

Biological Sciences (BSCI)

Chairperson: Edward Blumenthal, Ph.D.

Department of Biological Sciences website (<http://www.marquette.edu/biology/graduate-studies.shtml>)

Degrees Offered

Master of Science, Plan A only; Doctor of Philosophy

Program Description

The biological sciences graduate program aspires to train experimental scientists capable of teaching and directing independent research by providing a broad theoretical background and an appreciation for the rigor of the scientific method. This program provides excellent training in modern biology suitable for jobs in academia, industry and government, and offers students research experiences using all areas of modern biological techniques to study molecular, cellular, tissue, organ, systems and organism functioning.

Prerequisites for Admission

Applicants are expected to have completed a bachelor's degree in biology or related field. As a general rule, strong preference is given to applicants to the doctoral program. Only in exceptional circumstances are students admitted to the master's program. A master's degree is not a prerequisite for admittance to the doctoral program.

Application Deadline

Although no official deadline exists for the master's or the doctoral programs, completed applications should be received by December 15th for full consideration. Applications for admission received after this date are considered as space permits.

Application Requirements

Applicants must submit, directly to the Graduate School:

1. A completed application form and fee online (http://marquette.edu/grad/future_apply.shtml).
2. Copies of all college/university transcripts except Marquette.¹
3. A statement of professional goals and aspirations.
4. Three letters of recommendation that give evidence of the applicant's scholarly promise.
5. GRE scores (General Test is required, Subject Test is recommended).
6. (For international applicants only) a TOEFL score or other acceptable proof of English proficiency.

¹ Upon admission, final official transcripts from all previously attended colleges/universities, with certified English translations if original language is not English, must be submitted to the Graduate School within the first five weeks of the term of admission or a hold preventing registration for future terms will be placed on the student's record.

Biological Sciences Master's Requirements

Specializations: Biochemistry, Cell Biology, Developmental Biology, Ecology, Genetics, Microbiology, Molecular Biology, Neurophysiology, Physiology

The program of course work and research for the master's degree is determined in consultation with the student's advisory committee. Each student is advised to take such courses as are properly related to academic background and research interests. All master's students are required to gain the equivalent of one year of teaching experience during the program.

A master's student must complete a total of 26 credit hours: a minimum of twelve credit hours of graduate course work as listed below, five credits hours of research taken in the first two years, three credit hours of seminar courses, and six credit hours of thesis work. Eighteen of the 26 credit hours must be taken in biological sciences. During each term in residency, master's students are also required to enroll in BIOL 6952 Department Colloquium.

Master's students must submit a thesis outline to their advisory committee and successfully defend the outline. This defense constitutes the qualifying exam. At the completion of the program, master's students must submit a thesis that is approved by their advisory committee and must present a public seminar on their thesis research.

Required course work:

Course work selected from the following:

BIOL 5101	Biochemistry and the Molecular Basis of Biology
BIOL 5201	Genomics and Bioinformatics

BIOL 5401	Advanced Ecology	
BIOL 5403	Tropical Ecology in Panama	
BIOL 5703	Exercise Physiology	
BIOL 5806	Immunobiology	
BIOL 6011	Advanced Concepts in Genetics and Cell Biology	
BIOL 6012	Advanced Concepts in Cell Biology and Biochemistry	
BIOL 8101	Protein Structure and Function	
BIOL 8102	Biochemistry and Function of Nucleic Acids	
BIOL 8201	Epigenetics	
BIOL 8202	Principles of Eukaryotic Genetics	
BIOL 8301	Imaging and Cytoskeletons	
BIOL 8302	Protein Trafficking and Organelle Identity in Eukaryotic Cells	
BIOL 8401	Molecular Evolution	
BIOL 8501	Molecular and Cellular Signaling	
BIOL 8502	Systems Neuroscience	
BIOL 8504	Advanced Survey in Neuroscience	
BIOL 8506	Cellular Neurophysiology	
BIOL 8520	Behavioral Neuroendocrinology	
BIOL 8530	Glutamate Neurotransmission	
BIOL 8601	Stem Cell Biology	
BIOL 8603	Cell and Molecular Biology of Early Development	
BIOL 8702	Muscle Biology	
BIOL 8704	Cellular Homeostasis	
BIOL 8801	Prokaryotic Molecular Genetics	
BIOL 8802	Microbiology in the Environment	
BIOL 8803	Microbial Diversity and Ecology	
BISC 5140	Functional Neuroanatomy	
MSCS 5610	Data Mining	
MSCS 5720	Statistical Methods	
MSCS 5740	Biostatistical Methods and Models	
PSYC 8101	Advanced Statistics and Design 1	
Required research credits:		5
BIOL 6096	Laboratory Rotations in Biology	
BIOL 6097	Laboratory Research in Biology	
Seminar courses selected from:		3
BIOL 6005	Scientific Writing Workshop	
BIOL 8953	Seminar in Biochemistry and Genetics	
BIOL 8954	Seminar in Plant Molecular Biology	
BIOL 8955	Seminar in Neuroscience	
BIOL 8956	Seminar in Cell and Developmental Biology	
BIOL 8957	Seminar in Physiology	
BIOL 8958	Seminar in Ecology and Evolutionary Biology	
Thesis work:		6
BIOL 6999	Master's Thesis	
Total Credit Hours		26

Biological Sciences Doctoral Requirements

Specializations: Biochemistry, Cell Biology, Developmental Biology, Ecology, Genetics, Microbiology, Molecular Biology, Neurophysiology, Physiology

The program of course work and research for the doctoral degree is determined in consultation with the student's advisory committee. Each student is advised to take such courses as are properly related to academic background and research interests. All doctoral students are required to gain the equivalent of one year of teaching experience during the program.

A doctoral student must complete a program of study, defined in conjunction with their advisory committee, on an approved Doctoral Program Planning Form. Advancement to candidacy for the doctoral degree is considered following successful completion of the lecture course work specified in the Doctoral Program Planning Form and after passing the qualifying exam. Following advancement to candidacy, students must submit a Dissertation Research Plan that is approved by their advisory committee.

A typical doctoral student completes a minimum required 24 credit hours of course work and 12 credit hours of dissertation work. Course work includes a minimum of seven 2-3 credit graduate lecture courses, 5 credits of research, and 5 one-credit seminar courses. Students must take BIOL 6005 Scientific Writing Workshop as one of their five seminar courses. All students must enroll in BIOL 6952 Department Colloquium during each term in residence.

The student must submit and defend a dissertation and present a public research seminar after completing all other formal requirements for the doctoral degree.

Seven Lecture courses selected from the following: 14-21

BIOL 5101	Biochemistry and the Molecular Basis of Biology
BIOL 5102	Experimental Molecular Biology
BIOL 5201	Genomics and Bioinformatics
BIOL 5401	Advanced Ecology
BIOL 5403	Tropical Ecology in Panama
BIOL 5703	Exercise Physiology
BIOL 5806	Immunobiology
BIOL 6011	Advanced Concepts in Genetics and Cell Biology
BIOL 6012	Advanced Concepts in Cell Biology and Biochemistry
BIOL 8101	Protein Structure and Function
BIOL 8102	Biochemistry and Function of Nucleic Acids
BIOL 8201	Epigenetics
BIOL 8202	Principles of Eukaryotic Genetics
BIOL 8301	Imaging and Cytoskeletons
BIOL 8302	Protein Trafficking and Organelle Identity in Eukaryotic Cells
BIOL 8401	Molecular Evolution
BIOL 8601	Stem Cell Biology
BIOL 8603	Cell and Molecular Biology of Early Development
BIOL 8702	Muscle Biology
BIOL 8704	Cellular Homeostasis
BIOL 8801	Prokaryotic Molecular Genetics
BIOL 8802	Microbiology in the Environment
BIOL 8803	Microbial Diversity and Ecology
BIOL 8995	Independent Study in Biological Sciences
BISC 5140	Functional Neuroanatomy
MSCS 5610	Data Mining
MSCS 5720	Statistical Methods
MSCS 5740	Biostatistical Methods and Models
PSYC 8101	Advanced Statistics and Design 1

Required Research courses: 5

BIOL 6096	Laboratory Rotations in Biology
BIOL 6097	Laboratory Research in Biology

Required Seminar course: 1

BIOL 6005	Scientific Writing Workshop
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Additional 1-credit Seminar courses selected from the following: 4

BIOL 8953	Seminar in Biochemistry and Genetics
BIOL 8954	Seminar in Plant Molecular Biology
BIOL 8955	Seminar in Neuroscience
BIOL 8956	Seminar in Cell and Developmental Biology
BIOL 8957	Seminar in Physiology
BIOL 8958	Seminar in Ecology and Evolutionary Biology

Required dissertation credits:

12

BIOL 8999	Doctoral Dissertation	
Total Credit Hours		36-43

Courses

BIOL 5101. Biochemistry and the Molecular Basis of Biology. 3 cr. hrs.

Major themes in biochemistry are examined in the context of mammalian physiology. Topics include: Protein structure and enzyme catalysis, carbohydrate and lipid metabolism in relation to energy production, protein and nucleic acid synthesis, and the nature of the genetic code. 3 hrs. lec., disc.

BIOL 5102. Experimental Molecular Biology. 3 cr. hrs.

Purification, characterization and molecular analysis of proteins, nucleic acids, lipids and other biomolecules with emphasis on standard techniques widely used in research laboratories. 1 hr. lec., 4 hrs. lab. Prereq: BIOL 4101 or equiv.

BIOL 5201. Genomics and Bioinformatics. 3 cr. hrs.

The analysis of gene structure and genetic regulation in selected prokaryotes and plant and animal systems, as well as transgenic organisms. Introduction to the principles of bioinformatics and proteomics as applied to genome comparisons and protein structure and function. Models and algorithms for predictions of the biological properties of genetically modified nucleotide sequences and proteins.

BIOL 5401. Advanced Ecology. 3 cr. hrs.

Studies the interactions of organisms with each other and their abiotic environments beyond the introductory level. Both mathematical models and the evolutionary genetics involved in ecologically important traits are emphasized. Ecological concepts in current and classical scientific literature are explored. Mathematical and computer models are used to analyze and understand ecological interactions and processes in population, community, ecosystem and evolutionary ecology. These are combined with advanced concepts in population and ecological genetics. 3 hrs. lec, disc.

BIOL 5403. Tropical Ecology in Panama. 3 cr. hrs.

Tropical Ecology is the study of the biotic and abiotic interactions that shape the origin, maintenance and consequences of species diversity in the tropics. The incredibly high species diversity found in tropical forests has intrigued biologists for centuries, including such luminaries as Darwin and Wallace and continues to engage biologists today. Explores a variety of different forest types within the Republic of Panama to gain an appreciation for the basic patterns and processes of tropical forests and the mechanisms believed to be responsible for them. Modeled after the Organization for Tropical Biology's Tropical Ecology Field Course.

BIOL 5703. Exercise Physiology. 3 cr. hrs.

Study of the effects of acute and chronic exercise on selected organ systems. Particular emphasis will be placed on muscle, cardiovascular, respiratory, and environmental physiology.

BIOL 5806. Immunobiology. 3 cr. hrs.

Cellular and molecular mechanisms of the immune response. Nature of antigens and antibodies and their interactions. Special topics include complement, immediate and delayed hypersensitivity, transplantation and tumor immunobiology, immunosuppression, and immunological tolerance. 3 hrs. lec., disc.

BIOL 6001. Radioisotope Safety. 2 cr. hrs.

Ionizing radiation: proper safety procedures in the independent use of radioisotopes and current regulatory guidelines and licensing procedures. Prereq: BIOL 1002 and CHEM 1002; or BIOL 1009 and CHEM 1002; or cons. of dept. ch.

BIOL 6005. Scientific Writing Workshop. 1-3 cr. hrs.

Designed to teach basics of clear and effective scientific writing with emphasis on preparing and evaluating research manuscripts and proposals. Students learn editing techniques through deconstructing and revising others' work. Prereq: Second year grad. student or cons. of instr.

BIOL 6011. Advanced Concepts in Genetics and Cell Biology. 3 cr. hrs.

Introduces students to genetics and cell biology at an advanced graduate level. Topics cover foundational and cutting edge science across a variety of topics, including: DNA and RNA structure, Mendelian genetics, transcription and translation, regulation of gene expression, DNA mutation and repair, genomics and proteomics, membrane structure and function, membrane transporters and channels, membrane potential, protein transport within the cell and cellular signaling.

BIOL 6012. Advanced Concepts in Cell Biology and Biochemistry. 3 cr. hrs.

Introduces students to cell biology and biochemistry at an advanced graduate level. Topics cover foundational and cutting edge science across a variety of topics, including: carbohydrate and protein structure, protein folding, protein-ligand interactions, enzyme function, bioenergetics, the cytoskeleton, molecular motors and membrane compartments.

BIOL 6096. Laboratory Rotations in Biology. 1-3 cr. hrs.

Informal lab rotation of first-year graduate students based on mutual preferences of the student and faculty member including lab group meetings, literature research, bench work, presentation of findings and/or research plan to lab members. S/U grade assessment. Prereq: Cons. of dept. ch.

BIOL 6097. Laboratory Research in Biology. 1-3 cr. hrs.

Independent research of second year graduate students based on their dissertation/thesis research laboratories, including lab group meetings, literature research, bench work and presentation of findings. S/U grade assessment. Prereq: BIOL 6096 and cons. of dept. ch.

BIOL 6952. Department Colloquium. 0 cr. hrs.

Scholarly reports on selected topics in modern biology by visiting and resident investigators and graduate students. Registration and attendance required of all full-time graduate students in biology. SNC/UNC grade assessment.

BIOL 6995. Independent Study in Biological Sciences. 1-3 cr. hrs.

Investigations in selected areas of biology. Prereq: Cons. of instr. and cons. of dept. ch.

BIOL 6999. Master's Thesis. 1-6 cr. hrs.

S/U grade assessment. Prereq: Cons. of dept. ch.

BIOL 8101. Protein Structure and Function. 2 cr. hrs.

Advanced protein biochemistry stressing methodology and primary literature. Topics include: structural and chemical properties of amino acids, peptides and proteins; protein folding and assembly; protein-protein and protein-ligand interactions; enzyme kinetics and regulation; and the determination of protein structure. Uses examples from glycolytic and gluconeogenic metabolic pathways to highlight the structural basis for catalysis and regulation. Prereq: BIOL 4101/5101 or equiv.; or cons. of instr.

BIOL 8102. Biochemistry and Function of Nucleic Acids. 2 cr. hrs.

The biochemistry of RNA and DNA with emphasis on biological function and evolution. Specific topics include: nucleic acid structure, biophysical properties, biosynthesis, and molecular function. Prereq: BIOL 4101/5101 or cons. of instr.

BIOL 8201. Epigenetics. 2 cr. hrs.

Focuses on the molecular biology of epigenetic gene expression states of eukaryotic model organisms and introduces molecular and genetic approaches to the analysis of epigenetic problems. In particular, the course addresses DNA methylation, RNA interference, chromatin structure, transposable elements and gene silencing.

BIOL 8202. Principles of Eukaryotic Genetics. 2 cr. hrs.

Genetics of eukaryotic model organisms with a focus on genetic approaches to the analysis of contemporary biological problems. Eukaryotic chromosome structure and function. Prereq: BIOL 2201 or equiv.

BIOL 8301. Imaging and Cytoskeletons. 2 cr. hrs.

Discusses the principles of cytoskeleton and molecular motors and modern imaging tools developed for the studies of cellular mechanisms. Prereq: BIOL 2301 or equiv.

BIOL 8302. Protein Trafficking and Organelle Identity in Eukaryotic Cells. 2 cr. hrs.

An in-depth analysis of protein trafficking and organelle identity in eukaryotic cells. Discusses, in detail, mechanisms of protein translocation across biological membranes and the genetic and biochemical analysis of protein sorting to diverse organelles. Prereq: BIOL 2301 or equiv.

BIOL 8401. Molecular Evolution. 2 cr. hrs.

Covers introductory topics in molecular evolution based on readings from the literature. Topics include: online sequence databases; sequence alignment; detecting natural selection; building phylogenetic trees; testing alternative phylogenetic hypotheses; molecular clocks; reconstructing ancestral sequences; and gene duplication and loss. Students learn to use several software packages to perform these analyses. Prereq: Cons. of instr.

BIOL 8501. Molecular and Cellular Signaling. 2 cr. hrs.

Comprehensive survey of the major neurotransmitter systems including biochemical synthesis and degradation, receptors and intracellular signaling pathways. Emphasizes modern laboratory techniques and primary literature. Prereq: Cons. of instr.

BIOL 8502. Systems Neuroscience. 2 cr. hrs.

Comprehensive survey of nervous system function at the systems level and includes motor, sensory and regulatory systems. Prereq: Cons. of instr.

BIOL 8504. Advanced Survey in Neuroscience. 1 cr. hr.

An introduction to current neuroscience literature with a focus on research at Marquette. Prereq: Cons. of instr.

BIOL 8506. Cellular Neurophysiology. 2 cr. hrs.

Biophysical properties of membranes and membrane-bound proteins. In-depth study of electrotonic properties of membranes, electrical potentials, voltage-dependent and ligand-dependent ion channels. Emphasizes techniques and data interpretation. Prereq: Cons. of instr.

BIOL 8520. Behavioral Neuroendocrinology. 2 cr. hrs.

Examines neuroendocrine systems as they relate to behavioral processes and their underlying neurobiological mechanisms with emphasis on the contribution of neuroendocrine dysfunction to neuropsychiatric disease. Prereq: Cons. of inst.

BIOL 8530. Glutamate Neurotransmission. 2 cr. hrs.

Reviews critical aspects of glutamatergic signaling including an overview of glutamate receptors, transporter, and release mechanisms. The contribution of abnormal glutamatergic neurotransmission is discussed in light of a number of pathological states including stroke and schizophrenia. Students integrate course material into a novel research proposal. Prereq: Cons. of instr.

BIOL 8601. Stem Cell Biology. 2 cr. hrs.

Examines fundamental principles of developmental biology as they relate to embryonic and adult stem cells. Includes: origin of stem cells, regulation of stem cell niches, pluripotency and differentiation, relationship to cancer and experimental approaches to stem cell research. Also includes discussion of recent advances in stem cell biology. Prereq: BIOL 2301 or equiv.; or BIOL 3601 or equiv.

BIOL 8603. Cell and Molecular Biology of Early Development. 2 cr. hrs.

Study of the cellular and molecular mechanisms underlying the specification of cell fate in a variety of model organisms including fruit flies, nematodes, mice and zebra fish. Emphasizes genetic, biochemical and molecular techniques used in studying these complex systems. Prereq: BIOL 2301 or equiv.; or BIOL 3601 or equiv.

BIOL 8702. Muscle Biology. 2 cr. hrs.

Topics covered include: skeletal, cardiac and smooth muscle relative to their regulation, structure and function. Emphasizes similarities and differences between these three muscle types with regard to structural organizations, composition, mechanics and kinetics. In addition, covers development, regulation and disease states. Emphasizes critical reading of primary scientific literature. Prereq: BIOL 3701 or equiv.

BIOL 8704. Cellular Homeostasis. 2 cr. hrs.

Detailed study of the proteins and pathways involved in the maintenance of cell volume, pH, and ionic balance, including the analysis of the function of plasma membrane transporter and channel proteins. The emphasis will be on eukaryotic cells, but prokaryotic cells will also be covered. Prereq: BIOL 2301 or equiv., or cons. of instr.

BIOL 8801. Prokaryotic Molecular Genetics. 2 cr. hrs.

Basic principles of bacterial genetics and regulation of gene expression. Points of emphasis: 1) how genetics and regulation shape and are shaped by the biology of the organism, 2) principles that are important to all biologists, including the manipulation of bacteria in genetic cloning and protein production, 3) application of genetics to elucidate cell physiology and biochemistry. Prereq: BIOL 3801 or BIOL 4101 or BIOL 8102 or an equiv. of any of these; or cons. of instr.

BIOL 8802. Microbiology in the Environment. 2 cr. hrs.

The detection of microbial diversity, activity, growth and abundance in the environment using molecular methods. Involves examples from literature. Prereq: BIOL 3801 or equiv. or cons. of instr.

BIOL 8803. Microbial Diversity and Ecology. 2-3 cr. hrs.

Study of microbial phylogenetic and physiological diversity underlying the ecological interactions in natural communities. Emphasizes quantitative molecular techniques and sequencing used in studying microbial communities in the environment. Develops critical thinking and writing skills in determining research objectives and testing hypotheses. Prereq: none.

BIOL 8931. Topics in Biology. 1-3 cr. hrs.

Subject matter variable as determined by needs of biological sciences graduate students. Students may enroll more than once as subject matter changes. Prereq: Cons. of dept. ch.

BIOL 8953. Seminar in Biochemistry and Genetics. 1-3 cr. hrs.

Topics of current interest in biochemistry and genetics. Prereq: Cons. of instr.

BIOL 8954. Seminar in Plant Molecular Biology. 1-3 cr. hrs.

Topics of current interest in plant molecular biology. Prereq: Cons. of instr.

BIOL 8955. Seminar in Neuroscience. 1-3 cr. hrs.

Topics of current interest in neuroscience. Prereq: Cons. of instr.

BIOL 8956. Seminar in Cell and Developmental Biology. 1-3 cr. hrs.

Topics of current interest in cell and developmental biology. Prereq: BIOL 2301 or equiv.; or cons. of instr.

BIOL 8957. Seminar in Physiology. 1-3 cr. hrs.

Topics of current interest in physiology. Prereq: Cons. of instr.

BIOL 8958. Seminar in Ecology and Evolutionary Biology. 1 cr. hr.

Topics of current interest in Ecology and Evolutionary Biology are studied. Prereq: Cons. of instr.

BIOL 8995. Independent Study in Biological Sciences. 1-3 cr. hrs.

Investigations in selected areas of biology. Prereq: Cons. of instr. and cons. of dept. ch.

BIOL 8999. Doctoral Dissertation. 1-12 cr. hrs.

S/U grade assessment. Prereq: Cons. of dept. ch.

BIOL 9970. Graduate Standing Continuation: Less than Half-Time. 0 cr. hrs.

Fee. SNC/UNC grade assessment. Prereq: Cons. of dept. ch.

BIOL 9974. Graduate Fellowship: Full-Time. 0 cr. hrs.

Fee. SNC/UNC grade assessment. Prereq: Cons. of dept. ch.

BIOL 9975. Graduate Assistant Teaching: Full-Time. 0 cr. hrs.

Fee. SNC/UNC grade assessment. Prereq: Cons. of dept. ch.

BIOL 9976. Graduate Assistant Research: Full-Time. 0 cr. hrs.

Fee. SNC/UNC grade assessment. Prereq: Cons. of dept. ch.

BIOL 9984. Master's Comprehensive Examination Preparation: Less than Half-Time. 0 cr. hrs.

Fee. SNC/UNC grade assessment. Prereq: Cons. of dept. ch.

BIOL 9985. Master's Comprehensive Examination Preparation: Half-Time. 0 cr. hrs.

Fee. SNC/UNC grade assessment. Prereq: Cons. of dept. ch.

BIOL 9986. Master's Comprehensive Examination Preparation: Full-Time. 0 cr. hrs.

Fee. SNC/UNC grade assessment. Prereq: Cons. of dept. ch.

BIOL 9987. Doctoral Comprehensive Examination Preparation: Less than Half-Time. 0 cr. hrs.

Fee. SNC/UNC grade assessment. Prereq: Cons. of dept. ch.

BIOL 9988. Doctoral Comprehensive Examination Preparation: Half-Time. 0 cr. hrs.

Fee. SNC/UNC grade assessment. Prereq: Cons. of dept. ch.

BIOL 9989. Doctoral Comprehensive Examination Preparation: Full-Time. 0 cr. hrs.

Fee. SNC/UNC grade assessment. Prereq: Cons. of dept. ch.

BIOL 9995. Master's Thesis Continuation: Half-Time. 0 cr. hrs.

Fee. SNC/UNC grade assessment. Prereq: Cons. of dept. ch.

BIOL 9996. Master's Thesis Continuation: Full-Time. 0 cr. hrs.

Fee. SNC/UNC grade assessment. Prereq: Cons. of dept. ch.

BIOL 9998. Doctoral Dissertation Continuation: Half-Time. 0 cr. hrs.

Fee. SNC/UNC grade assessment. Prereq: Cons. of dept. ch.

BIOL 9999. Doctoral Dissertation Continuation: Full-Time. 0 cr. hrs.

Fee. SNC/UNC grade assessment. Prereq: Cons. of dept. ch.