

The Departments of Psychology and Biology offer a course major and an honors major in Neuroscience. Each Neuroscience major will be advised by the Neuroscience Faculty Administrator.

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2021-22 Neuroscience Academic Coordinator: Betsy Durning (edurnin1)

A. Entry Requirements for the Neuroscience Course Major and Honors Major

The study of Neuroscience involves advanced coursework with the following prerequisites. For admission to the Neuroscience special major, students must:

- complete (or otherwise satisfy) the following required courses (up to two credits of these taken at Swarthmore may be counted as Group B electives for the major), and
- obtain a minimum GPA of 3.0 (B) for these courses overall, as well as within all Biology courses and within all Psychology courses.

Biology	BIOL 001: Cellular and Molecular Biology BIOL 002: Organismal and Population Biology
Chemistry	CHEM 010: General Chemistry CHEM 022: Organic Chemistry I
Math/Stat	MATH 015: Elementary Single-Variable Calculus STAT 011: Statistical Methods
Psychology	PSYC 001: Introduction to Psychology PSYC 025: Research Design and Analysis

- The requirement for BIOL 001 and/or BIOL 002 may be satisfied by credit from the Biology AP exam (score of 5) if at least one credit in Biology has been completed at Swarthmore.
- The requirement for CHEM 010 will be satisfied if the student has placed out of it and completed CHEM 022.
- The requirements for MATH 015 and STAT 011 may be satisfied by placement out of these courses, as determined by the Department of Mathematics and Statistics
- The requirement for PSYC 001 may be satisfied with a Psychology AP exam score of 5.
- Provisional admission to the special major will normally be granted based on substantial progress in satisfying these entry requirements at the time of application.

B. Neuroscience Course Major Requirements

A special major at Swarthmore must include at least 10 credits and no more than 12 credits. A Neuroscience major will normally include two (2) Entry Requirement Courses (i.e., any two that have been taken at Swarthmore) and eight (8) Elective credits as specified below, including fulfilling the comprehensive requirement. Up to twelve credits may be included in the major, but only ten are required.

1. Electives

Majors will complete at least **eight (8) elective credits** from the following lists, to include **at least one seminar**. Normally, the seminar for course majors should be a Group A seminar; a Group B seminar may fill this requirement only with the approval of the Neuroscience Administrator. At least five (5) elective credits must be from Group A including at least one Foundation course and at least one course from each of Psychology and Biology. The remaining three (3) elective credits can be from either Group A, Group B, or Group C (see restrictions below). Note that all courses, including

seminars, are 1-credit unless otherwise specified.

It is possible to substitute or add electives from other universities (e.g., Systems Neuroscience at UPenn), including abroad, but students should seek Swarthmore faculty approval for such courses in advance.

Group A: Neuroscience Electives

BIOL 022	Neurobiology [Foundation Course*]
PSYC 030	Behavioral Neuroscience [Foundation Course*]

* At least one Foundation Course must be included. Both are recommended.

BIOL 020	Animal Physiology
BIOL 021	Neuroethology
BIOL 027	Systems Biology
BIOL 029	Developmental Neurobiology
BIOL 030	Animal Behavior
BIOL 121	Neural Systems and Behavior
BIOL 122	Reverse Engineering the Brain
BIOL 123	Learning and Memory
BIOL 124	Hormones and Behavior
BIOL 127	Behavioral Neuroendocrinology
BIOL 129	Developmental Neurotoxicology
BIOL 131	Animal Communication
BIOL 132	Evolution of Brain and Behavior
PSYC 031	Cognitive Neuroscience
PSYC 031A	Social, Cognitive, and Affective Neuroscience
PSYC 091	Advanced Topics in Behavioral Neuroscience
PSYC 130	Behavioral Neuroscience
PSYC 131	Cognitive Neuroscience
PSYC 131A	Psychology and Neuroscience: The Social Brain
PSYC 032/132	Perception: Laboratory Course & Seminar (2 credits)

Group B: Course Electives in Related/Overlapping Scientific Areas

NOTE: Students should inform their instructors in Group B courses (especially seminars) that they are majoring in neuroscience; this may allow for Neuroscience majors to sculpt their contributions and assignments to be more consistent with their major and interests.

BIOL 010	Genetics
BIOL 013	Stem Cell Biology
BIOL 014	Cell Biology
BIOL 016	Microbiology
BIOL 017	Microbial Pathogenesis and the Immune Response
BIOL 019	Omics
BIOL 023	Biology and Conservation of Amphibians and Reptiles
BIOL 024	Developmental Biology
BIOL 026	Invertebrate Biology
BIOL 034	Evolution
BIOL 039	Marine Biology
BIOL/CPSC 068	Bioinformatics
BIOL 111	Genome Regulation by Noncoding RNA seminar

BIOL 112	From Cells to Organs
BIOL 113	Stem Cells in Development and Regeneration
BIOL 114	Symbiotic Interactions
BIOL 115	Plant Molecular Genetics
BIOL 115E	Plant Molecular Genetics and Biotechnology
BIOL 116	Microbial Processes and Biotechnology
BIOL 117	Trends in Pharmacology
BIOL 119	Genomics and Systems Biology seminar
BIOL 120	Physiological Ecology
BIOL 125	Cellular Basis of Embryonic Development & Cancer
BIOL 126	Biomechanics in Development and Regeneration
BIOL 128	Evolution and Development
BIOL 134	Evolution of Animal Societies
BIOL 136	Molecular Ecology and Evolution
CHEM 038	Biological Chemistry
COGS 001	Introduction to Cognitive Science
CPSC 021	Introduction to Computer Science
MATH 056	Modeling
PSYC 024	Qualitative Methods
PSYC 027	Scientific Computing for Psychology
PSYC 028	Stereotypes, Prejudice, and Discrimination
PSYC 033	Cognitive Psychology
PSYC 034	Psychology of Language
PSYC 035	Social Psychology
PSYC 037	Multicultural Psychology
PSYC 038	Clinical Psychology
PSYC 039	Developmental Psychology
PSYC 040	Political Psychology
PSYC 042	Cognitive Behavior Therapy
PSYC 043	Computational Methods for Psychology and Neuroscience
PSYC 045	The Cognitive Science of Racism in America
PSYC 133	Metaphor and Mind
PSYC 134	Psycholinguistics
PSYC 135	Social Psychology
PSYC 137	Multicultural Psychology: Immigrant Adjustment
PSYC 138A	Clinical Psychology *
PSYC 138B	Clinical Psychology *
PSYC 139	Developmental Psychology

* Note that only one PSYC 138 seminar (either A or B) may be used as an honors preparation.

Group C: Research Electives

One unit of research (of up to 2 credits) in neuroscience from the following may be counted toward the minimum required 10 credits of the major. Additional research units may be counted for optional credits up to 12. Research electives are one way of fulfilling the comprehensive requirement (see below) for the Neuroscience major.

BIOL 098	Neuroscience Thesis Research
PSYC 096/097	Senior Thesis (2 credits)
PSYC 099	Senior Neuroscience Thesis
PSYC 102	Research Practicum in Perception and Cognition

PSYC 103	Research Practicum in Behavioral Neuropharmacology
PSYC 104	Research Practicum in Language and Mind
PSYC 105	Research Practicum in Psychology and Neuroscience: Social Imitation
PSYC 110	Research Practicum in Cognitive Neuroscience

2. Comprehensive Requirement for Course Majors

The comprehensive requirement is a Neuroscience Research Thesis, a complete scientific paper based on a research project conducted in Biology or Psychology or some other area related to neuroscience. Each Neuroscience major must identify their faculty thesis mentor before the end of the **junior fall semester**. A thesis project will be developed in collaboration with the thesis mentor.

A Neuroscience thesis can take many different forms that depend on the advisor's research style and interests, as well as the student's. For example, quantitative modeling of biological or cognitive processes underlying behavior is part of neuroscience, as well as direct measurement or manipulation of genetic, biological or physiological processes. Purely behavioral measures of explicit responses may be considered neuroscience methods when the structure of processing is under investigation in a way that helps to constrain theories concerning mechanisms underlying neurally controlled behaviors. In short, Neuroscience students may do many different kinds of theses, using many different kinds of scientific methods, as developed in concert with their advisor.

Thesis options. Each Neuroscience major must write their own Thesis, from one of the following options:

1. The thesis may be based on an individual research project directly supported by a faculty member as a Group C elective in either Biology or Psychology.
2. Students in Biology seminars and Psychology Research Practica often work on group projects and sometimes produce multi-authored research papers. Such a project may serve as the basis of a Neuroscience Research Thesis, but the paper must be a unique product of the student who submits it as their Thesis and should be undertaken under the guidance of the faculty member who taught the seminar or research practicum.
3. The thesis may be based on a separate research project, such as might occur during a summer (either at Swarthmore or at another institution). In this case, a student must secure the preliminary consent of a faculty mentor in either Biology or Psychology (whichever is more appropriate for the project) before beginning work on the project (i.e., before the summer research experience). The student must provide a one-page summary of the research project to both the faculty mentor and their academic advisor at the beginning of the fall semester of the senior year (no later than Friday of the first week of classes). If the faculty mentor approves the project for a Neuroscience Thesis, and consents to mentor the student through the process of writing the thesis, then the student will register for a 0.5 credit unit of Neuroscience Thesis during either (but not both) semester of the senior year.

Neuroscience Research Thesis: Guidelines for content and organization.

- The thesis should be organized in the format of a formal scientific paper, including the following sections: abstract, introduction, materials and methods, results, discussion, acknowledgments, and references.
- The thesis should report new empirical data on a research project that was conducted by the student.
- As the comprehensive exercise for an interdisciplinary special major, students should endeavor to explain their scientific question(s) and how their work is related to larger

themes in neuroscience in the thesis introduction and/or discussion.

- The length of the thesis is normally to be no more than 20 pages, double-spaced (exclusive of figures, tables, and references).
- The deadline for submitting the complete draft of the thesis will be set by the faculty research mentor; normally this would be within a week of the last day of spring semester classes.

Note that a Neuroscience Thesis may take other forms, as negotiated with the Thesis mentor and based on limitations/ability to conduct new studies; for example, a grant proposal or re-analysis of existing dataset(s) may be deemed appropriate for the completion of a Neuroscience thesis.

Neuroscience Research Thesis: Evaluation.

- A 0.5- or 1-credit thesis will be evaluated by the Swarthmore faculty thesis mentor.
- A 2-credit thesis will be evaluated by two faculty members, normally one from Biology and one from Psychology. One of these is the faculty thesis mentor, and the second will be determined by the student in consultation with the thesis mentor.

3. Sample Neuroscience Course Majors

The Neuroscience Major is demanding, but can be very flexible. It is important to receive advising from a faculty member in planning your program. Here we show several different possible programs. These are intended to be illustrative, and they should not take the place of advising.

ENTRY REQUIREMENTS (including 2 credits toward major)

AP in BIOL 001 plus BIOL 002 (1 credit counted toward major credits)

AP in PSYC (no credit) plus PSYC 025 (1 credit counted toward major credits)

AP in Calculus, STAT 011, CHEM 010, CHEM 022

SAMPLE PLANS FOR COMPLETING COURSE MAJOR REQUIREMENTS

- **“Minimalist” Neuroscience Major** (fewest credits, minimum in Group A). A total of 8 Elective credits = 5 from Group A (including 1 Foundation) + 3 from Groups B/C:

PSYC 030 (Group A Foundation)

BIOL 030 (Group A elective)

PSYC 031 (Group A elective)

PSYC 032 (Group A elective)

PSYC 130 (Group A elective/seminar)

BIOL 014 (Group B elective)

COGS 001 (Group B elective)

PSYC 105 (Research Practicum/Thesis)

- **“Core Emphasis” Neuroscience Major** – A total of 9-10 Elective credits = 8 credits from Group A (including 2 Foundation courses) + 1 or 2 Research credits:

BIOL 022 (Group A, Foundation)

PSYC 030 (Group A, Foundation)

PSYC 130 (Group A, seminar)

BIOL 123 (Group A seminar)

PSYC 031/131A (2-credit Group A electives)

PSYC 032/132 (2-credit Group A elective)

PSYC 105 or PSYC 096/097 (1-credit Research Practicum/Thesis or 2-credit Thesis)

- **“Cognitive Neuroscience Emphasis” Neuroscience Major** – A total of 8 Elective credits = 7

credits from Group A (including 1-2 Foundation courses) + 1 Research credit:
 PSYC 030/130 (Group A Foundation + Group A elective)
 BIOL 022 or BIOL 030 (Group A elective)
 PSYC 031A/131A (2-credit Group A electives)
 PSYC 032/132 (Group A elective)
 PSYC 102, 104 or 105 (1-credit Research Practicum/Thesis)

- **“Biology Emphasis” Neuroscience Major** - A total of 9 Elective credits =
 7 from Group A (including 1-2 Foundation courses) + 1 from Group B + 1 Research credit:
 BIOL 022 (Group A Foundation)
 PSYC 030, 031, or 032 (Group A)
 BIOL 029 (Group A)
 BIOL 030 (Group A)
 BIOL 123 (Group A seminar)
 BIOL 127 (Group A seminar)
 BIOL 131 (Group A seminar)
 BIOL 010 (Group B)
 BIOL 098 (1-credit Research Thesis)

C. Honors Neuroscience Major Requirements

Entry Requirements for admission to the Neuroscience Honors major are the same as those for admission to the Course major (see section A above).

The Neuroscience Honors major comprises two (2) Entry Requirement courses, at least one (1) of the two Foundation Courses, three (3) Honors Seminar preparations, and an Honors Research Thesis.

Students will be officially added to Honors on the Major/Minor Portal ONLY by the Academic Assistant to the Neuroscience Special Major once ALL of the following requirements have been met:

- A copy of the honors form, signed by the Neuroscience Special Major Administrator, has been received by the Academic Assistant to the Neuroscience Special Major.
- The Neuroscience Special Major Administrator has approved the student’s application to Honors via email to the Academic Assistant.
- The mentor of the student’s Honors Thesis has emailed their request to enroll the student in BIOL/PSYC 180 (i.e., Neuroscience Honors Thesis).

1. Neuroscience Foundation Courses: Honors majors will complete at least one of:

BIOL 022 Neurobiology
 PSYC 030 Behavioral Neuroscience

2. Honors Seminar Preparations

Majors will complete **three (3) seminar preparations** from the following groups, with at least two from Group A (normally one from BIOL and one from PSYC) and no more than two in one department. Note that each seminar preparation must include a different core course; together, the core course and the seminar constitute 1 2-credit Honors Preparation.

For example:

- If a Neuroscience Honors Major decided to take both PSYC 131 and PSYC 131A, they must also take both PSYC 031 and PSYC 031A.
- If a Neuroscience Honors Major decided to take both BIOL 122 and BIOL 129, they must also

take both BIOL 021 and BIOL 029 (or equivalent core courses).
Potential Honors Majors are strongly encouraged to speak with their Advisor early in the process to verify that these requirements are met.

Group A: Neuroscience Honors Preparations (Seminars)

BIOL 121	Neural Systems and Behavior
BIOL 122	Reverse Engineering the Brain
BIOL 123	Learning and Memory
BIOL 124	Hormones and Behavior
BIOL 127	Behavioral Biology
BIOL 129	Developmental Neurotoxicology
BIOL 127	Advanced Topics in Behavioral Biology
BIOL 131	Animal Communication
BIOL 132	Evolution of Brain and Behavior
PSYC 130	Behavioral Neuroscience
PSYC 131	Cognitive Neuroscience
PSYC 131A	The Social Brain
PSYC 032/132	Perception: Laboratory Course & Seminar (2 credits; no core course)

Group B: Honors Preparations (Seminars) in Related Scientific Areas

BIOL 111	Genome Regulation by Noncoding RNA
BIOL 112	From Cells to Organs
BIOL 115	Plant Molecular Genetics
BIOL 119	Genomics and Systems Biology
BIOL 120	Physiological Ecology
BIOL 125	Cellular Basis of Embryonic Development & Cancer
BIOL 128	Evolution and Development
BIOL 136	Molecular Ecology and Evolution
BIOL 134	Evolution of Animal Societies
PSYC 133	Metaphor and Mind
PSYC 134	Psycholinguistics
PSYC 135	Social Psychology
PSYC 137	Multicultural Psychology: Immigrant Adjustment
PSYC 138	Clinical Psychology
PSYC 139	Developmental Psychology

Neuroscience Honors Majors that have conducted their honors thesis research in conjunction with a member of the Biology Department at Swarthmore (or another institution but sponsored by a faculty member in Swarthmore's Biology Department) must enroll in one credit of BIOL 199 (Senior Honors Study) during their senior spring semester. This course is taken by honors candidates that are Biology, Biochemistry, and Neuroscience majors with theses that are biology focused. Students will participate in weekly meetings focused on presenting their thesis research orally and providing peer-feedback.

3. Honors Research Thesis (2 credits)

The Neuroscience Honors Thesis is a complete scientific paper based on a substantial research project that, according to the practices of the host department, may be completed in two semesters of research OR in one or two summers plus one semester of research. The project will be taken for one or two credits and will be graded by an External Examiner. Normally, Neuroscience Honors students that complete their theses with a Psychology mentor enroll for 2

1-credit semesters of PSYC 180; Neuroscience Honors students that complete their theses with a Biology mentor enroll for (a) 1 or 2 1-credit semesters of BIOL 180, and (b) 1 1-credit semester of BIOL 199 (in their senior spring semester).

The Honors thesis normally has a page limit of 20 pages, not counting references, figures, figure legends or tables.

An Honors thesis requires a significant investment of thought and time. This begins with careful advance planning. A Neuroscience Honors major will normally identify a faculty member in either Psychology or Biology who consents to be their thesis mentor no later than the **end of the junior fall semester**. Each Honors student will develop a thesis plan in collaboration with their thesis mentor by the end of their junior spring semester.