The Neuroscience Concentration at Brown

Table of Contents

NEUROSCIENCE CONCENTRATION
BROWN UNIVERSITY

The undergraduate concentration in neuroscience offers a program of study in the fields of knowledge important to an understanding of neural function. Neuroscience is an interdisciplinary program bringing together neurobiology (anatomy, physiology, biochemistry, molecular biology, development) with elements of psychology and cognitive science, as well as mathematical and physical principles involved in modeling neural systems. The concentration requires a general science background, a number of courses especially devoted to the brain sciences, and an in-depth experience that clearly defines the limits of knowledge in at least one aspect of neuroscience. The concentration allows considerable flexibility for students to develop the last two years along lines of individual preference. They may focus on areas of cellular and molecular neuroscience, behavioral neuroscience, cognitive neuroscience, computational neuroscience or some combination of these. Opportunities for independent study and honors are described elsewhere in this brochure. The degree awarded is the Sc.B. The concentration is administered by the Neuroscience Undergraduate Curriculum Committee (NUCC). For further information on the concentration, email neuroundergrad@brown.edu.
**For most up to date information please check Courses@Brown.

COURSES OFFERED BY THE DEPARTMENT OF NEUROSCIENCE

Primarily for Undergraduates

NEUR0010 *The Brain: An Introduction to Neuroscience*

Introduction to the mammalian nervous system with emphasis on the structure and function of the human brain. Topics covered include the function of nerve cells, sensory systems, control of movement and speech, learning and memory, emotion, and diseases of the brain. There are no prerequisites but a biology and/or chemistry course in high school is desirable.

Drs. Paradiso and Stein……..Sem.
Faculty…….....Summer

NEUR0680 *Computational Neuroscience*

A lecture and computing lab course providing an introduction to the quantitative analysis of neural activity and encoding, and to the modeling of neurons and neural systems. Emphasizes Matlab-based computer simulation. Prerequisites: NEUR0010, 1020 or 1030; APMA0410 or equivalent. *Enrollment limited.*

Dr. Bienenstock……..Sem. II

For Undergraduates and Graduates

NEUR1020 *Principles of Neurobiology*

A lecture course covering fundamental concepts of molecular and cellular neurobiology. Topics include structure and function of ion channels, synaptic transmission, synaptic plasticity and development. Prerequisite: NEUR0010 and BIOL0200

Dr. Aizenman…….Sem. II

NEUR1030 *Neural Systems*

This lecture course examines key principles that underlie the function of neural systems ranging in complexity from peripheral receptors to central mechanisms of behavioral control. Prerequisite NEUR0010 or equivalent.

Dr. Linden……....Sem. I

NEUR1040 *Neurogenetics*

This course will familiarize you with the relatively new and exciting field of neurogenetics. We will

cover basic topics, new ideas, and unsolved problems in neurogenetics primarily through the two assigned texts. Neurogenetics is essentially a "frontier" area in neuroscience, and the best way to approach this topic is by scientific literature, which will be covered in some lectures. Prerequisite: NEUR0010 and NEUR1020

Dr. Kaun…….....Sem. II

NEUR0650 *Biology of Hearing*

This course covers the sensory and perceptual system for hearing: the external, middle, and inner ears; the active processes of the cochlea; sound transduction and neural coding; neural information processing by the auditory system; and the nature of auditory perception and its biological substrate. Prerequisite: NEUR0010 or equivalent.

Dr. J. Simmons……...Sem. II

NEUR1440 *Neural Dynamics*

This course addresses mechanisms underlying this flexibility and its potential meaning for information processing in the brain. The course integrates biophysical, single neuron and human studies. Students will be introduced to computational modeling as a method to gain insight into dynamics, but no prior mathematics or programming background is required. Prerequisite: NEUR0010

Dr. Moore……Sem. II

NEUR 1530 *Communication In the Brain: What We Know and How We Know It*

Neurons communicate through the thousands of synapses they form. In this seminar-style course, we will explore the cellular and molecular underpinnings of synaptic transmission. We will then examine how synapse number and function can be modulated to shape circuit function during development, learning & memory formation, and in response to perturbations. We will develop scientific thinking skills and an understanding of experimental approaches in modern neuroscience by focusing on how the field investigates synaptic transmission and plasticity.

Dr. O'Connor-Giles……Sem. II

NEUR1540 *Neurobiology of Learning and Memory*

Exploration of learning and memory from the molecular to the behavioral level. Topics include declarative and procedural memory formation and storage, associative and non-associative learning, cellular and molecular mechanisms for learning, and disorders affecting learning and memory. Prerequisite: NEUR1020.

Dr. Linden …… Sem. II

NEUR 1560 *Developmental Neurobiology*

The course will explore core concepts of developmental biology in the context of the developing nervous system. Topics will include: neuronal specification, cell migration, axon guidance, synapse formation, and neural plasticity. Students will gain experience with the primary literature and learn about cellular and molecular mechanisms of brain development and the tools and model organisms used to study them. Prerequisite: NEUR 0010 and NEUR 1020 or BIOL 0200

Dr. Jaworski……..…….....Sem. II

NEUR1600 *Experimental Neurobiology*

A laboratory experience in neuroscience with emphasis on cellular neurobiology. Laboratory sessions will be supplemented by informal lectures designed to introduce topics and to discuss experimental approaches and concepts. Prerequisites: NEUR0010, NEUR1020, PHYS0030 or equivalent.

Dr.Stein……..Sem. II & Summer

NEUR1650 *Structure of the Nervous System*

A lecture and laboratory course on the anatomy of the central nervous system. Lectures provide an overview of the circuitry of the major neural systems for sensation, movement, cognition and emotion and emphasize a functional perspective. Laboratory exercises include brain dissections, analysis of histological slides of neural tissue, and

axon-tracing experiments. Prerequisites:NEUR0010, NEUR1020, and NEUR1030.

Dr. Berson……...Sem. I

NEUR 1660 *Neural computations in learning and decision making*

Your brain is constantly making decisions, receiving feedback about those decisions, and learning from that feedback. In this course we will examine the neuroscience underlying these processes from a computational perspective. The course will involve reading scientific papers from cognitive neuroscience, building and testing the computational models that have been developed to synthesize this literature, and, as a final project, extending an existing model of learning or decision making and characterizing its behavior. A primary goal for the course is to develop the tools and motivation to translate verbal theories of behavior into formal and testable computational models.

Dr. Nassar……..Sem. II

NEUR1740 *The Diseased Brain*

We will consider the mechanisms underlying a range of neurological and psychiatric diseases including Autism, Alzheimer's Disease, Fragile X Syndrome, Muscular Dystrophy and Tuberous Sclerosis. Emphasis will be on how insights on the cellular and molecular basis of these disorders are driving therapeutic development. Prerequisites: NEUR 1020. Suggested: NEUR1040 and BI0470

Dr. Fallon……Semester II

NEUR1930H *Neurological Disorders: Neural Dynamics + Neurotechnology*

A seminar course on neural dynamics and therapeutic approaches based on open-/closed-loop Brain-Computer Interfaces (BCIs) and neuromodulation for neurological and neuropsychiatric disorders. Topics include: (1) Disorders of consciousness: loss-of-consciousness in generalized epileptic and psychogenic seizures; closed-loop seizure control; Coma, medically induced coma and general anesthesia; Neuromonitoring of consciousness; (2) BCIs for auditory/visual/somatosensory disorders; (3) Movement disorders: BCIs for restoring movement/communication; adaptive-DBS for Parkinson's disease and essential tremor. (4) Neuropsychiatric disorders: DBS for major depression and obsessive compulsive disorder.

Dr. Truccolo…….Sem. I

NEUR 1930I *Neural Correlates of Consciousness*

This course will consider the neuroscience of consciousness from a variety of perspectives, using examples from behavior, neurophysiology, neuroimaging and neurology. The course content will focus on primary literature, using review articles for background. Students will lead discussions. Strongly Recommended: NEUR 1030.

Dr. Sanes……...Sem. I

NEUR 1930J *C2S Neurotech: from Concept to Startup- translating neurotechnology.*

To provide an understanding of the process of translating neurotechnology concepts into applications that can benefit people with nervous system disorders. It will emphasize principles useful to (1) recognize viable neuroscience concepts that can be applied to human nervous system disorders and (2) implement the essential engineering and clinical steps to translate concepts into real world, useful solutions. The course is for students interested in translational neuroscience research in academia or in entrepreneurship and commercialization of neurotech innovations.

Dr. Donoghue……...Sem. II

NEUR 1930L *Neurobiology of Love*

The goal of this course is to explore the underlying neurobiological principles of love and attachment. Topics include the relevant brain areas, the role of sensation and perception in love and attachment; how love and attachment influence action and behavior; plasticity and learning in these systems; and relevant neurodiversity related to love and attachment. You will gain a deeper understanding of

concepts and principles that apply throughout the brain. You will gain experience with primary literature and learn about the relevant experimental techniques. There will be an emphasis on how the neurobiology of love is portrayed in the popular press.

Dr. Linden……...……Sem. I

NEUR 1930N *Region of Interest: An In-Depth Analysis of One Brain Area*

An in-depth exploration of one region of the brain. Topics will include: cell types and properties; synaptic properties; plasticity; connections to other brain areas; sub-divisions within the area; the region's role in sensation and perception; the region's role in action and behavior; the region's role in learning and memory; and diseases and disorders. Students will gain a deeper understanding of concepts and principles that apply throughout the brain. Students will gain experience with primary literature and learn about techniques for studying the area.

Dr. Linden……...……Sem. II

NEUR1970 *Independent Study*

Laboratory oriented research in neuroscience, supervised by staff members. Written permission and approval by the Neuroscience Undergraduate Curriculum Committee required. Prerequisites: NEUR0010, NEUR1020 and NEUR1030.
Staff……..Sem I/II

NEUR2110 *Statistical Neuroscience*

An introduction to random dynamical systems and stochastic processes in Neuroscience. This is a lecture and computing lab course on the modeling of stochastic neural dynamics, with hands-on Matlab/Python-based applications to real and simulated data, directed to senior undergraduate and graduate students with a background in Computational Neuroscience and/or Applied Math/Biomedical Engineering. Topics include modeling of stochastic multivariate point processes and time series in Neuroscience and Neuroengineering, time and spectral domain analyses, state-space models, data assimilation and signal processing. These topics are addressed in the contexts of modeling neural dynamics in ensembles of neurons and brain networks, neural population encoding and decoding, among others. Example datasets include neuronal ensemble spike trains, local field potentials, ECoG/EEG. Sign-up sheet in Sidney Frank Hall, administrative offices, beginning on the first day of registration. Instructor permission required.

Dr. Truccolo…… Sem. I

Only for Graduate Students

NEUR2030,2040,2050,2060 *Graduate Core*
Dr. Sheinberg, Hart, Barnea, Desrochers
Sem. I/II

HOW TO DECLARE A NEUROSCIENCE CONCENTRATION

Declaring a concentration in Neuroscience requires some homework on your part and a bit of paperwork by all of us.

1. Acquaint yourself with the course requirements of the concentration and with other relevant courses offered at Brown that might form part of your program. You can also discuss the concentration at open houses in the Department of Neuroscience and with department representatives at various informational sessions held during the year in Sayles. This process should begin by early March. If you are looking to learn more about the concentration before declaring, please email neuroundergrad@brown.edu to schedule a meeting with a concentration advisor.

2. Lay out a schedule, semester by semester, of the courses you will need to complete the concentration during your remaining years at Brown. Make sure that courses taken in the same semester are given at different times, paying close attention to laboratories. Make sure that you have arranged to complete the prerequisites for the courses you schedule.

3. Enter your proposed plan on the form on page 10 of this brochure entitled **Neuroscience Concentration**: **Student/Advisor Agreement**.

4. Go to the office of the Department of Neuroscience (Sidney Frank Hall, administrative offices) or e-mail neuroundergrad@brown.edu and ask to be assigned a concentration advisor. You and your new advisor will be sent an email as confirmation; in addition, you will be pre-assigned to your advisor on the ASK (Advising Sidekick) online concentration declaration system.

5. Make an appointment to see this advisor to discuss your plans and preferences as soon as possible. Waiting too long to meet with your advisor may cause a delay in getting your concentration approved in ASK.

6. After consulting with your advisor, draw up a final draft of your proposal on the **Student/Advisor Agreement** form. This is a very important document because it functions as a contract between you and the Department of Neuroscience and becomes part of your permanent file in the department. Changes in your concentration courses can be made but this should never be done without first consulting your concentration advisor. You are responsible for the consequences of any changes made without departmental approval.

7. Using the ASK online forms, you should officially declare your concentration. Select the courses for your concentration using the **Student/Advisor Agreement** form as your guide. Once completed, your concentration declaration will automatically be sent to your concentration advisor for approval. Please be aware that your advisor may request changes. Your concentration is NOT approved until your advisor approves it in ASK. *Please keep your ASK profile as up to date as possible.*

8. Return your signed **Student/Advisor Agreement** form to the Neuroscience Administrative Office, Sidney Frank Hall.

NEUROSCIENCE CONCENTRATION REQUIREMENTS

BACKGROUND COURSES: MATH0090, 0100 or equivalent; CHEM0330& 0350 (or higher) PHYS0030, 0040 or equivalent; BIOL0200 or equivalent (For equivalents, see Frequently Asked Questions at the end of this brochure.)

NEUROSCIENCE CORE COURSES:

Basic Lecture Series:

NEUR0010 The Brain: An Introduction to Neuroscience
NEUR1020 Principles of Neurobiology
NEUR1030 Neural Systems

Statistics: 1 approved course

Laboratory Methods Course: 1 approved course

Critical Reading Course: 1 approved course

Four Thematic electives: In consultation with the concentration advisor, the student must select additional courses thematically related to his or her interest in neuroscience to make a total of 10 Neuroscience Core Courses. The student must write a short paragraph for each course justifying its inclusion in the concentration. (Organic chemistry does not satisfy this requirement). Two semesters of NEUR 1970 (Independent Study) can be used as an elective. See FAQ for more guidance on electives.

One semester of independent study, research or design (see below for info) - can overlap with course requirements.

The following courses are approved for concentration credit in their respective categories:

Laboratory Methods Courses:

NEUR0680	Computational Neuroscience
NEUR 1440	Neural Dynamics
NEUR1600	Experimental Neurobiology**
NEUR 1630	Big Data Neuroscience**
NEUR1650	Structure of the Nervous System**
NEUR1660	Neural Computation in L&D
NEUR1970	Independent Laboratory Research (two semesters)*
CLPS1190	Techniques in Physiological Psychology
CLPS1194	Sleep and Chronobiology Research
CLPS1491	Neural Modeling Laboratory
CLPS1492	Laboratory in Computational Cognitive Neuroscience
BIOL0800	Principles of Physiology
BIOL1170	Mammalian Physiology
BIOL1880	Comparative Biology of the Vertebrates

Statistics Courses:

PHP 1501, PHP 1510, PHP 2510,
APMA 0650, APMA 1650, CLPS 0900,
SOC 1100, EDUC 1110, BIOL 0495

Critical Reading Courses:

NEUR1440	Neural Dynamics
NEUR 1560	Developmental Neurobiology
NEUR 1660	Neural Computations In Learning and Decision Making
NEUR1930/40	Topics in Neuroscience
NEUR1970	Independent Laboratory Research (two semesters)*
CLPS1150	Memory and the Brain
BIOL1100	Cell Physiology and Biophysics
BIOL1110	Topics in Signal Transduction
BIOL1190	Synaptic Transmission and Plasticity
CLPS1400	The Neural Bases of Cognition

Enrollment in 200-level courses requires written permission of the instructor. Some courses may be restricted to graduate students.

Independent study can fulfill only one of the 10 core course requirements of the concentration.

*Certain courses in other departments may satisfy this requirement with written approval of your concentration advisor

For questions about courses not on this list, please consult with your concentration advisor.

*One summer of research can be used in lieu of one semester of NEUR1970. Please see concentration advisor for approval

** also cross-listed as BIOL courses

NEUROSCIENCE CONCENTRATION: STUDENT/ADVISOR AGREEMENT

Complete and return to the Department of Neuroscience / Box G-LN

Name_____ I.D. No. _____

Expected Year of Graduation_____ Box No. _____

Please list those courses you have completed and plan to complete, in order to satisfy the requirements for the concentration in Neuroscience. **Do not list AP or transfer credit for concentration requirements unless these credits appear on your internal Brown transcript**. See page 25 for further information.

Background Courses:

Semester or Year	Course Title	Course Number
_____	_____	MATH_____
_____	_____	PHYS _____
_____	_____	PHYS_____
_____	_____	BIOL0200_____
_____	_____	CHEM0330_____
_____	_____	CHEM0350_____

10 Core Concentration Courses:

Lecture Courses

_____	The Brain: An Introduction to Neuroscience	NEUR0010
_____	Principles of Neurobiology	NEUR1020
_____	Neural Systems	NEUR1030

Statistics Course *(see approved list)*

_____ _____ _____

Laboratory Course *(see approved list)*

_____ _____ _____

Critical Reading Course *(see approved list)*

_____ _____ _____

Four Thematic Electives

_____ _____ _____
_____ _____ _____
_____ _____ _____
_____ _____ _____

**Submit with this form a short paragraph for each of the additional courses justifying its inclusion in the concentration.*
**Also submit a short paragraph describing how you intend to complete your research requirement.*

I understand that I must satisfactorily complete the courses listed above in order to graduate with a concentration in Neuroscience. If I decide to alter this concentration program I will obtain the approval of my concentration advisor and submit a new copy of this form.

Student's Signature: _____ Date:_____

Advisor's signature: _____ Advisor's name:_____

GUIDELINES FOR INDEPENDENT STUDY
AND HONORS IN NEUROSCIENCE

In addition to the formal courses offered in the Department of Neuroscience, there is the opportunity for undergraduates to conduct independent work under the supervision of our faculty. There are two levels of independent work available: Independent Study Course and Independent Neuroscience Research. Each of these usually involves registering for NEUR1970. Honors in Neuroscience, described below in detail, requires maintenance of a distinguished academic record in course work of the concentration and completion of a thesis meriting the Honors designation.

I. Independent Study Course

In consultation with a faculty sponsor, students may organize independent study courses which cover material not available in regular courses. These independent courses might be reading projects or a combination of book work and some laboratory work. The sponsor will determine the type and amount of work and the manner in which performance is evaluated.

II. Independent Neuroscience Research

Undergraduates have the opportunity to apply to work with a Neuroscience faculty member to learn techniques used in current neuroscience research and to conduct a research project developed in consultation with the faculty advisor. These projects take a variety of forms including laboratory experiments, field work and mathematical and computer modeling. The student plays a major role in designing and performing the research project. Because research projects typically take two or more semesters to complete, the decision to conduct an independent research project is a significant commitment on the part of both the student and the advisor. Be prepared to devote from 10-20 hrs/wk to your independent research project. Since there are a limited number of positions within each lab, there sometimes are more students interested in conducting research than there are positions. It is advisable to begin looking for a position in a lab at least one semester before you would like to begin. Research advisors may require that you work in their lab for a summer or semester prior to beginning the Independent Neuroscience Research project. This serves as a trial period in which both you and the faculty sponsor can decide whether to progress to a joint research project. Most projects require at least two semesters of research plus a summer. Performance in Independent Neuroscience Research is assessed by reports (of a type specified by the advisor) at the end of each semester. The report after the final semester of research is a major paper describing the background, methods, results, and significance of the research project.

III. Arranging Independent Study in the Department of Neuroscience (NEUR1970)

1. Start your search for a faculty sponsor by consulting members of the Department of Neuroscience and the Neuroscience Graduate Program Faculty. These are individuals that have prior approval to sponsor NEUR1970. Choose potential advisors doing work in the area(s) you are interested in. Generally it is best to call a faculty member and make an appointment to discuss the possibility of working with them. If you would like to do an independent study with a sponsor that has not previously sponsored NEUR 1970, your sponsor will have to first fill the **NEUR 1970 Sponsor Application** and turn it in concurrently with your Independent Study Form.

2. Once you have tentatively arranged an independent course or research project with a faculty sponsor, the project *must* be formally approved by the Neuroscience Undergraduate Curriculum Committee. On the **Independent Study Form**, p. 13, describe the project you wish to undertake and obtain the signature of your faculty sponsor. Submit your proposal to the Neuroscience Undergraduate Curriculum Committee at neuroundergrad@brown.edu at least 1 month before you wish to begin the project.

3. Enrollment in NEUR1970 is closely regulated by the Department. Once your project has been approved, you will need to check with your advisor to see if he/she has approved you for enrollment on Banner. In addition, for each continuing semester of research under these course numbers, you will need to have your faculty sponsor sign a new **Independent Study Form**. You do not need to describe the project again. Take this form to Sidney Frank Hall, administrative offices, and check to see if you have been approved on Banner. [While all this may sound overly elaborate, it is our way of ensuring that your faculty sponsor is both authorized and willing to direct an undergraduate research project for the Neuroscience concentration.]

IV. Using Independent Study to Satisfy Concentration Requirements

In addition to background science courses and three core neuroscience lecture courses, the Neuroscience Concentration requires one laboratory course, one critical reading course and four elective courses thematically related to Neuroscience and to each other. Independent Study may be used to replace required courses as follows.

Regardless of how many semesters of independent study are taken, only one of the required courses in a student's concentration program may be replaced by independent study.

The required laboratory course OR the required critical reading course may be replaced by <u>two</u> semesters of Independent Neuroscience Research (e.g., NEUR1970).

With prior approval of the concentration advisor, two semesters of independent study may replace one of the four thematic electives. Summer research at Brown, in some cases, can be used in lieu of one semester of independent study, although you will not receive university credit.

V. Honors in Neuroscience

Honors in the concentration are given for excellence in scholarship and independent research. While independent research is a requirement for receiving an Honors Degree, simply completing such a project **does not** guarantee graduation with Honors. The awarding of a Sc.B. in Neuroscience with Honors is based on the following criteria:

1. Demonstration of quality *grades* in the concentration. Students who have earned a majority of "A" grades in courses required for the concentration and who are in good academic standing are eligible to apply for honors at the start of their penultimate (typically 7th) semester at Brown. Classes taken S/NC will count as qualifying towards that majority if they are marked "S* with distinction" indicating that had the student taken the course for a grade, the grade would have been an "A". Courses with a grade of S may be counted when a Course Performance Report indicates a grade of A. Students just shy of meeting the grade requirement for honors are encouraged to apply.

2. An appropriate independent research project must be completed to the satisfaction of the student's faculty sponsor, and the student must present a thesis describing the research project. The thesis must be written independently by each student; theses written by more than one student are not acceptable. The thesis is read and signed by the faculty sponsor and then is submitted for review to the Neuroscience Undergraduate Curriculum Committee by the announced deadline, usually two weeks prior to the public presentation described below. The thesis will be judged by the Neuroscience Undergraduate Curriculum Committee to merit Honors if it is of exceptional quality **and** if the project has a clear neuroscience focus.

3. Honors candidates must present the results of their studies in formal talks open to all interested faculty and students.

Students wishing to graduate with Honors must complete an **Honors Application**, which describes the proposed research and includes a sponsor's statement. The application must be signed by both the student and the faculty member who sponsors the project and must be received in the Department of Neuroscience by the date given below. An Honors Application is found on pages 17-19 of this brochure and may also be obtained from the Department of Neuroscience, Sidney Frank Hall, administrative offices. Note that the deadlines for submission of the Honors Application are different for students who plan to graduate in December and May.

The research project on which the thesis is based need not be carried out with faculty of the Department of Neuroscience or Neuroscience Graduate Program. Independent research projects supervised by other Brown faculty and under course designations other than NEUR1970 may be presented for honors, but students choosing to pursue this option are strongly encouraged to discuss the potential project with a member of the Neuroscience Undergraduate Curriculum Committee (x.3-1054) well in advance of beginning the project. Certain projects may not be judged appropriate for Honors in Neuroscience. Students electing to do their Honors project through a program or course other than NEUR1970 must also submit an Honors Application. The Committee will review the proposal promptly and may arrange a meeting to discuss the project with the student. As stated in section III, all independent study research projects conducted in the Department of Neuroscience (NEUR1970), including those intended to yield an honors thesis, must be approved before they can begin.

VI. Questions Concerning Independent Study and Honors

Any questions concerning the appropriateness of research for concentration credit or Honors should be addressed to the Neuroscience Undergraduate Curriculum Committee.

COMPLETING THE CONCENTRATION RESEARCH REQUIREMENT

As with other ScB concentrations, neuroscience concentrators are required (beginning with the class of 2023) to do the equivalent of one semester of independent study, research or design. This is a chance for the student to explore and apply the concepts that they have learned in their concentration courses. The following are ways in which this research requirement can be met.

1. Enrolling in independent study courses (NEUR 1970, CLPS 1970/80 or BIO 1950/60) for work in a lab. Keep in mind, to count this towards your concentration two semesters or one semester and a summer are required.
2. Enrolling in independent study (NEUR 1970) to work with a faculty member to explore an integrative topic related to neuroscience. See our section on independent study for more information.
3. Enrolling in a course-based research experience, also known as a CURE course. Current related CURE courses are NEUR 1630, CLPS 1195, CLPS 1591, but there might be new ones coming down the pipeline.
4. Participating in a structured summer research program (eg. an UTRA or an REU) that is equivalent in scope and scale as would be pursued during a semester of independent research.
5. Pursue a design or independent research project related to neuroscience that could be associated with a different course.
6. Anyone writing an honors thesis automatically fulfills the research requirement, in order to document your research requirement, please describe your plan in your Concentration Agreement and in ASK, be sure to discuss it with your concentration advisor to make sure it is appropriate.

Important Dates for the 2022 - 2023 Academic Year:

Last date to submit independent study application for Fall: September 16, 2022

Last date to submit independent study application for Spring: January 27, 2023

Honors Deadlines

Students graduating in May 2023:

Application due: October 1, 2022

Final thesis due: April 21, 2023

Poster Session: May 3, 2023

Students graduating in December 2022:

Application due: TBD

Final thesis due: December 3, 2022 (subject to change)

Final presentation: Please schedule with your concentration advisor

PROPOSAL FOR NEUROSCIENCE INDEPENDENT STUDY PROJECT
NEUR1970

INSTRUCTIONS:
FOR INITIAL PROJECT REVIEW:

1. Fill out this form and sign it below. On the back, describe the independent study project you wish to undertake.
1. Have the sponsor of your project sign below in the indicated space. This form becomes part of your permanent file and indicates that the sponsor agrees to support the work.
1. Submit the proposal form to neuroundergrad@brown.edu for review by the Neuroscience Undergraduate Curriculum Committee. Allow at least one week for this review process.
   If the project is approved, you will be notified and approved for enrollment on Banner.

FOR CONTINUATION REGISTRATION: Check here [ ]

1. If you have completed one or more semesters of NEUR1970 and wish to register for additional semesters, check the box above indicating that this is your intention, enter the relevant information on the form, have your faculty sponsor sign it, and submit it to the Department office. You will be notified of your enrollment approval on Banner.
   You do not need to describe the project again.

****

Name_____ Date_____

Class_____

Banner ID_____ Campus Box Number _____ Telephone_____

Title of Proposed Project:

SIGNATURES:

Student_____

Name of Independent Study Supervisor_____

Signature of Independent Study Supervisor_____

Do not write below this line

Neuroscience Undergraduate Curriculum Committee: Approved [ ] Denied [ ]

Signature _____ Date_____

DESCRIPTION OF NEUROSCIENCE INDEPENDENT STUDY PROJECT

FACULTY SPONSORS OF INDEPENDENT STUDY IN NEURO (NEUR1970)

NAME*	DEPARTMENT	AREA OF RESEARCH
A. Abdelfattah	Neuroscience	Optogenetics to record, trace, and manipulate brain circuits
W. Asaad	Neurosurgery	Neuronal mechanisms of learning and decision making
C. Aizenman	Neuroscience	Effects of experience on nervous system development
D. Badre	CLPS	Memory and Cognitive control
G. Barnea	Neuroscience	Mapping mouse olfactory circuits by molecular genetics
D. Berson	Neuroscience	Neural mechanisms of vision
E. Bienenstock	Neuroscience/Appl. Math	Theoretical neuroscience, artificial vision
S. Blumstein	CLPS	Neurolinguistics and speech processing
W. Bowen	Neuroscience	Neuropharmacology of sigma receptors
R. Burwell	CLPS	Neural basis of memory and attention
B. Connors	Neuroscience	Neural circuitry of cerebral cortex
T. Desrochers	Neuroscience	Neural mechanisms of sequential control
J. Donoghue	Neuroscience	Neural control of motion
J. Fallon	Neuroscience	Synaptic plasticity, autism, muscular dystrophy
A. Fleischmann	Neuroscience	Neural circuit mechanisms of sensory perception and behavior
M. Frank	CLPS	Computational modeling and neural mechanisms
S. Geman	Applied Math	Probability and statistics, natural and computer vision
A. Hart	Neuroscience	*C. elegans* and neurodegenerative disease
E. Hawrot	MPPB	Structure/function of ligand-gated ion channels
L. Hochberg	Engineering	Brain-computer interfaces
D. Hoffman-Kim	Neuroscience	Axon guidance, nerve guidance and repair
A. Jaworski	Neuroscience	Axon guidance mechanisms
S. Jones	Neuroscience	Computational modeling and neural dynamics
K. Kaun	Neuroscience	Molecular genetics of alcoholism
B. Lester	PHB	Developmental processes in children at risk
D. Lipscombe	Neuroscience	Physiology of neuronal ion channels
J. Marshall	MCB	Molecular biology of receptors and ion channels
S. Mayoral	Neuroscience	Oligodendroglia interactions in the CNS
C. Moore	Neuroscience	Brain dynamics, perception, optogenetics
E. Morrow	MCB	Autism and retinal development
A. Nurmikko	Engineering	Optoelectronics, neuroengineering
E. Oancea	Neuroscience	Signal transduction events
K. O'Connor-Giles	Neuroscience	Synapse formation, function and plasticity
M. Paradiso	Neuroscience	Information processing in visual cortex
R. Reenan	MCB	Neurogenetics and the evolution of brain function
J. Sanes	Neuroscience	Neural control of movement
D. Sheinberg	Neuroscience	Behavioral and neural analysis of objects and scenes
A. Simmons	CLPS	Auditory physiology and behavior
J. Simmons	Neuroscience	Bat echo location
W. Truccolo	Neuroscience	Theoretical Neuroscience, Neural Dynamics
T. Watanabe	CLPS	Vision: psychophysics, fMRI, computational modeling
T. White	Community Health	Alcohol and addiction studies
A. Zimmerman	MMI	Ion channel physiology and biophysics

CLPS	Cognitive, Linguistic, and Psychological Sciences
MCB	Department of Molecular Biology, Cell Biology and Biochemistry
MPPB	Department of Molecular Pharmacology, Physiology and Biotechnology
PHB	Department of Psychiatry and Human Behavior

DEPARTMENT OF NEUROSCIENCE
HONORS APPLICATION

The <u>three pages</u> of this form must be completed, signed by both the student and the faculty sponsor and returned to the Department of Neuroscience by email to neuroundergrad@brown.edu by the deadline stated in the GUIDELINES FOR INDEPENDENT STUDY AND HONORS IN NEUROSCIENCE.

Student Name_____Class_____Date_____

P.O. Box #_____Campus Address_____Telephone_____

E-mail address_____ Banner ID _____

I expect to satisfy the requirements for graduation with Honors as described in *The Neuroscience Concentration, Brown University,* available from the Department of Neuroscience.

I. Grades in Concentration (Honors requires mostly A's in concentration courses - see guide for info)

Course	Grade	Course	Grade
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

II. Thesis title (proposed):_____

_____

III. Thesis project. Briefly outline the proposed research project that will be the basis of your honors thesis. Describe the scientific rationale, the methods to be used and the way the data are to be analyzed**. Include a list of key references**. If you are part of a research team, for which aspects of the research project will you be responsible. (Use additional pages if necessary)

Signature of Student_____ Date_____

IV. Sponsor's Section

Students can be expected to devote 10-20 hours per week on the project during the school year. Faculty sponsors are expected to be available for regularly scheduled meetings with the student to review work and analyze progress. Students are expected to be intellectually involved in original research, with expectations appropriate for their level of experience.

1. Describe your role in the project and the role that you propose for the student. Will the student be supervised directly by you or by someone else in the laboratory?

2. Are sufficient resources available in your laboratory to support the student's project to completion?

3. In what laboratory activities, other than the research itself, will the student participate (e.g. regular laboratory meetings, etc.)?

_____ _____

Signature of Faculty Sponsor Date

_____ _____

Signature of Faculty Sponsor (print of type) Date

FREQUENTLY ASKED QUESTIONS ABOUT THE NEUROSCIENCE CONCENTRATION :

Q. What does NUCC stand for?
A. The Neuroscience Undergraduate Curriculum Committee.

Q. How do I get a concentration advisor?
A. Go to the Neuroscience office, Sidney Frank Hall, administrative offices (863-1054), and say that you have decided to concentrate in Neuroscience. You will automatically be assigned to an advisor. If you have not yet decided but simply want to talk to someone about your course selection you can also arrange this through the office.

Q. Can I choose my own advisor?
A. No. All faculty in the Department serve as concentration advisors and we try to distribute the advising load evenly among them. Your concentration advisor is the individual primarily responsible for monitoring your progress through the concentration and for completing the necessary forms. He or she will co-sign the **Student/Advisor Agreement** and will certify to the Registrar that you have completed the concentration, when and if you do. However, all faculty in the Department are available for consultation about specific aspects of your concentration and you should feel free to call on them.

Q. *I am a freshman who has just taken NEUR0010. What is the usual sequence of courses that I should take if I am thinking of being a Neuroscience concentrator?*
A. The three core courses of the Neuroscience concentration are NEUR0010, NEUR1020, and NEUR1030. We would recommend that you take NEUR1020 and NEUR1030 as a sophomore and use the spring semester of your first year to take basic science background courses.

Q. *I am a sophomore who has just taken NEUR0010. What is the usual sequence of courses that I should take if I am thinking of being a Neuroscience concentrator?*
A. As a sophomore who has just taken NEUR0010, you would probably want to enroll in NEUR1020, and then take NEUR1030 in the first semester of your junior year. NEUR1020 and 1030 are prerequisites for many of the upper level classes offered in the neuroscience department and for obvious reasons these should be taken sooner rather than later. Your selection of other courses really depends on the particular area of neuroscience which you have chosen for your focus. You should ask your concentration advisor for help in course selection.

Q. *I am really interested in neuroscience but I don't like Chemistry or Math. Is there some way I can be a Neuro major without taking these classes?*
A. No. The Neuroscience concentration only awards the degree of ScB and all students must do the basic science background courses or their equivalents.

Q. *Can Organic Chemistry be used as one of the four additional neuroscience classes?*
A. No. It can only be used to fulfill the Chemistry requirements in your background courses.

Q. *Can Chem0100 be used to satisfy one of my chemistry requirements?*
A. No.

Q. *I want to go to medical school. Is Neuroscience a good concentration for this?*
A. Yes. 70-80% of our concentrators go to medical school after graduation.

Q. I need to get letters of recommendation for med school/grad school/summer fellowship/etc. How do I find someone to write me a letter?
A. Contact the faculty member who is most familiar with you; for example your concentration advisor, or the director of a course in which you did well. Give the person you are asking at least one month's notice before the

due date. Make life easy for the reviewer by providing all the necessary paperwork, stamped addressed envelopes for the return of the letters where necessary, a resume if needed and a statement about why you are applying for this fellowship/graduate program etc.

Q. *Can I change my course selection after declaring my concentration?*
A. Yes. But, it is your responsibility to clear any changes in your concentration courses with your concentration advisor. You have signed a statement that you will do so. Beware of the frenzy of the shopping period when students tend to forget about their concentration requirements. If you fail to take and pass the required courses, you will not graduate.

Q. *There are only a limited number of NEUR1930/1940 courses offered and I need to satisfy the critical reading requirement. What should I do?*
A. As enrollment in critical reading courses is always limited and because the courses offered vary from year to year, it is important to carefully follow announcements for upcoming seminars. You must pre-register for these and you should sign up for the following semesters' seminars in the Neuroscience office starting on the first day of pre-registration. Also, see the answer to the next question.

Q. *Can I use a course not on the list to satisfy the critical reading course or laboratory requirement?*
A. Maybe, but in order to do so, you must file a petition to fulfill your critical reading course using a course not specifically approved in this handbook. This form can be obtained from the Neuroscience office. NUCC will consider each request individually.

Q. *I want to do NEUR1970. When should I begin to look for an advisor for my independent study project and how do I choose an advisor?*
A. Most students take NEUR 1970 as juniors and seniors, but as soon as you have decided that you want to do a neuroscience independent study project you should identify those areas of neuroscience that are particularly interesting to you. It is never too soon, but it can be too late. Some labs are harder to get into than others, so inquire early to avoid disappointment. The only faculty who are pre-approved to sponsor NEUR 1970 are members of the Neuroscience Graduate Program.

Q. Can I do my independent study with Professor Notinthensgp who is in the Center for Neurokinesis?
A. The only faculty who are pre-approved to sponsor NEUR 1970 are members of the Neuroscience Graduate Program. However, if you want to do an independent study project with, for example, a faculty member in another department in the Division of Biology and Medicine who has never sponsored a NEUR 1970 student, you can but your sponsor will have to first fill the **NEUR 1970 Sponsor Application** and turn it in concurrently with your Independent Study Form. In some cases you could also register for BIOL 1950/1960. *With the approval of your concentration advisor* you can use BIOL 1950/1960 toward your concentration as one of the four thematic elective courses or to satisfy the neuroscience lab requirement.

Q. *I got permission last year for Independent Study from both NUCC and my sponsor. Do I have to get permission again this year to continue my Independent Study?*
A. Yes, you need to get written permission from your independent study sponsor and NUCC to enroll for NEUR 1970 even if you enrolled for NEUR1970 the previous semester. However, you do not need to re-describe your research project.

Q. I am interested in working in a laboratory over the summer. How can I do this?
A. Spending a summer in the laboratory in which you are going to do an independent study project is a great idea and is strongly encouraged. There are also some great research opportunities at other universities - if you can bear the thought of being away from Providence for the summer. You can get information on applying for summer

research fellowships from Dean Thompson's office in Arnold. UTRA fellowships (undergraduate teaching/research assistant ships) are available on a limited basis for summer work at Brown. Summer fellowships generally provide you with a stipend to cover your living expenses.

Q. I'd like to try for honors. What do I need to do?
A. In order to be considered for honors you must obtain a GPA of at least 3.3 within the neuroscience concentration, submit a thesis, and present the results of your research at the Undergraduate Research Day in the spring. NUCC will formally review your thesis and decide if it merits honors. Simply writing a thesis is no guarantee of receiving honors. The composition and content of the thesis must also be of a high standard. See page 12 of the brochure for further information about Honors.

Q. Can I get honors in Neuroscience if I'm taking BIOL1950/1960?
A. Yes. In order to be considered for honors you do not have to have taken NEUR1970. But the thesis project which you undertake outside of the Neuroscience program should have a clear neuroscience focus and must be pre-approved by NUCC. If you have any doubts about the suitability of a project which you are planning to pursue for honors, you should submit a description of the project to NUCC before you invest time and effort in the work (preferably before the deadline for honors application). The committee can give you feedback and, if necessary, you will be able to make appropriate modifications.

Q. I want to double concentrate. Are there any restrictions I need to be aware of?
A. Yes. Excluding the background courses, no more than two courses can overlap between the two concentrations. Be aware that a combined A.B./Sc.B. requires 5 years residency. Also, it is important you also check with a concentration advisor for your non-neuro concentration, as they may have different restrictions than we do.

Q. If written permission is required to take a course, who do I get it from, and how?
A. Written permission should be sought from the course director. For NEUR1970 complete the form on pages 15-16 of this brochure, with your signature and that of your sponsor, and give that to the Department admin (Sidney Frank Hall, administrative offices), who will give it to NUCC. You will be notified of approval on Banner.

Q. What do I do if course enrollment is limited?
A. Enrollment is usually limited for Neuroscience laboratory and seminar courses. There is a sign-up sheet for limited enrollment classes in the neuroscience office. You should check with the office or the course director about when the class list will be decided upon. Seniors are given preference for limited enrollment classes.

Q. *What are the "equivalents" of required background courses in Biology, Math, Physics and Chemistry?* Does AP credit count?
A. If Brown has awarded you official advanced placement for a required course, this will automatically satisfy the Neuroscience concentration requirement for that course. If you have taken the AP or IB exams in high school, it is your responsibility to see that the scores are reported to Brown by the testing agency. They must appear on your internal transcript to be accepted for concentration credit. If they are not there, we will assume that you do not have them. In order to get AP credit to appear on your internal transcript you must submit a request in ASK.

- Students with AP, IB, or other exam credit for Biology 0200 satisfy the BIOL 0200 concentration requirement. Students may also place out of BIOL 0200 by passing a placement examination, in which case evidence must be provided to the Department of Neuroscience that this has been done.

- The Physics Department has an elaborate system for awarding advanced placement **credit** in its courses (http://www.physics.brown.edu). If you have been awarded advanced placement credit for the equivalent of PHYS0030 or PHYS0040 by the Physics Department, you must provide documentation of this to the

Department of Neuroscience. **Note: ENGN 0030 and 0040 may be used to substitute PHYS 0030 but you will still need to take PHYS 0040.**

- A required basic science course requirement can be waived if you provide a statement signed by the faculty member responsible for the course stating that you have had the equivalent course or experience.

Q. Can I use AP Statistics Credit to satisfy the concentration's statistics requirement?
A. Students declaring a Neuroscience concentration as of Spring 2010 may no longer use AP Statistics to satisfy the statistics requirement.

Q. Can I get concentration credit for summer courses?
A. It depends. Some summer courses can count toward the Neuroscience concentration and others cannot. For example, NEUR0010 and NEUR1600 are offered as summer courses by the Department of Neuroscience and can count as concentration courses. However, for courses taught at other institutions, Brown may refuse to accept transfer credit for courses that are not equivalent to existing Brown courses. Awarding concentration credit for courses taken elsewhere may require approval of the Neuroscience Undergraduate Curriculum Committee. If you plan to take summer courses related to your concentration, you should read the section in this brochure about using transfer credit to satisfy concentration requirements and discuss your plans with your concentration advisor.

Q. I am a Neuroscience concentrator and I want to spend a semester or year abroad. Will I have time to do this and still satisfy the concentration requirements? Can courses taken abroad be used to satisfy my concentration requirements?
A. It depends. Spending some time abroad is a great educational activity but requires careful planning to avoid problems with completing your concentration. The best strategy is to arrange your schedule at Brown so that you can complete the concentration here and not have to worry about it when you are overseas. It is often not possible to know in detail what courses you may be able to take at a foreign institution. For this reason it is good to have a back-up plan for completing the concentration at Brown in case things do not work out as you had hoped during your time abroad. If you are thinking about studying abroad, you should read the section in this brochure about using transfer credit to satisfy concentration requirements and consult with your concentration advisor and the Neuroscience Undergraduate Curriculum Committee.

Q. What's the deal with the WRIT requirement?
A. The university requires that all students take two writing, or WRIT-designated, courses while at Brown. The first should be taken during your First and Sophomore years, and the second one during your Junior or Senior year. Importantly, students must complete their WRIT requirement by the end of their 7th semester. Currently our concentration does not accept written work samples to fulfill the WRIT requirement. So you must make sure that you enroll in one of these courses by then. The WRIT courses do not have to be part of your concentration courses, and can be from any department as long as they have a WRIT designation. However we do offer some WRIT-designated neuroscience courses, including NEUR 1040 Intro to Neurogenetics, NEUR 1600 Experimental Neurobiology, and NEUR 1930N Region of Interest. To find other WRIT courses you can select this as a search filter in the Courses at Brown webpage. Here is more information from the university about the writing requirement.

Q. Which courses can be taken as electives?
A. The goal of the four thematic electives is to allow the students to explore courses that are thematically related to their interests in neuroscience. These do not have to be neuroscience courses, but the student has to be able to justify how they fit overall within the concentration as a whole. They also need not follow a single theme. Electives ideally should be upper-level courses (so that they have at least 1 prerequisite), that have substantial neuroscience

content, even if they are not taught directly by our department. Students often take a variety of CLPS, Applied Math or Biology courses that meet these criteria. But in some cases, courses such as genetics, cell biology, or CS courses can also be counted as electives, especially if the other electives they chose have a substantial neuroscience content. Thus, it is best to look at the concentration as a whole when discussing electives with your concentration advisor. The general rule is as follows: if you take your lab course and the four electives, at least three of those should have a strong neuroscience focus. Thus if you take BIO 800 (Physiology) as your lab course, then three of your electives have to have a strong neuro focus, the other one can be less related (eg. genetics). If you take Neuroanatomy, for example, as your lab course, then two electives have to have a strong neuro focus, the other two could be more tangential. That said, all your electives could be neuro focused, and that would be preferable. Organic chemistry cannot be used as an elective. You can always refer to NUCC if you and your advisor need some assistant approving a slate of electives.

For your reference here is a list of electives, List 1 contains courses (from Neuro and non-Neuro departments) that have no problems meeting the criteria of neuro-focused. List 2 has courses people have taken, but where you would have to look at the whole concentration in order to decide if they make sense. There are always new courses that are not on the lists, so this list should be used with caution, as you really want to explore the full curriculum: https://bit.ly/2mh8iIL

APPLYING TRANSFER CREDITS TO YOUR CONCENTRATION

If your plans include study at another institution in the US or abroad, there are several things to keep in mind.

- The University has a procedure for retroactively transferring credit for courses taken elsewhere, including courses taken abroad. To get official transfer credit for specific courses, the Brown department responsible for the course must confirm in writing that you have taken a course equivalent to a specific Brown course. There is a form for this obtainable from the Registrar. Such courses appear on your transcript.

- Departments have the authority (but are not obliged) to waive requirements for courses in their concentrations if you can demonstrate that you have had the equivalent course or covered the equivalent material. This can be done without your getting official Brown credit for the course, i.e. waived requirements do not count toward your required 32 tuition credits or the 30 successfully completed courses needed for graduation.

- If you anticipate replacing concentration courses with study at another institution, remember that retroactive University or concentration credit for courses requires official documentation by that institution that you have actually completed the work successfully. You should also bring back information about specific courses including, textbooks, syllabi, reading lists, laboratory exercises and anything else that will help us or another department evaluate your experience.

- The Department of Neuroscience will grant concentration credit for any of the 7 background courses taken at other institutions if the responsible Brown department certifies them to be equivalent to the applicable Brown courses. In some cases the Department may waive a background course requirement if evidence is presented that the equivalent material has been covered in a course or courses taken elsewhere, but for which you are not seeking official transfer credit. You must petition NUCC for such a waiver and provide evidence supporting your petition.

- The Department of Neuroscience allows transfer credit to satisfy up to 3 of the 10 courses that constitute the neuroscience core of the concentration. These core courses are NEUR0010, NEUR1020, NEUR1030, one neuroscience laboratory course, a statistics course, a critical reading course, and four thematically related electives. Such substitutions require the approval of NUCC, as do any requests for exceptions to this rule. This policy also applies to unassigned credits accepted by Brown from certain institutions. Such unassigned credits may or may not satisfy core requirements in the concentration.