

BIOMEDICAL SCIENCES (BMS)

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GRADUATE STUDY IN BIOMEDICAL SCIENCES

The Department of Biomedical Sciences offers a program of study culminating in the Ph.D. degree. Completion of this program prepares individuals for research careers in academia, institutes or industry.

The program is flexible and fosters a multi-disciplinary approach using our research, courses and facilities, as required, to cater to the career needs and research interests of individual students, in providing research training in a diverse range of areas of study in:

- Biochemistry
- Bioorganic Chemistry
- Cell
- Development Biology
- Immunobiology
- Molecular Biology
- Neurobiology
- Physiology

Some examples of the wide variety of research specialties of the faculty are: design, chemical synthesis, theoretical and spectroscopic characterization of analogs of regulatory peptides; the role of peptides in the regulation of gastrointestinal and cardiovascular functions, regulation of bone cell differentiation and function and promotion of cancer; immunobiology or pulmonary and vascular diseases; signal transduction in carcinogenesis; the molecular biology of collagen synthesis; the regulation of gene expression; the engineering of allosteric RNA catalysts for regulation of mRNA splicing; the cellular and genetic basis for differentiation of the brain and cardiovascular system; comparative neuroanatomy; respiratory mechanics and control; and environmental physiology. The Department encourages collaborative research interaction with faculty in the Departments of Pharmacology, Medicine and Surgery the Osteoporosis Research Center, The Boys Town National Research Hospital and the Veteran's Administration Hospital. The program is geared towards integration of structure and function, from cells to the organismic level. Students are educated mainly through participation in research, so emphasis is given to placing students in their research laboratories in the first semester. Didactic courses will be selected from cores of foundation and advanced courses, as required, to meet the educational needs of individual students and to support the training in their selected areas of research. For example, it is expected the students will take lectures in fundamentals of biochemistry and cell and molecular biology, in either course BMS 521 or course BMS 604 and Introduction to Biostatistics and its Applications (BMS 525), taking into consideration past coursework taken by the student as well as the depth of a particular subject required for the selected area of research. Other foundation courses include: Physiology (BMS 601), Human Neuroanatomy (BMS 624), and Cytochemistry and Histochemistry (BMS 627).

The Advisory Committee will determine which foundation courses are most appropriate and can also determine that any course need not be taken depending on the previous education of the student and the research area chosen. The Advisory Committee will similarly select courses from our core of more specialized or advanced courses, including Proteins: Peptides (BMS 720), Advanced Cell Biology (BMS 703) and Advanced Molecular Biology (BMS 704), The Cardiovascular System (BMS 641), Cancer Biology (BMS 705), Molecular Genetics (BMS 706), Physiology of Smooth Muscle (BMS 636), and Advanced Gastrointestinal Physiology (BMS 721), so as to best meet the research training objectives for the individual student. Thus, the Committee will play a major role both when preparing the initial Plan of Study and when responding to any further course needs arising during the progress of the student in the program. Students in the Biomedical Sciences program may also register for didactic courses of the Pharmacology and Medical Microbiology graduate programs, including the receptor pharmacology course (PHR 711), recent advances in Immunopharmacology of Allergic diseases (MIC 737) and Transmembrane Signaling Pathway (MIC 747).

A compulsory core of research courses includes: Directed Independent Research (BMS 795), Seminar (BMS 791), and either Master's (BMS 799) or Doctoral (BMS 899) Dissertation. The Graduate School requires all students to take the Responsible Conduct of Research course (IDC 601).

Program Goals

At the completion of their graduate program, the student will:

1. Demonstrate an appreciation for the use of specialized knowledge in a field of study in service to others;
2. Identify and suggest possible solutions to ethical dilemmas that occur in their work and in their field of study;
3. Analyze, interpret, and critique advanced knowledge in structural and functional biology;
4. Effectively communicate research findings at scholarly fore and in the literature alike, both orally and in writing.

Faculty

Primary Faculty: *Professors:* Agrawal, Beisel, Brauer, Bruce, Hallworth, He, Lovas, McLaughlin, Murphy, Petzel, Quinn, Reidelberger, Yee; *Associate Professors:* Bergren, Hanson, Mackin, D. Nichols, Smith, Soukup; *Assistant Professors:* Gale, Meyer, Patterson, Pisarri, ; *Professor Emeritus:* Babin, Creek, Fishkin; *Lecturer:* Haver; *Adjunct Professor* Adrian; *Adjunct Associate Professor* Crapon de Caprona.

Secondary Faculty: *Professors:* Anderson, Cullen, Morley, Thomas; *Associate Professors:* Haynatzki, Knezetic, Lambert; *Assistant Professors:* Bajenova, Cosgrove, Govindarajan, Rocha-Sanchez, Strauss-Soukup, Xiao; *Contributed Service Assistant Professors:* Temporo, Wang.

Admission Requirements

1. A bachelor's degree or equivalent, preferably with satisfactory completion of course work in a biological, chemical or physical science.
2. A GPA of 3.0 overall.
3. GRE scores in the 50th percentile or above for the quantitative and verbal parts of the examination.
4. The Graduate School requires all students from countries in which English is not the native language to demonstrate competence in English by a score of 550 in the TOEFL (Test of English as a Foreign Language) examination or 80 on the Internet-based Test (iBT) at the graduate level.

Master of Science (M.S.) and Doctor of Philosophy (Ph.D.)

The general requirements of the Graduate School listed under Administration and Policies Governing Graduate Study are met.

-The student will select an advisor. The student and his/her advisor will formulate a plan of study which will be presented to an Advisory Committee formed by the student and supervisor. The Advisory Committee will assist the student during the entire program.

- Courses can be selected from the list below or from related subjects, according to the individual needs of the student.

Neither the M.S. nor the Ph.D. degree will be conferred upon any student with an overall GPA of less than 3.0.

Comprehensive Examinations

Students are required to pass comprehensive examinations according to the guidelines of the Graduate School.

Thesis/Dissertation

M.S. and Ph.D. candidates must present and defend a thesis or dissertation. The defense of the Ph.D. dissertation is open to the faculty but only the examining committee may participate directly in the examination. Copies of the thesis or dissertation are to be presented to committee members and the Graduate Dean at least 30 days prior to the defense.

BMS 521 Principles of Biochemistry (4) II

Fundamental principles of structural biochemistry, enzymology, metabolism and molecular biology. **P:** CHM 323 and 324 (organic) or equiv.; **Sr. or Gr. Stgd. only with IC.** This course is offered in spring semesters only.

- BMS 525 Introduction to Biostatistics and Its Applications** (3) II 2006-07, AY
Organizing and summarizing; elementary probability; sampling distributions, confidence intervals; hypothesis testing using parametric and non-parametric methods; sample size and power; regression and correlation; analysis of variance; experimental design principles and analysis. 3R.
- BMS 540 Nutrition Facts and Fads** (2) I
A nutrition course designed for people with health care interests emphasizing proper nutrition, omnivorous diets, and basic food science concepts. The inadequacies of food faddism and identification of bogus claims and “quackery” will also be considered. **P: A Basic BIO course or a BMS course or IC**
- BMS 541 Comparative Vertebrate Neuroanatomy** (4) OD
Study of the evolution of the vertebrate central nervous system, including historical and philosophical background, characteristics and trends within major radiations, and unsolved problems. 2R, 4L. **P: IC.**
- BMS 545 Dental Physiology** (5) I
Lectures in human physiology. 5R. **P: Dental Dean’s consent.**
- BMS 550 Appetite Control and Body Weight Regulation** (2) II
Study of the physiology of body energy (weight) regulation through the control of food intake and energy expenditure. Study of the pathophysiology and treatment of obesity. **P: BMS 404 or equiv. or IC.**
- BMS 601 Physiology** (5) II
Mammalian and human physiology. 4R. 2D. **P: Gr. Stdg.; background in chemistry, biology and physics.**
- BMS 602 Human Gross Anatomy** (7) I
Detailed structure of the human body. Dissection of the cadaver combined with conferences, lectures, and assigned readings. 4R, 9L. **P: Gr. Stdg. or IC.**
- BMS 604 Fundamentals of Cell and Molecular Biology** (credit by arrangement) I
Study of the functional aspects of cell and molecular biology with an emphasis on eukaryotic cells. **P: IC.**
- BMS 605 Molecular Endocrinology** (3) I
Study of the function of endocrine glands at the organismal, cellular and molecular level. 3C and D. **P: BMS 601 or equiv. or IC.**
- BMS 606 Proteins: Structure-Function Relationships** (4) II
Topics covered include primary structure, principles of secondary and tertiary structures, enzyme kinetics, chemical modifications and their effects, protein-protein interactions, protein complementation and prediction of conformation. Presentation and model building by students are integral parts of this course. 4R. **P: BMS 521 or 600 or equiv.**
- BMS 607 Enzymes** (4) I, AY
Classification and properties of enzymes, kinetics, activators and inhibitors. Study of selected enzymes to demonstrate general principles. 3R. **P: BMS 521 or 600 or equiv. and BMS 606.**
- BMS 608 Peptide Chemistry** (4) I, AY
A detailed study of the theoretical and practical aspects of peptide synthesis, isolation, purification and structure. **P: IC and BMS 521 or BMS 600 or equiv.**
- BMS 610 Bone Biology Fundamentals** (3) I, AY
This course will focus on fundamental aspects of skeletal biology to include the microscopic anatomy and ultrastructure of bone, morphogenesis and embryologic development of the skeletal system, bone modeling and remodeling, biomechanics of bone, skeletal physiology, mineral homeostasis, and clinical evaluation of bone and mineral disorders. **P: IC**
- BMS 611 Advanced Respiratory Physiology** (1-3) I, OD
Studies in selected topics in respiratory physiology. **P: BMS 601; IC.**

- BMS 612 Readings in Respiratory Physiology** (1) I, OD
Directed readings in respiratory physiology. **P: IC.**
- BMS 615 Regulation of Gastrointestinal Function** (3) I, OD
Endocrine and neural control of gastrointestinal functions including secretion, motility and absorption with particular emphasis on the role of recently discovered regulatory peptides. **P: IC.**
- BMS 616 Methods in Gastrointestinal Organ and Cellular Physiology** (3) I, II, OD
Methods in research of gastrointestinal function using acutely isolated cell systems (such as parietal cells, isolated gastric glands, dispersed pancreatic acini and isolated islets) and isolated, vascularly perfused organs. **P: IC.**
- BMS 617 Muscle Physiology and Biophysics** (3) II, OD
Mechanics, energetics, biochemistry, ultrastructure, and function of striated muscle. Comparative physiology of cardiac and smooth muscle, and of vertebrate and invertebrate contractile systems. 3 C & D. **P: BMS 601; IC**
- BMS 619 Readings in Renal Physiology** (1) OD
Directed readings in renal physiology. **P: IC.**
- BMS 620 Methods in Renal Physiology** (1) OD
Practical measurements of fluid and ion fluxes and their regulation. **P: IC.**
- BMS 621 Teaching Practicum in Gross Anatomy** (1-3) I
Practical experience in teaching human gross anatomy. **P: IC.**
- BMS 624 Human Neuroanatomy** (4) II
Examination of the fundamental structure and function of the human central nervous system. 2.5R, 1.5L. **P: Gr. Stgd. or IC**
- BMS 627 Cytochemistry and Histochemistry** (2-4) OD
Theory and applications of basic cytochemical and histochemical techniques. Students will be required to identify a problem involving the application of light or electron microscopic histochemical and cytochemical techniques for its solution. 2-6 D & L. **P: IC.**
- BMS 629 Anatomical Methods** (2) OD
Exploration of techniques commonly used in research. 2-4 D & L. **P: IC.**
- BMS 630 Hearing** (4) OD
Introduction to auditory science. **P: IC.**
- BMS 631 Auditory Physiology I: The Periphery** (4) OD
An advanced graduate level course focusing on the anatomy and physiology of the external, middle and inner ears. **P: IC.**
- BMS 632 Auditory Physiology II: Central Pathways** (4) OD
An advanced graduate level course focusing on the anatomy and physiology of the central auditory system. **P: IC.**
- BMS 633 Signals and Systems in Auditory Science** (2) OD
A consideration of fundamental technical aspects of tools commonly used in auditory research. **P: IC.**
- BMS 634 Regulation of Renal Physiology** (3) OD
The regulation of renal function; the control of renal hemodynamics and tubular transport. The roles of extracellular and intracellular messengers. Analysis of the effects of three membrane bound enzyme second messengers systems including adenylate cyclase, phospholipases A2 and C with respect to renal fluid and electrolyte balance. **P: IC.**
- BMS 635 Protein Sequence Analysis** (2) OD
This course will introduce students to the theory and practice of purification of peptides and proteins, preparation of samples for structural determination, amino acid sequence analysis by automated Edman degradation, amino acid compositional analysis and mass spectrometry. **P: IC.**

- BMS 636 Physiology of Smooth Muscle (3) II, AY**
The role of smooth muscle in control of cardiovascular, pulmonary and gastrointestinal function; how the physiology of the smooth muscle cell integrates neural, hormonal, autocrine and local influences at the cellular level. 3R, L and D. **P: IC.**
- BMS 640 Protein Chemistry (2) OD**
A survey course covering the properties and determination of protein structure, chemical and biochemical analysis, elements of protein function and examples of protein-protein and protein-nucleic acid interactions. **P: IC.**
- BMS 641 The Cardiovascular System (1-4) I**
A study of the physiology, histology, embryology, pharmacology, and pathophysiology of the cardiovascular system. The student may enroll for part or all of the course with the consent of the major advisor. R, L, D, Q. **P: IC**
- BMS 642 The Respiratory System (1-3) I**
A study of the physiology, histology, embryology, pharmacology, and pathophysiology of the respiratory system. The student may enroll for part or all of the course with the consent of the major advisor. R, L, D, Q. **P: IC**
- BMS 643 The Renal System (1-3) I**
A study of the physiology, histology, embryology, pharmacology, and pathophysiology of the renal system. The student may enroll for part or all of the course with the consent of the major advisor. R, L, D, Q. **P: IC**
- BMS 644 The Gastrointestinal System (1-3) II**
A study of the physiology, histology, embryology, pharmacology, and pathophysiology of the gastrointestinal system. The student may enroll for part or all of the course with the consent of the major advisor. R, L, D, Q. **P: IC**
- BMS 645 The Endocrine System (1-2) II**
A study of the physiology, histology, embryology, pharmacology, and pathophysiology of the endocrine system. The student may enroll for part or all of the course with the consent of the major advisor. R, L, D, Q. **P: IC**
- BMS 646 The Reproductive System (1-2) II**
A study of the physiology, histology, embryology, pharmacology, and pathophysiology of the reproductive system. The student may enroll for part or all of the course with the consent of the major advisor. R, L, D, Q. **P: IC**
- BMS 703 Advanced Cell Biology (3) II, AY**
Detailed consideration of the functional aspects of cell biology with emphasis on eukaryotic cells. Topics include signal transduction, neuronal cell biology, synthesis, transport and processing of secretory proteins, extracellular matrix proteins, cell adhesions, and cytoskeleton. **P: IC**
- BMS 704 Advanced Molecular Biology (3) II, AY**
Detailed consideration of the structure, function and synthesis of DNA, RNA and proteins with emphasis on eukaryotic cells. Topics include DNA structure, transcription, translation, replication, recombinant DNA technology, eukaryotic viruses and control of cellular differentiation in normal and abnormal states such as cancer. **P: IC**
- BMS 706 Molecular Genetics (2) II, AY**
This course will include a review of the basic principles of genetics, a survey of medical and clinical genetics, and approaches to the identification of disease-causing genes. Special emphasis will be placed on methods and strategies for gene identification, linkage analysis and experimental design for identifying genes in humans and animal model systems. Issues associated with human genetics testing/screening and gene therapy will also be examined. 2R and D. **P: IC**
- BMS 707 Population Genetics (3) II, AY**
Consideration of the fundamentals of classical and modern population genetics. Topics include (but are not limited to) the Hardy-Weinberg Equilibrium, linkage disequilibrium, inbreeding, random genetic drift, mutations, selection, mutation-selection balance, population structure and coalescent theory for DNA sequence analyses. 3R. **P: Advanced undergraduate course in genetics and basic knowledge of statistics and probability theory or IC.**

- BMS 710 Bone Biology- Advanced Topics (3)**
This course will focus on molecular, clinical, epidemiological, genetic, and cellular aspects of bone biology, and introduce methodology used in skeletal research.
- BMS 720 Molecular Modeling of Peptides (3) I**
Fundamental principles of molecular mechanics and molecular dynamics. Introduction to computational techniques used in molecular modeling. Building a molecular model of selected peptides by students using state-of-the-art molecular modeling systems is an integral part of this course. R, L. **P: IC**
- BMS 721 Advanced Gastrointestinal Physiology (1) I**
Detailed analysis of the physiology of the gastrointestinal tract. This course will meet one hour per week over a three-year period covering six semesters. **P: Gr. Stgd.; IC.**
- BMS 790 Research Methods (3-5) I, II**
Methods and techniques used in on-going research projects. 3-5L. **P: IC.**
- BMS 791 Seminar (2) I, II**
Formal oral presentations and critical discussions of assigned subjects to familiarize students with the nature and extent of research literature, the analysis of research papers, and the collation and presentation of scientific information. **P: DC.**
- BMS 792 Journal Club (1) I, II**
Directed independent study involving readings and presentations of current physiological literature, followed by group discussion involving students and faculty members. This course is repeatable.
- BMS 794 Cell Physiology (2) I, II, OD**
Detailed discussions of fundamental principles of cell physiology. Emphasis on the regulation of cellular homeostasis by way of the analysis of extracellular and intracellular signaling pathways. The course will be based on discussions of assigned readings. **P: IC**
- BMS 795 Directed Independent Study (2) I, II, S**
Each student, supervised by faculty members, will pursue in-depth reading and discussions on current research topics of interest to faculty and students. The purpose is to provide an environment whereby the student is introduced to scientific research methods and can improve critical thinking and reading skills as well as exchanging scientific information. **P: IC.**
- BMS 797 Directed Independent Research (3-6) I, II, S**
Original investigation under supervision and guidance of individual staff members. Laboratory and conferences. **P: IC.**
- BMS 799 Master's Dissertation (1-3) I, II, S**
Review of the literature and research data; writing of the thesis. Students must register for this course in any term when engaged in formal preparation of the Master's thesis; however, six credit hours are the maximum applicable toward the degree. **P: IC.**
- BMS 899 Doctoral Dissertation (3-6) I, II, S**
Review of the literature and research data; writing of the dissertation. Students must register for this course in any term when engaged in formal preparation of the doctoral dissertation; however, twenty credit hours are the maximum applicable toward the degree. **P: IC.**