Neuroscience Major Curriculum Proposal
Spring, 2023

I. Overview

A total of 5 faculty members comprising 3.75 FTEs currently constitute the Neuroscience Department (one faculty member jointly appointed to both the Neuroscience and Psychology departments has recently been appointed to the role of Dean of Academic Life). This is a substantial increase from the 1.5 FTE faculty Neuroscience had in 2008. These relatively recent hires have substantially broadened our expertise within neuroscience and hence the sorts of elective coursework, centered in neuroscience, that we can offer. Given these changes, we are now in a position to re-examine and update our major curriculum requirements.

The neuroscience major currently consists of 4 *core* courses in neuroscience, taught by neuroscience faculty, including a writing-intensive Cumulative Undergraduate Experience (CUE); 8 *cognate* courses in biology, chemistry, math, philosophy, and psychology; and 3 *elective* courses. The current elective requirement presents two different lists that students must use in selecting courses: one list of courses offered by neuroscience faculty, and one list of courses offered by faculty in other departments intellectually adjacent to neuroscience.

II. Summary of Proposed Changes

This document outlines several changes to the major requirements for neuroscience.

(1) The cognate requirement in philosophy, which currently requires students to take either *Phenomenology* (PHL 229) or *Philosophy of Mind* (PHL 328/338) has been expanded to also include *Neuroethics* (PHL 249) and the *Philosophy of Dreaming* (PHL 3XX) as options to satisfy this requirement.

(2) The current elective lists have been condensed into a single list of courses centered in neuroscience and offered primarily by Neuroscience Department faculty. Students will now choose two (rather than three) of these courses to complete the elective requirement.

(3) A new 200-level elective list has been created and added: Neuroscience in Context. Majors will now be required to roster one course from this list.

(4) We are proposing a new minor in neuroscience.

III. Proposed Scheme for the Neuroscience Major

Following the adoption of the changes outlined above, the neuroscience major scheme and catalog copy would read as follows (additions highlighted in red, eliminations noted by ~~strikethrough~~). There is no change to the total number of courses required by the major (15).

1. Four (4) core courses in neuroscience

NSC 201 – Mind & Brain, with laboratory
NSC 300 – Brain & Behavior, with laboratory
NSC 301 – Neurons & Networks, with laboratory
NSC 401 – Advanced Seminar in Neuroscience (CUE)

2. ~~Eight (8)~~ Six (6) foundational courses in the sciences

BIO 160 - Foundations of Biological Inquiry
BIO 165 - From Ecosystems to Organisms
BIO 175 - From Organisms to Molecules
CHM 103 - General Chemistry I
CHM 104 - General Chemistry II
~~MTH 119 - Statistical Analysis OR MTH 121 - Calculus I OR MTH 122 - Calculus II OR MTH 223 - Calculus III~~
~~PHL 229 - Phenomenology OR PHL 328/338 - Philosophy of Mind*~~
PSY 101 – Introduction to Psychology

3. One (1) course in mathematical/computational perspectives
The goal of this cognate is to further student's practice in mathematical or computational thinking. Students who have placed out of Calculus I or II are still required to take a different course on this list
MTH 119 - Statistical Analysis
MTH 121 - Calculus I
MTH 122 - Calculus II*
MTH 226 - Linear Algebra*
CSI 102/104/106/109 - Computer Science I
*courses with pre-requisites, options for students who have placed out of Calc I and/or II

4. One (1) course in philosophical perspectives on mind, brain & world
PHL223- Modern Philosophy

PHL 229 - Phenomenology
PHL 249 - Neuroethics
PHL 328/338 – Philosophy of Mind
PHL 2XX - Philosophy of Dreams

4. One (1) 200-level elective in neuroscience in context

NSC 205 - Sex, Gender, and the Brain
NSC 206 - Rethinking Drugs & Drug Abuse *(renumbered & renamed course; replaces NSC 115)*

5. Two (2) 300-level electives in neuroscience

NSC 302 - States of Consciousness
NSC 304 - Receptors & Channels
NSC 305 - Hormones & Behavior
NSC 307 - Neuroscience of Anxiety
NSC 308/309 - Embodied Cognition *(renumbered course; replaces NSC 202/203)*
NSC 313 - Neuropharmacology & Cell Signaling *(new course)*
NSC 314 - Sensory Systems & Behavior *(new course)*
PSY 410 - Memory and Amnesia

~~3. Three (3) elective courses in neuroscience. Choose one (1) elective from each list.~~

~~List A - Neuroscience Seminars~~
~~NSC 302 - States of Consciousness~~
~~NSC 304 - Receptors & Channels~~
~~NSC 305 - Hormones & Behavior~~
~~NSC 306 - Neuroscience of Anxiety~~
~~PSY 410 - Memory and Amnesia~~

~~List B - Perspectives~~
~~BIO 205 - Cell Biology~~
~~BIO 215 - Genetics~~
~~BIO 220 - Biochemistry~~
~~BIO 240 - Developmental Biology~~
~~BIO 245 - Comparative Anatomy~~
~~PHL 229 - Phenomenology*~~
~~PHL 249 - Neuroethics~~
~~PHL 328/338 - Philosophy of Mind*~~
~~PSY 212 - Learning and Behavior~~
~~PSY 214 - Sensation and Perception~~

~~BIO 250 - General Physiology~~ ~~PSY 217 - Cognitive Processes~~
~~BIO 265 - Behavior~~ ~~PSY 240 - Abnormal Psychology~~
~~PHL 223 - Modern Philosophy~~ ~~PSY 312 - Psychopharmacology~~

IV Proposed Scheme for the Neuroscience Minor

Following the adoption of the changes outlined above, the neuroscience minor scheme and catalog copy would read as follows (additions highlighted in red). A minor in neuroscience is 5 courses, plus 1-4 prerequisites depending on which core course a student chooses.

1. Two core courses in neuroscience
    NSC 201 - Mind & Brain
    NSC 300 - Brain & Behavior* OR NSC 301 - Neurons & Networks^
    **embedded requirement for this option include PSY 101*
    ^embedded requirements for this option include BIO 160, BIO 175, CHM 103, CHM 104

2. Three neuroscience electives, with at least 1 200-level neuroscience in context course and at least 1 300-level neuroscience elective.

V Rationales for the Proposed Changes

(1) Expansion of the philosophy cognate options

The neuroscience major at Muhlenberg is somewhat unique in that it includes philosophy - alongside biology, chemistry, math, and psychology - as one of the 'neuroscience cognate' disciplines. Neuroscience is by nature interdisciplinary; historically, knowledge in neuroscience has been both created and challenged by its relationship with scholarly activities within these cognates. Our department believes that students are best trained in neuroscience by also being exposed to conversations in adjacent 'cognate' disciplines - as foregrounded by the current eight cognate requirements of the major, which often serve as necessary prerequisites to core neuroscience requirements. Additionally, we as the faculty of the Neuroscience Department have expertise and interest in several of these cognate scholarly communities, and two of us have formal appointments to two of these cognate departments. Our recent external review highlighted the distinctiveness and merit of this structure, particularly the uniqueness of the philosophy cognate. Currently, the philosophy cognate can be fulfilled with either *Phenomenology* or *Philosophy of Mind*. Given the expertise of the current Philosophy Department at Muhlenberg, we propose to expand the options for this requirement to include two additional courses, *Neuroethics* and *Philosophy of Dreaming*, as they include substantial consideration of neuroscience and its relationship to current scholarly

conversations in philosophy and ethics. This will also provide both students and Philosophy faculty more flexibility in sustaining this valuable intellectual relationship across our departments.

(2) Centering electives within the Neuroscience Department

The current elective requirement maximizes student flexibility, in that it allows students to take up to two of the three of their elective courses outside of the Department. To some extent this model is a remnant of a different time in our Department's history, when we had fewer faculty with more limited expertise, and depended upon contributions of faculty from cognate departments to offer electives that might extend or complicate core neuroscience knowledge. Although we like the richness and diversity that these courses have afforded students, this elective structure has been challenging to assess and difficult to coherently narrate with respect to our major's learning goals. Moreover, the five faculty now appointed to the Neuroscience Department have considerably diverse and broad expertise that is not well captured by the current structure.

We are now in a position to offer more advanced courses within the department that showcase the breadth of neuroscience knowledge and foreground research methods particular to molecular, systems, behavioral, and cognitive neuroscience. Given our ability to offer these advanced courses in rotation, we believe that reducing the elective requirement from three courses to two is sustainable. Several of the departmental courses in the new elective list have been offered for many semesters - and wonderfully, many of these also enroll majors from cognate disciplines, and often count toward other majors' requirements. For example, *Receptors & Channels* (NSC 304) is routinely taught annually to ~15 students, including neuroscience, biochemistry, and biology majors. *States of Consciousness* (NSC 302) and *Embodied Cognition* (NSC 202/203) have often enrolled nonmajors looking for a deeper experience in neuroscience beyond the introductory level, given their prerequisites. We are hopeful that our electives can continue to serve many populations on campus. Centering electives in our department will help us to offer a more coherent developmental experience in neuroscience for not only our majors but also others with this interest.

(3) Creation of a new elective list within the neuroscience major

Our Department has been actively considering ways that we can reach potential neuroscience majors during their first year at Muhlenberg. Currently, students who express interest in neuroscience typically begin the major by completing cognate requirements in biology, chemistry, math, and psychology prior to beginning the core requirements of the major, and usually during their first two semesters. In practice, this means that we don't meet neuroscience majors until they are sophomores; it also means we only meet students who have passed successfully through the gauntlet of these

courses. We are concerned that, however unintentionally, our major is failing to appropriately mentor and retain students interested in neuroscience during their earliest time at the College.

At the same time, our Department has a long history of connecting non-majors to conversations within neuroscience by offering courses that do not first require prerequisite coursework. For example, *Mind & Brain*, the first core requirement of the major, has no prerequisites and is also open to non-majors wishing to satisfy a distribution requirement in the natural sciences (SC). Enrollments in this course have ranged from 24-54 students in the nearly 20 years it has been offered, and roughly 30% of this enrollment, on average, are non-majors. *Sex, Gender, and the Brain* (NSC 205), a newer course, has also enrolled both majors and non-majors, and can be used to satisfy the current elective requirement. On the other hand, *Drug Science* (NSC 115; previously titled *Drugs & Drug Abuse*) has been offered regularly, and is frequently over-enrolled with a long wait list, but is only open to non-majors.

The common orientation of these courses is best captured by the category of 'neuroscience in context'. In ways that are sometimes parallel and sometimes thoughtfully intersectional, neuroscience has increasingly considered the influence of sexism, homophobia, transphobia, ableism, structural inequality, and the criminal justice system on the neuroscientific study of sex, gender, disability, and drugs. This new elective category - from which the major will require students to take at least one course - reflects the Department's attempt to begin to include these conversations within the culture and practice of (neuro)science. We hope that these courses, like *Mind & Brain*, will enroll a mix of majors and non-majors, because we see these courses as importantly situating neuroscience across the traditional liberal arts disciplines.

At the same time, these courses present the best opportunity we have to reach first-year students interested in neuroscience. We have built a four year course schedule to ensure that at least one 'neuroscience in context' is offered every semester that includes seats reserved for first-years. In the 2023-2024 and 2024-2025 academic years, these courses will be *Sex, Gender, and the Brain* (NSC 205) and *Rethinking Drugs & Drug Abuse* (NSC 206; renumbered and renamed from NSC 115, see below). We will be adding additional courses to this list for the 2025-2026 and 2026-2027 academic years. Students will now have the flexibility and opportunity to complete neuroscience coursework during their first year that can count toward an eventual major in neuroscience (in some balance with cognate requirements). We are revising our Summer Advising recommendations to reflect this change.

(4) Renumbering and renaming select courses

In conversations that led to this proposal, we have decided to renumber *Embodied Cognition* (currently NSC 202/203, renumbered NSC 308) to reflect that it is now an advanced elective within the department, parallel to the other 300-level courses that satisfy this requirement. We have also renamed and renumbered *Drug Science* to *Rethinking Drugs & Drug Abuse* (currently NSC 115, renumbered NSC 206) to more transparently reflect its learning goals and its placement in the 'neuroscience in context' elective list.

We have also proposed changing the numbering of two core courses: *Brain & Behavior* (NSC 310, new number NSC 300) and *Neurons & Networks* (NSC 311, new number NSC 301) in order to more transparently indicate that these courses are foundational (and prerequisites) to many of the 300-level electives.

(5) Creation of a minor in neuroscience
In conversations about increasing access to the major for interested students, we determined that creation of a minor was the best way to allow students with late-breaking excitement about the discipline to fit in a smaller course of study.

VI New Courses & Course Descriptions

NSC 206 - Rethinking Drugs & Drug Abuse *(renumbered & renamed course; replaces NSC 115)*
A foundational study of pharmacology including neuroscientific, chemical, and historical points of reference. We will discuss the pharmacological principles of drug action, including the absorption, distribution, elimination, and dose-behavior relationships of key drug families as well as the putative mechanisms by which these drugs act on targets in biological tissues. Will also examine the biological basis of drug addiction and the ways in which the scientific characterization of pleasure-reinforcing drugs has been shaped by neuroscience data. Key course readings and discussions will frame the myriad beliefs that underpin narratives and stigmas surrounding drug use and science-based drug policy. We will consider the representation of drugs in both science and society and the resulting consequences for drug regulation, research, and education. *This course satisfies an SC general academic requirement.*

NSC 308/309 - Embodied Cognition *(renumbered course; replaces NSC 202/203)*
Embodied cognition is an increasingly influential and popular scientific research program. It investigates brain function in the context of an organism's embodied interactions with the material, social, and (in the case of human beings) cultural environment. This interdisciplinary field

incorporates multiple perspectives including neurophysiology, ethology, ecological psychology, phenomenology, cybernetics, and dynamical systems theory. By the end of this course you will have encountered each of these perspectives, and will feel comfortable talking, writing and thinking about them. This course also includes a lab section which features, among other activities, experimental and experiential demonstrations, discussion and synthesis of primary literature, and the development and investigation of simple behaving robots. *This course satisfies an SC general academic requirement. This course satisfies an IL general academic requirement if taken simultaneously with PSY 217/218, when taught by Dr. Alexandra Frazer. Prerequisite: Completion of NSC 310 or completion/simultaneous enrollment in PSY 217/218 or permission of instructor.*

NSC 313 - Neuropharmacology & Cell Signaling *(new course)*

A critical discussion of pharmacology and signal transduction in a broad range of signaling pathways particular to the nervous system. Course lectures will introduce the evolving perspectives and methods of cell and network physiology, signaling mechanisms and their regulation, as well as the actions of drugs on those mechanisms. Students who complete this course will be able to describe, at an integrative level, the chemical signals that underlie behavior as well as the drugs that modulate these signals so as to change behavior. Topics discussed will include neurotransmitter systems, the neural substrates of drug action, pharmacokinetics, neuropeptides, and the possible neuropharmacology of neural disorders. *Prerequisite: Completion of BIO 175 or permission of instructor.*

NSC 314 - Sensory Systems & Behavior *(new course)*

All behaviors, from phototaxis by a bacterium to echolocation by bats, rely on processing of sensory information. As behaviors become more complicated, so does the underlying neural processing. In the course we will look at how diverse groups organize and process sensory information. During this course you will learn the basic principles of information encoding in sensory systems, learn behavioral tools for investigating mechanisms of sensory processing, and apply your knowledge in a real world context. Our systems of exploration will include examples from electromagnetic-, chemical-, auditory-, thermal-, and mechanical-perception.

VII Anticipated Schedule of Course Offerings

Course	**F23**	**S24**	**F24**	**S25**	**F25**	**S26**	**F26**	**S27**
	sections(seats)							
NSC201	3 (48)		2 (32)		3 (48)		3 (48)	
NSC310	2 (32)		2 (32)		2 (32)		2 (32)	
NSC311		2 (32)		2 (32)		2 (32)		1 (16)
NSC401	1 (12)	1 (12)	1 (12)	1 (12)	1 (12)	1 (12)	1 (12)	1 (12)
300-level electives								
NSC 304 - Receptors & Channels			1 (16)			1 (16)		
NSC 305 - Hormones & Behavior		1 (16)				1 (16)		
NSC 307 - Neuroscience of Anxiety		1 (16)		1 (16)		1 (16)		1 (16)
NSC 308/309 - Embodied Cognition *(renumbered course; replaces NSC 202/203)*		1 (16)						1(16)

NSC 313 - Neuropharmacology & Cell Signaling *(new course)*				1 (16)	1(16)			1 (16)
NSC 314 - Sensory Systems & Behavior *(new course)*			1 (16)				1 (16)	
PSY 410 - Memory and Amnesia	1 (16)		1 (16)		1 (16)		1 (16)	
To be developed: NSC 3XX - Theoretical Neuroscience (tentative title)								1(16)
Neuroscience in context electives								
NSC 206 - Rethinking Drugs & Drug Abuse	2 (40)			1(20)			1 (20)	
NSC 205 - Sex, Gender, and the Brain		1 (20)	1 (20)			1 (20)		
To be developed: NSC 2XX - Conservation Neuroscience					1 (20)			

To be developed: NSC 2XX - The Damaged Brain						1(20)		