

Neuroscience Education: Goals For The Undergraduate Program

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The term *neuroscience* is used to describe an extremely large interdisciplinary field that includes but is not limited to: behavioral and cognitive neuroscience, neurobiology, computational neuroscience, neurophilosophy, and history of neuroscience. Neuroscience programs should provide students with the tools to study the nervous system, behavior and cognitive processes from a variety of perspectives. At its core, an undergraduate program must feature coursework in biological processes, chemistry, mathematics and psychology that will provide a framework for the student's advanced studies in pursuit of more focal interests within the field of neuroscience. Further, an undergraduate program should also satisfy the goals inherent to liberal arts education.

Graduates of an undergraduate program in neuroscience are expected to have completed a curriculum that enables them to demonstrate the following core competencies:

Awareness of critical natural science and psychological principles.

Students are expected to have completed course work in a variety of core natural science subjects, including chemistry, mathematics and biology, and to have completed course work in psychology or biopsychology related to the understanding and organization of behavior in humans and non-human animals. Some controversy exists as to the exact courses required or extent of training necessary (see the PKAL Occasional Paper on Neuroscience [1998] and Boitano & Seyal [2001] for further discussion), but there is no doubt that neuroscience education has and will continue to be based on a natural science core curriculum.

Awareness of experimental methodology, design and data analysis.

Students should be able to employ the scientific method for their own inquiry. Many of the courses that our graduates complete should have a substantial component dedicated to the introduction and discussion of experimental methods and data analysis. Further, students will have had opportunities to make use of their skills in experimental design and methodology through participation in research and course-related laboratories.

Our graduates should be able to choose and perform appropriate statistical analyses for their experimental results and interpret the results.

Awareness of historical trends and theoretical perspectives that inform the field of neuroscience.

The introduction and discussion of scientific (and social) history and the major theoretical perspectives that inform the field should be included in many of the courses our students complete. It is particularly important to include discussion at all levels of the curriculum, so that introductory students can rely on the context supplied by such information for their other studies and advanced students become increasingly able to synthesize information from disparate areas of the field.

Advanced awareness of a particular area or areas of study within neuroscience.

Students should plan and complete an additional sequence of coursework within one or more areas within neuroscience, to include an intensive research experience or independent project. As Ramirez (1997) succinctly states "...the goal of the advanced level is to help students become independent investigators." By increasing the focus to a particular area of the larger field of neuroscience at the advanced level, students will be aided in accomplishing mastery of the literature, further development of their laboratory methods, and in their ability to perform independent research.

Critical thinking and independent thought.

The development of critical thinking skills are a necessary component of any liberal arts curriculum, and neuroscience education is not unique. Our graduates develop their critical thinking skills as a direct result of our instructional practices, and attention must be paid to this concern across the curriculum.

Effective communication skills.

The ability to communicate effectively across formats is an essential skill for all students. All coursework should include instruction in writing, whether it be specific instruction in technical writing formats, such as the APA style, or simply feedback-based comments on essay and other written assignments. In addition, students must become technically proficient, not only with graphical programs in order to present their ideas as figures or graphs, but also with aspects of instructional technology, such as webpage construction and presentation software. Similarly, it is expected that across the curriculum, if not through explicit course work, our graduates will have had substantial practice to develop their oral communication skills.

Ethics.

From the treatment of animal subjects to the trust that clinicians and patients must place on research findings, students should be able to articulate the reasons ethical conduct in science is important, including the concept of personal responsibility for research conduct. A common feature of neuroscience courses should be discussion of ethical considerations.

In addition, students completing an undergraduate program in neuroscience are expected to demonstrate the following other competencies:

Awareness of Humanities, Social Sciences and other fields.

In accord with the liberal arts tradition, our graduates should have completed course work to inform their perspective in a variety of subject areas outside the natural sciences. Students should work closely with advisors to ensure appropriate breadth in their undergraduate curriculum.

Appreciation of diversity.

The ability to interact with individuals from a variety of cultural backgrounds is not merely desirable, but essential for all graduates. Our graduates should have examined issues related to diversity from a variety of perspectives in the course of completing their degree.

Beyond the competencies our students should achieve during their undergraduate years, it is expected that neuroscience program faculty and advising staff will work with individual students to develop a career plan as part of the advising process.

Career planning.

We expect that our graduates will have been afforded the opportunity in the course of their undergraduate years to be informed of the various career possibilities that exist for neuroscience graduates, and to have received advising relevant to the accomplishment of the individual student's career goals.

For further and more in-depth discussion on the neuroscience curriculum, see:

PKAL Occasional Paper on Neuroscience: From the PKAL workshop on interdisciplinary connections: Undergraduate neuroscience education, held at Davidson College in 1995. http://www.pkal.org/open.cfm?d_id=18

Ramirez, J.J. (1997) Undergraduate education in neuroscience: A model for interdisciplinary study. Neuroscientist 3 (3), 166-8.

Boitano, J.J. and Seyal, A.A. (2001) Neuroscience curricula for undergraduates: A survey. Neuroscientist 7 (3), 202-6.