Neuroscience, B.S.

Bachelor of Science in Neuroscience

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www.cmu.edu/ni (http://www.cmu.edu/ni)

Neuroscience is an interdisciplinary field in which scientists from many backgrounds apply the tools of biology, cognitive science, psychology, chemistry, mathematics, statistics, computer science, and engineering to develop a comprehensive understanding of brain function at the level of molecules, neurons, brain circuits, cognitive brain modules, and behavior. Research in neuroscience across these disciplines has grown substantially in the past two decades, and a solid understanding of the physiological basis of many aspects of brain function both in health and disease has come along with this growth in research. Along with this comes an increasing need for students to begin careers in neuroscience and to be prepared to work on the problems in neuroscience and to bring new answers to the public and to patients. In order to be successful in developing new treatments and answering outstanding questions in the field, neuroscientists need to be conversant in many different levels of inquiry from neurobiology to cognitive neuroscience to computational neuroscience.

The Dietrich College of Humanities & Social Sciences and the Mellon College of Science have joined forces to establish an exciting interdisciplinary program leading to a Bachelor of Science in Neuroscience. The goal of this degree program is to provide an intensive interdisciplinary education to enable outstanding students to become leaders in identifying and solving tomorrow's Neuroscience problems using a variety of methods. The program's interdisciplinary curriculum is designed for students to gain a fundamental understanding of brain function on many different levels and to begin to specialize within the broad field of Neuroscience. Students in Mellon College of Science or Dietrich College may have a primary major in Neuroscience in any of the three concentrations. Students from other colleges may have a second major in Neuroscience in any of the three concentrations, subject to double-counting restrictions.

A degree in neuroscience provides excellent preparation for medical school or other graduate programs in the health professions. These students are aided by the Carnegie Mellon Health Professions Program (HPP), an advisory and resource service for all Carnegie Mellon students who are considering careers in the health care field. (See the HPP (http://coursecatalog.web.cmu.edu/intercollegeprograms/pre-professional/health-professions-program/) section in this catalog or www.cmu.edu/hpp (http://www.cmu.edu/hpp) for more information.)

Students wishing to pursue the Neuroscience major through Dietrich College should contact Emilie O'Leary (emilier@cmu.edu). Students wishing to pursue the Neuroscience major through the Mellon College of Science should contact the Biological Sciences Undergraduate Programs Office (bio-ungrad@andrew.cmu.edu). Students wishing to pursue an additional major in either the Neurobiology or Computational Neuroscience concentrations should contact the Biological Sciences Undergraduate Programs Office (bio-ungrad@andrew.cmu.edu). Students wishing to pursue an additional major in the Cognitive Neuroscience concentration should contact Emilie O'Leary (emilier@cmu.edu). It is highly recommended that students pursing this major/additional major work closely with academic advisors when schedule planning each semester.

As a note, students who completed psychology courses under the old numbering system will still have those courses count towards the requirements previously specified. New course numbers will take effect starting Fall 2025. Spring 2026 courses will be updated once course scheduling begins. The old course numbers remain in use until then, with catalog updates reflecting the changes beginning Fall 2026.

Learning Outcomes

Students who pursue this major will:

- Gain a broad understanding of Neuroscience at many different levels of analysis, including: cellular biology of the brain, brain systems, cognitive brain function, and computational brain modeling
- Gain an understanding of the sciences underlying Neuroscience, including: Biology, Chemistry, Computer Science, Cognition and Psychology, and other emerging areas
- Develop a comprehensive understanding of brain function in health and disease
- Be familiar with neuroanatomy & neurophysiology and their implications for nervous system function
- Be prepared for advanced study in neurobiology, cognitive neuroscience, and/or neural computation
- Be able to collaborate with Neuroscientists across a wide range of systems and levels of analysis
- Prepare for careers in Neuroscience related companies, Neuroscience research, and/or medicine
- Be prepared for specialization within subfields of Neuroscience given their concentration selection

Degree Requirements

All students must complete the following:

1. General Science Requirements (see section A)
2. Core Neuroscience Courses (see section B)
3. Requirements for one concentration (see sections C, D, or E)*
4. 18 additional relevant course units in their home concentration or other neuroscience areas (some examples listed in sections C, D, E, & F). At least 9 of these units must be at the 300-level or above.
5. Their home college's General Education requirements
6. Free elective units to come to a total of 360 total course units

* **Double-counting restrictions and additional majors & minors**

- Students may not major in two concentrations.
- Students using Neuroscience as an additional major or who have an additional major or minor to Neuroscience may only double-count at most 3 courses between this an their other major or minor (this restriction does not apply to prerequisites, General Education Requirements, or the General Science Requirements – section A).
- Other majors and minors may have more stringent double-counting restrictions, please consult with your neuroscience advisors and with the advising staff for the relevant host department for the other majors/minors.

A. General Science Requirements

		Units
21-120	Differential and Integral Calculus	10
21-122	Integration and Approximation	10
03-121	Modern Biology	9
or 03-151	Honors Modern Biology	
03-201	Undergraduate Colloquium for Sophomores *Only required for MCS Students	1
03-220	Genetics *New course code (03-330) starting Fall 2027	9
or 03-221	Genomes, Evolution, and Disease: Introduction to Quantitative Genetic Analysis	
09-105	Introduction to Modern Chemistry I	10
09-106	Modern Chemistry II	10
09-207	Techniques in Quantitative Analysis [1]	9-12
or 09-221	Laboratory I: Introduction to Chemical Analysis	
or 03-124	Modern Biology Laboratory	
09-217	Organic Chemistry I [1]	9
or 33-122	Physics II for Biological Sciences and Chemistry Students	
33-121	Physics I for Science Students	12
15-110	Principles of Computing [2]	10-12
or 15-112	Fundamentals of Programming and Computer Science	
or 02-120	Programming for Scientists	
36-200	Reasoning with Data [2]	9
or 36-218	Probability Theory for Computer Scientists	
or 36-219	Probability Theory and Random Processes	
or 36-225	Introduction to Probability Theory	
		108-113

[1] Neurobiology concentration students are required to complete 09-217 & 09-207 or 09-221.
[2] Computational Neuroscience concentration students are required to complete 21-122, 15-112 or 02-120, & 36-218 or 36-219

B. Core Neuroscience Courses

		Units
85-170	Foundations of Brain and Behavior [3]	9
or 03-161	Molecules to Mind	
85-110	Cognitive Psychology	9
or 85-213	Human Information Processing and Artificial Intelligence	
03-362	Cellular Neuroscience	9
03-363	Systems Neuroscience	9
15-386	Neural Computation [4]	9
or 02-319/03-360	Genomics and Epigenetics of the Brain	
or 85-414	Cognition in the Age of AI	
or 85-419	Introduction to Parallel Distributed Processing	
or 85-420	Biologically Intelligent Exploration	
or 86-375	Computational Perception	
		45

[3] Cognitive Neuroscience concentration students are required to complete 85-170.
[4] Computational Neuroscience concentration students are required to complete 15-386.

C. Neurobiology Concentration

Didactic Core: Students must complete all of the following		Units
03-231	Honors Biochemistry	9
03-320	Cell Biology *New course number (03-240) starting Fall 2027	9
		18

* Neurobiology concentration students must complete 09-217 & 09-207 or 09-221 in their General Science Requirements (section A, above)

Required laboratory, data analysis, & methodological courses		Units
03-343	Experimental Techniques in Molecular Biology	12
03-346	Experimental Neuroscience	12
or 03-345	Experimental Cell and Developmental Biology	
		24

Electives in Neurobiology (minimum of 18 additional units, at least 9 units at 300-level or above)**		Units
03-133	Neurobiology of Disease	9
02-250	Introduction to Computational Biology	12
03-350	Developmental Biology	9
03-365	Neural Correlates of Learning and Memory	9
03-366	Neuropharmacology: Drugs, Brain and Behavior	9
03-439	Introduction to Biophysics	10
03-442	Molecular Biology	9
09-218	Organic Chemistry II	9
09-208	Techniques for Organic Synthesis and Analysis	9
or 09-222	Laboratory II: Organic Synthesis and Analysis	
42-202	Physiology	9
42-203	Biomedical Engineering Laboratory NOTE: VERY Limited Seating Available for 42-203	9

** At least 9 of these units must be 300-level or above

D. Cognitive Neuroscience Concentration

Didactic Core. Students must complete all of the following		Units
85-100	Introduction to Psychology	9
36-309	Experimental Design for Behavioral & Social Sciences	9
or 85-309	Statistical Concepts and Methods for Behavioral and Social Science	
		18

Required laboratory, data analysis, & methodological courses		Units
85-300	Introduction to Research Methods	9
85-370	Cognitive Neuropsychology Research Methods	9
		18

Electives in Cognitive Neuroscience (minimum of 27 additional hours)**		Units
85-130	Developmental Psychology	9
85-150	Social Psychology	9
85-190	Psychopathology	9
85-411	Introduction to Music Cognition Research	9
85-413	Perception	9
85-414	Cognition in the Age of AI *	9
85-419	Introduction to Parallel Distributed Processing *	9
85-426	Reverse engineering brains and machines	9
85-432	Data Science for Psychology and Neuroscience	9
85-454	Health Psychology	9
85-471	How the Brain Makes Meaning	9
85-472	Cognitive Neuropsychology	9

* If not used as a core course
**At least 18 of these units must be 300-level or above

E. Computational Neuroscience Concentration

Strong candidates for the Computational Neuroscience Concentration will have earned a B average in 21-127, 21-241, 15-112, and 15-122. We strongly recommend meeting with your advisor to discuss interest in this major and for help planning appropriate schedules to support student success.

Didactic Core. Students must complete all of the following*		Units
21-127	Concepts of Mathematics	12
15-122	Principles of Imperative Computation	12
or 15-150	Principles of Functional Programming	
21-241	Matrices and Linear Transformations	10
or 21-240	Matrix Algebra with Applications	
		34

* Computational Neuroscience concentration students must complete 21-122, 15-112 or 02-120, and 36-218 or 36-219 in their General Science Requirements (section A, above) and 15-386 in their Core Neuroscience Courses (Section B, above). Students must complete a minimum of 60 units in this concentration. Students should select their required laboratory and elective courses to complete a minimum of 31 units (Four 9 unit courses or a lesser number of 9 and 12 unit courses could be combined to complete this requirement).

Required laboratory, data analysis, and methodological courses (18-24 total units)		Units
42/86-631	Neural Data Analysis	12
42-632	Neural Signal Processing	12
15-494	Cognitive Robotics: The Future of Robot Toys	12
15-883	Computational Models of Neural Systems	12
85-419	Introduction to Parallel Distributed Processing	9
85-420	Biologically Intelligent Exploration	9

Electives in Computational Neuroscience (minimum of 9 units)		Units
03-360/02-319	Genomics and Epigenetics of the Brain	9
02-512	Computational Methods for Biological Modeling and Simulation	9
10-301	Introduction to Machine Learning	12
or 10-315	Introduction to Machine Learning (SCS Majors)	
or 10-601	Introduction to Machine Learning	
15-387	Computational Perception	9
15-451	Algorithm Design and Analysis	12
15-453	Formal Languages, Automata, and Computability	9
15-494	Cognitive Robotics: The Future of Robot Toys	12
15-883	Computational Models of Neural Systems	12
16-299	Introduction to Feedback Control Systems	12
16-311	Introduction to Robotics	12
21-228	Discrete Mathematics	9
or 15-251	Great Ideas in Theoretical Computer Science	
21-259	Calculus in Three Dimensions	10
21-341	Linear Algebra	9
36-226	Introduction to Statistical Inference	9
36-350	Statistical Computing	9
36-401	Modern Regression	9
36-462	Special Topics: Statistical Machine Learning	9
42/86-631	Neural Data Analysis	12
42-632	Neural Signal Processing	12
42-688	Introduction to Neural Engineering	12
85-414	Cognition in the Age of AI	9

F. Additional Neuroscience Electives

Students are required to take a minimum of 18 additional relevant course units beyond those required for the concentration. These electives can be additional coursework from their home concentration or other neuroscience areas. Some examples are listed in sections C, D, & E above as well as in the list below. At least 9 of these additional 18 units must be at the 300-level or above.

NOTE: this list is not restrictive. Concentration advisors can approve additional elective courses that contribute to the student's neuroscience education, subject to additional approval by the major steering committee.

Examples of Additional Electives relevant to major*		
33-122	Physics II for Biological Sciences and Chemistry Students unless used for Science Core (section A)	9
76-385	Introduction to Discourse Analysis	9
80-210	Logic and Proofs	9
80-211	Logic and Mathematical Inquiry	9
80-220	Philosophy of Science	9
80-254	The History of Analytic Philosophy and Its Influence	9
80-270	Problems of Mind and Body: Meaning and Doing	9
80-280	Linguistic Analysis	9

* Up to 9 units of applicable undergraduate research course work (e.g. 03-445 or 85-507/85-508) can count as a neuroscience elective (not towards a concentration). A maximum of 27 additional units can be counted as a free electives.

Free Electives (depending on concentration & college)	**51-61**
TOTAL units to degree	**360**