chaffin, Cornwall, Dufour, Fralick, Hamood, Hardy, Jansen, Kang, Lee, MacDonald, Schneider, Stocco, Straus, Sutton, Syapin, Thomas, Urbatsch, Weidanz, Williams
Associate Faculty: Bryan, Gangwani, Lakshmanaswamy, Miller, Perez, Tarwater, Trott, Zhang

About the Program

This program is an interdisciplinary degree supported by all basic science departments in the Texas Tech University Health Sciences Center (TTUHSC). The Texas Tech University general academic campus administers a complimentary track in Applied Science Biotechnology.

The biomedical sciences 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 non-thesis 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 TTUHSC campus or at a biotechnology industry laboratory. Students who choose to do their research at the TTUHSC 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.

GBTC Courses:

5338. Biochemical Methods (3:1:6). Provides integrated approach to modern biochemical techniques and 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).

6202. Biomedical Informatics (2:0:2). Prerequisite: GBTC 6301. Personal laptop meeting the School of Medicine laptop guidelines is required.

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).

Cell and Molecular Biology (GCMB)

Douglas M. Stocco, Ph.D. Interim Chairperson for

the School of Medicine Department of Cell Biology & Biochemistry

Jeffrey Thomas, Ph.D., Graduate Advisor

Primary Faculty: Chilton, Cornwall, Dufour, Hutson, Kang, Lado, Lee, Maurer, Reynolds, Thomas, Webster

Joint Faculty: Hardy, MacDonald, Schneider, Stocco, Urbatsch, Williams

Associate Faculty: Coué, Dai, Rumbaugh

About the Concentration

Cell and Molecular Biology will prepare students for careers in cellular, developmental, and molecular biology. Employment opportunities for graduates include traditional university professorships, positions in the biotechnology industry, and governmental appointments. The curriculum centers around three courses: Cell Structure and Function, 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.

Cell and Molecular Biology offers two instructional tracks for masters students. 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 pre-medical sciences track is designed for students whose eventual goal is towards a teaching career in the anatomical sciences or who need additional preparation for medical school. Students in the pre-medical sciences 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 concentration. Please contact Jan Emets at 806.743.2701 or jan.emets@ttuhsc.edu for more information concerning admissions for M.S. Research track and Ph.D.; and Terri Lloyd at 806.743.2556 or terri.lloyd@ttuhsc.edu for Pre-Medical Sciences M.S. track information. Website: <http://www.ttuhsc.edu/cbb/>.

GCMB Courses:

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, hormone action, and advanced genetics. 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. Enrollment limited to students admitted to Pre-Medical Sciences M.S. concentration.
- 5130. Research Presentation Skills (1:0:0).** A comprehensive coverage of the most widely used research presentation methods used at national and international meetings. The course is offered at the request of a faculty member or the request of a student or group of students. May be repeated with credit. Prerequisite: Successful completion of the GSBS core curriculum or consent of course director.
- 5231. Advanced Training in Histology II (2:0:2).** Students will participate in the histology laboratories in the Structure and Function of Major Organ Systems block of the first year School of Medicine curriculum, attend all histology lectures, 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 in Pre-Medical Sciences. Enrollment limited to students admitted to Pre-Medical Sciences M.S. concentration.
- 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 in Pre-Medical Sciences. Enrollment limited to students admitted to Pre-Medical Sciences M.S. concentration.
- 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 in Pre-Medical Sciences. Enrollment limited to students admitted to Pre-Medical Sciences M.S. concentration.
- 5340. Educational Project in Biomedical Sciences (3:0:0).** 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. Projects might include self-directed learning units/sessions, or upgrading or creation of educational materials as presented on WebCT. Required of all Pre-Medical Sciences students. Enrollment limited to students admitted to Pre-Medical Sciences M.S. concentration.
- 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. Enrollment limited to students admitted to Pre-Medical Sciences M.S. concentration.
- 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. Enrollment limited to students admitted to Pre-Medical Sciences concentration.
- 6000. Master's Thesis (V1-6).**
- 6055. Laboratory Methods (V1-6).** Prerequisite: Consent of instructor. Taken as (1) hands-on introduction to the laboratories in which a student may wish to do thesis or 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.

- 6320. Advanced Cell Biology (3:3:0).** Prerequisite: GSBS core curriculum or consent of course director. 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.
- 6340. Cell Structure and Function (3:3:0).** Topics include structure/function relationships involved in DNA replication, transcription, protein tracking, cytoskeletal organization and function, cell division, and adhesion.
- 7000. Research (V1-12).**
- 7101. Seminar (1:1:0).** Students will attend and participate in departmental seminars.
- 8000. Doctoral Dissertation (V1-12).**

Cell Physiology and Molecular Biophysics (GPHY)

Luis Reuss, M.D., Chairperson for the School of Medicine
Department of Cell Physiology and Molecular Biophysics

Raul Martinez-Zaguilan, Ph.D., and Michaela Jansen,
Ph.D., Graduate Advisors

Primary Faculty: Altenberg, Artigas, Cuello, Fowler, Guan,
Jansen, Lutherer, Martinez-Zaguilan, Perez-Zoghbi,
Pressley, Reuss, Sutton
Associate Faculty: Blanton, Das, Jumper, Laski, Prien, E.
Reuss, Sennoune, Terreros

About the Concentration

The concentration's main research interest is focused on membrane proteins ranging from their structure to their function in health and disease, and utilizes both cellular and molecular approaches to study these areas. The research involves, among others, the following topics: (a) ion transport and the role of ligand- and voltage-gated potassium channels in normal physiological and pathophysiological conditions; (b) structure/function correlations and structural modeling of transporters that include the sodium-potassium pump, proton pumps and multidrug-resistance proteins; and (c) structure-function studies of proteins involved in membrane traffic and fusion. State-of-the-art approaches and techniques such as X-ray crystallography, molecular spectroscopy, patch-clamp electrophysiology, and confocal microscopy are used to carry out the various research endeavors. The School of Medicine Department of Cell Physiology and Molecular Biophysics has established these research efforts.

GPHY Courses:

- 5220. Experiments in Molecular Cell Physiology (2:0:2).** A laboratory course coordinated with the topics of GPHY 5320. Students will perform experiments that illustrate basic biophysical and physiological concepts, analyze the results and interpret them. Prerequisite: current enrollment in GPHY 5320.
- 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 the functions, regulation and interactions. No prerequisites are required.
- 5320. Molecular Cell Physiology (3:3:0).** An introduction to the physical and chemical bases of cell physiology. This course starts with a review of physical chemistry applied to biology and focuses on membrane phenomena, muscle contraction and molecular aspects of signaling. Lecture material is supplemented by readings from

textbooks, review articles and original research papers. Prerequisite: consent of the instructor. This course can be taken together with GPHY 5220.

- 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.
- 5904. Systems Physiology (9:4:0).** This course provides the student with a basic understanding of the organ systems of the human body. Their functions, regulation and interactions are emphasized.
- 6000. Master's Thesis (V1-6).**
- 6105, 6205, 6305. Advanced Topics in Cell Physiology and Molecular Biophysics (1:1:0; 2:2:0; 3:3:0).** Prerequisite: Consent of instructor. Advanced training in a specialized area of cell physiology. May be repeated for credit with change in content.
- 7000. Research (V1-12).**
- 7101. Cell Physiology and Molecular Biophysics Seminar (1:1:0).** Showcases internationally acclaimed researchers and provides the student with the most current information on a variety of interesting topics in cell physiology, as well as an introduction to state-of-the art techniques and instrumentation.
- 7103. Advanced Topics in Cell Physiology and Molecular Biophysics (1:1:0).** This course gives the student experience in organizing and presenting lectures. The overall objective is to assist the student in developing the skills required to teach in any area of cell physiology and molecular biophysics.
- 7120. Readings in Cell Physiology and Molecular Biophysics (1:1:0).** This course is designed to complement the Cell Physiology and Molecular Biophysics Seminar Series and provide a forum for the students to become familiar with some of the speakers publications. The readings course will examine the hypothesis that was tested, the techniques employed, the most important results obtained, and the conclusions that were drawn from the study and require that the students further develop skills in reading, analysis, integration of knowledge and oral presentation of original science articles and reviews. May be repeated for credit.
- 8000. Doctoral Dissertation (V1-12).**

Immunology and Infectious Diseases (GIID)

Matthew Grisham, Ph.D., Professor and Chair for the School of Medicine Department of Immunology and Molecular Microbiology
Robert Bright, Ph.D., Graduate Advisor

Primary Faculty: Brackee, Bright, Chaffin, Colmer-Hamood, Fralick, Grisham, Hamood, Rolfe, Siddiqui, Straus,
Joint Faculty: Reilly, Rumbaugh, San Francisco,
Associate Faculty: Cordero, Grammas, Griswold, Miller, Reid, Schneider, Williams, Wright
Adjunct Faculty: Ahmad, Dowd, Wolcott

About the Concentration

Immunology and Infectious Diseases is designed to graduate exceptionally well trained professionals who possess the necessary background and experience for a career in research and teaching in Immunology and Infectious Diseases. Applicants are urged to possess research experience and should have a basic knowledge of microbiology and prior course work in several disciplines of biological sciences. Prior coursework in

certain areas such as Microbiology (General and Pathogenic), Cell Biology, Immunology, and Biochemistry, though not a requirement, is helpful. Students with deficiencies in these areas may be admitted and required to enroll in these classes as part of their first year of graduate school.

Students have the opportunity to rotate through research laboratories (three are recommended, but not a requirement) to broaden their education and research experience, and to assist in the identification of a field of specialization for their thesis or dissertation research. Major areas of current research activities include: microbial pathogenesis, bacterial gene regulation, biofilms, multi-drug resistance, immunology (cancer and infectious diseases), tumor antigen identification, vaccines and phage and immunotherapy. For further information, see <https://www.ttuhsu.edu/som/immunology>.

GIID Courses:

- 5181, 5281, 5381. Selected Topics in Immunology and Infectious Diseases (1:1:0; 2:2:0; 3:3:0).** Prerequisite: Biomedical Sciences core curriculum or consent of instructor. Self-study courses provide students with a specialized topic within their area of interest that is not typically offered within the Texas Tech University system. Participants must agree upon objectives, grading criteria, and deadlines.
- 5340. Cellular and Molecular Immunology (3:3:0).** Prerequisite: Core curriculum or 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.
- 6000. Master's Thesis (V1-6).**
- 6323. Genetics and Molecular Biology of Prokaryotes (3:3:0).** Prerequisite: Core curriculum, GIID 6346 or consent of instructor. 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: Core curriculum, introductory courses in Immunology and Infectious Diseases, or consent of instructor. Lectures and discussions concerning the molecular analysis of mechanisms by which pathogenic bacteria produce infections. The regulation and expression of virulence factors are emphasized. The course also includes writing an NIH-styled grant proposal. Students may choose to write their proposals on any virulence related subject. They are also required to present and successfully defend their proposals.
- 6325. Advances in Virology (3:3:0).** Prerequisite: Core curriculum, GIID 6347, or consent of instructor. Covers a broad range of topics including virus/host interactions, molecular pathogenesis of latent, persistent or cytolytic virus infections, and research strategies to treat and prevent viral infections.
- 6329. Advances in Immunology (3:3:0).** Prerequisite: Core curriculum, Cellular and Molecular Immunology GIID 5340 or consent of the instructor. This 3 credit course provides students with an advanced course in the discipline of Immunology. The course includes the peer review process as it relates to specific aspects of Immunology and includes Immunologic based investigations in the fields of cancer, host defense, and infectious diseases. The course is literature driven utilizing both manuscripts and research proposals as examples to understand the peer review process and attempts to bridge the gap between the textbook and the literature. Both written oral participation by the students on specialized topics is required. Students will participate in the process of manuscript revision and mock scientific review processes associated with government review panels and will be responsible for a written research proposal based on the present NIH R01 format.
- 6330. Vaccine Development (3:3:0).** Prerequisite: Core curriculum, general immunology or consent of the instructor. This course will cover important steps involved in vaccine

development, including antigen discovery, efficacy testing in animal models, process development, pre-clinical development and vaccination strategies. This course will combine classroom sessions by TTUHSC professors and expert vaccinologists with instructor-assigned self-reading.

- 6335. The Pathogenesis of Infectious Disease (3:3:0).** Prerequisite: Core curriculum, introduction courses in Immunology and Infectious Diseases or consent of the instructor. A study of the processes by which microorganisms produce disease in humans and how the host responds. The bacterial, mycological and parasitic aspects of infectious disease will be taught. Students will be expected to understand all major bacterial, fungal, and parasitic diseases. Students must understand the mechanisms by which the virulence factors of these organisms allow them to cause their respective diseases.
- 6340. Mucosal Immunology (3:3:0).** Prerequisite: Core curriculum, Cellular and Molecular Immunology (GIID 5340) or consent of instructor. This 3 hour credit course provides students with an advanced course in the discipline of mucosal immunology. This course will utilize didactic lectures, literature reviews and faculty-led discussions to expose the students to basic concepts of mucosal immunology with particular emphasis on the intestinal immune system. Both written and oral participation by the students on specialized topics is required. Students will select and present various cutting-edge topics in mucosal immunology as well as submit a written review on a current topic related to mucosal immunology.
- 6346. Medical Bacteriology (3:3:0).** Prerequisite: Core curriculum or consent of instructor. A study of classification, structure, virulence and microorganisms that cause human disease and the ways to control these organisms.
- 6347. Medical Mycology, Parasitology, and Virology (3:3:0).** Prerequisite: Core curriculum or consent of instructor. 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. The biology of fungi, parasites and viruses that cause human disease, the epidemiology and control of infections will be taught. Students will be expected to understand the major organisms and viruses.
- 7000. Research (V1-12).**
- 7101. Immunology and Infectious Diseases Seminar (1:1:0).** Prerequisite: GSBS 5174 or consent of instructor. Weekly seminar series designed to provide training in research data presentation and analysis. This course will allow students to develop their presentation skills by providing experiences in both written and oral communication, presentations, and critiques. Use of visual aid equipment and software is mandatory.
- 8000. Doctoral Dissertation (V1-12).**

Pharmaceutical Sciences (GPSC)

Thomas Abbruscato, Ph.D., GSBS Associate Dean,
Graduate Advisor

Thomas Abbruscato, Ph.D., Chair, Pharmaceutical
Sciences

Junxuan Lu, Ph.D., Chair, Biomedical Sciences

Primary Faculty: Abbruscato, Ahsan, Bickel, Cucullo,
Karamyan, Karbowniczek, Liu, Lu, Lockman, Markiewski,
Mehvar, Smith, Srivastava, Srivenugopal, Stoll,
Thekkumkara, Trippier, M. Wang, Weidanz, Weis, R.
Zhang

Joint Faculty: Wright

Associate Faculty: Gunaje, Kwon, Leff, Mark, Moridani

About the Program

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 biology, biochemistry, pathophysiology, immunology and cancer therapy, toxicology, and medicinal chemistry. 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. 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 teresa.carlisle@ttuhsc.edu.

GPSC Courses:

- 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 pharmaceutics for the development of formulations that are stable and therapeutically effective.
- 5220. Drugs of Abuse (2:2:0).** This course is designed to teach the pharmacology of different classes of abused drugs and the physiologic and societal aspects of addiction. Course Prerequisite: Biochemistry, Principles of Drug Action and Physiology-based Pharmacology.
- 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.
- 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.
- 5312. Toxicology (3:3:0).** This course is designed to familiarize students with the general principles of toxicology. Course Prerequisite: Biochemistry and Principles of Drug Action. In addition, though not required, the completions of Pharmacology is recommended.
- 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.

- 5329. Basic Pharmacokinetics (3:3:0).** Course Prerequisite: Principles of Drug Action. Fundamentals of the kinetics of drug absorption, distribution, and elimination, with particular emphasis on application to design of dosage regimens.
- 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.
- 5504. Principles of Drug Action (5:5:0).** This introductory course is designed to facilitate understanding of fundamental concepts relating to drug action. It covers basic principles of pharmacology, toxicology, and medicinal chemistry. Course prerequisites include the admission to the Pharmaceutical Sciences Graduate Program, and students must have passed GPSC 5610 General Biochemistry.
- 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).

Pharmacology and Neuroscience (GPHM)

Reid L. Norman, Ph.D., Chairperson for the School of Medicine Department of Pharmacology and Neuroscience
Michael Blanton, Ph.D., GSBS Associate Dean, Graduate Advisor

Primary Faculty: Bergeson, Blanton, Das, Dickerson, Escamilla, Freeman, Grammas, Henderson, Kruman, Lombardini, Mahimainathan, Momeni, Norman, Perez, Popp, Roghani, Syapin, Tenner, Wu, Xu, Young
Joint Faculty: Kang
Associate Faculty: Artigas, Jansen, Reynolds
Adjunct Faculty: Reilly

About the Concentration

The objective is to prepare students for careers in research and teaching. The faculty of the concentration seeks to foster a creative and productive research atmosphere, to provide encouragement and positive challenges, 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 aging, biochemical and behavioral pharmacology, circadian pharmacology, neuropharmacology, and molecular pharmacology. In addition, the SOM Pharmacology and Neurosciences department houses the South Plains Alcohol and Addiction Research Center (SPAARC), a team of graduate faculty and other investigators with research interests focused on all aspects of drug use. For more information: <http://www.ttuhsu.edu/som/pharmacology>.

GPHM Courses:

- 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).** 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 (V1-8).**
- 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 course will enhance student skills in scientific public speaking through a series of seminars that are critiqued by the Department of Pharmacology & Neuroscience faculty. Weekly seminars are designed to provide training in research data presentation and analysis or critical evaluation and presentation of a manuscript in press. A required course for pharmacology and neuroscience graduate students, it is taken during the fall and spring semesters. The course is designed such that students must interact by participating in the questions and answer component of all seminars as well as during lunch with invited speakers. Grades are determined by faculty evaluation of seminar presentation, and by participation during seminars.
- 8000. Doctoral Dissertation (V1-12).**