Neuroscience Major Proposal

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Intellectual Merit

The inner workings of the brain have been shrouded in mystery since humans began to contemplate their own thoughts. Modern advances in technology, genetics, and data science have begun to shed light on these mysteries at an accelerating pace. Increasingly, addressing these mysteries requires an interdisciplinary set of skills, cutting across the humanities, social sciences, natural sciences and engineering. Rice University is already experiencing significant growth in faculty whose research is rooted in and uniquely poised to contribute to neuroscience.

In the past decade, the field of neuroscience has experienced tremendous growth. These advances include understanding the genetic basis of some neurological disorders, the development of sophisticated imaging tools to visualize the workings and interconnections of the brain, advancement of computational theories that explain information processing in the brain, and engineering of breakthrough neuroprosthetics that can restore lost sensory and brain function. These advances were made possible through a combined effort of research from neuroscientists, applications from neuroengineers, and implementation by clinicians. For example, the cochlear implant is widely accepted to be the most successful neuroprosthetic. The development of the implant required collaborative efforts between neurophysiologists and auditory bioengineers to decipher the auditory code, electrical engineers to develop electrodes, methods to transfer information across the scalp and to implement signal processing algorithms, psychophysicists and cognitive scientists to develop and evaluate methods to measure patient performance, and of course clinicians to refine surgical methods to reduce trauma in the inner ear.

Despite exponential growth in neuroscience during the past decade, fundamental understanding of how the brain works remains rudimentary. We are extremely limited in our ability to treat, much less cure, damage to the brain from trauma or disease, and our mechanistic understanding of many common neuropathies such as Alzheimer’s and Parkinson’s disease remains extremely limited. Indeed, many scientists have suggested that neuroscience research has reached a critical moment in its history, and further progress is dependent on the development and application of new technologies.

Rice University, collaborating with colleagues throughout the other institutions of the Texas Medical Center (TMC), is in a unique position to lead in creating new scientific and engineering breakthroughs through research and provide a world-class educational mission for training tomorrow’s neuroscience scholars, scientists, and engineers. Rice is rapidly building one of the best computational, developmental, systems, and engineering neuroscience programs in the country. Rice’s partnership with the other TMC institutions forms the largest concentration of neuroscience researchers, engineers, and educators in the world.

Many of Rice’s peer institutions offer neuroscience major or incorporate aspects of neuroscience in their undergraduate curricula. Table 1 details neuroscience undergraduate majors in the top 20 universities.
Table 1 - Neuroscience undergraduate major degrees in the top 20 universities

(Rankings from US News and World Report, 2016)

<table>
<thead>
<tr>
<th>University</th>
<th>Major?</th>
<th>Home Department/Institute</th>
<th>Alternative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Princeton</td>
<td>YES</td>
<td>Princeton Neuroscience Institute</td>
<td></td>
</tr>
<tr>
<td>Harvard</td>
<td>YES</td>
<td>Neurobiology</td>
<td></td>
</tr>
<tr>
<td>Yale</td>
<td>NO</td>
<td></td>
<td>Neuroscience track in Psychology Major</td>
</tr>
<tr>
<td>Columbia</td>
<td>YES</td>
<td>Psychology &amp; Biology</td>
<td></td>
</tr>
<tr>
<td>Stanford</td>
<td>NO</td>
<td></td>
<td>Neurobiology track in Biology Major, Neuroscience track in</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Psychology Major</td>
</tr>
<tr>
<td>U Chicago</td>
<td>YES</td>
<td>Neurobiology</td>
<td></td>
</tr>
<tr>
<td>MIT</td>
<td>YES</td>
<td>Brain and Cognitive Science</td>
<td></td>
</tr>
<tr>
<td>Duke</td>
<td>YES</td>
<td>Institute for Brain Sciences</td>
<td></td>
</tr>
<tr>
<td>Penn</td>
<td>YES</td>
<td>Interdisciplinary</td>
<td></td>
</tr>
<tr>
<td>Caltech</td>
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<td></td>
<td>Neurobiology track in Biology Major</td>
</tr>
<tr>
<td>Johns Hopkins</td>
<td>YES</td>
<td>Interdisciplinary</td>
<td></td>
</tr>
<tr>
<td>Dartmouth</td>
<td>YES</td>
<td>Psychology &amp; Brain Science</td>
<td></td>
</tr>
<tr>
<td>Northwestern</td>
<td>YES</td>
<td>Neurobiology</td>
<td></td>
</tr>
<tr>
<td>Brown</td>
<td>YES</td>
<td>Neuroscience</td>
<td>Neurobiology concentration in Biology Major, Behavioral and</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>evolutionary neuroscience concentration in Psychology Major</td>
</tr>
<tr>
<td>Cornell</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Vanderbilt</td>
<td>YES</td>
<td>Interdisciplinary</td>
<td></td>
</tr>
<tr>
<td>Wash U</td>
<td>YES</td>
<td>Interdisciplinary</td>
<td></td>
</tr>
<tr>
<td>Rice</td>
<td>NO</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Notre Dame</td>
<td>YES</td>
<td>Biological Sciences</td>
<td></td>
</tr>
<tr>
<td>Cal-Berkeley</td>
<td>YES</td>
<td>Molecular and Cell Biology</td>
<td></td>
</tr>
</tbody>
</table>
Unique Intellectual Contributions

The proposed curriculum will produce graduates with a broad background in the multidisciplinary field of neuroscience. Disciplines within neuroscience that are emphasized in this program range from integrative neuroscience and mind and brain to neuroengineering. The Rice neuroscience major will provide opportunities for experiential learning, as well as an emphasis on advanced quantitative and computational skills. This will provide a strong foundation for students interested in pursuing neuroscience research and applications, giving them the skills that will be needed as the field continues to mature. The program will be unique amongst the top 20 US universities in that none of the other undergraduate programs require core courses in neuroengineering in combination with strengths in biology and social sciences. In addition, the Rice neuroscience initiative offers training in engineering tool development and in data science, which is at the forefront of computational and network neuroscience, and puts Rice at the competitive forefront for the BRAIN (Brain Research through Advancing Innovative Neurotechnologies) initiatives offered through NIH, NSF, and DOD.

Our proposed new undergraduate major in neuroscience will take full advantage of Rice University’s unique multidisciplinary and synergistic areas of cognitive sciences, neurobiology, and neuroengineering. The proposed major does overlap with the existing Cognitive Science major, but the two majors have distinctive focuses. Neuroscience focuses on the study of the brain, while Cognitive Science focuses on the study of the mind. Courses on the relationship between the mind and brain are core for both programs, but the Neuroscience major requires additional courses with biological approaches to understanding the brain at a molecular and cellular level and engineering approaches to measuring and manipulating the brain, while the Cognitive Science major requires courses from psychology, linguistics, and philosophy that study the mind without relying on neural data. The Cognitive Science major is growing rapidly, with more than fifty graduating majors in Spring 2017. A survey of Cognitive Science majors shows that only a sizeable minority (32%) would have majored in Neuroscience instead of Cognitive Science, indicating both student demand for the Neuroscience major, and that the proposed major does not supersede demand for Cognitive Science. Therefore, the proposed major has been designed to offer a complementary program with a greater focus on the study of the brain, limiting overlap with the requirements for Cognitive Science.

Neuroscience Minor

In 2013, a Rice neuroscience minor was initiated through collaboration with Baylor College of Medicine and The University of Texas Health Science Center at Houston. It is currently administered through the BioSciences department in the Wiess School of Natural Sciences. The number of neuroscience minors awarded has increased markedly each year since its inception with neuroscience being the fourth most awarded minor at Rice in 2017 (Table 2).

Over the last several years, three (3) new neuroscience courses were created and added to the Rice Course Catalog:

- NEUR 362 (& PSYC 362) - COGNITIVE NEUROSCIENCE
- NEUR 380 (& BIOC 380 & PSYC 380) - NEUROSYSTEMS, and
- NEUR 385 (& BIOC 385) - FUNDAMENTALS OF NEUROSCIENCE

These three courses serve as the core of the neuroscience minor and consistently maintain an enrollment of approximately 250 students per year (total for all three courses). Class offerings are being expanded to include more in-depth and multidisciplinary neuroscience courses aligned with research expertise existing at Rice and other TMC institutions. This will serve to both enhance the neuroscience minor and provide
the foundation for a neuroscience major at Rice. Additionally, we plan to expand opportunities for cutting-edge undergraduate research in local neuroscience and engineering labs. When the minor was created, we created a class (NEUR 310 – formerly NEUR 485) to enable students to work in these labs – this has proven extremely popular. Over 50 unique students per year have participated in the class. Another measure of this program’s success is undergraduate authorship in peer-reviewed publications (see Table 3 for a recent sampling).

Table 2 - Minors awarded

![Table 2 - Minors awarded](image)
Table 3 - Sampling of recent Rice undergraduate neuroscience co-authorships (Rice student’s name in bold)


Administration of the Neuroscience Programs

The NeuroX steering committee will oversee the neuroscience minor and major programs under the auspices of the BioSciences department. The BioSciences department will offer both major and minor programs as the major is tailored for those students who are interested in a more comprehensive and in-depth program in neuroscience. The committee will determine the appropriate curricular content for the neuroscience major and minor and will provide oversight on course content. The NeuroX steering committee will consult with the participating department chairs and offer advice on personnel appropriate to teach the courses included in the neuroscience curriculum, with department chairs serving their traditional role in assigning teaching within departmental guidelines. The department of BioSciences will serve as the home department in terms of administration of the program, including tracking of majors, management of teaching assistants, responding to requests by the administration about the program, assigning major advisors, routing course change requests, providing timely general announcement material, maintaining a web site presence, and other duties associated with managing majors and minors at Rice. Appropriate resources to carry out these duties will be provided by Rice central administration and some participating schools and departments (see letters of support section). In consultation with the appropriate Rice department chairs, the steering committee will also recommend faculty from other TMC institutions to include in the NeuroX initiative, both through teaching in the neuroscience curriculum and participating in NeuroX related collaborative research at Rice. This strong collaboration with the world’s largest medical complex is a key distinguishing element of the Rice neuroscience undergraduate major and minor programs. However, with the proposed major program, all declared Rice students would be able to obtain the neuroscience major solely by taking Rice courses offered by Rice faculty.

Curriculum for the Neuroscience Major

The proposed Bachelor of Arts (BA) degree program with a major in Neuroscience provides a strong and broad education covering the breadth of fundamental disciplines on which neuroscience is based and includes multiple opportunities for experiential learning.

The Neuroscience curriculum is designed with the intent that all majors will gain a robust foundation in science and engineering basics and additional experience in the multidisciplinary core areas that contribute to the breadth of modern neuroscience. Project-based laboratory courses will be required, and students will be encouraged to pursue independent research.

To achieve these goals, a BA with a major in Neuroscience will require a range of 122-126 credit hours of course work. The proposed neuroscience major program includes 12 foundation courses (34 to 35 credit hours), 4 core courses (12 credit hours), project-based lab courses (4 to 6 credit hours, lab courses and independent study courses), and 4 elective courses (minimum 12 credit hours). These course requirements account for 62-66 credit hours to satisfy the major requirements. With the university’s “60 hours outside of the major” requirement (which includes coursework completed as distribution credit, FWIS, LPAP, etc.), the range of total hours required for the BA program comes to 122-126 credit hours, dependent on course selection.

Mechanics and Commitments to the Neuroscience Curriculum
The proposed curriculum has the support of all the departments and schools involved in providing the courses and research opportunities for prospective degree recipients (see letters of commitment). All of the foundation, core, and laboratory courses required for the major will be taught on Rice campus by Rice faculty with one exception of the core course (NEUR 380) taught on Rice campus by J. David Dickman. Dr. Dickman has a primary appointment at Baylor College of Medicine (BCM) and joint appointments with a cross-institutional Memorandum of Understanding (MoU) in Rice departments of BioSciences and Psychology. A non tenured-track lecturer has been hired to contribute additional neuroscience-focused courses within the BioSciences department. In addition, the Rice neuroscience program seeks to capitalize on the tremendous opportunity to include the broad and extensive neuroscience expertise at our neighboring institutions of the Texas Medical Center (TMC) in the neuroscience curriculum. Therefore, the curriculum also includes undergraduate research opportunities at the other TMC institutions and several elective courses that are currently taught on Rice campus by faculty who have primary appointments at BCM or University of Texas Health Science Center (UTHSC). In addition to Dickman’s MoU, five cross-institutional MoUs currently exist to promote educational and research interactions with these TMC colleagues. The elective courses taught by TMC colleagues, although not essential for the major curriculum, provide an expanded and valuable repertoire of topics available for Rice students.

The curriculum has been designed to be broad and flexible so that if a tenured, tenure-track, or non-tenured faculty member is not offering a particular course, the NeuroX steering committee could appropriately adjust the curriculum with minimal impact on students’ study plans.

Proposed Language for General Announcements
Including Degree Requirements and Program Learning Outcomes

Overview

The Neuroscience program, housed in the BioSciences Department, provides a strong interdisciplinary education covering the breadth of fundamental disciplines on which neuroscience is based and includes multiple opportunities for experiential learning. Neuroscience uses diverse methodologies to investigate the brain and its relationship to the mind, and includes the analysis of brain structures related to specific cognitive processes and representations, investigations of the biochemical processes that occur in brain functions, and the interactions and correlations among the brain, behavior, and biology that can be observed and modeled. The primary aim of the neuroscience degree program is to provide an understanding of how the cognition and behavior of organisms are encoded in neural processes. Such an understanding of the brain, bringing to bear many types of knowledge, is necessary as a basis for understanding and solving many practical problems including but not limited to: neurophysiology of disease; treatment for pathologies related to aging, stroke, autism, and hearing and other impairments; human behavior relating to risk, addiction, and social pathologies; memory, learning, and acquisition of literacy; neural basis of emotion and its relation to human perception and behavior.

The Neuroscience program offers a broad range of introductory and advanced courses that lead to either a Bachelor of Arts (BA) Degree with a Major in Neuroscience or a Minor in Neuroscience. The BA degree is designed with the intent that all majors will gain a robust foundation in science and engineering basics and additional experience in the multidisciplinary core areas that contribute
to the breadth of modern neuroscience. Project-based laboratory courses are required, and students will have the opportunity to pursue independent research. This program is appropriate for students with interests in pursuing advanced degrees in the future. The Minor is available for students who choose other majors but desire strong foundational knowledge of the diverse aspects of how the brain functions. Neuroscience students are encouraged to participate in undergraduate research, and numerous students have already availed themselves of the neuroscience research opportunities at Rice and within the Houston community.

For additional information, please see the Neuroscience website: http://neuroscience.rice.edu/.

**Undergraduate**

**Bachelor’s Program**

- Bachelor of Arts (BA) Program with a Major in Neuroscience

**Minor**

- Minor in Neuroscience

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**Outcomes**

**Program Learning Outcomes for the BA Degree for a Major in Neuroscience**

Upon completing the BA degree with a major in Neuroscience, students will be able to:

1. Demonstrate knowledge of the biological basis for brain and neuron function and experimental strategies that led to our current understanding of brain and neuron function.
2. Demonstrate knowledge of the key issues, questions, and perspectives that define systems neuroscience.
3. Demonstrate the ability to analyze and interpret neuro-scientific data.
4. Understand multiple experimental methods to measure and manipulate brain activity.
5. Demonstrate how to apply the modern scientific method, including designing and executing experiments, and collecting, analyzing, and interpreting meaningful data.

**Program Learning Outcomes for the Minor in Neuroscience**

Upon completing the minor in Neuroscience, students will be able to:

1. Demonstrate knowledge of the key issues, questions, and perspectives that define contemporary neuroscience.
2. Understand neuroscience as an interdisciplinary field and demonstrate the ability to draw on, and synthesize, key findings and concepts in the sciences, humanities and/or engineering in both the evaluation of existing theories and in the formulation and solution of new problems in neuroscience.

### Requirements for the BA Degree with a Major in Neuroscience

Students pursuing the BA degree with a major in Neuroscience must complete:

- A minimum of 62-66 credit hours to satisfy major requirements, dependent on course selection.
- A minimum of 122-126 credit hours to satisfy degree requirements, dependent on course selection.
- A minimum of 60 credit hours outside of major requirements.

The courses listed below satisfy the requirements for this major. In certain instances, courses not on this official list may be substituted upon approval of the major’s academic advisor (or official certifier). Students and their academic advisors should identify and clearly document the courses to be taken.

**Foundation Courses – 12 courses (34 - 35 credit hours)**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 101</td>
<td>Single Variable Calculus I</td>
<td>3</td>
</tr>
<tr>
<td>MATH 102</td>
<td>Single Variable Calculus II</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 121</td>
<td>General Chemistry I</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 123</td>
<td>and General Chemistry Lab I</td>
<td>1</td>
</tr>
<tr>
<td>CHEM 122</td>
<td>General Chemistry II</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 124</td>
<td>and General Chemistry Lab II</td>
<td>1</td>
</tr>
<tr>
<td>PHYS 125</td>
<td>General Physics I or PHYS 101: Mechanics</td>
<td>4</td>
</tr>
<tr>
<td>PHYS 126</td>
<td>General Physics II or PHYS 102: Electricity/Magnetism</td>
<td>4</td>
</tr>
<tr>
<td>BIOC 201</td>
<td>Introductory Biology</td>
<td>3</td>
</tr>
<tr>
<td>CAAM 210</td>
<td>Introduction to Computational Engineering</td>
<td>3</td>
</tr>
<tr>
<td>PSYC 203</td>
<td>Introduction to Cognitive Psychology</td>
<td>3</td>
</tr>
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</table>

Select 1 from the following: 3-4

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>STAT 305</td>
<td>Intro to Stats for BioSciences (4 credit hours)</td>
</tr>
<tr>
<td>STAT 310</td>
<td>Probability &amp; Statistics (3 credit hours)</td>
</tr>
<tr>
<td>STAT 312</td>
<td>Probability &amp; Statistics for Engineers (3 credit hours)</td>
</tr>
</tbody>
</table>

**Core Courses – 4 courses (12 credit hours)**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>NEUR/PSYC 362:</td>
<td>Cognitive Neuroscience</td>
<td>3</td>
</tr>
<tr>
<td>NEUR/BIOC/PSYC 380:</td>
<td>Fundamental Neuroscience Systems</td>
<td>3</td>
</tr>
<tr>
<td>NEUR 383/ELEC 380:</td>
<td>Introduction to Neuroengineering</td>
<td>3</td>
</tr>
<tr>
<td>NEUR/BIOC 385:</td>
<td>Molecular/Cellular Neuroscience</td>
<td>3</td>
</tr>
</tbody>
</table>
Project-Based Laboratory Courses – 3 courses (4-6 credit hours)

{NEW} BIOC212 Experimental Neuroscience 2

Select 2 courses from the following list: 2-4

- NEUR 364 Cognitive Neuroscience Lab (1 credit hour)
- BIOC 415 Experimental Physiology (1 credit hour)
{NEW} BIOC 417 Exp Cell and Molecular Neuroscience (1 credit hour)
- NEUR 310 Independent Study in Neuroscience (minimum of 3 credit hours)

Elective Courses – 4 courses (12 – 13 credit hours)

{NEW} BIOC 475 Advanced Neurodevelopment
{NEW} BIOC 449 Advanced Cell and Molecular Neuroscience
BIOE 381/ELEC 381 Fundamentals of Electrophysiology
BIOE 492 Sensory Neuroengineering
CAAM/NEUR 415/ELEC 488 - Theoretical Neuroscience
CAAM/NEUR 416/ELEC 489 - Neural Computation
COMP 440/ELEC 440 Introduction to Artificial Intelligence (4 credit hours)
EBIO 321 Animal Behavior
ELEC 382/NEUR 382 Introduction to Computational Neuroscience
ELEC 475 Learning from Sensor Data
LING 411 Neuro-linguistics
NEUR 301 Advanced Cognitive Neuroscience: Attention and Perception
NEUR 302 Advanced Cognitive Neuroscience: Higher Cognitive Functions
NEUR 310 Independent Study in Neuroscience*
PHIL 103 Philosophical Aspects of Cognitive Science
PHIL 303 Theory of Knowledge
PHIL 312 Philosophy of Mind
PHIL 358 Philosophy of Neuroscience
PHIL 359 Animal Minds
PSYC 354 Introduction to Social and Affective Neuroscience
PSYC 375 Neuropsychology of Language and Memory
PSYC 432 Brain and Behavior

* The course 310 can be repeated and counted as an elective if a student has chosen NEUR 310 to count as a Project-Based Laboratory Course. It can only be repeated as an elective once for credit towards the major.

Policies

Transfer Credit
For Rice University’s policy regarding transfer credit, see Transfer Credit. Some departments and programs have additional restrictions on transfer credit. The Office of Academic Advising maintains the university’s official list of transfer credit advisors on their website: http://oaa.rice.edu. Students are encouraged to meet with their academic program’s transfer credit advisor when considering transfer credit possibilities.

Departmental Transfer Credit Guidelines
Students pursuing the major in Neuroscience should be aware of the following program-specific transfer credit guidelines:

- Requests for transfer credit will be considered by the program director (and/or the program’s official transfer credit advisor) on an individual case-by-case basis.

Opportunities

Academic Honors
The university recognizes academic excellence achieved over an undergraduate’s academic history at Rice. For information on university honors, please see Latin Honors (summa cum laude, magna cum laude, and cum laude) and Distinction in Research and Creative Work. Some departments have department-specific Honors awards or designations.

Research in Neuroscience
Research is highly encouraged for all neuroscience programs, and many opportunities are available for independent research at Rice and other institutions of the Texas Medical Center. Students can receive course credit for independent research through the course NEUR 310 with the option to repeat for credit once as an elective for the major.

For additional information, please see the Neuroscience website: http://neuroscience.rice.edu/.
### Assessment plan and Curriculum Map

<table>
<thead>
<tr>
<th>Learning Outcomes</th>
<th>PLO 1: Demonstrate knowledge of the biological basis for brain and neuron function and experimental strategies that led to our current understanding of brain and neuron function.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Embedded location (Where?)</td>
<td>NEUR 385</td>
</tr>
<tr>
<td>Materials (What?)</td>
<td>Pre-course exam, midterm exam and final exam.</td>
</tr>
<tr>
<td>Measure (How?)</td>
<td>Use of rubric to compare between results of pre-course exam, midterm exam and final exam.</td>
</tr>
<tr>
<td>Standard (To what extent?)</td>
<td>80% should achieve good or satisfactory, or as specified by the rubric, which is constructed by Neuroscience steering committee</td>
</tr>
<tr>
<td>Responsible (Who?)</td>
<td>Neuroscience steering committee, Behnaam Aazhang, Director, and Assistant Chair of BioSciences, Susan Cates. Reported to instructors of relevant courses by steering committee director, the steering committee does follow up in 1 to 2 years as specified in report</td>
</tr>
<tr>
<td>Timeline (When?)</td>
<td>AY 18-19 then every 3 years. Follow-up AY 19-20.</td>
</tr>
<tr>
<td>Who receives results and who is responsible for follow-up?</td>
<td>Director Behnaam Aazhang &amp; Assistant Chair of Biosciences Susan Cates.</td>
</tr>
<tr>
<td>Learning Outcomes</td>
<td>PLO 2: Demonstrate knowledge of the key issues, questions, and perspectives that define systems neuroscience.</td>
</tr>
<tr>
<td>-------------------</td>
<td>----------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Embedded location (Where?)</td>
<td>NEUR 380</td>
</tr>
<tr>
<td>Materials (What?)</td>
<td>One or more of the questions in the NEUR 380 final exam.</td>
</tr>
<tr>
<td>Measure (How?)</td>
<td>Exam rubric for NEUR 380 final exam.</td>
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<td>Standard (To what extent?)</td>
<td>80% should achieve good or satisfactory, or as specified by the rubric, which is constructed by Neuroscience steering committee</td>
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<tr>
<td>Responsible (Who?)</td>
<td>Neuroscience steering committee, Behnaam Aazhang, Director, and Assistant Chair of BioSciences, Susan Cates. Reported to instructors of relevant courses by steering committee director, the steering committee does follow up in 1 to 2 years as specified in report</td>
</tr>
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<td>Who receives results and who is responsible for follow-up?</td>
<td>Director Behnaam Aazhang &amp; Assistant Chair of Biosciences Susan Cates.</td>
</tr>
<tr>
<td>Learning Outcomes</td>
<td>PLO 3 : Demonstrate the ability to analyze and interpret neuroscientific data.</td>
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<tr>
<td>-------------------</td>
<td>--------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Embedded location (Where?)</td>
<td>NEUR 362</td>
</tr>
<tr>
<td>Materials (What?)</td>
<td>One or more labs from NEUR 362.</td>
</tr>
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<td>Measure (How?)</td>
<td>Lab rubric for assessed labs in NEUR 362.</td>
</tr>
<tr>
<td>Standard (To what extent?)</td>
<td>80% should achieve good or satisfactory, or as specified by the rubric, which is constructed by Neuroscience steering committee</td>
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</tr>
<tr>
<td>Who receives results and who is responsible for follow-up?</td>
<td>Director Behnaam Aazhang &amp; Assistant Chair of Biosciences Susan Cates.</td>
</tr>
<tr>
<td>Learning Outcomes</td>
<td>PLO 4: Understand multiple experimental methods to measure and manipulate brain activity.</td>
</tr>
<tr>
<td>-------------------</td>
<td>--------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Embedded location (Where?)</td>
<td>NEUR 383</td>
</tr>
<tr>
<td>Materials (What?)</td>
<td>Students' final proposal and/or class presentation from NEUR 383.</td>
</tr>
<tr>
<td>Measure (How?)</td>
<td>Rubric analyzing final proposal and/or class presentation in NEUR 383.</td>
</tr>
<tr>
<td>Standard (To what extent?)</td>
<td>80% should achieve good or satisfactory, or as specified by the rubric, which is constructed by Neuroscience steering committee</td>
</tr>
<tr>
<td>Responsible (Who?)</td>
<td>Neuroscience steering committee, Behnaam Aazhang, Director, and Assistant Chair of BioSciences, Susan Cates. Reported to instructors of relevant courses by steering committee director, the steering committee does follow up in 1 to 2 years as specified in report</td>
</tr>
<tr>
<td>Who receives results and who is responsible for follow-up?</td>
<td>Director Behnaam Aazhang &amp; Assistant Chair of Biosciences Susan Cates.</td>
</tr>
<tr>
<td>Learning Outcomes</td>
<td>PLO 5 : Demonstrate how to apply the modern scientific method, including designing and executing experiments, and collecting, analyzing, and interpreting meaningful data.</td>
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<tr>
<td>Embedded location (Where?)</td>
<td>BIOC 212</td>
</tr>
<tr>
<td>Materials (What?)</td>
<td>Student team poster assignment from BIOC 212.</td>
</tr>
<tr>
<td>Measure (How?)</td>
<td>Rubric analyzing performance of team poster assignment in BIOC 212.</td>
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<td>Standard (To what extent?)</td>
<td>80% should achieve good or satisfactory, or as specified by the rubric, which is constructed by Neuroscience steering committee</td>
</tr>
<tr>
<td>Responsible (Who?)</td>
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</tr>
<tr>
<td>Who receives results and who is responsible for follow-up?</td>
<td>Director Behnaam Aazhang &amp; Assistant Chair of Biosciences Susan Cates.</td>
</tr>
</tbody>
</table>
Faculty
The following faculty will regularly offer courses in the undergraduate major.

Full professors
Behnaam Aazhang (Electrical & Computer Engineering)
Jim Dannemiller (Psychology)
J. David Dickman (Professor, Baylor College of Medicine & Rice BioSciences and Psychology)
Randi Martin (Psychology)
Timothy Schroeder (Philosophy)
Charles Siewert (Philosophy)
Devika Subramanian (Computer Science & Electrical & Computer Engineering)

Associate professors
Suzanne Kemmer (Linguistics)
Rob Raphael (Bioengineering)

Assistant professors
Bryan Denny (Psychology)
Simon Fischer-Baum (Psychology)
Caleb Kemere (Electrical & Computer Engineering)
Alexander Morgan (Philosophy)
Ankit Patel (Electrical & Computer Engineering & Baylor College of Medicine)
Xaq Pitkow (Electrical & Computer Engineering & Baylor College of Medicine)
Jacob Robinson (Electrical & Computer Engineering)
Julia Saltz (BioSciences)
Rosa Uribe (BioSciences)

Other faculty
David Caprette (Teaching Professor, BioSciences)
Jamie Catanese (Lecturer, BioSciences)
Jon Flynn (Lecturer, BioSciences)
Fabrizio Gabbiani (Professor, Baylor College of Medicine & Rice Electrical & Computer Engineering)
Anne Sereno (Professor, UTHSC & Rice Psychology)
Harel Shouval (Professor, UTHSC & Rice Electrical & Computer Engineering)

Faculty participating in undergraduate research
These faculty members listed above will accept Rice undergraduates into their research laboratories for independent study. Faculty members at Rice, the University of Texas Health Science Center, and Baylor College of Medicine who will accept Rice undergraduates into their research laboratories for independent study are listed in Appendix III.
Inter-divisional Agreement

Interdivisional Agreement between the Office of the Provost and the Schools of Engineering, Humanities, Natural Sciences, and Social Sciences concerning the administration of the existing Neuroscience Minor and proposed Neuroscience Major at Rice University – September 2017

This agreement consists of the following four points:

1) General day-to-day administration of both the neuroscience minor and major (including managing course scheduling, responding to student queries, tracking minor and second major enrollment paperwork, reporting on progress toward learning outcomes, and related tasks) will be the responsibility of the BioSciences Department.

2) Long-term administrative planning and management of the current neuroscience minor and proposed neuroscience major will be the responsibility of the NeuroX steering committee. The NeuroX steering committee will propose the curricular content for the Neuroscience degrees, including curricular design and degree requirements, and provide faculty advisors for students. The NeuroX steering committee will consult with the respective department chairs regarding course availability. The department chairs will maintain their traditional role in making teaching assignments within departmental guidelines.

3) The NeuroX steering committee will consist of faculty representatives from each of the Schools of Engineering, Humanities, Natural Sciences, and Social Sciences, with potential candidates nominated by their respective deans in consultation with department chairs. Neuroscience faculty from other institutions of the Texas Medical Center may also be invited to serve on the committee. The chair will be appointed by the provost and will report to the provost through the advisor to the provost on health related research and educational initiatives. The final membership of the steering committee will be decided jointly by the chair of the steering committee and the provost. All members will serve three-year terms.

4) The budget for the administration of the Neuroscience program (including staff support, an NTT instructor line, and operating expenses) is separately funded from A1 funds within the Department of Biosciences budget in the School of Natural Sciences. The budget will be subject to review as part of the annual budget meeting with the School of Natural Sciences. There will also be a separate annual budget review for the Neuroscience program with the chair of the steering committee.

Marie Lynn Miranda, Ph.D.
Howard R. Hughes Provost
Professor of Statistics

Antonio Merlo, Ph.D.
Dean School of Social Sciences
George A. Peterkin Professor

Reginald Deslouches, Ph.D.
William & Stephanie Sick Dean and Professor of Civil and Environmental Engineering
George R. Brown School of Engineering

Peter Rossky, Ph.D.
Dean, Wiess School of Natural Sciences
Harry C. and Olga K. Wiess Chair

Lora Wildenthal, Ph.D.
Interim Dean, School of Humanities
Professor of History

Email provost@rice.edu  Office 713-348-6506  Fax 713-348-6971  Rice University Office of the Provost MS 7 430 Allen Center 6100 Main St. Houston TX 77005  riceüyorprovost
October 2, 2017

Committee on the Undergraduate Curriculum 
Rice University 

Dear Committee Members:

I enthusiastically support the NeuroX steering committee’s proposal to create a Neuroscience major. The steering committee has carefully developed a proposal on a cross-disciplinary major cutting across different aspects of neuroscience from cells to systems to behavior. The proposal includes curricula at the needed scientific and mathematical depth for students to understand how our neurological system functions, and how we compute, learn, and memorize.

The major includes a number of inquiry-based learning opportunities, including laboratory courses and research courses, which will be offered in laboratories at both Rice and other institutions in the Texas Medical Center (TMC). This emphasis is in line with and will support the university’s quality enhancement plan.

Neuroscience at its core is a cross-disciplinary field, and at Rice it includes faculty from four schools: the Brown School of Engineering, the Wiess School of Natural Sciences, the School of Humanities, and the School of Social Sciences. In addition, the inclusion of a Shepherd School of Music faculty member and chairs of two prominent neuroscience departments at the TMC on the NeuroX Steering committee is designed to strengthen communication among neuroscience researchers within Rice and the TMC. This communication is especially important for a field as broad as neuroscience, which has stakeholders across campus and the TMC.

With my best regards,

Marie Lynn Miranda, PhD 
Howard R. Hughes Provost
October 3, 2017

Committee on Undergraduate Curriculum
Rice University

Dear Chairperson of the Committee on the Undergraduate Curriculum:

We are writing to enthusiastically endorse the launch of a new cross-disciplinary major in Neuroscience; four Rice University Schools support it: Natural Sciences, Engineering, Social Sciences, and Humanities. The program will be administratively housed in the Biosciences department in the School of Natural Sciences. We applaud this faculty led, multi-disciplinary initiative which plays a critical role in building Rice’s collaborative effort with other institutions in the Texas Medical Center (TMC).

Rice is uniquely positioned to launch a very successful major in Neuroscience both because of the quality of its faculty, and because of its existing collaborative research on neuroscience and neuroengineering with the TMC. The cross disciplinary coursework with emphasis on experiential learning in laboratory courses and research laboratories will train our students to tackle broadly how our neurological system works, and how we compute, learn, and memorize.

To conclude, we wholeheartedly support the establishment of a new major in Neuroscience at Rice University. If we can be of further assistance, please do not hesitate to contact any of us.

Sincerely,

Peter J. Rossky, Ph.D.
Dean, Wiess School of Natural Sciences
Harry C. and Olga K. Wiess Chair

Antonio Merlo, Ph.D.
Dean, School of Social Sciences
George A. Peterkin Chair

Reginald DesRoches, Ph.D.
Dean, George R. Brown School of Engineering
William & Stephanie Sick Chair

Lora Wildenthal, Ph.D.
Interim Dean, School of Humanities
To: Committee on the Undergraduate Curriculum  
Re: Neuroscience Major Proposal  
Date: August 27, 2017

We are writing to express our full and enthusiastic support for the proposal submitted for creating a new Neuroscience major. Students across campus will benefit from this broadly interdisciplinary major, as it will allow them to tackle core questions of how the mind and brain work from a diverse set of disciplinary perspectives. Our departments and our faculty are pleased to participate in this effort.

Specifically, the proposed Neuroscience major requires several courses as core or foundational requirements. These courses are central to the Neuroscience major and we will continue to offer these courses each year on the Rice campus for the foreseeable future. In addition, a number of courses offered by our departments are also included as elective courses for the major. These courses are central to the curriculum offered by our own departments as well, and I assure the committee that our department will continue to staff them and teach them with enough frequency such that students registered for the major will be able to fulfill the requirements within a four year period.

Overall, we strongly support the timely proposal to develop a Neuroscience major at Rice. This faculty-led initiative will be welcomed by the undergraduate students and provide an academic home for many who have been actively lobbying for a Neuroscience major. We look forward to its success. If can be of any further help, please contact me.

Sincerely,

Janet Braam  
Wiess Professor and Chair of Biosciences Department  
Rice University

Edward W. Knightly  
Department Chair and Professor, Electrical and Computer Engineering  
Professor of Computer Science  
Rice University

Eduardo Salas  
Professor and Allyn R. and Gladys M. Cline Chair,  
Department of Psychology,  
Rice University
Marina Vannucci
Noah Harding Professor and Chair
Statistics Department
Rice University

Don Morrison
Professor and Chair
Department of Philosophy
Rice University
Appendix I. Course descriptions

Core courses

NEUR/PSYC 362, Spring: Cognitive Neuroscience (3 credit hours)
S. Fischer-Baum (PSYC) Pre-req: PSYC 203. Survey of theory and research on how mental processes are carried out by the human brain, with an emphasis on relating measures of brain activity to cognitive functioning, methods surveyed included electrophysiological recording techniques, functional imaging techniques and methods that involve lessoning or disrupting neural activity.

NEUR/BIOC/PSYC 380, Spring: Fundamental Neuroscience Systems (3 credit hours)
J. D. Dickman (BCM & Rice BIOS and PSYCH) – Recommended pre-req: PSYC 101. A broad overview of the brain's neural systems that subserve perception, learning, and behavior. The course is highly integrative with thematic content including functional organization of the nervous system, neural encoding and decoding, sensory systems, motor systems, and high-level concept processing.

NEUR 383/ ELEC 380, Fall: Introduction to Neuroengineering: Measuring and Manipulating Neural Activity (3 credit hours)
J. Robinson (ECE) Pre-reqs: (PHYS 101 OR PHYS 111 OR PHYS 125 OR PHYS 141) AND (PHYS 102 OR PHYS 112 OR PHYS 126 OR PHYS 142)]. An introduction to quantitative modeling of neural activity and the methods used to stimulate and record brain activity.

NEUR/BIOC 385, Fall: Fundamentals of Cellular and Molecular Neuroscience (3 credit hours)
D. Caprette (BIOS) Pre-req: none (BIOC 201 to be added as prerequisite for fall 2018). Cellular, molecular, and integrative mechanisms of neural function, including membrane and axon physiology, synaptic transmission and plasticity, and sensory and motor systems.

Project-Based Laboratory courses

{NEW} BIOC 212, Fall and Spring (Summer possible): Experimental Neuroscience (2 credit hours)
J. Catanese and Jon Flynn (BIOS) Pre-req: BIOC 201. Project-based neuro-topic lab course; Pre-req or co-req: BIOC 201). Introduction to scientific method, principles of experimental design, selected research strategies, record keeping, and technical communication as related to neuroscience.
NEUR 310, Fall, Spring, Summer: *Independent Research for Neuroscience* (variable credit, 3 credit hours required to count for lab course requirement).

Pre-req: BIOC212 or BIOC 211. Independent research in Rice and other TMC institution neuroscience faculty laboratories. Students conduct research at least 3 hours per week in the laboratory for each semester hour of credit. If taken for 3 or more hours, the course fulfills one lab course requirement. Requires a proposal abstract, weekly reports, and a research paper (fall semester) or a proposal abstract, weekly reports, and a poster presentation or a research paper (spring semesters). Students wishing to perform their research in an off-campus lab must submit a completed application to the NEUR 310 instructor at least 2 weeks prior to the start of classes and may not register for fewer than 3 credit hours. Students are strongly advised to secure research advisors and register for the class well in advance of the start of classes. Instructor Permission Required. Repeatable for Credit.

NEUR 364, Spring: *Cognitive Neuroscience Lab* (1 credit hour)

A. Sereno (UTHSC) Pre-req: PSYC 362 or NEUR 362. Equips students with the tools to apply cognitive neuroscience techniques to health or clinical topics and to investigate sensorimotor and cognitive measures in a human model.

BIOC 415, Fall and Spring: *Experimental Physiology* (1 credit hour)

D. Caprette (BIOS) Pre-req: BIOC 311 or (BIOC 211 or BIOC212 and BIOC/NEUR 385). Laboratory studies in membrane, nerve, and muscle physiology, with emphasis on experimental design, data analysis, and data interpretation. The course parallels the early part of BIOC/NEUR 385 by testing models for the origin of membrane potentials and action potentials, generation and conduction of action potentials, conduction velocity, refractory properties of nerves, motor unit concept and neuromuscular mechanisms for regulating contractile strength. Includes a significant technical writing component.

{NEW} BIOC 417: *Experimental Cell and Molecular Neuroscience* (1 credit hour)

Jon Flynn (BIOS) Pre-req: BIOC 212 and BIOC 385. New course initiated in Spring 2018. Laboratory studies to emphasize skills similar to those emphasized in BIOC 415 but employing invertebrate models. Focus will include topics such as sensory systems, motor systems, cell biology of neurons, neurohistology, and related areas.

Elective courses

{NEW FY19} BIOC 449: *Advanced Cell and Molecular Neuroscience* (3 credit hours)

Jon Flynn (BIOS) Pre-reqs: BIOC/NEUR 385. Explores current research and current primary literature in depth. Specific topics will include newly discovered receptors, new mechanisms for synaptic plasticity such as retrograde signaling, sensory systems research and. comparative studies of visual systems, motion detection, color vision, and related areas.
{NEW, FY19} BIOC 475/NEUR 475; Advanced Neurodevelopment (3 credit hours)
Rosa Uribe (BIOS) Pre-reqs BIOC/NEUR385. Explores current research and primary literature in the area of development of neural tissues and organs, including the regulatory proteins, signal transduction pathways, and patterning mechanisms critical for development and repair. Comparative studies among diverse systems will be included.

BIOE 492 Spring: Sensory Neuroengineering
R. Raphael (BIOE). Pre-reqs: BIOE 332 or permission of instructor. Explores how bioengineering techniques and principles are applied to understand and model sensory systems, with a focus on the auditory, vestibular, and visual systems. The interaction between the electrical, mechanical and optical aspects of these systems, and ways to modulate these interactions, will be explored. The course will also cover the design of current auditory, visual and somato-sensory neuroprosthetics (i.e., cochlear implants, retinal implants and brain-machine interfaces), as well as emerging technologies for neural stimulation. Graduate/Undergraduate Equivalency: BIOE 592.

CAAM/NEUR 415/ELEC 488, Fall: Theoretical Neuroscience: Cells, Circuits, and Systems
F. Gabbiani (BCM, Rice ECE), H. Shouval (UTHSC, Rice ECE). Recommended Prerequisite(s): CAAM 210 or MATH 211 or CAAM 335 or MATH 355. We present the theoretical foundations of cellular and systems neuroscience from distinctly quantitative point of view. We develop the mathematical and computational tools as they are needed to model, analyze, visualize and interpret a broad range of experimental data.

CAAM/NEUR 416/ELEC 489, Spring: Neural Computation: Function of brain networks
X. Pitkow (BCM, Rice ECE). Pre-reqs: knowledge of calculus, linear algebra, and probability and statistics. How does the brain work? Understanding the brain requires sophisticated theories to make sense of the collective actions of billions of neurons and trillions of synapses. Word theories are not enough; we need mathematical theories. The goal of this course is to provide an introduction to the mathematical theories of learning and computation by neural systems. These theories use concepts from dynamical systems (attractors, chaos) and concepts from statistics (information, uncertainty, inference) to relate the dynamics and function of neural networks. We will apply these theories to sensory computation, learning and memory, and motor control. Our learning objectives are for you to formalize and mathematically answer questions about neural computations including “what does a network compute?”, “how does it compute?”, and “why does it compute that way?”

COMP 440/ELEC 440 Fall: Intro to Artificial Intelligence
D. Subramanian (COMP). Pre-reqs: COMP 310 AND (STAT 310 OR ECON 307 OR ECON 382 OR STAT 312 OR STAT 331 OR ELEC 331 OR ELEC 303) AND (MATH 354 OR MATH 355 OR CAAM 335). A foundational course in artificial intelligence, the discipline of designing intelligent agents. The course will cover the design and analysis of agents that do the right thing in the face of limited information and computational
resources. The course revolves around two main questions: how agents decide what to do, and how they learn from experience. Tools from computer science, probability theory, and game theory will be used. Interesting examples of intelligent agents will be covered, including poker playing programs, bots for various games (e.g., WoW), DS1 -- the spacecraft that performed an autonomous flyby of Comet Borrely in 2001, Stanley -- the Stanford robot car that won the Darpa Grand Challenge, Google Maps and how it calculates driving directions, face and handwriting recognizers, Fedex package delivery planners, airline fare prediction sites, and fraud detectors in financial transactions.

**EBIO 321: Animal Behavior**

J. Saltz (BIOS). Pre-reqs: BIOC 201 AND EBIO 202. Evolutionary theory is used to evaluate behavioral adaptations of organisms to their environment.

**ELEC 382/NEUR 382, Spring: Introduction to Computational Neuroscience**

F. Gabbiani (BCM, Rice ECE), H. Shouval (UTHSC, Rice ECE), A. Patel (BCM, Rice ECE). Pre reqs: CAAM 210 recommended. Introduction to methods and theories used to describe and understand neural information processing in the brain. Models covered will range from single neuron to networks for sensory, motor and learning tasks. Programming exercises will be done using MATLAB.

**ELEC 475 Spring: Learning from Sensor Data**

B. Aazhang (ECE). Pre-reqs: background in linear algebra and probability. This course will offer students depth in a few topics while focusing on applications; leading students to start a formulation, develop algorithms, and finally consider building a system. The course will focus on a probabilistic approach to working with sensor data. That includes characterizing statistical properties of data, designing a system based solely on data, and a statistical analysis of the performance of the resulting system. The framework to study the physical system will be data driven. Topics will include representation of data, estimating key characteristics of data, and powerful data processing tools. These tools will be used in inference, regression, classification, and clustering problems. The course will step back to consider sensors and systems used to gather data. Topics will include sensors, electrodes and biosensors as well as amplifiers and microprocessors. The course will conclude with applications to recording and stimulations of cardiac and neurological systems.

**LING 411: Neuro-linguistics**

S. Kemmer (LING) Pre-reqs: none. Study of language and the brain. Includes localization of speech, language, and memory functions, hemispheric dominance, pathologies of speech and language associated with brain damage, and hypotheses of the representation and operation of linguistic information in the cortex.

**NEUR 301, Spring: Advanced Cognitive Neuroscience: Attention and Perception**

J. Dannemiller (PSYC) Instructor Permission Required. Overview of neuropsychological and cognitive neuroscience approaches to higher mental functions including sensation and
perception, attention, motor control, and neuroplasticity. Other topics include basic neuroanatomy, experimental and clinical investigative methods, and the historical and philosophical context of contemporary neuroscience.

**NEUR 302, Fall: Advanced Cognitive Neuroscience: Higher Cognitive Functions**
R. Martin (PSYC) Instructor Permission Required. Overview of neuropsychological and cognitive science approaches to higher mental functions, including language, memory, executive functions, reasoning, and numerical processing.

**PHIL 103: Philosophical Aspects of Cognitive Science**
T. Schroeder (PHIL), A. Morgan (PHIL). Pre-reqs: none. Examines current research in cognitive science and its philosophical implications. Topics include whether the mind is a computational system, how the mind is organized, what relations minds bear to brains.

**PHIL 303: Theory of Knowledge**
T. Schroeder (PHIL). Pre-reqs: none. Examines the question: What is knowledge, and how is it possible that we have it? Topics include: analysis of knowledge, justification and evidence, skeptical challenges, and relativism.

**PHIL 312: Philosophy of Mind**
C. Siewert (PHIL). Recommended pre-req: One course in philosophy or permission of the instructor. Inquiry into the nature of mind. Questions include: how should we conceive of the relationship of mind and body? What is consciousness, and how might it be explained? How can mental states be causes? Can one’s mind and its contents die outside one’s brain?

**PHIL 358: Philosophy of Neuroscience**
A. Morgan (PHIL). Pre-reqs: none. Explores various philosophical questions raised by neuroscience. How do we investigate and explain the brain? Do psychological explanations ultimately ‘reduce’ to neuroscience? Are mental states nothing more than electro-chemical states of the brain? Does the brain literally perform computations on internal representations? Could neuroscience ever explain consciousness? Repeatable for Credit.

**PHIL 359: Animal Minds**
A. Morgan (PHIL). Pre-reqs: none. Examines various philosophical questions raised by the science of animal cognition: What is it to have a mind? How can we learn about animal minds? Are animals conscious? Do they have beliefs or concepts? What does this tell us about the nature and value of animal minds? Repeatable for Credit.

**PSYC 354, Spring: Introduction to Social and Affective Neuroscience**
B. Denny (PSYC) Pre-req: PSYC 202. Overview of social and affective neuroscience research, including examination of the neurobiological mechanisms supporting social cognition; inter-personal processes; emotion and motivation; and emotion regulation. These
topics will be examined in both healthy and affectively-disordered populations, with links made to the fields of health psychology and clinical neuroscience.

**PSYC 375, Spring: Neuropsychology of Language and Memory**
R. Martin (PSYC). Pre-reqs: PSYC 203 AND (PSYC 309 OR LING 309 OR LING 200 OR ANTH 200) AND (PSYC 362 OR NEUR 362 OR NEUR 380 OR BIOE 380 OR PSYC 380) or permission of instructor. An introduction to the neural basis of language and memory, covering patient-based and neuroimaging approaches. Topics include the neural basis of speech perception, language comprehension, language production, short-term memory, working memory, semantic and episodic memory, and domain-specific memory (e.g., verbal, spatial, and emotional memory).

**PSYC 432: Brain and Behavior**
TBD. Pre-reqs: PSYC 101 AND PSYC 203 AND PSYC 362 or permission of instructor. Recommended pre-reqs: PSYC 339 and PSYC 340. An in-depth examination of the neural basis of higher mental functions in humans, including perception, attention, memory, motor skill, and language. Claims and controversies in cognitive neuroscience will be discussed.
Appendix II. Illustrations – sample degree plans

Illustration 1 presents a plan for a student with no pre-matriculation credit and no intent to perform independent research. Illustration 2 presents a plan for students with no pre-matriculation credits, but with the aim of studying abroad.

Illustration 1 – No AP credit

No AP and 122 minimum hrs required (62 in major, 60 outside). This illustration has the student completing 126 hrs.

Non-specified electives are outside the major and include distribution courses.

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| SOPHOMORE YEAR  |                |
| 15              | 16             |
| PHYS 125        | PHYS 126       |
| 4               | 4              |
| BIOC 201        | CAAM 210       |
| 3               | 3              |
| BIOC 212 (LAB)  | NEUR 380       |
| 2               | 3              |
| (Elective) 3    | (Elective) 3   |
| (Elective) 3    | (Elective) 3   |
| (Elective) 3    | (Elective) 3   |
| (Elective) 3    | (Elective) 3   |
| (Elective) 3    | (Elective) 3   |

| JUNIOR YEAR     |                |
| 16              | 16             |
| PSYC 203        | STAT 305       |
| 3               | 4              |
| NEUR 385        | NEUR 362       |
| 3               | 3              |
| NEUR 383        | NEUR ELECTIVE 1|
| 3               | 3              |
| NEUR LAB 1 1    | (Elective) 3   |
| (Elective) 3    | (Elective) 3   |
| (Elective) 3    | (Elective) 3   |
| (Elective) 3    | (Elective) 3   |
| (Elective) 3    | (Elective) 3   |

| SENIOR YEAR     |                |
| 16              | 15             |
| NEUR ELECTIVE 2 | NEUR ELECTIVE 4|
| 3               | 3              |
| NEUR ELECTIVE 3 | (Elective) 3   |
| 3               |                 |
| NEUR LAB 2 1    | (Elective) 3   |
| (Elective) 3    | (Elective) 3   |
| (Elective) 3    | (Elective) 3   |
| (Elective) 3    |                 |
Illustration 2 – No AP credit and Study Abroad

No AP and 122 minimum hrs required (62 in major, 60 outside). This illustration has the student completing 126 hrs.

Non-specified electives are outside the major and include distribution courses.

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| SOPHOMORE YEAR | 16 | 16 |
| PHYS 125 | 4 | PHYS 126 | 4 |
| BIOC 201 | 3 | CAAM 210 | 3 |
| BIOC212 (LAB) | 2 | NEUR 380 | 3 |
| STAT 305 | 4 | (Elective) | 3 |
| (Elective) | 3 | (Elective) | 3 |

| JUNIOR YEAR | 16 | (STUDY ABROAD) 15 |
| PSYC 203 | 3 | (Elective) | 3 |
| NEUR 385 | 3 | (Elective) | 3 |
| NEUR 383 | 3 | (Elective) | 3 |
| NEUR LAB 1 | 1 | (Elective) | 3 |
| (Elective) | 3 | (Elective) | 3 |
| (Elective) | 3 | |

| SENIOR YEAR | 16 | 15 |
| NEUR LAB 2 | 1 | NEUR ELECTIVE 2 | 3 |
| NEUR ELECTIVE 1 | 3 | NEUR ELECTIVE 3 | 3 |
| (Elective) | 3 | NEUR 362 | 3 |
| (Elective) | 3 | (Elective) | 3 |
| (Elective) | 3 | (Elective) | 3 |
| (Elective) | 3 | |
Appendix III. Research Opportunities for Rice Students

Rice University Faculty

Professors
Behnaam Aazhang (Electrical & Computer Eng.)
Richard Baraniuk (Electrical & Computer Eng.)
Kathleen Beckingham (BioSciences)
James L. Dannemiller (Psychology)
J. David Dickman (Neuroscience)
Suzanne Kemmer (Linguistics)
Herbert Levine (Bioengineering)
Randi C. Martin (Psychology)
James McNew (Biosciences)
Timothy Schroder (Philosophy)
Charles Siewert (Philosophy)
Michael Stern (Biosciences)
Devika Subramanian (Computer Science)
Marina Vanucci (Statistics)
Moshe Y. Verdi (Computer Science)
Rick K. Wilson (Political Science)

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Cassey O’Callaghan (Philosophy)
Peter Lwigale (Biosciences)
Robert Raphael (Bioengineering)

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Bryan Denny (Psychology)
Simon Fischer-Baum (Psychology)
Caleb Kemere (Electrical & Computer Eng.)
Jessica M. Logan (Psychology)
Alex Morgan (Philosophy)
Ankit Patel (Electrical & Computer Eng.)
Xaq Pitkow (Electrical & Computer Eng.)
Jacob Robinson (Electrical & Computer Eng.)
Julia Saltz (Biosciences)
Rosa Uribe (Biosciences)
Weiwei Zhong (Biosciences)


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Nachum Dafny (Neurobiology and Anatomy)
Valentin Dragoi (Neurobiology and Anatomy)
David Marshak (Neurobiology and Anatomy)
Anne Soreno (Neurobiology and Anatomy)
Anthony Wright (Neurobiology and Anatomy)

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Edward Cooper (Neurology)
Benjamin Deneen (Neuroscience)
Javier Medina (Neuroscience)
Jeffry Neul (Pediatrics)
David Res (Neuroscience)
David Shine (Neuroscience)
Andreas Tolias (Neuroscience)

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Benjamin Arenkijel (Molecular and Human Genetics)
Mauro Costa-Mattioni (Neuroscience)
Benjamin Deneen (Neuroscience)
Herman Dierick (Molecular and Human Genetics)
Joanna Jankowsky (Neuroscience)
Daoyun Ji (Molecular and Cellular Biology)
Nuo Li (Neuroscience)
Hui-Chen Lu (Pediatrics)
Russell Ray (Neuroscience)
Melanie Samuel (Neuroscience)
Roy Sillitoe (Pathology and Immunology)
Tatiana Schnur (Psychology)
Francois St-Pierre (Neuroscience)
Kimberly Tolias (Neuroscience)
Xiaolong Jiang (Neuroscience)
Jeffrey Yau (Neuroscience)
Mignshan Xue (Neuroscience)


Baylor College of Medicine (BCM) Faculty

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Michael Beauchamp (Psychiatry)
William Brownell (Otolaryngology)
Richard De La Garza (Psychiatry & Behavioral Sci.)
J. David Dickman (Neuroscience)
Fabrizio Gabbiani (Neuroscience)
Andy Groves (Neuroscience)
Thomas Kosten (Psychiatry & Behavioral Sciences)
Jeffrey Noebels (Neurology)
Paul Pfaffinger (Neuroscience)
Matthew Rasband (Neuroscience)
John Swann (Pediatrics)
Theodore Wensel (Biochemistry & Molecular Bio.)
Samuel Wu (Ophthalmology)
Huda Zoghbi (Molecular and Human Genetics)

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David Res (Neuroscience)
David Shine (Neuroscience)
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