Department of Neuroscience

Strategic Education Plan 2022

I. Overview / preamble

The Department of Neuroscience is somewhat an outlier in the College of Science regarding instruction because it does not have its own, independent undergraduate major, nor does it run a graduate program. The department achieves its instructional mission through the Neuroscience and Cognitive Science (NSCS) undergraduate program, a joint venture of various departments that is housed in the School of Mind, Brain and Behavior (MBB).

In contrast to most traditional majors, the NSCS major has two foci, Neuroscience and Cognitive Science. The dual nature of the program generates a curriculum with an unusual complexity and some significantly negative academic constrains (see section II).

The source of courses in the NSCS major and thereby the way how instruction is credited to departments is unusual and not entirely fair. All neuroscience courses are solely offered in the NSCS program through the Department of Neuroscience. In contrast, all Cognitive Science-related courses of the NSCS program are also offered in otherwise independent majors originating in various contributing departments including mostly Psychology, Linguistics, Philosophy, and Bioinformatics. Accordingly, every contributing department "double dips" courses offered in the NSCS major, except for the Department of Neuroscience. Consequently, the health of the NSCS major is of particular interest to the instructional income of the Department of Neuroscience.

The unusual nature of the NSCS program also generates an inequitable situation for the Department of Neuroscience regarding credit for NSCS instruction. While student credit hours (SCHs) are fairly credited to the participating departments that offer the respective courses, the credit for the NSCS majors is solely distributed to MBB and not the participating departments. This generates an unsustainable situation for the Department of Neuroscience because approximately 70-80% of all NSCS students take the neuroscience focus. Thus, the Department of Neuroscience has only a limited benefit from attracting and instructing most NSCS majors unless credit for both SCHs and majors is fairly distributed among contributing departments.

II. The state of the NSCS program

To generate a strategic plan maximizing student enrollment and retention, the Department of Neuroscience reviewed the current NSCS program and identified several challenges that potentially limit student enrollment and/or overall student engagement and satisfaction, the latter being a potential retention problem.

A review of overall student enrollment in the NSCS major showed that after a steady growth from 57 students in 2010 (inception) to a peak of 618 students in spring 2020, student enrollment slightly declined and plateaued at about 550-562 in 2021. As such, NSCS enrollment lags behind the enrollment of comparable majors (like MCB, BMCB, EEB, Physiology). Therefore, the program requires further initiatives to become more attractive for students in order to further increase student enrollment.

A 2021-2022 census of the entire NSCS student population showed that 76% of students elected neuroscience as their focus. Importantly, a 2021-2022 census of only upper division NSCS students revealed that 77% of the students are still in the neuroscience focus. Finally, a 2021-2022 census of the emphasis-association of students in the neuroscience focus revealed that 48% are mostly interested in the neurobiology emphasis, and 9% in development and aging, 5 % in computation, and the remaining 3% in language & communication. Accordingly, the neuroscience focus and the neurobiology curriculum are clearly the key attraction for students to enroll in the NSCS major, and students appear to remain in the neuroscience focus as they reach the upper division level. Therefore, reforming the neuroscience focus and neurobiology curriculum is likely a basis for further growth in NSCS enrollment. Moreover, the significant bias of NSCS students towards neuroscience also highlights the urgency of developing a streamlined neuroscience major with a curriculum that is better tailored to the interest and needs of most of the students, especially those who seek higher academic degrees or employment in the biotech industry with its molecular cellular bias.

While exciting and attractive to students on one side, the dual nature of the NSCS major generates a complexity and requirement that may somewhat limit student enrollment and retention, especially for students that expect a streamlined major. Briefly, the program requires all students to take 6 major core courses that are shared for each of the 2 foci of the program. Subsequently, students must take at least 2 more core courses that are specific to each major. Many, if not most, of these courses are prerequisites for electives that are offered through 7 different thematic emphases. While the program offers a large number of electives per se, it severely limits the number of electives a student can reasonably take during a 4-year tenure due to time constrains that arise from the large number of core courses.

This potential “bottle neck” requires further analysis but is likely a significant problem for student retention and enrollment. Unfortunately, attempts of modernizing the neuroscience curriculum to increase the attractiveness of the neuroscience path are limited. Altogether, the departmental review identified the following constrains in the NSCS major:

- An unusual curricular complexity of the current NSCS major with implications for student enrollment and retention, especially in the neuroscience focus.
- Lack of contemporary course offerings in emphases of the neuroscience focus that likely limit the attractiveness to new and currently enrolled students.
- Underuse of best practices maximizing student engagement affecting student retention.

Next to the faculty review of the NSCS major, the department used 2 student surveys and two separate student focus groups to assess the program. The resulting student-centric assessment strongly underscores (reiterates) the faculty-centric view of the program.

Main findings of the student surveys

49 and 90 NSCS students responded to the surveys taken in 2020 and 2021, respectively. The main finding are as follows:

- 70-78% of students expressed that Neuroscience courses are their most favorite courses (NSCS 307 Cellular Neurophysiology, NROS 310 Molecular & Cellular Bio of Neurons, NROS

430 Neurogenetics, NROS 418 Systems Neuroscience).
- 64%-73% expressed dissatisfaction with the neuroscience focus and stated that there are not enough (contemporary) neuroscience courses that are part of the current NSCS curriculum.
- 85-95% expressed a high and explicit interest in the development of new neuroscience courses explicitly in the areas of molecular and cellular neurobiology of disease, molecular and cellular neurobiology of drug addiction, molecular and cellular neurobiology of aging, neuropharmacology, and neuroanatomy.

Main findings of students focus groups 1 (n=35 students)
2 different student focus groups (35 and 25 student each) were held to discuss and assess the NSCS major. The main finding are as follows:
- many students (55% and 88%, respectively) expressed dissatisfaction and indicated that the neuroscience focus lacks a sufficient number of contemporary neuroscience courses with a molecular, genomic, proteomic, disease and/or foundation emphasis.
- 70% of students (one group only) expressed a dissatisfaction about the lack of a specifically first-year neuroscience course that is part of the NSCS curriculum.
- 50% of students expressed a preference for NSCS core courses to be taken before year 2; currently, the first NSCS course (NSCS 200) is taken by the end of year 2 or later.
- 90% of students expressed preference for neuroscience courses (NSCS 307 Cellular Neurophysiology, NROS 310 Molecular & Cellular Bio of Neurons, NROS 430 Neurogenetics and NROS 418 Systems Neuroscience).

Altogether, the review of the NSCS major suggest that the neuroscience focus is the major driving force for the success of the NSCS major. However, it is also suggested that changes in the curriculum and organization of the NSCS major are needed to improve student retention and enable further growth of the program. Due to the attractiveness of neuroscience, a serious consideration of a new stand-alone and streamlined neuroscience major is warranted.

III. Strategies to maximize student enrollment and retention.
The Department of Neuroscience envisions the following initiatives to increase student retention and enrollment in the NSCS major and maximize credits for SCHs and majors awarded.
- Undergraduate Certificate in Neurobiology
- Accelerated Master's degree in Neuroscience targeting NRSC students
- Master’s degree in Neuroscience targeting students with a B.S. in the life sciences
- Expanding existing student success activities and implementing new ones to maximize student retention during years 1-3.
- Implementing targeted outreach initiatives to increase enrollment (high to mid school events; science cafes, etc.
- New undergraduate major in Neuroscience

1. Certificate Program in Neurobiology
Rationale. A number of courses in the NSCS program show moderate to high enrollment from non-NSCS majors, indicating that there is significant interest of non-NSCS students for

neuroscience classes. Next to the existing NSCS minor, a Certificate Program in Neurobiology is likely to attract non-NSCS students and increase overall enrollment NSCS/NROS courses.

Objective. The 12-month Certificate Program in Neurobiology is specifically designed to provide significant in-depth training in molecular, cellular and system neurobiology. This program is specifically designed for UA students majoring in any field of life sciences and are interested to expand their interdisciplinary knowledge of biology. The Certificate in Neurobiology will enhance a student's chances of continuing higher education in life sciences including neuroscience on a graduate level and/or expand their employment options in industry.

Pre-requisites for enrollment. Currently enrolled UA student in any field with a GPA of 2.75 who has successfully taken at least 1 semester of General Biology and 1 semester of General Chemistry. Concurrent enrollment in these courses during the 1st semester is acceptable.

Curriculum
(12 units minimum)
Required coursework (9 units)
NROS 310 – *Molecular and Cellular Biology of Neurons* (3 units)
NROS 307 – *Cellular Neurophysiology* (3 units)
NROS 418 – *Fundamental Principles in Systems Neuroscience* (3 units)
Elective coursework (3 units)
NROS 308 – *Methods in Neuroscience* (1 unit)
NROS 330 – *Neuroanatomy* (3 units)
NROS 412 – *Molecular Mechanisms of Learning and Memory* (3 units)
NROS 430 – *Neurogenetics* (3 units)
NROS 440 – *How to Build a Brain: Mechanisms of Neural Development* (3 units)

2. Master of Science Programs in Neuroscience
Rationale. Graduate education in Neuroscience at the UA is currently limited to a Ph.D. degree that is offered by the Graduate Interdisciplinary Program in Neuroscience, which is independent of the Department of Neuroscience. Therefore, there is a market niche for master programs in Neuroscience or Neurobiology. There is likely much demand for such degrees since a recent "burning glass" analysis suggests that the neuroscience workforce is on the rise in Arizona and nationwide. Moreover, master's degrees are preferred for employment in the biotech and pharma industry.

We propose the development of two master programs: An accelerated BS/MS program in Neuroscience for NSCS students with a neuroscience focus. In addition, we propose a traditional MS program in Neuroscience that will attract students nationwide.

a. Accelerated Master's Program in Neuroscience
Objective. The Accelerated Master's Program (AMP) in Neuroscience will allow UA undergraduate students to earn both a Bachelor of Science degree in Neuroscience & Cognitive Science, and a Master of Science degree in Neuroscience in a total of 5 years. A minimal set of advanced courses

will provide a valuable opportunity to expand in-depth knowledge of neuroscience with established investigators and to learn how to approach and evaluate the scientific literature. The experience of designing, performing, and evaluating research will be a central component of the training.

The AMP is specifically designed for NRSC students who aim to gain significant research experience at the graduate level for employment in neuroscience research-orientated careers in academia and industry, pre-medical students who may conduct research in the future, students who would like to expand their research experience before launching into a Ph.D. program, and others who might find graduate-level research experience beneficial for a future career or position in science policy, teaching or others.

Eligibility. The program is open to students who declared Neuroscience & Cognitive Science (NSCS) as their major and are in good academic standing.

Curriculum. Students complete the minimum undergraduate units and 30 units of graduate work to obtain the combined BS/MS degree. Graduate course work includes a Master's Thesis and at least 15 regularly graded units of course work, with a minimum cumulative GPA of 3.0. Only grades of C or better in graduate course work satisfy requirements for the degree.

The curriculum includes two neuroscience core courses (NRSC 588, NRSC 560), two semesters of NRSC 695F, one Statistics course, one Writing, one Ethics course, one elective course. Students join a lab for their 12-month thesis work.

Required Coursework (15 units minimum of regularly graded courses)
NRSC 588 – *Molecular and Cellular Neuroscience* (4 units)
NRSC 560 – *Systems Neuroscience* (4 units)
SLHS 649 – *Survival Skills and Ethics* (3 units)
or MCB 695E – *Science, Society, and Ethics* (1 unit)
NROS 5xx – *Scientific Grantsmanship* (2 units)
or SLHS 696a – *Topics in Speech, Language, and Hearing Sciences* (2 units)
or MCB 575 – *Scientific Communications* (3 units)
EIS 513 – *Applied Biostatistics* (4 units)
or EPID 576B *Biostatistics for Research* (3 units)
or MATH 509C – *Statistics for Research* (3 units)
or PSY 510 – *Statistics Fundamentals* (3 units)

A minimum of 3 regularly graded units of graduate-level elective course work. Elective courses include, but are not limited to:
CMM 518 – *Fundamental Genetic Mechanisms* (3 units)
CMM 525A – *Functional Human Histology* (4 units)
CMM 565A – *Fundamentals of Light Microscope and Electronic Imaging* (3 units)
CMM 595H – *Problems in the Biology of Complex Diseases* (2 units)
CMM 695D – *Human Genetic Disease Colloquium* (3 units)
GENE 539 – *Methods Cell Biology & Genomics* (3 units)

GENE 670 – *Recent Advances in Genetics* (2 units)
INFO 521 – *Introduction to Machine Learning* (3 units)
MATH 585 – *Mathematical Modeling* (3 units)
MCB 546 – *Genetics & Molecular Networks* (4 units)
MCB 582 – *Modeling Human Disease* (3 units)
NRSC 572 – *Neurodevelopment in Action* (3 units)
NRSC 695D – *Human Genetic Disease Colloqium* (3 units)

In addition, the following pass/fail graded courses are required:
NROS 6xx – *Journal Club* (1 unit) for two semesters
NROS 6xx – *Seminar* (1 unit) for two semesters
NROS 910 – *Thesis* (3 units), for two semesters

Remaining graduate units may be fulfilled by additional, pass/fail graded graduate-level courses, such as:
NROS 900 – *Research*
NROS 6xx – *Lab Presentations and Discussion*

b. Master Program (MS) in Neuroscience (stand-alone program)
Objective. The 2-year Master's Program will provide students with in-depth knowledge of neuroscience and research skills to prepare them for either continuing education on a Ph.D. and M.D. level, or expand their employment options in the field of neuroscience, science policy, biomedical research, teaching neuroscience, and others. The experience of designing, performing, and evaluating research will be a central component of the training.

Eligibility. Students who hold a BA/BS degree in any life science with a minimum GPA of 3.0, or are expected to hold a BA/BS degree at the time they start the program.

Highlights. In addition to in-depth training in Neuroscience research, the program will enable students to gain experience with undergraduate teaching through teaching assistantships during their 1st semester and teaching undergraduate summer course during their last semester on their own. Students will start the program with a 1-week "Neuroscience immersion" boot camp.

Curriculum. Graduate work includes a Master's Thesis and at least 15 regularly graded units of course work. The curriculum includes two neuroscience core courses (NRSC 588, NRSC 560), two semesters of NRSC 695F, one Statistics course, one Writing, one Ethics course, one elective course, and two research rotations (taken in fall). After rotations, students join a lab for their thesis work

Required Coursework (15 units minimum of regularly graded courses)
Neuroscience immersion (1 week, boot camp)
NRSC 588 – *Molecular and Cellular Neuroscience* (4 units)
NRSC 560 – *Systems Neuroscience* (4 units)
SLHS 649 – *Survival Skills and Ethics* (3 units)
or MCB 695E – *Science, Society, and Ethics*
NROS 5xx – *Scientific Grantsmanship* (2 units)

or SLHS 696a – *Topics in Speech, Language, and Hearing Sciences* (2 units)
or MCB 575 – *Scientific Communications* (3 units)
EIS 513 – *Applied Biostatistics* (4 units)
or EPID 576B *Biostatistics for Research* (3 units)
or MATH 509C – *Statistics for Research* (3 units)
or PSY 510 – *Statistics Fundamentals* (3 units)

In addition, the following pass/fail graded courses are required:
NROS 7xx – *Research Rotations* (3 units, 6 week)
NROS 695F – Journal Club (1 unit) for two semesters, offered every semester
NROS 6xx – Seminar (1 unit), offered every semester
NROS 910 – Thesis (3 units), for two semesters, offered every semester

Remaining graduate units may be fulfilled by additional, pass/fail graded graduate-level courses, such as:
NROS 900 – *Research*
NROS 6xx – *Lab Presentations and Discussion*

3. Student retention
Current State*.* A census of student retention in the NSCS major for the past years 2018-20 shows a steadily increasing trend from 65% in 2018 to 73% in 2020. This increase in retention appears to be mostly driven by a smaller number of students switching to another major at the UA while the number of "not enrolled" students, likely students dropping out altogether, remained stable around 14-16%. Most of the students not being retained are first generation and underrepresented minority (URM) students that typically have little or no knowledge/ experience of college education and/or research.

Principle to increase student retention*.* Education literature strongly suggests that connecting STEM students in a community of mentors and/or peers triggers formation of natural (non-forced) relationships that significantly promote the success rate of students and thereby increase retention. A landmark study on minority retention in STEM found that a student self-identifying with 'being a science person,' and being recognized as such, created a sense of belief in their own abilities to succeed in the sciences, and thus enhanced their chances of persisting college education, especially for years 1 and 2. Finally, studies showed that non-curricular activities like participation in academic clubs and studying frequently in study groups increases the likelihood of student persistence and degree completion.

Objective. Increase student retention to more than 90% by implementing supportive and best practice curricular and noncurricular activities that are known to increase STEM retention beyond early attrition points.

Curricular activity 1. This step has been already implemented. In fall 2021, the program offered NSCS 195B (Engaging Topics in Neuroscience and Cognitive Science) to first year students (n=60). This 1-unit course provides an opportunity for first years to immediately connect with peers and faculty of the NRSC program facilitating networking and early entry into labs. A student survey and

focus data indicated that the participating students recommend that all students should take this course as it was instrumental in educating students about student research, and how to connect with the larger neuroscience research community on campus.

Curricular activity 2. Based on the success of NSCS 195B, the department will develop a new first year spring course (NROS 215 Introduction to Experimental Neuroscience). The course will employ hands-on electrophysiological recordings from simple preparations with low-cost equipment. The main objective will be to illustrate how basic experiments are used to understand basic mechanisms of excitable membranes and synaptic connections of neurons. The course will also highlight diseases of the nervous system and "big questions" of contemporary Neuroscience. The course will be student centered with ample in-class research activities using active learning pedagogies that have been known to increase student curiosity, engagement, and success.

Curricular activity 3. Implement the use of trained preceptors for all NRSC core courses. While the program is already using preceptors, their use is limited to a few courses. Expanding their use to all core courses will better cultivate student peer relationships and increase student experience and retention. To properly train preceptors, the department will develop a preceptor workshop (8-10 weeks) dedicated to professional development and leadership skills. Students take this workshop alongside fulfilling their duties as a preceptor (combined 3 credits).

Non-curricular activities. A series of existing NSCS-sponsored community activities connects first- and second-year students (mentees) to third- and fourth-year students who are involved in clubs, outreach, and research.

The Neuron and Glia mentor program consists of upper division students (Glia) acting as a supportive mechanism for lower division students (Neurons). Significantly expanding this peer-mentor community will ensure that first year students are connected immediately with other NSCS students. Learning upperclassman's experiences and bonding with other our NSCS students will generate a "feel-at-home" experience and increase student retention.

The department will also establish once-a-month "Ask me anything: conversations with the faculty" series. This event will have NSCS students meeting one featured faculty for an informal Q&A session where students can ask questions ranging from advice on how to apply to graduate school to how the featured faculty achieves "work-life" balance, etc. This will establish a trusting relationship between the students and the faculty and promote retention.

Finally, the department will provide additional non-academic student opportunities (community building social events, movie night, bowling night, art exhibits, fundraising events).
Since such community-building events are often facilitated by individual faculty, graduate students, post-docs or student organizations, the department will generate a system of incentives and logistical support. The program is currently supporting and/or associated with 5 student organizations: the Neuroscience & Cognitive Science Association of Students (NSCSAS), Fight the Stigma (FTS), Students Supporting Brain Tumor Research (SSBTR), NSCS Ambassadors, and Nu Rho Psi.

Next to increasing student experience and retention, the implementation of a multiprong approach of academic and non-academic activities aimed toward student success, engagement and retention is a strong asset to compete for federal funding mechanisms offered by NIH and NSF that aim to decrease attrition in STEM at various transition points (Community College transfer students, first-year students, post baccalaureate students). In addition to offering a suite of STEM student success activities, successful proposals will enable the possibility of offering paid undergraduate research opportunities to students in laboratories of members of the Neuroscience department and the larger Neuroscience campus community.

Metrics of success. Implement longitudinal tracking cohorts to understand the effectiveness of supportive curricular and noncurricular activities on student retention and academic/career pathways. This will include direct (pre and post exam) and non-direct assessments (student surveys, focus groups) to be implemented on a yearly basis.

4. New Undergraduate Program (BS) in Neuroscience

Rationale. The enrollment in the currently existing combined NSCS major lags behind the enrollment of comparable majors, indicating the need of further initiatives to attract students and increase student enrollment in the College of Science. The vast majority of current NSCS students (70-80%) are enrolled in the neuroscience focus indicating a much greater interest in neuroscience than cognitive science. Moreover, ample evidence indicates that the current NSCS joint major is not fully satisfying the interests and needs of the students in the neuroscience focus due to severe limitations of the joint curriculum.

A new neuroscience major that is streamlined to the needs of neuroscience-only orientated students (like, for example, a genetics requirement for pre-med students) is likely to attract an additional group of students and increase total enrollment in the College of Science. To attract specifically out-of state students, it is essential to offer a contemporary and state-of the-art neuroscience major to be competitive nationwide. The new major will emphasize areas of neuroscience that are highly attractive to students, especially disease-orientated neuroscience, and strongly encourage intellectually challenging experiences in research labs. The department has a very strong interest to offer a streamlined neuroscience major that attracts in- and out-of state students, and provides the department with academic independence.

Objective. The new major in Neuroscience is envisioned to provide cutting-edge training in neuroscience through innovative teaching and hands-on research experiences. The major intends to develop a deep understanding of current ideas and problems in neuroscience while building foundational skills in logic, reasoning, and communication – skills relevant to any career. The program will emphasize active learning and problem-solving skills, encourage interdisciplinary pursuits, and provide hands-on and intellectually challenging experiences in research labs. The degree will provide students with a strong foundation in molecular, cellular, systems, developmental, and translational neuroscience to enable them to pursue careers in medicine and other health care fields, biomedical and neuroscience research, bioethics and science education.

Curriculum. The new major includes core courses building a strong foundation in genetics, molecular, cellular and system neurobiology. Beyond the required courses, students select elective

courses that are grouped in 4 emphases. Courses taken as part of the emphases must also address laboratory and writing skills. Independent laboratory research is a strongly encouraged supplement in all emphases.

Foundational and Supporting Coursework. Next to the requirement of general education, the major will require rigorous foundational course work in Biology (MCB 181L, 181R), Chemistry (CHEM 151, 152, 241A, 243A), Physics (PHYS 102, 103, 182 or 241), Mathematics (MATH 122A/B or 125, MATH 263).

NROS major (40 units)
Core requirements (22 units)
NROS 215 – *Introduction to Experimental Neuroscience* (3 units)
NROS 307 – *Cellular Neurophysiology* (3 units)
NROS 308 – *Methods in Cellular Neurophysiology* (1 unit)
NROS 310 – *Molecular and Cellular Biology of Neurons* (3 units)
NROS 3xx – *Neuroinformatics and Scientific Coding* (3 units)
NROS 3xx – *Fundamental Principles in Systems Neuroscience* (3 units)
NROS 3xx – *Molecular Genetics and Gene Networks* (3 units)
NROS 3xx – *Molecular, Genetic & Genomic Approaches in Neuroscience* (3 units)

Emphasis 1. Neuroscience and Human Health (18 unit minimum)
Three of the following courses (9 units):
NROS 330 – *Principles of Neuroanatomy: Cells to Systems* (3 units)
NROS 430 – *Neurogenetics* (3 units)
NROS 4xx – *Drugs, Brain and Behavior* (3 units)
NROS 4xx – *Neural Circuits in Health and Disease* (3 units)
NROS 4xx – *Diseases of the Nervous System* (3 units)
NROS 4xx – *Neurobiology of Addiction* (3 units)
NROS 4xx – *Complex Neuropsychiatric Behavioral, Cognitive and Emotional Disorders* (3 units)

One Lab/Research/Internship (3 units)
One upper division elective (see emphasis 4 for elective options) (3 units)

Additional required elective courses (6 units)
One upper division elective (3 units)
Writing emphasis elective (3 units)
(See emphasis 4 for elective options)

Emphasis 2. Molecular and Cellular Neurobiology (18 unit minimum)
Three of the following courses (9 units):
NROS 412 – *Molecular Mechanisms of Learning and Memory* (3 units)
NROS 415 – *Electrophysiology Laboratory* (3 units)
NROS 430 – *Neurogenetics* (3 units)
NROS 440 – *How to Build a Brain: Mechanisms of Neural Development* (3 units)
NROS 4xx – *Neurobiology of Addiction* (3 units)

PHYS 431 – *Molecular Biophysics* (3 units)
PSY 496L – *Intro to Neural Data Analysis* (3 units)

One Lab/Research/Internship (3 units)
One upper division elective (see emphasis 4 for elective options) (3 units)

Additional required elective courses (6 units)
One upper division elective (3 units)
Writing emphasis elective (3 units)
(See emphasis 4 for elective options)

Emphasis 3. Systems Neurobiology
Three of the following courses (9 units):
NROS 330 – *Principles of Neuroanatomy: Cells to Systems* (3 units)
NROS 381 – *Animal Brains, Signals, Sex, and Social Behaviors* (3 units)
NROS 420 – *Sensing and Action in Predator/Prey Encounters* (3 units)
NROS 4xx – *Neural Circuits in Health and Disease* (3 units)
NROS 4xx – *Neurobiology of Addiction* (3 units)
NROS 4xx – *Molecular Basis of Drives and Emotions* (3 units)
NROS 4xx – *Complex Behavioral, Cognitive and Emotional Disorders* (3 units)
NROS 4xx – *Brain Development in Infancy, Childhood, and Adolescence* (3 units)
ECOL 346 – *Bioinformatics* (4 units)
or ISTA 457 – *Neural Networks* (3 units)
or NSCS 344 – *Modeling the Mind: Comp. Models of Cognition*
PSY 496L – *Intro to Neural Data Analysis* (3 units)

One Lab/Research/Internship (3 units)
One upper division elective (see emphasis 4 for elective options) (3 units)

Additional required elective courses (6 units)
One upper division elective (3 units)
Writing emphasis elective (3 units)
(See emphasis 4 for elective options)

Emphasis 4. Thematic
This emphasis is meant for students who have a very clear and compelling interest in particular topics of neuroscience
Three of the following courses (9 units):
NROS 330 – *Principles of Neuroanatomy: Cells to Systems* (3 units)
NROS 381 – *Animal Brains, Signals, Sex, and Social Behaviors*
NROS 412 – *Molecular Mechanisms of Learning and Memory* (3 units)
NROS 415 – *Electrophysiology Laboratory* (3 units)
NROS 420 – *Sensing and Action in Predator/Prey Encounters* (3 units)
NROS 430 – *Neurogenetics* (3 units)
NROS 440 – *How to Build a Brain: Mechanisms of Neural Development* (3 units)

ECOL 346 – Bioinformatics (4 units)
or ISTA 457 – Neural Networks (3 units)
or NSCS 344 – Modeling the Mind: Comp. Models of Cognition
PHYS 431 – *Molecular Biophysics* (3 units)
PSY 496L – *Intro to Neural Data Analysis* (3 units)
NROS 4xx – *Drugs, Brain and Behavior* (3 units)
NROS 4xx – *Neural Circuits in Health and Disease* (3 units)
NROS 4xx – *Diseases of the Nervous System* (3 units)
NROS 4xx – *Neurobiology of Addiction* (3 units)
NROS 4xx – *Drives and Emotions* (3 units)
NROS 4xx – *Complex Behavioral, Cognitive and Emotional Disorders* (3 units)

One Lab/Research/Internship (3 units)
One upper division elective (3 units)
NROS 392/492 – Directed Research (3 units)
NROS 399/499 – Independent Study (3 units)
NROS 399H/499 – H Honors Independent Study (3 units)
NROS 4xx – Internship Experience (3 units)
NROS 4xx – Senior Capstone (3 units)
NROS 498H – Honors Thesis (3 units)

Writing Electives (3 units minimum)
NROS 4xx – *Bioethics* (3 units)
NROS 4xx – Science Writing Strategies, Skills & Ethics (3 units)
NROS 4xx – *Senior Capstone* (3 units)
NROS 498H – *Senior Honors Thesis* (3 units)
ECOL 379 – *Evidence Based Medicine* (3 units)

5. Necessary graduate course development and faculty investments
New Course development

- Several undergraduate courses like Neurogenetics and Neuroanatomy can be modified to add a section for the graduate level.
- Several new courses need to be developed, mostly for the proposed new major (indicated as NROS xxx)

Faculty Needs
The proposed certificate and master programs can be established with existing faculty, assuming the current pool is maintained. The proposed new stand-alone major in neuroscience is a long-term goal and can only be established with at least 4 additional faculty (1 lecturer and 3 tenure-track faculty with expertise in addiction, cognition, big-data neuroscience, and complex diseases of the nervous system).