BIOMEDICAL SCIENCES (BMS)

Program Director: Philip R. Brauer
Department Office: Criss II, Room 313

GRADUATE STUDY IN BIOMEDICAL SCIENCES

The Department of Biomedical Sciences offers programs of study culminating in the Ph.D. and M.S. degrees. Completion of the programs prepares individuals for research careers in academia, institutes, or industry. The programs are flexible and employ a multi-disciplinary approach using our research, courses, and facilities to cater to the career needs and research interests of the individual student, in diverse areas of study in:

Biochemistry and Bioorganic Chemistry

Bone Biology

Cancer Biology

Cell and Developmental Biology

Molecular Biology and Gene Regulation

Neurobiology

Physiology

Pulmonary and Vascular Biology

Some examples of the variety of research specialties of the faculty are: design, chemical synthesis, theoretical and spectroscopic characterization of regulatory peptide analogs; the role of peptides in the regulation of gastrointestinal and cardiovascular functions; regulation of bone cell differentiation and function; cancer biology and signal transduction in carcinogenesis; inflammation and asthma; arteriosclerotic and restenotic diseases; the regulation of gene expression; ribozyme, riboswitch and small RNA regulation of gene expression; the cellular and genetic basis for differentiation of the brain and cardiovascular system; comparative neuroanatomy; neurophysiology; signal transduction in hearing and hearing disorders; and respiratory mechanics and control. The Department encourages collaborative research interaction with faculty in the Departments of Biology, Physics, Chemistry, Pharmacology, Medical Microbiology and Immunology, Medicine, Surgery, the Osteoporosis Research Center, the Boys Town National Research Hospital, and the Veteran's Administration Hospital.

Students are trained mainly through participation in research, thus emphasis is given to placement of students in research laboratories early in their program. A faculty advisory committee will determine the foundation and elective courses most appropriate and that best meet the individual's training. A compulsory core of research courses includes: Fundamentals of Cell and Molecular Biology (BMS 604), Responsible Conduct of Research (IDC 601), Seminar (BMS 791), Journal Club (BMS 792), and either Master's Thesis (BMS 799) or Doctoral Dissertation (BMS 899). In addition, students are required to take at least 9 credit hours (Ph.D. program) or 6 credit hours (M.S. program) from a list of advanced courses. Students may also register for graduate courses offered in other departments and programs with the approval of their advisory committee.

Program Goals

At the completion of this graduate program in Biomedical Sciences, students will:

1. Demonstrate advanced knowledge in molecular and cellular biology and in their field of specialization.
2. Demonstrate independent critical and analytical thinking, both within their field of study and beyond, for use in the service to others.
3. Identify and suggest possible solutions to ethical dilemmas that occur in their work and field of study, and understand the importance of professional ethics in all aspects of scientific communication and laboratory work.
4. Demonstrate competence in the laboratory, including application of the scientific method and appropriate use of basic and state of the art laboratory tools and techniques.
5. Demonstrate written and oral skills necessary for communication of research, knowledge, and ideas to scientists and non-scientists.

Faculty

Primary Faculty: *Professors*: D. Agrawal, K. Beisel, P. Brauer, L. Bruce, D. Cullen, R. Hallworth, D. He, S. Lovas, D. Petzel, T. Quinn, R. Reidelberger, J. Yee; *Associate Professors*: D. Bergren, L. Hansen, R. Mackin, D. Nichols, D. Smith, G. Soukup; *Assistant Professors*: H. Gale, R. Meyer, E. Patterson, T. Pisarri; *Resident Assistant Professors*: G. Jia; Z. Shao;

Secondary Faculty: *Professor*: M. Hulce; *Associate Professors*: D. Cosgrove, V. Govindarajan, A. Kincaid, J. Knezetic, M. Nichols, J. Soukup, J. Threlkeld, G. Wang; *Assistant Professors*: S. Rocha-Sanchez, P. Xiao, G. Xiao, L. Zhao.

Emeritus Faculty: R. Andrews, D. Babin, H. Badeer, R. Creek, R. Murphy, D. Watt, I. Wells.

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.
5. M.S. applicants must identify a faculty member to serve as major advisor as part of the application.

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

All students must meet the general requirements of the Graduate School listed under Administration and Policies Governing Graduate Study. In addition:

1. The student will select a major advisor and the student and his/her major advisor will formulate a plan of study that will be presented to an advisory committee formed by the student and major advisor. The advisory committee will assist the student during the entire program.
2. Courses can be selected from the list below or from related subjects, according to the individual needs of the student with the approval of the student's advisory committee.

The deadline for applications to the doctoral program is normally January 15th for admission in the fall semester.
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

Doctoral students are required to pass comprehensive and qualifying 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 is open to the public, but only the examining committee may participate directly in the examination. Copies of the thesis or dissertation are to be presented to their advisory committee and the Graduate Dean at least 30 days prior to the defense.

BMS 521 **Principles of Biochemistry** (4) II
This course examines the fundamental principles of structural biochemistry, enzymology, metabolism and molecular biology. **P: CHM 323 and 324 (organic) or equiv.; Sr. or Gr. Stdg. only with IC.**

BMS 601 **Human Physiology** (4) II
This course examines basic concepts of cellular physiology and organ system physiology of the nervous, endocrine, reproductive, muscle, cardiovascular, respiratory, gastrointestinal, and renal systems, as well as multisystem integration. **P: Gr. Stdg. or IC.**

BMS 602 **Human Gross Anatomy** (6) I
This course examines the detailed structure of the human body, including dissection of the cadaver, combined with conferences, lectures, and assigned readings. **P: Gr. Stdg. or IC.**

BMS 603 **Microscopic Anatomy** (4) I
This course provides a comprehensive examination of the light microscopic anatomy and ultrastructure of cells, tissues, and organs. A combination of lectures, discussions, and laboratories is employed with a major focus on a laboratory experience using the light microscope. **P: Gr. Stdg. or IC.**

BMS 604 **Fundamentals of Cell and Molecular Biology** (6) I
This course consists of lectures on the functional aspects of cell and molecular biology with an emphasis on eukaryotic cells. **P: IC.**

BMS 605 **Fundamentals of Genetics and Molecular and Cellular Pathology** (2) I
This course is an introduction to fundamentals in patterns of inheritance, genetic diseases, cytogenetics, cell injury, and neoplasia. Topics will include Mendelian genetics and genetic diseases, cytogenomics, use of online genomic databases, wound healing, and molecular basis of neoplasia as well as basic principles of pathology. **P: Gr. Stdg. 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. **P: BMS 521 or 600 or equiv.**

BMS 610 **Bone Biology Fundamentals** (3) I, AY
This course examines fundamental aspects of skeletal biology, including 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 621 **Teaching Practicum in Gross Anatomy** (3) I
This course provides practical experience in teaching human gross anatomy. **P: IC.**

BMS 624 **Human Neuroanatomy** (4) II
This course consists of examination of the fundamental structure and function of the human central nervous system. **P: Gr. Stdg. or IC.**

BMS 630 **Fundamentals of Hearing** (3) I, II, S
This is an advanced graduate level course focusing on the anatomy and physiology of the auditory system. The course will introduce students to the basics of normal human hearing with a focus on the peripheral auditory system, neural coding of sound, and the perception of simple sounds. **P: Gr. Stdg. or IC.**

BMS 660 **Introduction to Systems Biology** (3) II
This course presents a quantitative description of both metabolic networks and the molecular signaling pathways controlling the various phenotypes of living cells. Topics include an introduction to high-throughput technologies for genomics, epigenomics/ epigenetics, transcriptomics, interferomics (RNA interference), proteomics, and metabolomics, as well as applications to biomarker discovery and drug development. **P: IC.**

BMS 667 **Developmental Biology** (3) II
This course covers cellular and molecular events underlying animal development and cell differentiation in vertebrate and invertebrate organisms. Topics will include the early body plan, cell determination and diversity, organogenesis, morphogenesis, and stem cells, and includes vertebrate (mouse, chick, frog, fish, human) and invertebrate (fly, worm) models. **P: Gr. Stdg. or IC.**

BMS 703 **Advanced Cell Biology** (3) II, AY
This course consists of 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
This course consists of 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 705 **Advanced Neuroscience** (3) I, AY
This course consists of detailed examination of the physiology, cell biology, and molecular biology of the nervous system, with emphasis on mammalian systems. The course will include membrane physiology, ion channels, synaptic physiology, neurotransmitters and receptors, sensory receptors, neural circuits, and advanced techniques. **P: IC.**

BMS 720 **Advanced Topics in Molecular Structure/Function** (3) I, II, S
This course covers functional aspects of molecular structure, peptide chemistry, and molecular interactions. Topics vary will change with each iteration of the course permitting students to repeatedly enroll in the course but with each covering a different topic. Nine credit hours are the maximal applicable toward the degree. **P: IC.**

BMS 730 **Advanced Topics in Cell and Molecular Biology** (3) I, II, S
This course covers functional aspects of eukaryotic cells including gene regulation/expression, signal transduction, and cell-cell and cell-substrate interactions. Topics vary will change with each iteration of the course permitting students to repeatedly enroll in the course but with each covering a different topic. Nine credit hours are the maximal applicable toward the degree. **P: IC.**

BMS 740 **Advanced Topics in Physiology** (3) I, II, S
This course covers specific aspects of physiology and pathophysiology of whole organisms and organ systems as well as cellular physiology. Topics vary will change with each iteration of the course permitting students to repeatedly enroll in the course but with each covering a different topic. Nine credit hours are the maximal applicable toward the degree. **P: IC.**

BMS 747 **Cellular and Molecular Mechanisms of Transmembrane Signaling** (3) I, II, S
Detailed analysis of how an external signal is transduced into a cell language resulting in a response. Intracellular pathways involved in signal transduction will be examined. Discussions on various cell proteins and cross-talk among intracellular signal transduction pathways. **P: IC.**

BMS 750 **Advanced Topics in Morphology and Anatomy** (3) I, II, S
This course covers functional morphology ranging from cellular ultrastructure to gross anatomy and embryology. Topics vary will change with each iteration of the course permitting students to repeatedly enroll in the course but with each covering a different topic. Nine credit hours are the maximal applicable toward the degree. **P: IC**.

BMS 760 **Advanced Topics in Neuroscience** (3) I, II, S
This course integrates the areas of neuroanatomy, neurophysiology, neuropharmacology, and neuropathology at both the cellular and organismal level. Topics vary will change with each iteration of the course permitting students to repeatedly enroll in the course but with each covering a different topic. Nine credit hours are the maximal applicable toward the degree. **P: IC.**

BMS 790 **Research Methods** (3-5) I, II
Methods and techniques used in on-going research projects. **P: IC.**

BMS 791 **Seminar** (1) I, II
This course consists of 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. This course is repeatable. **P: DC.**

BMS 792 **Journal Club** (1) I, II
This course consists of readings and presentations of current scientific literature, followed by group discussion involving students and faculty members. This course is repeatable. **P: DC.**

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
This course consists of original investigation under supervision and guidance of individual staff members. **P: IC.**

BMS 799 **Master's Dissertation** (1-3) I, II, S
This course consists of 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
This course consists of review of the literature and research data and the 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.**

BIOSCIENCE MANAGEMENT (MBS)

Program Director: Deborah Wells
Program Office: College of Business Administration

PROFESSIONAL SCIENCE MASTER'S DEGREE

The Professional Science Master's in Bioscience Management is an interdisciplinary program offering graduate students and working professionals the opportunity to study the business of science. Increasingly, bioscience industry employers are seeking science-trained professionals with an understanding of business, including skills in project management, team building, marketing, finance, and communication. This degree provides graduates with a multi-disciplinary advantage in today's highly competitive job market.

Program Goals

Students who complete the M.S. in Bioscience Management will

1. Understand the process of technology commercialization in the biosciences, including intellectual property protection, regulation, clinical trials, marketability analysis, branding, pricing, financing, licensing, business formation, and management.
2. Be able to develop business plans for commercializing new bioscience products and services.
3. Be well-versed in current issues, developments and techniques in the biological sciences, including the fields of microbiology, genetics, biochemistry, biotechnology, drug development, and biological systems.
4 Develop the leadership and interdisciplinary teaming skills required to be successful in a context that combines science and business.

Faculty

Professors: N. Hanson, R. Moorman;
Associate Professors: W. Duckworth, W. Hamilton, M. Reedy, A. York;
Assistant Professors: P. Raval, K. van Dijk, T. Wachner;
Adjunct Professors: M. Ahn, H. Runge, M. Dixon, W. Watts.