Neuroscience
Interdepartmental
Undergraduate Program

Undergraduate Handbook
http://krieger.jhu.edu/neuroscience
Last updated August 2015
NEUROSCIENCE AT JOHNS HOPKINS—AN OVERVIEW

What makes Hopkins the right choice for neuroscience?
Johns Hopkins is home to faculty and researchers who study the nervous system at many levels. Their presence allows for innovative courses that offer students a broad overview of the neuroscience field, as well as more advanced training and research opportunities in one of three focus areas: cognitive neuroscience, systems neuroscience and cellular and molecular neuroscience. The interdepartmental nature of the neuroscience major enables students to work with faculty from the Krieger School of Arts & Sciences, the Whiting School of Engineering, the School of Medicine, and the Krieger Mind/Brain Institute. The major offers two degree programs: a four-year B.S. based primarily on course work, and a five-year B.S./M.S. involving additional course work and a yearlong intensive research experience. The B.S./M.S. Program is currently open to only concurrent students. The Program does not currently offer a terminal M.S. Neuroscience Degree. For more information about the B.S./M.S. program, visit http://krieger.jhu.edu/neuroscience/ba_ms/index.html.

Work with faculty who are leaders in their fields
Faculty and undergraduates work side by side in state-of-the-art research labs. At Johns Hopkins, research is an essential tool of learning. It means asking questions, reading research literature and working collaboratively to discover the answers. From day one, students benefit from both the breadth and depth of expertise found at a large research university and the individual attention of faculty, academic and administrative advisors.

Tap into a wealth of resources
Courses for the neuroscience major are from a wide range of departments, including Biology, Biomedical Engineering, Biophysics, Cognitive Science, Psychological and Brain Sciences, and the School of Medicine. The strength of each of these departments/schools provides numerous opportunities for research and study.
FOCUS AREAS

The Neuroscience Program provides a broad overview of the field, as well as more advanced training in a student-selected specialized area. Degree requirements are essentially the same for each concentration, except that the specific upper level courses reflect the student’s focus area. Students choose one of the following three focus areas:

Cognitive Neuroscience (CG)
Cognitive neuroscience focuses on how cognitive functions, such as language or memory, are implemented by the brain. Drawing upon a variety of techniques for probing the working brain at cognitive and neural levels—including functional neuroimaging, analysis of cognitive impairments in brain-damaged patients, and electrophysiological techniques—research in cognitive neuroscience seeks to relate mental representations and computations to brain mechanisms and processes.

Systems Neuroscience (ST)
Systems neuroscience seeks to relate brain structure and functioning to behaviors and related physiological processes. Research in this area explores the description and analysis of neural circuits. This includes identifying the brain nuclei and interconnections making up a circuit, and characterizing the intrinsic and extrinsic factors that modulate the development and adult functioning of the circuit. Topics as diverse as learning and memory, communication, and motivated behaviors (e.g., reproduction, feeding, aggression) are explored from this perspective. Another large section of systems neuroscience involves the visual, auditory, and somatosensory systems as well as learning and adaptation of the motor system.

Cellular and Molecular Neuroscience (CM)
Cellular and molecular neuroscience focuses on the mechanisms by which information flows within and between cells in the nervous system, and the mechanisms that develop and maintain the cellular structure of the nervous system. Topics include the molecular basis of membrane permeability, action potentials, sensory transduction, synaptic transmission, neuronal modulation, mechanisms of drug action, and the molecular basis of disorders of the nervous system.

NEUROSCIENCE PROGRAM ADMINISTRATION

Neuroscience Program Committee (NPC)
The undergraduate Neuroscience Program is administered by a committee consisting of representatives from the principal participating departments and institutes.

Linda Gorman, Ph.D., Interim Chair, Director
Director of Undergraduate Studies, Neuroscience
Teaching Professor, Psychological & Brain Sciences, KSAS

Jay Baraban, Ph.D., Director of the B.S./M.S. Program
Professor, Neuroscience, SOM

Vikram Chib, Ph.D.
Assistant Professor, BME

Susan Courtney, Ph.D.
Professor and Chair, Psychological & Brain Sciences, KSAS

Samer Hattar, Ph.D.
Associate Professor, Biology, KSAS

Patricia Janak, Ph.D.
Professor, Psychological & Brain Sciences, KSAS

Hey-Kyoung Lee, Ph.D.
Associate Professor, Mind/Brain Institute, KSAS

Michael McCloskey, Ph.D.,
Professor, Cognitive Science, KSAS

Shreesh Mysore, Ph.D.
Assistant Professor, Psychological & Brain Sciences, KSAS

Brenda Rapp, Ph.D.
Professor, Cognitive Science, KSAS

Haiqing Zhao, Ph.D.
Associate Professor, Biology, KSAS
ADMINISTRATIVE STAFF
Our administrative offices are located in 434 Dunning Hall; 410-516-8878

Hope Fisher, Academic Program Administrator
Hope.Stein@jhu.edu 410-516-6196

Academic Program Coordinator
410-516-6436

Laurie Troyer, Administrative Secretary
Laurie.Troyer@jhu.edu 410-516-8878

FACULTY ADVISORS
At the end of freshman year each student is assigned a faculty advisor whose area of expertise corresponds to the student’s own focus area.

Cognitive Neuroscience

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<thead>
<tr>
<th>Professor Name</th>
<th>Location</th>
<th>Phone</th>
<th>Email</th>
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<tbody>
<tr>
<td>Dr. Hita Adwanikar</td>
<td>419 Dunning</td>
<td>516-6852</td>
<td><a href="mailto:hita@jhu.edu">hita@jhu.edu</a></td>
</tr>
<tr>
<td>Dr. Vikram Crib</td>
<td>707 N Broadway</td>
<td>443-923-2716</td>
<td><a href="mailto:vchib@jhu.edu">vchib@jhu.edu</a></td>
</tr>
<tr>
<td>Dr. Susan Courtney</td>
<td>227 Ames</td>
<td>516-8894</td>
<td><a href="mailto:courtney@jhu.edu">courtney@jhu.edu</a></td>
</tr>
<tr>
<td>Dr. Michael McCloskey</td>
<td>147C Krieger</td>
<td>516-5325</td>
<td><a href="mailto:mccloskey@cogsci.jhu.edu">mccloskey@cogsci.jhu.edu</a></td>
</tr>
<tr>
<td>Dr. Brenda Rapp</td>
<td>135 Krieger</td>
<td>516-5248</td>
<td><a href="mailto:rapp@cogsci.jhu.edu">rapp@cogsci.jhu.edu</a></td>
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Systems Neuroscience

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<th>Professor Name</th>
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<tbody>
<tr>
<td>Dr. Patricia Janak</td>
<td>246 Dunning</td>
<td>516-7981</td>
<td><a href="mailto:Patricia.janak@jhu.edu">Patricia.janak@jhu.edu</a></td>
</tr>
<tr>
<td>Dr. Sheesh Mysore</td>
<td>222 Ames</td>
<td>516-6706</td>
<td><a href="mailto:Shreesh.Mysore@jhu.edu">Shreesh.Mysore@jhu.edu</a></td>
</tr>
<tr>
<td>Dr. Linda Gorman</td>
<td>434 Dunning</td>
<td>516-3868</td>
<td><a href="mailto:lgorman1@jhu.edu">lgorman1@jhu.edu</a></td>
</tr>
<tr>
<td>Dr. Jason Trageser</td>
<td>418 Dunning Hall</td>
<td>516-8877</td>
<td><a href="mailto:jtrages3@jhu.edu">jtrages3@jhu.edu</a></td>
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Cellular and Molecular Neuroscience

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<tbody>
<tr>
<td>Dr. Samer Hattar</td>
<td>226 Mudd</td>
<td>516-4231</td>
<td><a href="mailto:shattar@jhu.edu">shattar@jhu.edu</a></td>
</tr>
<tr>
<td>Dr. Hey-Kyoung Lee</td>
<td>348 Dunning</td>
<td>516-5712</td>
<td><a href="mailto:heykyoungle@jhu.edu">heykyoungle@jhu.edu</a></td>
</tr>
<tr>
<td>Dr. Haiqing Zhao</td>
<td>224A Mudd</td>
<td>516-7391</td>
<td><a href="mailto:hzhao@jhu.edu">hzhao@jhu.edu</a></td>
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MAJOR REQUIREMENTS
The Neuroscience Major consists of 4 core courses, 4 upper level courses (3 of which must be in one focus area—Cognitive, Systems or Cellular and Molecular), the foundational Math and Science courses; General Biology I & II with labs or Biochemistry and Cell Biology with labs, Organic Chemistry I (for students applying to medical school Organic Chemistry II & lab), Physics I & II with labs, Calculus I & II, Probability and Statistics for the Life Sciences course (550.211 or students may substitute 550.111 AND 550.112 OR 550.311) and 6 credits of neuroscience related Research concurrent with Scientific Communication.
SAMPLE B.S. PROGRAM
The following course sequence is only a suggestion and is based on the assumption that there are no AP/IB/TR credits applied. Please consult with your faculty advisor when selecting and registering for classes.

Freshman Year: Fall
030.101 Intro. Chemistry I
030.105 Chemistry Lab
110.106 Calculus I
020.151 General Biology I
060.XXX Writing Course OR
200.141 Foundations of Brain, Behavior & Cognition OR
050.105 Intro to Cog. Neuropsychology OR 080.105 Intro to Neuroscience

Freshman Year: Spring
030.102 Chemistry II
030.106 Chemistry Lab II
110.107 Calculus II
020.152 General Biology II
020.154 General Biology Lab II
060.XXX Writing Course OR
200.141 Foundations of Brain, Behavior OR 080.203 Cognitive Neuroscience (BBC suggested)

Sophomore Year: Fall
080.305 Nervous System I*
030.205 Organic Chemistry I
060.XXX Writing Course
Elective in (H) or (S)

Sophomore Year: Spring
080.306 Nervous System II
030.206 Org. Chemistry II**
030.225 Organic Chemistry Lab**
550.211 Prob. Stats for Life Sciences

Junior Year: Fall
171.103 General Physics I
173.111 General Physics Lab I
Elective in (H) or (S)
080.570 Research in NS****
020.305 Biochemistry**
020.315 Biochemistry Lab***

Junior Year: Spring
171.104 General Physics II
173.112 General Physics Lab II
080.551 Research in NS****
080.203 Cognitive Neuroscience
Upper Level Neuroscience Course OR
020.306 Cell Biology***
020.316 Cell Biology Lab***

Senior Year: Fall
080.561 Research in Neuroscience
Or Medical Tutorial
Upper Level Neuroscience Course
Upper Level Neuroscience Course
080.250 Neuroscience Lab*****
Elective in (H) or (S)

Senior Year: Spring
080.564 Research in Neuroscience
Or Medical Tutorial
Upper Level Neuroscience Course
050.211 Statistics
Elective in (H) or (S)
Elective in (H) or (S)

*NSI & NSII can be taken sophomore or junior year.
**For students interested in applying to medical school
***Students with a Cellular and Molecular Concentration will substitute Biochem/Cell Biology for Gen Bio I & II. Biochemistry is recommended for students interested in applying to medical school.
****Research in Neuroscience can be taken at any time. (6 credits are needed for the major)
*****Neuroscience Lab can be taken any time after completing

CORE COURSES

080.203 Cognitive Neuroscience
B. Rapp/S. Park
(No listed as 050.203 Cognitive Neuroscience: Exploring the Living Brain)

This course surveys theory and research concerning how mental processes are carried out by the human brain. Currently, a wide range of methods for probing the functioning brain is yielding insights into the nature of the relation between mental and neural events. Emphasis will be placed on developing an understanding of both the physiological basis of the techniques and the issues involved in relating measures of brain activity to cognitive functioning. Methods surveyed include electrophysiological re-cording techniques such as EEG, VEP, ERP, single/multiple unit recording, and MEG; functional imaging techniques such as PET and fMRI; methods that involve lessening or disrupting neural activity such as WADA, cortical stimulation, animal lesion studies, and the study of brain-damaged individuals. (3 credits)

080.305 The Nervous System I: Cells, Molecules and Systems
S. Hendry/H. Zhao

A half century’s research in neuroscience has brought the field to a point where the cell and molecular biology of neurons allows us to understand how the nervous system is put together and how it functions. The Nervous System I and II introduce the fields of cellular, molecular, and systems neuroscience by integrating the knowledge that each field contributes to our understanding.

In The Nervous System I, the structural and electrical properties of neurons will be explored in the context of how the auditory system of birds and mammals is organized and how it works to detect sounds, locate their sources, appreciate their content, and understand their meaning. In addition, the cellular and molecular biology of synapses will be examined in parallel with the anatomy and physiology of the vertebrate visual system as a way to explain contrast detection, color perception, visual guidance of movement, and face recognition. (3 credits)
080.306 The Nervous System II: Cells, Molecules and Systems
S. Hendry/H. Zhao
The Nervous System II uses the functional organization of the somatosensory system as a means to examine mechanisms of neural development. Generation and maturation of neurons, guidance of axons, formation of synapses, and the regressive events that shape the adult nervous system will be examined. At the same time we will explore the structure and function of brain regions that allow us to feel pain and temperature, detect vibration, recognize shape, and perceive where we are in space. Finally, the single-neuron events that lead to adaptive changes in function will be explored in the context of central nervous system control of movement and of the higher order functions of speech and memory.

These two semesters are designed to be creatively redundant. Essential concepts that bind together the nervous system will be stressed repeatedly. The goal here is for all students to leave the year’s study with their own point of view of how the nervous system works.

Prerequisites: 080.305 The Nervous System I (3 credits)

080.250 Neuroscience Lab: A Practical Approach
L. Gorman/J. Trageser
This course will give students the hands-on experience of the interdisciplinary nature of neuroscience. Students will use anatomical and neurophysiological techniques to understand the basic underlying principles of neuroscience.

Prerequisites: 200.141 Foundations of Brain, Behavior and Cognition (BBC) OR 080.305 AND 080.306 (3 credits)

Upper-level Courses

Twelve credits from Neuroscience or neuroscience related 300-level or above. Each semester, students should check the program’s website http://krieger.jhu.edu/neuroscience/courses/index.html for a complete list of upper-level courses that they may select from to satisfy their concentration requirements.

Science & Math Courses

General Biology I & II with labs or Biochemistry and Cell Biology with labs (for Cellular & Molecular Concentration)
General Chemistry I & II with labs
Organic Chemistry I (for students applying to medical school Organic Chemistry II & lab)
Physics I & II with labs
Calculus I & II
Probability and Statistics for the Life Sciences

NEUROSCIENCE RESEARCH

The Neuroscience major requires that students complete at least six credit hours of research. Therefore, students are urged to take advantage of the many opportunities to participate in research projects carried out at any of the Johns Hopkins campuses. That agreement specifies the student’s work in terms of research; the length of time the student will spend working; times when the student is expected to be present; student contribution to the lab/research supervisor (e.g. a certain amount of time, a paper, the results of an experiment, etc.); and lab contribution (e.g. supervision, readings, guidance in pursuing the project, etc.).

When attempting to identify potential research (lab) supervisors, students should talk to their faculty advisor or see Dr. Linda Gorman, who is in charge of overseeing all neuroscience research performed at the School of Medicine or under the direction of a part-time faculty member at the Homewood campus. Students should also consult departmental web pages (http://krieger.jhu.edu/neuroscience/) and other online information. The Neuroscience site lists many of the researchers on all Johns Hopkins campuses. The research interests of faculty members in each department are usually listed, along with selected bibliographies of published works. Students are also encouraged to do a Pub Med search for more recent papers and to find review papers, which are usually easier to understand.

Students are encouraged to read a brief selection of the articles that have been published by the potential supervisors, to ensure that the nature of the research being conducted is understood and can be intelligently discussed by the student. It is best to contact faculty via e-mail to discuss possible research opportunities. Students should introduce themselves as undergraduate neuroscience majors and explain their interest in working for credit in the faculty member’s laboratory. Supervised research is initiated by a verbal agreement between the student and the faculty member/lab supervisor with whom s/he wishes to work. Students are urged to make these arrangements well before the end of the semester prior to which they wish to begin work.
If the research supervisor is not a full-time faculty member on the Homewood campus, students must register under Dr. Linda Gorman as their full-time Homewood faculty sponsor. Students working in labs not located on the Homewood campus must also register under Dr. Gorman, who will determine whether the work is relevant to the Neuroscience major and will agree to serve as the student’s sponsor. Students must first sign-up for Scientific Communication (080.500), which is a co-requisite, before registering for Neuroscience Research (080.5XX).

Scientific Communication: Neuroscience (080.500), which is a 0.5 credit course. The Scientific Communication section is taken concurrently with Neuroscience Research and consists of a two hour research orientation session held at the beginning of the semester, and a two hour exit session held at the end of the semester. Each section meets on different dates and times and these dates and times will change each semester. See the “special notes” listing in the course description to sign up for the section that fits your schedule.

The number of credits earned for supervised research ranges from one to three, and is determined at the end of the semester. Each 40 hours of work is worth one credit. Because the semester is about 13 weeks long, each credit requires about three hours per week on average. If the student works regularly during the semester, then three hours a week will yield one credit, six hours will yield two credits, and nine hours will yield three credits. Students may, of course, work more some days and weeks than others. The School of Arts & Sciences stipulates that students may earn no more than three credits of research, independent study, or internship per semester, and no more than six credits per academic year (fall/intersession/spring/summer).

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<th>Year of Study</th>
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**GENERAL UNIVERSITY DISTRIBUTION REQUIREMENTS**

In addition to the specific degree requirements, students in the Neuroscience Program must fulfill other Arts & Sciences requirements for graduation. The relevant requirements are:

- 120 total credits needed to graduate (so they do not need to overload in one semester)
- 12 W credits (writing intensive courses) - 6 credits needs to be from the English or Writing Seminars areas if the student is pre-me
- No more than 4 Carey Business School and School of Education courses.

The distribution credits have recently changed. For students graduating in 2016 and 2017 they are:

- 18 H and/or S credits (humanities or social science) & 12 additional H, S, Q and/or E (quantitative or engineering) - Q & E are covered by our major requirements

For new sophomores, the distribution requirements are:

- 9 credits of Humanities (H)
- 9 credits of Social Science (S)
- 9 credits of Natural Science, Quantitive or Engineering (N, Q, E)

**Math/Science Sequence**

Certain courses, such as the required Physics and Calculus, are counted toward both the major and the distribution requirements (E or Q). Organic Chemistry II and Organic Chemistry Lab are optional for the major but required by medical schools.

**Writing Requirement**

Some upper-level electives that have the “W” designation can be double-counted as well; students should complete a minimum of two classes in English Writing/Literature if considering applying to medical school. http://web.jhu.edu/prepro/

**Foreign Language**

Students who take the first semester of an foreign language must complete the second semester course as well or lose the credit from the first term.
NEUROSCIENCE HONORS

Conferred upon graduating seniors who meet the following criteria:

- Cumulative GPA of at least 3.5
- Major GPA of at least 3.5
- Presentation of research findings at the JHU Undergraduate Research Day OR Undergraduate Research Symposium
- A letter of recommendation from the research mentor attesting to the student’s significant contribution to the research process

During the semester prior to graduation, students who meet the GPA requirements should submit verification of their research presentation, along with their research mentor’s letter of recommendation, to the Neuroscience Program Administrator in 434 Dunning Hall. Students who meet all the criteria will receive recognition, along with a special notation in the graduation program and on their transcripts.

The deadline dates to submit for honors:

December Graduates
Your materials need to be emailed to Hope Fisher by October 16th.

May Graduates
Your materials need to be emailed to Hope Fisher by February 26th.

You must have all materials to Hope Fisher, the Neuroscience Program Administrator, 4pm on the due date above. The Program Office will submit all of your paperwork to Academic Advising.

JHU NU RHO PSI
http://krieger.jhu.edu/neuroscience/nu-rho-psi/

JHU Nu Rho Psi is the undergraduate organization of the JHU Neuroscience Program. To become a member, students must either be a neuroscience major, work in a neuroscience related field, or have an interest in neuroscience. Each September, the NRP board holds a membership drive to encourage students to participate. Interested students complete an application form and pay a $60 life-time membership fee. To remain a member, one must clock in at minimum 20 hrs. per academic year in volunteer work; if a student fails to do so, her/his membership is discontinued unless the individual is willing to pay another membership fee of $60 for the following year. To accommodate the wide-ranging interests of the student population, NRP is divided into four areas:

Research
This area includes weekly seminars, an Undergraduate Research Symposium, and the Undergraduate Research Day (NEW).

Community Service
This area includes Brain Awareness Week, an effort to reach out to all majors on campus; Making Neuroscience Fun, community service educational outreach program; Kids Enjoying Exercise Now (KEEN) and HOP Kids: KKI, HOP Kids CC and CTY. Nu Rho Psi is also involved in other community projects.

Neuroscience Program Interface
This area includes such activities as participating as a Major Ambassador, participating in Open Houses, becoming a member of the Undergraduate Steering Committee, and organizing Neuroscience Program social events.

Public Relations
This area includes publicizing Nu Rho Psi events, maintaining alumni relations, working with the National Nu Rho Psi organization, and fundraising.

Visit the JHU Nu Rho Psi website:
http://krieger.jhu.edu/neuroscience/nu-rho-psi/
National Nu Rho Psi Honors

JHU Nu Rho Psi is the alpha Maryland chapter of the National Neuroscience Honor Society, Nu Rho Psi, and eligible members of JHU Nu Rho Psi, who meet the following criteria, are invited to join the National Nu Rho Psi Organization. National NRP Honors is offered to all active NRP students during their junior or senior year.

The following criteria need to be met to apply for National NRP:
* Major or minor in Neuroscience
* Completion of at least 3 semesters of college courses
* Completion of at least 9 semester hours of Neuroscience-related courses
* Undergraduate cumulative GPA of 3.2 and a minimum GPA of 3.5 in Neuroscience courses

Students that apply for National NRP will be honored and will receive a stole with the NRP inscription to signify their achievements and a National NRP Pin from the National NRP. There will also be an honors luncheon for all honors members at the end of the year. You will need to speak with Hope Fisher (hope.stein@jhu.edu) if you are interested in becoming a member. Memberships are all submitted together in the spring, but students graduating early are encouraged to submit their application early.

Visit JHU Nu Rho Psi at http://www.nurhopsi.org/drupal/

RESOURCES AT JOHNS HOPKINS UNIVERSITY

Neuroscience Website
Our website provides detailed and up-to-date information on the program. Please check regularly on such topics as: course information, major checklists, contact information, research, events, resources, jobs/internships, grants/funding opportunities.
http://krieger.jhu.edu/neuroscience/

B.S./M.S. Program
The principal aim of the B.S./M.S. program is to allow students with a serious interest and commitment to pursuing research in a future M.D., M.D./Ph.D. or Ph.D. program to spend a full-time research year in a laboratory. Students are expected to concentrate fully on their research, attend seminars and journal clubs, and write extensively about their research and related topics. The B.S./M.S. program is structured to provide students with a genuine, intensive research experience. Students applying to the B.S./M.S. should be finished with their Neuroscience Major requirements prior to beginning the program. Information about the program can be found at http://krieger.jhu.edu/neuroscience/bams-program, or by contacting the Neuroscience office, 434 Dunning.

Office of Pre-Professional Advising
The Office of Pre-Professional Advising provides guidance to students interested in pursuing graduate education in the fields of health care, law, or business. This includes individual advising, general information sessions, program presentations, and information about internship and volunteer opportunities. They also offer workshops on the application process, essay writing, and interview techniques. The office also coordinates the work of the Health Professions Recommendation Committees. Members of these committees act as interviewers and writers for Johns Hopkins University students/alumni in the application process. The office is located at 300 Garland Hall. The website is http://web.jhu.edu/prepro. It is highly recommended that students interested in these career paths contact the office of Pre-Professional Advising during their sophomore year and sign up to receive their emails.
Career Center
The Career Center provides students with information about the types of
careers that may be of interest to individuals, and the steps that should be taken
to prepare for those careers. It is highly recommended that students start
working with the Career Center as soon as the beginning of their junior year to
obtain more information on various options related to their major. The office
offers students a central location for information about graduate programs,
finding internships, test preparation, interview techniques, and learning about
professional schools. The Career Center website provides a place to schedule
an appointment with a counselor as well as a list of career links ranging from
geographic location to professional associations. The office is located on the
third floor of Garland Hall; the web address is www.jhu.edu/careers.

Academic Advising
Upon entering the university, freshmen are assigned an academic advisor by
the Office of Academic Advising. Only after students declare their major (as
rising sophomores) are they assigned to a faculty advisor within their
specialization major. Students are still required to meet with an academic
advisor to ensure that all university requirements are being fulfilled prior to the
students’ anticipated graduation. Students who switch to neuroscience are
highly advised to discuss their intentions with the Director of Undergraduate
Studies and have a “Change of Major” form completed by the Neuroscience
Office.

During the spring semester of their junior year, students are required to
complete the neuroscience major checklist and verify their progress with the
Neuroscience Program administrator and/or their respective faculty advisor,
and then submit the checklist to Academic Advising as requested.