Trinity University

Neuroscience Major

Student Handbook

Fall 2009 - Spring 2010

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Modern Neuroscience

The study of the nervous system is a relatively new endeavor. While some of the basic concepts that guide neuroscientific research were developed by Cajal and other anatomists in the late 19th Century, it would not be until the second half of the 20th Century, due in part to the development of a slew of different methodologies, that neuroscience would become a vibrant field of study.

It is not uncommon these days to find references in the newspapers to exciting new results regarding the location of brain activity during human emotion, cognition, perception or motor control. This fact indicates that humans find it fascinating to learn the nuts and bolts of how we act the way we do. But it also seems to suggest that we already know almost everything there is to know about these matters. This could not be further from the truth.

In many ways, Neuroscience is just beginning to unravel the mysteries of the brain, and we mean unravel in a literal sense: there are about 100 billion neurons in a human brain and as many “support” cells, neatly organized into networks and nuclei in a volume no larger than 1400 cubic centimeters. Each one of these cells communicates with about 1,000 of its neighbors and it is such crosstalk that brings about neural function. How do neurons communicate? What do they say to one another? What “language” do they speak? And, how does their collected behavior bring about our ability to move, perceive, feel and think? These are some of the questions that neuroscientists are beginning to ask in a myriad ways: from teasing apart the biochemical pathways that are responsible for memory formation to the description and computational simulation of the large-scale networks that control language and grasping.

What makes Neuroscience such an exciting field of study is precisely the number of unanswered questions and the many levels at which the questions can be pursued. A person majoring in Neuroscience will generally decide to pursue additional training in research or applied domains, or both.

Here is a list of some of the areas in which Neuroscience majors could expect to specialize:

Behavioral or systems neuroscience. The study of the basic neural processes underlying behavior. Generally carried out in rodents through the use of well-described behavioral paradigms accompanied by temporary or chronic lesions, electrophysiology, microdialysis or pharmacological techniques.

Biomedical engineering. Modern advances in neuroscience and engineering are coming together to help handicapped individuals regain their mobility and dexterity through the use of machine-brain interfaces that use continuous brain recordings to control robotic systems.

Cognitive neuroscience. The study of the large-scale networks underlying the processes responsible for human cognition. Involves working with human subjects under normal conditions or as “natural lesion” experiments in diverse patient populations. Techniques include human brain mapping carried out by techniques such as electroencephalography (EEG), magnetoencephalography (MEG), and functional magnetic resonance imaging (fMRI).

Computational neuroscience. The application of computational methods to simulate and analyze cellular and network behavior. Mathematically heavy analysis of cell interaction in both abstract and naturalistic (biologically-based) networks. Generally done in collaboration with “wet-lab” groups.

Developmental psychobiology. The study of the development of behavior in normal and affected human individuals from the point of view of brain function. Includes language and cognitive development. Techniques include EEG and psychophysical studies as well as behavioral research in zebra finches, canaries and rodents.

Developmental neuroscience. Research involving the molecular, cellular and network processes that result in the formation of nervous systems. Techniques include genetic manipulation techniques and various anatomical techniques in developing organisms such as zebra fish embryos, chicken and rodents.

Neurobiology. The study of the cellular and molecular processes responsible for neuronal network formation and function. Employs a host of techniques, from genetic manipulation to cell culturing of neurons and glia in the laboratory.

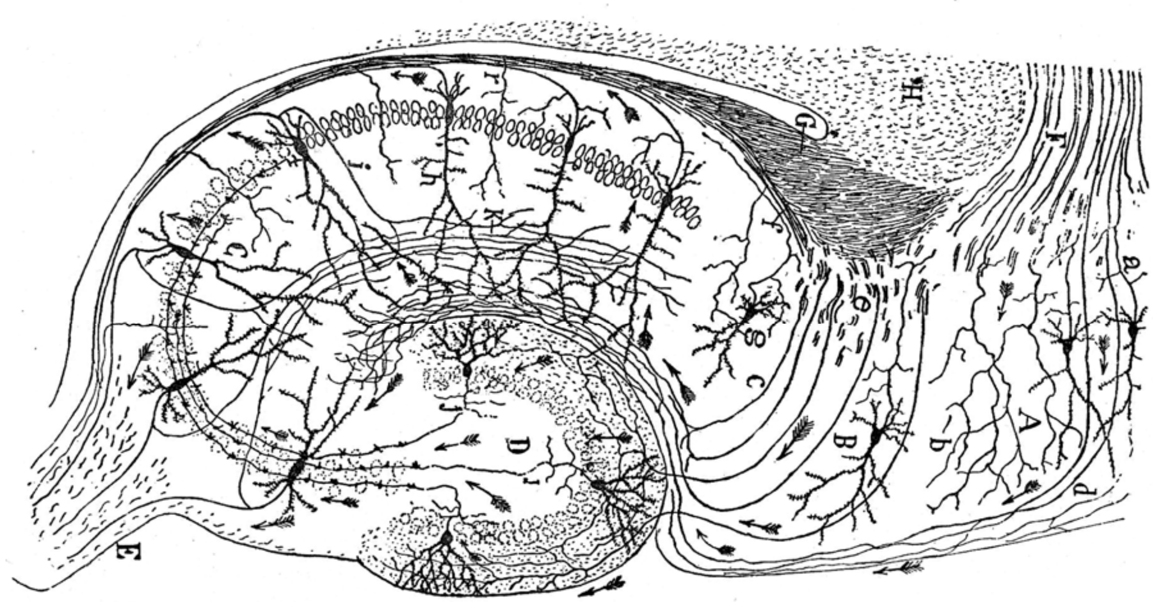
Neurochemistry. The study of the chemicals that make up the brain, from their synthesis to their location in different neural structures to the disorders that occur when their regulation goes arwy. Various molecular and cellular techniques are utilized.

Neuroethology. The study of the neural processes underlying animal behavior in natural settings (as opposed to laboratory settings). Research in insects, crustaceans, fish, amphibians or mammals through behavioral paradigms and pharmacological, lesioning and electroencephalographic techniques.

Neurology. The field of medicine involved in the treatment of human brain disorders and lesions. Approaches are mainly pharmaceutical and rehabilitative. Surgery is becoming more and more common (see below)

Neurosurgery. The field of medicine involved in the surgical treatment of human brain dysfunction. Chronic stimulation and focal lesions of specific brain structures have been used to treat disorders from Tourette's syndrome and Depression to Parkinson's disease. Surgical intervention is also carried out to remove cancerous tissue and aneurysms.

Pharmaceutical research. Research in the design and testing of new pharmacological approaches to brain dysfunction and possibly cognitive enhancement. Drug design, discovery and testing will be a major developing field as human populations live longer lives. Chemical, biochemical and genetic techniques are involved as well as Behavioral neuroscience studies.



Hippocampal circuits drawn by Santiago Ramón y Cajal at the turn of the 20th century. In order to isolate single cells, Cajal employed a stain developed by Camillo Golgi in 1873. Based on his anatomical studies, Cajal proposed the *neuron doctrine* which indicates that neurons do not form a continuous network but rather communicate through a small gap between their somatic projections. Arrows denote the direction of the "nervous impulse".

The Major in Neuroscience

The Bachelor of Science in Neuroscience is a multi-disciplinary program designed to provide an understanding of the nature and functioning of the nervous system from the molecular to the behavioral level. Courses are taught by faculty from the Biology, Chemistry and Psychology departments, offering a broad spectrum of topics and approaches to the study of neural systems structure and function.

Neuroscience Advisory Committee:

Faculty	Department	Email address	Telephone
Dr. Mark Brodl	Biology	Mark.Brodl@trinity.edu	-7246
Dr. Paula Hertel	Psychology	Paula.Hertel@trinity.edu	-8380
Dr. James Roberts (co-chair)	Biology	James.Roberts@trinity.edu	-7233
Dr. Jessica Hollenbeck	Chemistry	Jessica.Hollenbeck@trinity.edu	-7659
Dr Kimberley Phillips (co-chair)	Psychology	Kimberley.Phillips@trinity.edu	-7102
Dr. Michelle Johnson	Biology	Michele.Johnson@trinity.edu	-8918

Requirements for the Degree:

The requirements for the degree of Bachelor of Science with a major in Neuroscience are as follows:

I. The common curriculum

II. Specific degree requirements for the neuroscience major (46-50 semester hours)

A. Core curriculum in neuroscience (11-14 hours):

NEUR 2310 Introduction to Neuroscience
NEUR 2110 Introductory Laboratory in Neuroscience
NEUR 3447 Neurobiology and lab
NEUR 4000 Neuroscience Seminar (4 semesters)
NEUR 4390 Independent Research in Neuroscience

B. Supporting courses in biology (9 hours):

BIOL 1311 Integrative Biology I
BIOL 1111 Introductory Biology Laboratory
BIOL 1312 Integrative Biology II
BIOL 1212 Methods for Biological Problem Solving

C. Supporting courses in chemistry (8 hours):

CHEM 1318 Chemistry in the Modern World
CHEM 1118 Introduction to Analytical Methods
CHEM 2319 Organic Chemistry
CHEM 2119 Laboratory Methods in Organic Chemistry

D. Supporting Statistics/Modeling courses

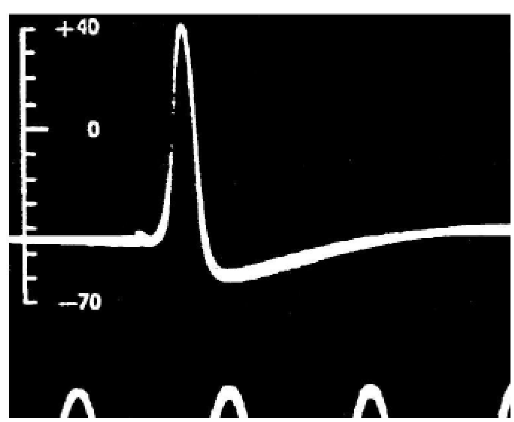
PSYC 2401 Statistics and Methods I
PSYC 2402 Statistics and Methods II

E. Three elective courses from the following set, at least one in each discipline (10-11 hours):

BIOL 3432 Vertebrate Physiology
BIOL 3440 Animal Behavior
BIOL 3443 Developmental Biology
BIOL 3446 Advanced Cell Biology
BIOL –91 Selected Topics (3 hours, advisory approval required)
PSYC 2330 Fundamentals of Cognition
PSYC 3311 Sensation and Perception
PSYC 3331 Memory and Cognition
PSYC 3333 Simulation of Neural and Cognitive Processes
PSYC 3360 Special Topics in Psychology (advisory approval required)

III. Electives sufficient to total 124 semester hours (inclusive of common curriculum).

In 1939, Hodgkin and Huxley published the first description of an action potential following membrane depolarization. This figure shows the oscilloscope signal published with their findings. The scale is in millivolts and the peaks at the bottom of the image are a time stamp.
Subsequent studies by the same group would lead to the explanation of the roles of sodium and potassium ions in the generation of action potentials.



Becoming a Major in Neuroscience

Typically, major declaration occurs during the spring semester of the sophomore year. By this time, you should have taken the biology and chemistry requirements for the neuroscience major and the Introduction to Neuroscience and the Introductory Laboratory in Neuroscience. It is recommended you take the two statistics courses in your second year as these are common requirements for upper level courses.

If you are interested in the Neuroscience Major, feel free to contact one of the faculty in the advisory committee for more information and advice.

Guidelines for acceptance of majors

Full acceptance in the major is granted if the following requirements are met at the time of application:

Completion of NEUR 2310/2110, BIOL 1311/1111, CHEM 1318/1118, and PSYC 2401 (MATH 3310 or MATH 3311 with approval of the Steering Committee) with a grade of C or better.

An overall grade point average of at least 2.0.

Provisional acceptance is allowable with the approval of the chairs and is routinely given while the statistics requirement is being met.

Course Descriptions

NEUR 2310 Introduction to Neuroscience

A survey of basic neuroscience, starting with fundamentals of neuronal structures and ending with higher brain functions and their relations to mind and behavior. (Also listed as PSYC 2310.)

NEUR 2110 Neuroscience Laboratory

The neuroscience laboratory provides students with a hands-on approach to understanding the scientific method through neuroscientific techniques and data analysis, including anatomical, electrophysiological and computer simulations. Students will engage in laboratory exercises as well as in solving problem sets. This course is appropriate for both non-science majors and science majors. Spring semester only. (Also listed as PSYC 2110.)
Prerequisite or corequisite: NEUR/PSYC 2310.

NEUR 3447 Neurobiology

Neurobiology focuses on the organization and function of nervous tissues and systems. The course begins with a molecular and cellular overview, followed by an examination of neural system function at the level of signaling and synaptic transmission, sensory systems, and central system integration and control. With this foundation, the course briefly explores brain development and plasticity. 3 class hours and 3 laboratory hours a week for one semester. Additional hours in lab are required to monitor experiments. (Also listed as BIOL 3447.)
Prerequisites: BIOL 1312, 1212, CHEM 2319, 2119.

NEUR 4_90 Independent Research in Neuroscience

Independent empirical research on problems in neuroscience. May be repeated once. (The research topic must be approved by the Faculty Advisory Committee.) (Also listed as BIOL 4390 and PSYC 4395 and PSYC 4396.) This course fulfills the Senior Experience requirement of the University's Common Curriculum.
Prerequisites: Consent of instructor and Senior standing.

See details on pages 15-21 of this Handbook.

BIOL 1311 Integrative Biology I

This course is designed to introduce students to the wide range of knowledge in the biological sciences and with the methods that have built this knowledge base. The course is organized around a series of topic-based modules, each of which will integrate modern biological approaches at the cellular, organismal, and population levels. Modules for this first semester course will include global biology change, sexual reproduction, the evolution of hemoglobin, or other contemporary topics. Grades for this course will be determined by exams on each module, a comprehensive final exam, and take home exercises and assignments. This course is appropriate for non-science majors and will meet 3 class hours a week for one semester in the fall only.

BIOL 1111 Introductory Biology Laboratory

This is an introductory laboratory course that provides an understanding of the scientific methods used to investigate biological questions and how the results of these studies are communicated. The semester is divided into three investigative modules in which student groups learn a technique, conduct an experiment or study, and write their results in the form of a scientific paper. Each group will also make a presentation on the biodiversity of particular groups of organisms. This laboratory course is appropriate for both non-science majors and science majors. Grades are determined from the reports and presentations. 3 laboratory hours a week for one semester in the fall only. BIOL 1311 must be taken concurrently.

BIOL 1312 Integrative Biology II

This course is a continuation of BIOL 1311 and builds on that material with a different set of topic based modules. Modules for this second semester course will include genetically modified organisms, metabolism, the evolution of birdsong, or other contemporary topics. Grades for this course will be determined by exams on each module, a comprehensive final exam, and take home exercises and assignments. 3 class hours a week for one semester in the spring only. BIOL 1212 must be taken concurrently.

Prerequisites: BIOL 1311/1111. CHEM 1318 is strongly recommended.

BIOL 1212 Methods for Biological Problem Solving

This methods course for science majors develops analytical, laboratory, and field skills through small-scale exercises and investigative experiments. Biochemistry and molecular biology, organismal physiology, and ecology will be used to address the processes of experimental design and data analysis, with emphasis on calculation skills and proper application of statistics. The use of supporting organismal and literature databases in scientific investigation will be incorporated. Grades for the course will be determined by a combination of tests, problem sets, and writing assignments. 3 scheduled laboratory hours, plus 1-2 hours of follow-up laboratory work and outside reading/writing each week. BIOL 1312 must be taken concurrently.

BIOL 3432 Vertebrate Physiology

This course is a study of the principles of homeostasis with emphasis on major vertebrate organ systems. This course begins with a detailed molecular investigation of excitable membrane physiology (nerve and muscle) followed by a systematic investigation of endocrine, cardiovascular, respiratory, renal and gastrointestinal physiology. Integrative problem sets are assigned to address the complex interactions between organ systems. Laboratory experience involves experimentation with sophisticated physiological equipment and computerized data acquisition systems to reinforce concepts presented in lecture. Lecture examinations, laboratory reports, homework problem sets, and a research paper with presentation will be used to assess student understanding in this course. 3 class hours, 3 laboratory hours per week for one semester.

BIOL 3440 Animal Behavior

In this course we investigate the current state of knowledge in animal behavior, taking as a framework the "four questions" of behavior, as defined by Niko Tinbergen, one of the founders of the field: 1) the adaptive value of specific behaviors; 2) how behaviors have evolved over time; 3) how behaviors develop within an individual; and 4) the neural, hormonal, and physiological mechanisms underlying behavior. We give greatest emphasis to the first two questions, as addressed by the modern field of behavioral ecology. The laboratory focuses on developing skills of observation of naturally occurring behavior in the lab and field, and in the design and analysis of hypothesis-driven experiments. Grades are based on participation, summaries of scientific articles from the current literature each week, brief summaries of lab results, two midterm exams, and a semester-long in-depth literature review of a specific topic within the field of animal behavior. This literature review culminates in a final paper and a presentation to the class. 3 class hours, 3 laboratory/field hours a week for one semester.

Prerequisite: Junior level standing or permission of instructor. MATH 1320 (Statistical Methods) or PSYC 2401 (Statistics and Methods I) strongly recommended.

BIOL 3443 Developmental Biology

Through integration of information from various biology sub-disciplines, course topics include the following: vertebrate body-plan pattering, genetic control of the Drosophila body plan, early morphogenesis, cell differentiation, organogenesis, gamete formation, and fertilization. The laboratory follows development using microscopy and through special projects involving several animal systems, including avian. Course assessment includes in-class examinations, oral presentations, and group projects. 3 class hours and 3 laboratory hours a week for one semester. Additional laboratory hours are required to monitor experiments.

Prerequisites: at least one area B biology course; BIOL 3426 and NEUR 3447 recommended.

BIOL 3446 Cell Biology

Cells form the basic working units of organs and the systems that organs comprise. This course is designed to build an understanding of the fundamental processes that govern the operations of cells. Cells face challenges of maintaining boundaries, communicating with neighboring

cells, transporting essential components across barrier membranes, generating chemical energy, regulating cell phenotype, and maintaining cell structure. In order to function as part of a specialized tissue or organ, cells elaborate specific subsets of organelles to dedicate themselves to performing specific functions. The course will provide the background to understand the cellular mechanisms of specialized cells, and allow one to predict the underlying cellular physiology of most tissue systems. The laboratory takes an investigative approach, introducing microscopic, molecular, and biochemical tools for studying cells. Grades for the course are to be determined by in-class examinations and laboratory reports. 3 lecture hours, 3 laboratory hours a week for one semester.
Prerequisite: At least one Area B course or permission of instructor.

BIOL --91 Selected Topics
Study of a topic or field not covered by other courses. Lower division offerings will provide an introductory approach to a topic. Upper division courses will involve in-depth analysis of a specific area and will usually require prerequisite courses, at the discretion of the instructor. May be repeated for credit on different topics.

CHEM 1318 Chemistry in the Modern World
Fundamental concepts in chemical science, taught from perspectives of chemistry in the modern world. The course provides multiple entry points for the study of chemical science by all students through the initial development of important concepts in a contemporary context. The content will include molecular structure, bulk properties of chemicals, and chemical change. Lecture, 3 hours per week.
Corequisite: CHEM 1118.

CHEM 1118 Introduction to Analytical Methods
Emphasis is placed on the development of laboratory skills that are fundamental to experimental chemistry. Laboratory operations include the use of modern potentiometric and spectrophotometric methods of analysis as well as traditional gravimetric and volumetric procedures. Laboratory, 3 hours per week.
Corequisite: CHEM 1318.

CHEM 2319 Organic Chemistry
Introduction to the basic principles of organic chemistry through studies of the structures, properties, and reactions of carbon-based compounds. Lecture, 3 hours per week.
Corequisite: CHEM 2119.
Prerequisite: CHEM 1318 or equivalent.

CHEM 2119 Laboratory Methods in Organic Chemistry

The laboratory stresses modern techniques for the preparation and analysis of organic compounds. Infrared spectral analyses and chromatographic separations are introduced. Laboratory, 3 hours per week.
Corequisite: CHEM 2319.
Prerequisite: CHEM 1118 or equivalent.

MATH 3310 Mathematical Models in Life Sciences

The course is designed to introduce basic tools to study mathematical models in the life sciences including their practical applications. The focus will be on understanding the processes, implications, and results of modeling phenomena in lie sciences in the laboratory setting or field. The course investigates exponential growth and logistic models, cooperative, competitive, and predator-prey models, harvesting models, and epidemiological models. The integrated laboratory experience consists of several experiments on model organisms such as bacteria, flour beetles (Tribolium), protists, and duckweed. In addition, human epidemiological data will also be utilized. Offered every Fall semester.
Prerequisite: MATH 1307 or 1311.

MATH 3311 Probabilistic Models in Life Sciences

The central topic of this course is probabilistic modeling with emphasis on biological sequence comparison and applications in functional analysis of DNA and protein sequences and their evolution. Biological experiments will be introduced to motivate new concepts and enhance understanding of the material covered. Emphasis will be on comprehending the biological and mathematical principles underlying the models introduced and applying this understanding to evaluate and interpret the biological significance of experimental results.

Basic concepts of probability will be presented, with a special attention to conditional probability. Probabilistic models and algorithms used in global and local pairwise sequence alignment will be developed. The expectation, variance, and standard deviation of discrete and continuous random variables, along with a number of common distribution functions, will be explained. Markov models and the application of discrete Markov chains in biology and biological sequence analysis will also be covered. These concepts will be used to extend the ideas from the pairwise sequence alignments to the problems of multiple sequence alignment, evolutionary distances, and phylogenetic tree construction. Offered every Spring semester.
Prerequisite: MATH 1307 or 1311.

PSYC 2401 Statistics and Methods I

Instruction in measurement processes, descriptive statistics, correlational and inferential reasoning and basic statistical procedures. Students become acquainted with major procedures and issues involved in the framing of psychological research. Instruction includes the use of computerimplemented statistical packages and the method and style of writing about psychological research.

PSYC 2402 Statistics and Methods II
Instruction in additional techniques in inferential reasoning, including analysis of variance and major nonparametric statistics. All topics are presented within the context of research design and methodology. Related statistical packages for computer-assisted analysis and further instruction in writing are included.
Prerequisite: PSYC 2401 or consent of instructor.

PSYC 2330 Fundamentals of Cognition
An introduction to the principles of cognitive psychology. Topics include the development of the cognitive paradigm, attention, higher order processes in perception, language, memory, problem-solving, and human-computer interaction. Application to other domains in Psychology and disciplines will be discussed.

PSYC 3311 Sensation and Perception
Study of sensory and perceptual systems. Emphasis is on the relationship of neurophysiological and cognitive principles. Major focus is on vision (visual neurophysiology, spatial vision, form, color, depth and motion) with some discussion of psychophysical methods, audition, speech perception and the chemical senses. Demonstrations and conducting experiments are part of course. Prerequisites: PSYC 1300, 2401.

PSYC 3331 Memory and Cognition
Examination of the fundamental principles of memory and thought, the experimental evidence to support these principles, and the theoretical perspectives used to understand them.
Prerequisites: PSYC 1300 and 2402 or consent of instructor.

PSYC 3333 Simulation of Neural and Cognitive Processes
The interrelations among the study of the mind, the elaboration of brain mechanism, and studies in artificial intelligence. Discussion of modern computers as a model of brain functioning with emphasis on the question of parallel versus serial processing and contemporary approaches to information processing in the nervous system. Students will gain experience in modeling these processes on computers.
Prerequisites: PSYC 1300 or 2330.

PSYC 3360 Special Topics in Psychology
In depth study of theory and research within a particular domain of psychology. May be repeated on different topics.
Prerequisite: Consent of instructor.

Trinity University Neuroscience Major
Independent Research in Neuroscience (NEUR 4390)

The Neuroscience major at Trinity University requires that all students complete one semester of independent research in neuroscience for credit by registering for the course NEUR 4390. Students are able to fulfill this research requirement through research on- and off-campus as long as it fulfills the following expectations:

(1) students develop a meaningful research project for which it is reasonable to expect completed results no later than the end of the semester in which you are enrolled in 4390,
(2) students will work an average of 10 hours/week on the project during the semester (or 30 hours/week in the summer)
(3) the research mentor/project sponsor will provide feedback to the student in preparing a written report and a presentation based on the research results

Requirements for research proposal:

All materials are due to be submitted electronically to the Neuroscience Steering Committee via Pearl de la Cruz (pearl.delacruz@trinity.edu). To graduate with a major in Neuroscience, you must submit the proposal ***no later than September 1, 5:00 pm during your senior year****. [Note: for students graduating in 2010, the submission deadline is October 15, 2009.]*

All proposals must have the following sections:

Abstract. This should be a concise summary of your proposed project. Do not exceed 200 words. You and your Trinity sponsor must sign and date the Abstract page. You must use the cover sheet on page 17.

Introduction to the project. You should discuss the general problem to be addressed, the theoretical context of the work, and the most relevant literature to the problem. You must also state the hypothesis to be tested in your project.

Methodology. Describe the techniques and methods to be used to test the hypothesis. Discuss why these methods were chosen. Identify the materials and supplies you will need to conduct this research. Indicate any potential pitfalls and how you are prepared to address them.

Data analysis. Indicate how you will analyze and interpret your data. Justify your analysis.

Significance. Indicate the contribution of the work to the published literature/field. If this project is a portion of a larger project in the laboratory, state how this project fits into the whole.

Location. Indicate precisely where the research will be conducted. If the research is to be conducted off-campus, the off-campus sponsor must provide a separate letter of support for project, indicating that he/she has read the proposal and agrees to supervise the proposed research.

References. Citations should follow APA style (6th ed).

Formatting. Number all pages on the bottom center of the document. Use Times New Roman, 11 point font; double-space throughout. The entire proposal can be no longer than 5 pages.

Requirements for research report:

The student must submit a written report to the Neuroscience advisory committee by the first day of finals for that semester. The report must be written in the style and format of a scientific research article (Abstract, Introduction, Methods, Results, Discussion, References, Tables, Figures). Before submission to the advisory committee, the report must first be submitted to the project sponsor, and the version the student will hand in by the due date will be a revision that is responsive to comments made by the project sponsor.

Requirements for research presentation:

In the same semester in which the student is registered for research credit, the student must publicly present the research. The presentation should be 15 minutes, with time for questions. The research mentor/project sponsor is expected to provide feedback to the student in preparing the presentation.

Neuroscience 4390 – Research Proposal Cover Sheet and Contract

Name of Trinity student: ____
Name and location of research sponsor: ____
Title of research proposal: ____
Approximate cost of materials and supplies: _____________________________________
Funding source(s) and amount: ____
Semester of data collection: ____

Attach to this form your research proposal, including your introduction, methodology, data analysis, significance, location (with letter of support if off-campus), and references. Details on proposal content and format are provided in the Neuroscience Major Student Handbook on page 15.

By signing this contract, the Trinity student and non-Trinity research mentor or Trinity project sponsor named below agree to fulfill the above-stated expectations for an independent research project as part of the requirements of the Neuroscience major.

Signature of Trinity student: ____ Date: ______________

Signature of off-campus research mentor: ________________________________Date: ______________
(Required for off-campus research only)

Signature of on-campus faculty advisor: _________________________________ Date: ______________
(Required for off-campus research only)

Signature of on-campus research project sponsor: __________________________ Date: _____________
(Required for on-campus research only)

ABSTRACT

On-Campus Neuroscience Research Opportunities

Brodl
Projects investigate the trafficking of secretory products from cells, both the mechanisms and how those mechanisms are regulated by hormonal induction and stress. Neuroscience students would review the literature on the cell and molecular biology of secretory processes and the roles for secretion in neuron development and function.

Childers
Projects typically test hypotheses concerning how children deduce the meaning of a new verb. Neuroscience students would review what is known about brain areas involved in the acquisition of words (nouns or verbs) in adults or children.

Hertel
Projects typically concern the effects of attentional focus on performance on other cognitive tasks, such as memory or interpretation. We examine performance differences associated with depressed and anxious states. Neuroscience students would review literature on cortical activation associated with the relevant cognitive processes in depressed or anxious states.

Hollenbeck
Research in the Hollenbeck Lab is focused on the structure and function of designed ankyrin repeat proteins. The ankyrin repeat (AR) is one of the most common protein sequence motifs, and AR proteins have a variety of different functions inside the cell. Of specific interest is the AR domain within transient receptor potential (TRP) ion channels. TRP channels are key transducers of diverse sensory and environmental signals. For example, a single cysteine residue within TRPA1 becomes covalently modified by pungent compounds from mustard oils such as wasabi. This modification activates the ion channel which leads to the sensation of pain. Our lab has developed a model system to monitor structural changes within the AR domain due to similar amino acid modifications, and we are working to develop a functional assay to complement these experiments.

Johnson
My research examines the mechanisms of lizard social behavior and the ecological contexts in which these behaviors occur. I'm particularly interested in the neural, muscular, and hormonal traits that underlie reproductive behaviors, and how variation in these traits produces variation in behavior within and among species. Research in my lab involves field work (both locally and in the Caribbean) to determine how the environment influences neuroendocrine traits and behavior; histological and biochemical techniques to analyze tissues associated with these traits; and laboratory experiments on captive animals to allow careful, systematic manipulation of the animals and their environment.

King
Projects involve understanding how cells interact with their neighbors. Cellular junctions help regulate movement of molecules within an organism, provide structural and metabolic support, prevent infection by forming a barrier and play a critical role in preventing the metastases of

tumors. We use lung and kidney cell models exposed to common pathological stressors (i.e. inflammatory stimuli or high oxygen concentrations) to examine tight junction function. We would be interested in pursuing glial-neuronal cell interaction model. Our studies focus on identifying the cellular signals and molecular mechanisms that lead to the disruption of cellular junctions. Our long-range goals are to understand how the cells control their junctions thereby minimizing the detrimental effects caused by stressors on cellular junctions.

Murphy
Projects investigate visual communication signals in birds and fish to study the adaptive function and the underlying honesty enforcing mechanisms that regulate signal intensity. For example, neuroethological research can focus on effects of testosterone and corticosterone in signal design and regulation, and how the physiological costs of testosterone, or the costs of stress — as indicated by corticosterone, vary with an individual's phenotypic quality, and how this translates into the amount of resources available to invest in signaling. Most research in the lab is on wild Goldfinches in Canada, Orioles in Mexico, and local Titmice in the hill-country, as well as on captive female Betta fish (and some captive birds). Neuroscience students would review the literature on the endocrine and neural mechanisms involved in the maintenance of communication signals and/or the sensory reception and processing of these signals.

Phillips
The focus of the lab is capuchin monkey behavioral biology. I am primarily interested in the neuroanatomical correlates of skilled motor actions and the mechanisms accounting for variation. Current research is focused on brain development and the development of skilled motor actions, and the macrostructural and microstructural organization of the corpus callosum.

Roberts
The major research area in the Roberts' lab focuses on the role of the sex steroids, estrogens and androgens in mediating protection/recovery of the brain from damage due to oxidative stress, focusing on the nigro-striatal pathway and its degeneration in Parkinson's disease. Estrogens generally are protective while androgens are in general damaging. This whole system is characterized from the perspective of the changes which occur as the animal's age progresses. Astrocytes, the largest cell population in the brain regulate neuronal homeostasis and have been implicated in affecting the viability and functioning of surrounding neurons under stressed conditions. In addition, much attention has been focused on estrogen interactions in non-neuronal cell types. Recent data from our lab suggests indirect actions of estrogen through $ER\alpha$ in neighboring glia to protect dopamine neurons against MPP^+ toxicity in mouse mesencephalic cultures. These results prompted us to study estrogen signaling in astrocytes to evaluate the mechanism of estrogens indirect neuroprotective effects on DA neurons.

Wallace
Projects investigate mechanisms of performance under pressure. Specifically, our lab examines the relationship between measures of approach and avoidance orientations (e.g., behavioral activation and inhibition systems) and performance outcomes in different social situations. Neuroscience students would review literature on the physiological and neurological roots of the performance mechanisms they study.

Yoder

Projects explore developmental changes in reasoning and learning about emotionally-laden topics during college years. Work here is associated with identifying behavioral evidence of prefrontal cortical changes associated with late adolescence and early young adulthood.

B. Guidelines for off-campus research

For off-campus research, students should follow these guidelines to ensure that they receive credit for the experience:

1. It is the student's responsibility to make contact with potential outside research mentors, and inquire about research opportunities in their laboratory. Students should communicate to their potential research mentors the expectations for a research experience, as outlined in the research contract (page 18).

2. The Neuroscience major will have contracts available for research mentors outside of Trinity who agree to take on students for Neuroscience research. The contract will outline the following expectations: (A) that students are given a meaningful research project for which it is reasonable to expect results within one semester, (B) that students will work an average of 10 hours/week on the project during the semester (or 30 hours/week in the summer), and (C) that the research mentor will provide feedback to the student in preparing a written report and a presentation based on the research results. The contract will also specify a due date, by which time the written report will be submitted to their Faculty Advisor.

3. The student must submit an application for approval—including an outline of the proposed research, the name of the research mentor and the location of the research, the signed contract from the research mentor, and a due date for the research report—to the faculty advisor, two weeks before registration for the semester in which he/she intends to register for research.

4. The student must hand in a written report to their Faculty Advisor by the end of the final exam period for that semester. In addition, students should submit an electronic copy of the report to the HHMI Grant Coordinator, Kimberly Messersmith, at kmessers@trinity.edu. The report must be written in the style and format of a journal research article (Abstract, Introduction, Methods, Results, Discussion). The report must be submitted first to the research mentor, and the version the student will hand in by the due date will be a revision that is responsive to comments made by the research mentor.

5. In the same semester in which the student is registered for research credit (or the fall semester in the case of summer research), the student must present the research as part of the Neuroscience seminar series. The presentation should be fifteen minutes, with time for questions. The research mentor is expected to work with the student in preparing the presentation.

The grade for the research experience will be determined by the faculty advisor based on the written report and presentation, as well as communication with the research mentor about the student's performance.

Looking Towards the Future

Assuming that you are not considering attending medical school (in which case by now you already know what your next steps should be), what can you expect once you graduate with a B.S. in Neuroscience? By the time you need to answer this question you will know a good deal about the different applications of neuroscientific knowledge and will also know to some extent which field(s) attracts you the most. Regardless of the answer to that question, success in Neuroscience will most likely require you to attend graduate school.

At the moment the most sought after degree in Neuroscience is a Doctor of Philosophy (Ph.D.) degree. There are a few programs that offer Masters of Science (M.S.) programs but they are quickly disappearing due to the requirements of most entry level positions both in academia and in industry.

A Ph.D. program on average lasts around 5 years. Many programs will tell you that the range is from 4-7 years, but it is rather uncommon to have people graduate in less than 5 years. In a typical program you will spend the first year (sometimes into the second) taking a few core courses and a few electives. During the first year, students are required to do “lab rotations” which means that you will spend a few months in 2-4 different laboratories doing research aiding in your decision of a laboratory to perform your thesis research. The final two to three years emphasize research and the writing of the Ph.D. dissertation. After your second year you will typically take a “qualifying” or “comprehensive” evaluation that is meant to gauge your preparedness to continue with the program to thesis research. The work done during your Ph. D. dissertation will generally produce 1-3 publications in peer-reviewed journals and thus set a basis for your future career.

Applying to graduate school

The next step in your career is obtaining an advanced degree in an area of your interest. Some people decide to apply to graduate school fresh out of Trinity, while others may decide to take one or two years to gain some more experience before committing fully to a research career. You could decide to gain more experience by working in a lab as a research assistant. This type of work may facilitate your admission in to some graduate programs. You should discuss with members of the neuroscience steering committee for guidance.

Once you are ready to tackle graduate-school applications, you should do a search for suitable institutions. Most major universities have a Neuroscience Program. An internet search with the name of the institution and the word “neuroscience” will usually produce the appropriate link to the departmental homepage. The Association of Neuroscience Departments and Programs (ANDP- more detail below: http://www.andp.org/) maintains a clearing house and updated database on all neuroscience graduate training programs. In choosing which institutions to look at, you could also ask your advisor or other faculty members. You can also look at the board on the first/fourth floor of CLS where a number of posters from different programs are located. You could also do a search based on a specific researcher whose work is particularly interesting to you.

Applications to graduate school typically include four elements: an official undergraduate transcript, GRE scores, letters of recommendation and a personal statement, and are generally due between December and February (to start the following fall).

The Graduate Record Examination (GRE)

The GRE has gone through many changes in the last few years, but the basic idea is to test for Quantitative reasoning, Verbal reasoning and Analytical skills. The highest score you can obtain is 800 on each of the three segments. For most institutions, the Quantitative and Verbal segments are the most carefully looked at. You should always aim to obtain the highest scores possible, but scores above 600 are desirable on each of the Quantitative and Verbal sections. **It is highly recommended that you study carefully for your GRE.** You can either take a course or follow a study guide (available online or at major bookstores) at your own pace. If you are unsatisfied with your GRE scores, you may take the GRE over again. However, you should know that the GRE maintains a cumulative record of your scores for 5 years. More information on the GRE can be found at http://www.ets.org.

Recommendation letters

An application for admission to graduate school typically requires three recommendation letters from people who know your academic abilities and your personal qualities. These are generally faculty at Trinity or research advisors at other institutions where you may have carried out research. Make sure you provide them with all the necessary information (transcript and Personal Statement –see below) as well as an addressed stamped envelope, and allow plenty of time (at least a couple of weeks) for them to write the letters before the applications are due. A list of the institutions with deadlines is very useful when you are applying to a large number of universities. Increasingly, institutions are moving toward online applications. If the institution to which you are applying has an online recommendation process, be sure to speak with your prospective letter writers before submitting their names to the institution. It is also important

Personal Statement

It is what it sounds like. Usually a two-three page essay explaining the reasons why you want to attend graduate school in the specific program to which you are applying. You don't need to be verbose, but you do need to be articulate. Importantly, this is the only portion of your application in which you do the talking. So make sure your enthusiasm and commitment come through clearly. You may insert a bit of personal history regarding your basic motivation, but the most important information is what you have accomplished thus far, whether in scientific research or academically. So don't leave it to the last minute. Go through a few drafts and have other people read it to make sure you are communicating your ideas succinctly (run it past your academic advisor). It is useful to make this available to the people that you are asking for letters of recommendation.

Financial support during graduate school

By now you are probably wondering: how am I going to afford 5 more years of school? The good news is: you don't have to worry about that! Most neuroscience graduate programs will provide you with tuition remission (you don't pay for your courses) and a modest stipend (by modest we mean "about as much as you need to survive"… about $20-28K these days…. Such that you DO NOT have to work to participate in graduate school…. Indeed, you are NOT allowed to have an outside second job!). In some institutions you may need to do some teaching assistantships in return for your education.

Association of Neuroscience Departments and Programs

The Association of Neuroscience Departments and Programs (ANDP; http://www.andp.org/) maintains an up to date listing of all neuroscience graduate programs in the United States. They work with the SfN to manage an online database of graduate programs and list the requirements for contact/application to the individual program. They also maintain useful information concerning life as a neuroscience graduate student and the current state of the job market as experienced by recent neuroscience PhD graduates.

The Society for Neuroscience

If you have not joined as an undergraduate student, once in graduate school you should join the Society for Neuroscience (http://www.sfn.org).

From their website:

SfN provides professional development activities, information, and educational resources for neuroscientists at all stages of their careers, including undergraduates, graduates, and post doctoral fellows. The Society also provides programs to increase participation of scientists from a diversity of cultural and ethnic backgrounds.

As the largest organization of researchers studying the nervous system, the Society for Neuroscience remains committed to directing national efforts to increase the diversity among individuals participating in neuroscience research.

Currently, SfN, the American Psychological Association, the Texas Consortium, and Vanderbilt University maintain the fellowship programs listed below, which provide minority students in the neurosciences with professional opportunities to develop and enhance their career paths.

Minority Neuroscience Fellowship Program

The SfN Minority Neuroscience Fellowship Program is an extramural training program supported by NIMH and NINDS that is designed to increase the diversity of the pool of individuals participating in mental health-related neuroscience research and teaching programs. This program offers pre- and postdoctoral training stipends, travel, mentoring, SfN member resources, and enrichment programs.

Neuroscience Scholars Program

This three-year fellowship for underrepresented minorities is coordinated by the Society's Committee on Diversity in Neuroscience and provides travel assistance to the Society's annual meeting along with mentoring, enrichment opportunities, and SfN membership benefits. During their tenure, fellows will increase their number of professional contacts, develop a network of lifelong contacts, acquire the necessary skills to present their work, and be better equipped to advance their scientific careers.

APA Diversity Fellowship Program in Neuroscience

The goal of the MFP in Neuroscience is to increase the number of ethnic minorities who complete the doctorate in neuroscience and who conduct research in areas of importance to the NIMH. The APA does this by providing financial support and professional guidance to individuals pursuing doctoral degrees in neuroscience.

Meharry/Vanderbilt Alliance for Training in Neuroscience

This joint venture between Meharry Medical College and Vanderbilt University brings together a research-intensive institution and an institution that has a historic focus on training African American minorities. A training grant, jointly sponsored by NIMH, NINDS, and NIDA, supports predoctoral and postdoctoral trainees and provides the foundation for advancement and career development. The vision of the Meharry/Vanderbilt Alliance in Neuroscience includes programs that affect all aspects of neuroscience graduate education from summer undergraduate research internships to postgraduate training. These linked activities create a vibrant center for diversity training in neuroscience that will serve as a model for an innovative program which addresses the national need to optimize the development of the nation's human resource pool.

Texas Consortium in Behavioral Neuroscience

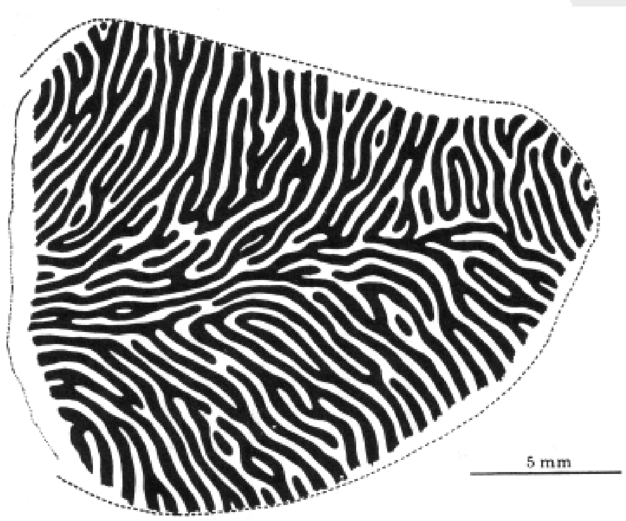
The Texas Consortium in Behavioral Neuroscience is the first regional training program designed to increase the number of behavioral neuroscientists from underrepresented populations. Ten pre-doctoral and five postdoctoral students will be intensively trained in conducting high quality research in behavioral neuroscience relevant to the missions of NIMH, NIDA, and NINDS. Hispanic and African American leaders with demonstrated knowledge of successful neuroscience training programs for underrepresented populations provide direction for this program.

Specialized Neuroscience Research Programs (SNRP)

The Specialized Neuroscience Research Programs was designed to assist in infrastructure development leading to well-established, state-of-the-art neuroscience research programs. This program also fosters innovative and effective partnerships and collaborations between minority institutions and established neuroscience laboratories, at federal and non-federal research institutions, and creates, supports, and maintains a stimulating academic and intellectual milieu to inspire and prepare students and fellows to pursue research centers in neuroscience. The SNRP program provides support to develop and sustain competitively funded neuroscience research projects and programs.

Committee on Women in Neuroscience

The **Committee on Women in Neuroscience (C-WIN)** is charged with implementing initiatives to increase the awareness of women's issues in the field, advance the interests of women in neuroscience, and to foster networking and mentoring opportunities for young women pursuing a career in neuroscience.



By the early 1970s, Hubel and Wiesel had described the single-cell activity of the mammalian visual cortex as well as its functional architecture.

The figure shows the arrangement of retino-cortical projections from the eyes (one in black, the other in white) to the primary visual cortex of juvenile primates. The image was produced by the injection of a radioactive substance to one of the pathways followed by the exposure of a sensitive film to the cortical tissue.