

Neuroscience, PHD

Program Director: SuJean Choi, Ph.D.

Neuroscience Graduate Program website (<http://www.marquette.edu/grad/programs-neuroscience.php>)

Degree Offered

Doctor of Philosophy

Educational Goals and Student Learning Outcomes

Upon completion of the neuroscience doctorate program, a student is able to:

1. Demonstrate an in-depth mastery of advanced interdisciplinary concepts in the neurosciences.
2. Demonstrate independent scientific reasoning.
3. Design and execute original research in an area of neuroscience specialization.
4. Demonstrate effective oral communication of interdisciplinary neuroscience concepts.

Program Description

Neuroscience is the study of the structure and function of the brain and nervous system and is currently one of the fastest growing areas in science education and research. The graduate program in neuroscience involves, at a minimum, faculty from the Departments of Biological Sciences; Biomedical Engineering; Biomedical Sciences; Mathematics, Statistics and Computer Science; Philosophy; Physical Therapy-Exercise Science; and Psychology. It is designed to provide students with research training and didactic course work that includes a broad foundation of neuroscience that can then be complemented with specialized courses within subfields.

Neuroscience Doctorate

Specializations: Behavioral and Cognitive Neuroscience; Cellular and Molecular Neuroscience; Computational, Neurorehabilitation and Neuroimaging Neuroscience

Neuroscience is the interdisciplinary study of the function of the nervous system, encompassing a broad spectrum of approaches from cellular and molecular function to anatomical circuitry to behavior, disorders and treatments. The neuroscience doctoral program is designed with interdisciplinary research training and curriculum, research writing and analysis skills toward preparing students for doctoral-level interdisciplinary career opportunities in the growing arena of neuroscience research and industry. The program involves faculty from the Departments of Biological Sciences; Biomedical Engineering; Biomedical Sciences; Physical Therapy-Exercise Science; Mathematics, Statistics and Computer Science; Philosophy; and Psychology. The program is designed to provide students with research training and didactic course work that includes a broad foundation in neuroscience that can then be complemented with specialized courses within subfields.

Code	Title	Hours
Required courses:		
BISC 5140	Functional Neuroanatomy	3
NRSC/BISC 8001	Neuroscience Foundations 1	4
NRSC/BISC 8002	Neuroscience Foundations 2	4
NRSC/BISC 8003	Individual Development Plan	1
NRSC/BISC 8004	Science Writing and Ethics 1 (or equivalent) ¹	1
NRSC/BISC 8005	Science Writing and Ethics 2 (or equivalent) ¹	1
NRSC/BISC 8096	First Year Lab Rotations (taken three times at 1 cr. each)	3
Graduate statistics course from BIOL, BISC, MSCS, PSYC or another course as approved by the director of graduate studies.		3-4
A minimum of 12 credit hours from within the declared specialization. ²		12
NRSC 8999 Doctoral Dissertation		12
Total Credit Hours:		44-45

¹ Taking an equivalent course, such as PSYC 8125 Advanced Research Methods or MSSC 6090 Research Methods/Professional Development (repeated twice) may increase the overall credit total.

² Depending on the specialization, 2-3 credits are taken at the 6000 or 8000 level, and a maximum of 3 credits may be taken at the 5000 level. One final course (at least 2-3 credits) may be chosen from the courses and seminars offered in any of the specializations or other doctoral level courses offered by participating departments (e.g., Biological Sciences; Biomedical Engineering; Biomedical Sciences; Physical Therapy-Exercise Science; Mathematics, Statistics and Computer Science; Philosophy; and Psychology), as appropriate to individual training plans.

Specializations

BEHAVIORAL AND COGNITIVE NEUROSCIENCE

Students in this specialization acquire a foundational background in behavioral and cognitive processes and their neuroanatomical and neurophysiological foundations. Areas of focus include: perception, attention, learning, memory, executive functioning, social and affective functioning, reward, stress, mental health and disorders, development, aging and dementia.

Behavioral and cognitive neuroscience students must complete a minimum of 12 credit hours from the following list:

Code	Title	Hours
Required course:		
PSYC 8740	Foundations and Processes of Human Cognition	3
or PSYC 8780	Biological Bases of Behavior	
Choose three of the following (may not repeat). At least two courses must be from the PHIL or PSYC courses below:		9
PSYC 8102	Advanced Statistics and Design 2 (or other approved advanced/applied statistics course)	
PSYC 8740	Foundations and Processes of Human Cognition	
PSYC 8780	Biological Bases of Behavior	
PHIL 6440	Philosophy of Science	
PHIL 6450	Philosophy of Mind	
PHIL 6470	Problems in Metaphysics	
PHIL 6959	Seminar in Philosophy (when topic approved by director)	
Alternative course/seminar with director approval.		

Cellular and Molecular Neuroscience

Students in this specialization acquire a foundational background in core neuroscience concepts including a strong understanding of both neuronal and non-neuronal cells of the nervous system, electrical/chemical mechanisms of synaptic signaling, structure/function of the nervous system, and behavioral, physiological, and cognitive outputs of the healthy and dysfunctional nervous system. Areas of focus include: fundamental processes underlying drug and alcohol addiction, stress, depression, schizophrenia, learning and memory, obesity and eating disorders, neurodegeneration, circadian biology, ion channel function and spinal cord injury.

Cellular and molecular neuroscience students must complete a minimum of 12 credit hours from the following list:

Code	Title	Hours
BIOL 8101	Protein Structure and Function	2
BIOL 8102	Biochemistry and Function of Nucleic Acids	2
BIOL 8202	Principles of Eukaryotic Genetics	2
BIOL 8302	Protein Trafficking and Organelle Identity in Eukaryotic Cells	2
BIOL 8603	Cell and Molecular Biology of Early Development	2
BIOL 8704	Cellular Homeostasis	2
BISC 5155	Diseases of the Brain	3
BISC 6097	Laboratory Research in Neuroscience (Laboratory Research in Neuroscience)	1
BISC 8953	Seminar in Neuroscience	1
Alternative course/seminar with director approval.		2-3

Computational, Neurorehabilitation and Neuroimaging Neuroscience

Students in this specialization acquire a foundational background in computational modeling, neurorehabilitation and/or neuroimaging. Computational modeling explores processes from single neurons to neuronal networks including neural interconnections, neural signal processing, and synaptic plasticity. Neurorehabilitation explores the mechanisms and clinical and laboratory methods for studying neural disorders and the treatment strategies to address them. Neuroimaging neuroscience explores imaging physics, mathematics, and methods toward problems in basic and applied neuroscience. Areas of focus include: statistical models for magnetic resonance imaging, computational models of gene regulatory networks, predictive models of neurophysiological processes and clinical outcomes, human visuomotor processing, functional neuroimaging, brain structural and functional connectivity, spinal cord imaging and human motor control, neural and neurodevelopmental disorders, neurodegenerative diseases, and rehabilitative strategies.

Computational, neurorehabilitation and neuroimaging neuroscience students must complete a minimum of 12 credit hours from within focus area 1, 2 or 3. See course lists for each focus, below:

Computational

Code	Title	Hours
Choose at least 12 credit hours for the Computational focus area:		
Statistical Analysis/Data Science courses		
MSSC 5760	Time Series Analysis	3
MSSC 5780	Regression Analysis	3
MSSC 6010	Computational Probability	3
MSSC 6020	Statistical Simulation	3
MSSC 6230	Multivariate Statistical Analysis	3
MSSC 6240	Design and Analysis of Scientific Experiments	3
Computer Science courses		
COSC 5600	Fundamentals of Artificial Intelligence	3
COSC 5610	Data Mining	3
COSC 5800	Principles of Database Systems	3
COSC 6050	Elements of Software Development	3
COSC 6060	Parallel and Distributed Systems	3
Mathematical courses		
MSSC 6030	Applied Mathematical Analysis	3
MSSC 6040	Applied Linear Algebra	3
MSSC 6110	Applied Discrete Mathematics	3
MSSC 6120	Optimization	3
MSSC 6130	Dynamical Systems	3
Alternative course/seminar with director approval.		3

Neurorehabilitation

Code	Title	Hours
Complete the following 12 credit hours for the Neurorehabilitation focus area:		
EXRS 6001	Applied and Rehabilitative Systems Physiology	3
EXRS 6030	Advanced Principles and Instrumentation in Biomechanics	3
EXRS 6201	Neurophysiological Principles in Disease and Rehabilitation	3
Additional course/seminar with director approval.		3

Neuroimaging

Code	Title	Hours
Choose at least 12 credit hours for the Neuroimaging/Neuroengineering focus area:		
Neural Systems courses		
BIEN 5600	Neural Engineering	3
BIEN 6600	Neuromotor Control	3
Signal Processing courses		
BIEN 6200	Biomedical Signal Processing	3
BIEN 6210	Advanced Biomedical Signal Processing	3
BIEN 6220	Multidimensional Biomedical Time Series Analysis	3
Modeling courses		
BIEN 5230	Intelligent Biosystems	3
BIEN 5710	Analysis of Physiological Models	3
Imaging courses		
BIEN 5500	Medical Imaging Physics	3
BIEN 5510	Image Processing for the Biomedical Sciences	3
BIEN 6500	Mathematics of Medical Imaging	3
Alternative course/seminar with director approval.		3

ACCELERATED BACHELOR'S-DOCTORAL DEGREE PROGRAM

The Graduate School offers a combined bachelor's-doctoral program available to outstanding Marquette University biomedical sciences undergraduate students. This program enables students to complete their undergraduate degree within the first year of the neuroscience graduate program, allowing them to complete their doctorate in less time than traditional graduate students. Biomedical sciences undergraduate students can apply for early admission to the neuroscience doctoral program in the first term of their junior year. The cellular and molecular neuroscience specialization must be chosen. Students may request permission to move to another specialization, though requests are not guaranteed.

Students accepted into this program are eligible to enroll in up to 14 credits (7-8 credits/semester) of graduate neuroscience courses in their senior year that can be used to fulfill both undergraduate and graduate degree requirements. Interested students should contact their adviser early in their undergraduate career to plan the curriculum for the biomedical sciences major accordingly. Students must submit an application to the Graduate School, indicate their interest in the accelerated degree program and meet all other admission criteria as stated in the Application Requirements section. If accepted to the ADP, students must notify the Graduate School upon successful completion of bachelor's degree, and their admission as a full-time graduate student is then activated.

University Policies

- Academic Censure - Graduate School (<https://bulletin.marquette.edu/policies/academic-censure/graduate/>)
- Academic Integrity (<https://bulletin.marquette.edu/policies/academic-integrity/>)
- Academic Misconduct (<https://bulletin.marquette.edu/policies/academic-misconduct-policy/>)
- Academic Program Definitions (<https://bulletin.marquette.edu/policies/academic-programs-defined/>)
- Accelerated Degree Programs (<https://bulletin.marquette.edu/policies/accelerated-degree-programs/>)
- Attendance - Graduate School (<https://bulletin.marquette.edu/policies/attendance/graduate/>)
- Awarding Diplomas and Certificates (<https://bulletin.marquette.edu/policies/awarding-diplomas-certificates/>)
- Background Checks, Drug Testing (<https://bulletin.marquette.edu/policies/background-checks-drug-testing/>)
- Class Rank (<https://bulletin.marquette.edu/policies/class-rank/>)
- Commencement (<https://bulletin.marquette.edu/policies/commencement/>)
- Conferral of Degrees and Certificates (<https://bulletin.marquette.edu/policies/conferral-degrees-certificates/>)
- Course Levels (<https://bulletin.marquette.edu/policies/course-levels/>)
- Credit Hour (<https://bulletin.marquette.edu/policies/credit/>)
- Credit Load - Graduate School (<https://bulletin.marquette.edu/policies/credit-load/graduate/>)
- Faculty Grading (<https://bulletin.marquette.edu/policies/faculty-grading/>)
- Family Education Rights and Privacy Act-FERPA (<https://bulletin.marquette.edu/policies/ferpa/>)
- Grade Appeals (<https://bulletin.marquette.edu/policies/grade-appeals/>)
- Grading System - Graduate School and Graduate School of Management (<https://bulletin.marquette.edu/policies/grading-system/graduate-management/>)
- Graduation - Graduate School (<https://bulletin.marquette.edu/policies/graduation/graduate/>)
- Immunization and Tuberculosis Screening Requirements (<https://bulletin.marquette.edu/policies/immunization-and-tuberculosis-screening/>)
- Last Date of Attendance/Activity (<https://bulletin.marquette.edu/policies/last-dateof-attendance-activity/>)
- Military Call to Active Duty or Training (<https://bulletin.marquette.edu/policies/militarycall-active-duty-training/>)
- Registration - Graduate School (<https://bulletin.marquette.edu/policies/registration/graduate/>)
- Repeated Courses - Graduate School (<https://bulletin.marquette.edu/policies/repeated-courses/graduate/>)
- Student Data Use and Privacy (<https://bulletin.marquette.edu/policies/student-data-use-privacy/>)
- Transcripts-Official (<https://bulletin.marquette.edu/policies/transcripts-official/>)
- Transfer Course Credit - Graduate School (<https://bulletin.marquette.edu/policies/transfer-course-credit-policy/graduate/>)
- Withdrawal - Graduate School (<https://bulletin.marquette.edu/policies/withdrawals/graduate/>)

Graduate School Policies

- Academic Performance (<https://bulletin.marquette.edu/graduate/policies/academic-performance/>)
- Academic Programs Overview (<https://bulletin.marquette.edu/graduate/policies/academic-programs-overview/>)
- Advising (<https://bulletin.marquette.edu/graduate/policies/advising/>)
- Assistantships and Fellowships (<https://bulletin.marquette.edu/graduate/policies/assistantships-andfellowships/>)
- Certificate Concurrent Enrollment (<https://bulletin.marquette.edu/graduate/policies/certificate-concurrent-enrollment/>)
- Conduct (<https://bulletin.marquette.edu/graduate/policies/conduct/>)
- Confidentiality of Proprietary Information (<https://bulletin.marquette.edu/graduate/policies/confidentiality-proprietary-information/>)

- Continuous Enrollment (<https://bulletin.marquette.edu/graduate/policies/continuous-enrollment/>)
- Courses and Prerequisites (<https://bulletin.marquette.edu/graduate/policies/courses-prerequisites/>)
- Cross-listed Courses (<https://bulletin.marquette.edu/graduate/policies/cross-listed-courses/>)
- Deadlines (<https://bulletin.marquette.edu/graduate/policies/deadlines/>)
- Graduate Credit (<https://bulletin.marquette.edu/graduate/policies/graduate-credit/>)
- Graduate School Policies (<https://bulletin.marquette.edu/graduate/policies/>)
- Independent Study (<https://bulletin.marquette.edu/graduate/policies/independent-study/>)
- Intellectual Property (<https://bulletin.marquette.edu/graduate/policies/intellectual-property/>)
- Research Involving Humans, Animals, Radioisotopes or Recombinant DNA/Transgenic Organisms (<https://bulletin.marquette.edu/graduate/policies/research-involving-humans-animals-radioisotopes-recombinant-dnatransgenic-organisms/>)
- Temporary Withdrawal from Graduate Program (<https://bulletin.marquette.edu/graduate/policies/temporary-withdrawal-graduate-program/>)
- Time Limitations (<https://bulletin.marquette.edu/graduate/policies/time-limitations/>)
- Working with Minors (<https://bulletin.marquette.edu/graduate/policies/working-minors/>)

NRSC 8001 Neuroscience Foundations 1 (4 credits)

Comprehensive survey of nervous system function at the cellular level including biochemical synthesis and degradation, receptors and intracellular signaling pathways. Same as BISC 8001; credit is not awarded for both.

Prerequisite: Admitted to NRSC program or cons. of instr.

Level of Study: Graduate

Last four terms offered: 2022 Fall Term, 2021 Fall Term, 2020 Fall Term, 2019 Fall Term

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=NRSC%208001>)

NRSC 8002 Neuroscience Foundations 2 (4 credits)

Comprehensive survey of nervous system function at the systems and behavioral level and includes motor, sensory and regulatory systems, imaging, cognitive and computational modeling. Same as BISC 8002; credit is not awarded for both.

Prerequisite: Admitted to NRSC program or cons. of instr.

Level of Study: Graduate

Last four terms offered: 2023 Spring Term, 2022 Spring Term, 2021 Spring Term, 2020 Spring Term

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=NRSC%208002>)

NRSC 8003 Individual Development Plan (1 credits)

Guidance of students toward identifying their current interests to facilitate future career paths as well as develop a graduate career plan based on necessary skills and expertise. Same as BISC 8003; credit is not awarded for both.

Prerequisite: Admitted to NRSC program or cons. of instr.

Level of Study: Graduate

Last four terms offered: 2022 Fall Term, 2021 Fall Term, 2020 Fall Term, 2019 Fall Term

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=NRSC%208003>)

NRSC 8004 Science Writing and Ethics 1 (1 credits)

An introduction of scientific writing skills necessary for a successful career in science. Same as BISC 8004; credit is not awarded for both.

Prerequisite: BISC 8003 or NRSC 8003.

Level of Study: Graduate

Last four terms offered: 2022 Fall Term, 2021 Fall Term, 2020 Fall Term, 2019 Fall Term

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=NRSC%208004>)

NRSC 8005 Science Writing and Ethics 2 (1 credits)

Advanced writing skills necessary for grant writing. Same as BISC 8005; credit is not awarded for both.

Prerequisite: BISC 8004 or NRSC 8004.

Level of Study: Graduate

Last four terms offered: 2021 Fall Term

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=NRSC%208005>)

NRSC 8096 First Year Lab Rotations (1 credits)

Introductory lab rotations for first year graduate students based on mutual preferences of the student and faculty member. May include lab group meetings, literature search, bench work, presentation of findings and/or research plans to lab members. Same as BISC 8096; credit is not awarded for both.

Prerequisite: Admitted to NRSC program or cons. of instr.

Level of Study: Graduate

Last four terms offered: 2023 Spring Term, 2022 Fall Term, 2022 Spring Term, 2021 Fall Term

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=NRSC%208096>)

NRSC 8931 Topics in Neuroscience (1-3 credits)

Subject matter varies as determined by needs of neuroscience graduate students. May be repeated, as subject matter changes. Same as BISC 8931; credit is not awarded for both.

Prerequisite: Admitted to NRSC program or cons. of instr.

Level of Study: Graduate

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=NRSC%208931>)

NRSC 8999 Doctoral Dissertation (1-12 credits)

S/U grade assessment.

Prerequisite: Cons. of dept. ch.

Level of Study: Graduate

Last four terms offered: 2023 Spring Term, 2022 Fall Term, 2022 Spring Term, 2021 Fall Term

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=NRSC%208999>)

NRSC 9970 Graduate Standing Continuation: Less than Half-Time (0 credits)

Fee. SNC/UNC grade assessment. Designated as less than half-time status only, cannot be used in conjunction with other courses, and does not qualify students for financial aid or loan deferment.

Prerequisite: Cons. of prog. dir.

Level of Study: Graduate

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=NRSC%209970>)

NRSC 9974 Graduate Fellowship: Full-Time (0 credits)

Fee. SNC/UNC grade assessment. Designated as full-time status. If a student is already registered in other courses full time, this continuation course is not needed.

Prerequisite: Cons. of program dir.

Level of Study: Graduate

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=NRSC%209974>)

NRSC 9975 Graduate Assistant Teaching: Full-Time (0 credits)

Fee. SNC/UNC grade assessment. Designated as full-time status. If a student is already registered in other courses full time, this continuation course is not needed.

Prerequisite: Cons. of program dir.

Level of Study: Graduate

Last four terms offered: 2023 Spring Term, 2022 Fall Term, 2022 Spring Term, 2021 Fall Term

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=NRSC%209975>)

NRSC 9976 Graduate Assistant Research: Full-Time (0 credits)

Fee. SNC/UNC grade assessment. Designated as full-time status. If a student is already registered in other courses full time, this continuation course is not needed.

Prerequisite: Cons. of program dir.

Level of Study: Graduate

Last four terms offered: 2022 Spring Term, 2021 Fall Term, 2021 Spring Term, 2020 Fall Term

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=NRSC%209976>)

NRSC 9987 Doctoral Qualifying Examination Preparation: Less than Half-Time (0 credits)

Fee. SNC/UNC grade assessment. Allows a student to be considered the equivalent of less than half-time status. Requires that the student is working less than 12 hours per week toward their doctoral qualifying exam.

Prerequisite: Cons. of program dir.

Level of Study: Graduate

Last four terms offered: 2021 Spring Term, 2020 Fall Term, 2020 Spring Term

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=NRSC%209987>)

NRSC 9988 Doctoral Qualifying Examination Preparation: Half-Time (0 credits)

Fee. SNC/UNC grade assessment. Allows a student to be considered the equivalent of half-time status. Requires that the student is working more than 12 to less than 20 hours per week toward their doctoral qualifying exam. May be taken in conjunction with credit-bearing or other non-credit courses to result in the status indicated, as deemed appropriate by the department.

Prerequisite: Cons. of program dir.

Level of Study: Graduate

Last four terms offered: 2023 Spring Term, 2022 Fall Term, 2022 Spring Term, 2021 Fall Term

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=NRSC%209988>)

NRSC 9989 Doctoral Qualifying Examination Preparation: Full-Time (0 credits)

Fee. SNC/UNC grade assessment. Allows a student to be considered the equivalent of full-time status. Requires that the student is working 20 hours or more per week toward their doctoral qualifying exam. May be taken in conjunction with credit-bearing or other non-credit courses to result in the status indicated, as deemed appropriate by the department.

Prerequisite: Cons. of program dir.

Level of Study: Graduate

Last four terms offered: 2023 Spring Term, 2022 Fall Term, 2021 Spring Term, 2020 Fall Term

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=NRSC%209989>)

NRSC 9997 Doctoral Dissertation Continuation: Less than Half-Time (0 credits)

Fee. SNC/UNC grade assessment. Allows a student to be considered the equivalent of less than half-time status. Requires that the student is working less than 12 hours per week on their doctoral dissertation. All 12 dissertation credits required for the degree should be completed before registering for non-credit Doctoral Dissertation Continuation.

Prerequisite: Cons. of program dir.

Level of Study: Graduate

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=NRSC%209997>)

NRSC 9998 Doctoral Dissertation Continuation: Half-Time (0 credits)

Fee. SNC/UNC grade assessment. Allows a student to be considered the equivalent of half-time status. Requires that the student is working more than 12 to less than 20 hours per week on their doctoral dissertation. All 12 dissertation credits required for the degree should be completed before registering for non-credit Doctoral Dissertation Continuation.

Prerequisite: Cons. of program dir.

Level of Study: Graduate

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=NRSC%209998>)

NRSC 9999 Doctoral Dissertation Continuation: Full-Time (0 credits)

Fee. SNC/UNC grade assessment. Allows a student to be considered the equivalent of full-time status. Requires that the student is working 20 hours or more per week on their doctoral dissertation. All 12 dissertation credits required for the degree should be completed before registering for non-credit Doctoral Dissertation Continuation.

Prerequisite: Cons. of program dir.

Level of Study: Graduate

Last four terms offered: 2023 Spring Term, 2022 Fall Term, 2022 Spring Term, 2021 Fall Term

Schedule of Classes (<https://bulletin.marquette.edu/class-search/?details&code=NRSC%209999>)