Neurosciences Doctoral Program

Degree Offered

Doctor of Philosophy

Program Description

Neuroscience is a dynamic, rapidly growing field devoted to study of the central and peripheral nervous systems in health and disease. During the past three decades, a group of eminent scientists with research interests in many areas of neuroscience has been assembled in the basic science and clinical departments of the Medical College of Wisconsin. These individuals, who have an impressive record of pre- and post-doctoral training, research, and extramural funding in the neurosciences, form the core faculty for this training program. The research areas of the neuroscience faculty include functional imaging, electrophysiological, biochemical, cellular and molecular approaches to questions of fundamental and clinical importance.

The Neuroscience Doctoral Program (NDP) is committed to providing a specialized education in neuroscience ranging across molecular and cellular mechanisms, systems neuroscience, and brain imaging. This education is designed to serve the students well as they move on to pursue specialized research projects. During the first year, students take a core curriculum designed to provide a foundation in neuroscience as well as biochemistry, cell biology, genetics, molecular biology, physiology, signaling, laboratory techniques, and biostatistics. Students also take 4-6 credits of elective courses and a summer course on general writing to help with the qualifying exam and professional development.

Students will also explore their individual research interests through 3-4 laboratory rotations that emphasize experimental design and integration into a research team. Students are encouraged to take advantage of the diversity of neuroscience research opportunities in the participating departments. Once a student selects a dissertation advisor at the end of their first year, they will become affiliated with one of the following graduate programs: Biochemistry; Biophysics; Cell and Developmental Biology; Microbiology and Immunology; or Pharmacology and Toxicology. In addition, students may also pursue a clinical focus if admitted into the Basic and Translational Science Program. Additional information about individual departmental programs is given elsewhere in this publication.

During the second year of their studies, students will take a course in writing an NIH-style fellowship, and prepare and defend a proposal

based on their own research that will provide them with valuable experience in mastering a scientific problem, formulating a suitable hypothesis, and drafting a feasible and productive experimental scheme with which to test it. *The qualifying exam for NDP students will be administered by the graduate program that their thesis laboratory is affiliated with (e.g. Biochemistry; Biophysics; Cell and Developmental Biology; Physiology, Microbiology and Immunology; or Pharmacology and Toxicology)*. Successful completion of this qualifying exam is a major step towards being admitted to candidacy for a PhD degree in the thesis department. During their second semester and in subsequent years, students are also expected to successfully complete a number of advanced courses selected with the guidance of their dissertation mentor, dissertation committee, and the Graduate Program Director of their affiliated department. Upper level students will focus on the development of their research skills, performance of their doctoral research, and completion of their dissertation.

Once affiliated with a particular laboratory and department, students can expect attentive personal mentoring by their dissertation advisor. Throughout their graduate careers, students in the Interdisciplinary Program continue to meet as a group to share ideas, insights and research accomplishments with each other and with the faculty.

Degrees Offered

This program prepares students for advanced study in one of the following PhD degree-granting programs: **Biochemistry; Biophysics; Cell and Developmental Biology; Physiology, Microbiology and Immunology; Pharmacology and Toxicology; and Basic and Translational Science.**

Program Admissions Requirements

*In addition to the general **Graduate School admission requirements**, this program has additional specific requirements.*

Applicants must have a bachelor's degree from an accredited college or university. Successful applicants will show undergraduate achievement in science and mathematics courses and have prior research experience.

Fields of Research

Faculty participating in the Neuroscience Doctoral Program have diverse research interests such as:

- **Neurodegeneration and Neurotrauma**

  Neurodegenerative diseases including ALS, Parkinson's Disease and

Spinal Cord Injury are studied using stem cells, animal models and human tissues.

- **Neuroimaging, Tissue to Brain**
  State-of-the-art brain imaging is used to study language, vision, hearing, learning and memory, and brain diseases including cancer.

- **Cellular and Synaptic Communication**
  Neuronal Communication at the cellular level is studied using cutting-edge genetic and electrophysiological tools in order to dissect mechanisms of development and disease in the visual system, learning and memory, and addiction.

- **Function of Neural Systems in Normal and Disease states**
  Sleep disruption, breathing, chronic stress, reward and drug abuse systems, hearing, touch and temperature sensation and chronic pain.

Required First-Year Curriculum

16215, 16216, 16217, 16218. Foundations in Biomedical Sciences I-IV

Foundations in Biomedical Sciences (FBS) is broken into 4 course modules and represents the bulk of the didactic core coursework for first year NDP students. Each course module presents students with integrated and immersive cellular/molecular and systems/physiological level course material. This challenging, high-paced set of courses engage students in the major research interests and teaching philosophies of the participating departments which helps prepare students with a strong foundation for their journey into their elective courses that will ultimately guide their PhD dissertation work.

16210. IBR (Introduction to Biomedical Research)

This course reflects student's participation in laboratory research rotations and their attendance at seminars and/or journal clubs.

16242. Techniques in Molecular and Cellular Biology

The objective for the Techniques course is to provide a theoretical and practical foundation underlying a number of the most common experimental techniques required for biomedical research. The information presented in this course will introduce procedures and experimental strategies that are commonly used in biomedical research projects and will facilitate students' comprehension of the scientific literature even if they don't use the techniques in their own research. The lecture materials present the theory behind each technique, the practical limitations of each techniques, and the types of questions that each technique addresses, with emphasis on how

each can be applied to generate new insight into biomedical research questions.

16245. Statistics for Basic Sciences

This course is designed to provide graduate students working in the research laboratory or studying the experimental sciences with fundamental knowledge in biostatistics. It will focus on descriptive statistics, elements of probability theory, estimation, tests of hypotheses, methods of categorical data tabulation and analysis. After completion of the course, students should be able to develop an appropriate study plan to explore a biomedical research question and execute simple statistical analysis of the data collected in the study. Emphasis will be placed on understanding concepts as well as learning to apply the covered statistical techniques. Students will also learn how to read, interpret, and critically evaluate statistical concepts in the literature.

16290 & 16291. Professional Development 1 and 2

This course is taken in the spring of the first year and fall of the second year and incorporates a multifaceted approach to introduce students to important elements of Professional Development. The course will incorporate lectures, active learning, and team-based approaches to such topics as preparing a laboratory notebook, scientific writing and reviewing, how to structure an effective hypothesis, research ethics, formulating an individual development plan, and presentation skills. Students will also participate in Responsible Conduct in Research training activities and engage in peer review discussions of the four laboratory rotation reports.

16292 and 16293. Writing a Scientific Paper & Writing an Individual Fellowship

These courses span the summer of the first year and fall of the second year. The goal of these courses is to enhance specific skill sets related to scientific writing and presentation. These courses will focus on the processes important for the preparation of scientific manuscripts and an NIH F-type research proposal. These courses will include didactic components, and will require students to work individually, or in small groups. Students will also engage in peer review activities to improve interpersonal, professionalism, and leadership skills.

Neuroscience-specific required first year courses:

16271. Fundamentals of Neuroscience

Fundamentals of Neuroscience follows a multidisciplinary approach to current knowledge about the structural and functional properties of the nervous system. The mechanisms of the nervous system are described at the molecular, cellular, systems and complex brain function levels. The course includes in-class lectures, seminars from prominent

scientists (video archives), and written assignments. The purpose of this course is to introduce 1st year graduate students to the structure and function of the human nervous system.

16272. Graduate Neuroanatomy

Graduate Neuroanatomy is a lab-based course intended to accompany MCW course Fundamentals of Neuroscience. The purpose of this course is to introduce 1st year PhD students to the anatomy of the human nervous system.

Neuroscience-specific required second year course:

12298 Journal Club. *1 credit.*

Weekly readings will be selected from contemporary and historical literature in neuroscience. Informal discussions will include participation from students and faculty.

Neuroscience-specific elective courses for years 2-5

12221 Advanced Systems Neuroscience. *3 credits. Prerequisite: 12211 or consent of the course director.*

This course covers many selected areas in systems neuroscience, including neuronal information processing and control systems, cerebral hemodynamics, metabolism and neuronal activity, sensory systems, motor systems, attention systems, learning and memory and motivational systems. Some lectures introducing fundamental concepts and current research topics are presented but learning occurs primarily through readings and discussions.

12237 Cellular and Molecular Neurobiology. *3 credits. Prerequisite: 12211 or consent of the course director.*

Readings and discussion in cellular, molecular, and developmental neurobiology. Among the topics covered in this course are ion channels and the ionic basis of potentials; mechanisms of synaptic transmission; neurotransmitter receptors and their receptors; sensory signal transduction and neural development.

16277 Cognitive Neuroscience (offered every other year)

Cognitive neuroscience examines human brain information processing at the level of large-scale neurobiological systems. Some examples include information processing that underlies learning and retrieving concepts, comprehending and producing language, directing and maintaining attention, and recognizing sensory objects. Each session in this course will begin with a 1-hour contextual lecture, followed by review and discussion of two relevant landmark papers, sometimes with opposing views. Emphasis will be placed on understanding the processing models central to each domain, the extent to which these models are supported by empirical evidence from neuroimaging, and the relevance of the field to a variety of human brain disorders.

Suggested Electives from other departmental offerings:
There are a number of courses offered by other departments at the Medical College of Wisconsin that can be taken by students in the Neuroscience Doctoral Program depending upon their research interests. The goal is to provide each student with the basics of modern neuroscience and then allow them to customize a program of course work that best meets their needs.