Department/Program: Behavioral Neuroscience Program

Degree: BNS Bachelor of Arts (BA; 2005-2015) or BNS Bachelor of Science (BS; beginning fall 2015)

Assessment Coordinators: Janet Finlay / Mike Mana

Program Mission: Behavioral neuroscience (BNS) integrates elements of biology, chemistry, mathematics, physics, and psychology to study nervous system structure and function. The undergraduate BNS major at Western Washington University engages students in the study of nervous system structure and function at all levels, from molecular/cellular to systems/whole organism. In addition to required lecture and laboratory classes focused on neuroscience, majors complete supporting laboratory and lecture classes in biology, chemistry, mathematics, and physics. Flexibility in elective credits allows BNS majors and their academic advisors to create a curriculum that best meets the student’s future goals, whether those goals are employment in entry-level research and healthcare positions or postgraduate training in neuroscience, medicine, dentistry or related disciplines. In addition to coursework, BNS majors are encouraged to collaborate with faculty members on original research relevant to neuroscience.

Program Student Learning Outcomes

Content competencies: BNS graduates will possess knowledge of

1. Fundamental principles in molecular, cellular, and systems neuroscience and the neural basis of normal and abnormal behavior.
2. Foundational principles in the natural sciences, especially as they relate to understanding neuroscience.
3. The process and limitations of basic and applied biomedical research, especially as they relate to neuroscience.
4. Laboratory/diagnostic techniques and equipment common to the natural sciences, especially neuroscience.

Process competencies: BNS graduates will have developed the ability to

5. Think integratively and creatively about issues related to the natural sciences, especially neuroscience.
6. Think critically, in a scientific and quantitative manner, about issues related to the natural sciences, especially neuroscience.
7. Integrate principles from across the natural sciences, especially in the context of understanding neuroscience.
8. Communicate precisely and effectively, in written and spoken word, in general and in matters related to neuroscience.
9. Engage independently and collaboratively in the scientific process.
10. Recognize the applicability of an education in neuroscience to real world settings and their lives post-graduation.
**Student Learning Outcomes Assessed in 2014-15:**

<table>
<thead>
<tr>
<th>Assessment Measures</th>
<th>SLOs Assessed*</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Online quiz in 200-level BNS course (Psy 220) to assess foundational knowledge.</td>
<td>1,2</td>
<td>In the 2014-2015 academic year, faculty elected to initiate an assessment of how well BNS majors acquire foundational information in BNS (Items 1 and 2 from the 4-item list of content competencies presented above) from the first course in the BNS sequence (Psy 220). To accomplish this, faculty developed a Canvas-based quiz to assess student learning outcomes in 6 basic teaching objectives in BNS. A copy of this quiz appears in Appendix A and data generated by the first administration of this quiz in Spring 2015 appears in Appendix B.</td>
</tr>
<tr>
<td>Successful employment in a neuroscience-related field or acceptance to post-graduate education</td>
<td>1-10</td>
<td>Since inception of the BA in BNS in 2005, we have been recording the number of graduates employed in a neuroscience-related field or accepted to postgraduate education. These data have been collected via ongoing contact with graduates (i.e. through email and the BNS Facebook page). Results appear in Appendix C.</td>
</tr>
<tr>
<td>Senior exit survey</td>
<td>1-10</td>
<td>Since Spring 2012, we have asking graduates to self-report satisfaction with their supporting, basic, and breadth courses as well as their overall knowledge in key areas of BNS. Our survey response rate is currently ~33%. A copy of the current survey is attached as Appendix D. Survey results are summarized and attached as Appendix E.</td>
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</tbody>
</table>

*One or two SLOs will be assessed each year. At least one SLO assessed must be a direct assessment measure of student performance (i.e. capstone coursework; senior level exam, paper, presentation or project; portfolio of student work; licensing or professional exam; reports from employers, internship supervisors etc.). Indirect assessment activities measure outcomes via self-report or survey.

**Changes based on assessment findings:**

The BNS major is currently in a transition phase with the BA terminating in Summer 2015 and a new BS being introduced in Fall 2015. Due to this transition, combined with the fact that this is the first year of an independent formal assessment of the BNS major, substantive changes to the BS in BNS will not occur in the upcoming year. This inaugural formal assessment has served to reinforce the need for minor curricular adjustments that had been revealed as opportunities for enhancement based on our ongoing informal assessments. One example, has been the need to enhance opportunities for students to engage in additional coursework in neurodevelopment (as supported by the data in Appendix E, Figure 7). Turnover in faculty positions, resulted in a temporary void in this area which has recently been filled by a new faculty member who will be reviving a seminar course in neurodevelopment. A major objective for the upcoming academic year will be to continue to compile outcomes data as described in Appendices A-E.

For the 2014-2015 academic year, BNS-affiliated faculty elected to focus the year’s assessment efforts on how well our students acquire foundational information in BNS (Items 1 and 2 from the 4-item list of Content Competencies presented above) from PSY 220: Behavioral Neuroscience, the first course in the neuroscience sequence. To accomplish this, we developed a Canvas-based quiz to assess student learning outcomes in 6 basic teaching objectives in BNS. These included teaching objectives related to:

1) Functional gross and cellular anatomy
2) Electrical and chemical signaling
3) Common methods in BNS
4) Genome and envirome: development of brain and behavior
5) Basic brain/behavior relationships
6) Neuroplasticity

Faculty were asked to submit representative questions from existing PSY 220 exams relevant to each of these foundational teaching objectives in BNS. Over the course of several subsequent meetings, faculty reviewed these questions and developed a test bank that could be used to assess knowledge in each of the 6 foundational teaching objectives. Faculty teaching PSY 220 in the Spring 2015 quarter were asked to choose several questions for each of the 6 foundational teaching objectives to develop a 15-20 question quiz that would be delivered to all PSY 220 students during the last week of classes.

Faculty chose Canvas as the vehicle for administering this assessment for its ease of use, to save class time for lecture and discussion, and to take advantage of some of the analyses that Canvas offers regarding the usefulness of the questions. Canvas was instructed to randomize the order of presentation for quiz questions and to allow 90 sec for each question; these precautions were taken to increase the likelihood that students took the exam individually and without the aid of text books or notes from class. Upon completion of the quiz, students received a bonus of up to 1% towards their final grade in PSY 220…the actual amount of the bonus was scaled to reflect how well students did on the quiz. Faculty chose to offer a scaled bonus towards each student’s final grade in the hopes that this would encourage each student to take the exam as seriously as possible.

The assessment quiz created and administered by faculty teaching PSY 220 in Spring 2015 is presented below. For clarity of presentation, the questions are organized according to each of the six teaching objective categories defined above. The assessment quiz is followed by Appendix B, in which the results of the quiz are presented and discussed.
Teaching Objective 1. The functional anatomy of the nervous system, at a gross and a cellular level.

Primary motor cortex is located in the ____________ lobe; it controls the movements on the ____________ side of the body.
   a. parietal; opposite
   b. frontal; same
   c. parietal; same
   d. frontal; opposite
   e. temporal; opposite

The dorsal and ventral roots of a given segment of spinal cord come together to form a ____________.
   a. nerve
   b. neuron
   c. tract
   d. pathway
   e. ganglion

The space between adjacent myelin sheaths, where the axon is exposed and action potentials are regenerated, is called a/an:
   a. terminal button.
   b. axon hillock.
   c. axon spine.
   d. Golgi apparatus.
   e. node of Ranvier.

The release of hormones from the pituitary gland is controlled by a region of the brain called the:
   a. hypothalamus.
   b. thalamus.
   c. hippocampus.
   d. pineal body.
   e. optic chiasm.

Teaching Objective 2. The electrical and chemical signaling properties that neurons use to encode information and communicate.

Metabotropic neurotransmitter receptors often change the function of a neuron by producing intracellular signals called______.
   a. first messengers
   b. neurotransmitters
   c. calcium
   d. second messengers
   e. sodium and calcium
In addition to its reinforcing properties, cocaine blocks voltage-gated sodium (Na⁺) channels. Given this, you would expect that this drug would prevent a neuron from generating ________________.
   a. a resting membrane potential.
   b. an action potential.
   c. an excitatory postsynaptic potential.
   d. an inhibitory postsynaptic potential.
   e. a resting membrane potential.

An action potential can normally travel only in one direction along an axon because______________.
   a. the ions can only flow in one direction
   b. refractory periods make it impossible for an action potential to travel in the direction that they came from
   c. of the Na+/K+ pump
   d. myelin ensures that the action potential moves in 1 direction only
   e. of a combination of electrical forces and a concentration gradient

Reuptake by transport proteins or breakdown by enzymes are 2 mechanisms of neurotransmitter ______.
   a. activation
   b. inactivation
   c. exocytosis
   d. endocytosis
   e. recycling

Teaching Objective 3. Common methods used by neuroscientists to study brain-behavior relations.

The Morris water maze is most commonly used to assess ________________ in rodents.
   a. procedural memory
   b. implicit memory
   c. recognition memory
   d. spatial memory
   e. motor ability

An fMRI scan is most often used to inform scientists about the ______ of different regions of the brain.
   a. structure
   b. shape
   c. activation
   d. thickness
   e. volume
Teaching Objective 4. The development of brain and behavior.

Genetically identical mice can demonstrate significant differences in brain development and behavior, depending on the care that they receive from their mothers. Some of these changes can then be passed on to their offspring. The study of the way that environmental factors or experience produce changes in gene expression that can be passed on to future generations is called:

a. genetics.
b. genome.
c. **epigenetics.**
d. enviromics.
e. nativism.

The birth of new neurons in the human brain begins within 3 weeks of conception and continues until:

a. until the 3\(^{rd}\) trimester.
b. birth.
c. until adolescence

d. until around the 21\(^{st}\) birthday

e. **across a person's entire lifespan.**

The nervous system is not fully develop in humans until about _____ of age.

a. 1-2  
b. 5-6  
c. 13-15  
d. **20-25**  
e. 65-70

A __________ is a piece of DNA that contains the instructions for creating a single protein.

a. **gene**  
b. chromosome  
c. nucleus  
d. ribosome  
e. mitochondria
Teaching Objective 5. Brain/behavior relationships

We would expect drugs that are useful in the treatment of schizophrenia to also reduce a person’s ability to perceive ________________, which depends on the activity of dopamine receptors in the brain.

a. reward  
b. light  
c. pain  
d. music  
e. touch

Your roommate’s grandmother develops symptoms including tremor in her hands and an inability to initiate movements. It is possible that she has degeneration of dopaminergic neuronal cell bodies located in her ____________.

a. reticular formation  
b. caudate nucleus  
c. nucleus accumbens  
d. substantia nigra  
e. thalamus

Damage to the _________________ stream of visual information cause visual-form agnosia, in which objects can be seen (e.g., I see a face) but not specifically identified (e.g., can’t recognize an image of your mother).

a. parietal  
b. dorsal  
c. ventral  
d. frontal  
e. occipital

You have been instructed to imagine performing a sequence of finger movements, without actually performing them. As you are thinking about this sequence of movements, you would expect to see an increase in neural activity/cerebral blood flow increases in the:

a. primary motor cortex.  
b. temporal cortex.  
c. premotor cortex.  
d. cingulate cortex.  
e. hypothalamus.
Teaching Objective 6. The neural changes that underlie “neuroplasticity”

Post-synaptic NMDA receptors detect the coincidence of pre-synaptic __________ release and post-synaptic membrane depolarization caused by activation of _______________ receptors.

a. glutamate; AMPA  
b. GABA; AMPA  
c. glutamate; dopamine  
d. dopamine; glutamate  
e. GABA; glutamate

We use __________ memory to consciously recall facts, but rely on our __________ memory to remember learned skills and habits.

a. implicit, explicit.  
b. long-term, short-term.  
c. emotional, short-term.  
d. explicit, implicit.  
e. emotional, implicit.
Appendix B. Results of the BNS assessment quiz for foundational teaching objectives for Spring 2015 sections of Psy 220: Behavioral Neuroscience. A total of 9 students were identified with an interest in the BNS major from the Spring 2015 quarter.

Figure 1. Preliminary data indicate that student competency varied across the 6 identified foundational areas. Students struggled most with questions related to the electrochemical signaling properties of cells in the nervous system, and were most competent with questions related to the methods used by behavioral neuroscientists.
Appendix C. Employment and postgraduate education outcomes of BNS graduates have been tracked through personal contact with alumni through mechanisms such as email and the BNS Facebook page. Outcomes are represented in Figure 2, based on reporting of 81 of 107 graduates since the program inception in 2005.

Figure 2. Employment and postgraduate education outcomes of BA in BNS graduates since creation of the major in Fall 2005. Outcomes data have been collected through ongoing communication with graduates via email and the BNS Facebook page. Of the 107 students graduating with a BA in BNS to date, outcomes data are available for 81 students.
The BNS Program began administering an exit survey in Spring 2012. A copy of the survey appears below. Of the 60 students graduating with a BA in BNS since Spring 2012, we have completed surveys from 20 students (a return rate of ~33%). Data obtained from the exit survey are presented in Appendix E, below.

### Behavioral Neuroscience Program Exit Survey

#### Did you find the content of the following courses to be consistent with your expectations for a supporting course:

<table>
<thead>
<tr>
<th>Course</th>
<th>Not at all</th>
<th>Somewhat</th>
<th>Moderately</th>
<th>Quite a bit</th>
<th>Very much</th>
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<td>Chem 121 General Chemistry I</td>
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</table>

#### Did you find the content of the following courses to be consistent with your expectations for a basic requirement:

<table>
<thead>
<tr>
<th>Course</th>
<th>Not at all</th>
<th>Somewhat</th>
<th>Moderately</th>
<th>Quite a bit</th>
<th>Very much</th>
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<td>Bio 204 Evol, Ecology &amp; Biodiversity</td>
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#### Did you find the content of the following courses to be consistent with your expectations for a breadth requirement:

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<th>Course</th>
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<th>Quite a bit</th>
<th>Very much</th>
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#### Did you find the subject matter of the following courses relevant to your educational goals:

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<th>Course</th>
<th>Not at all</th>
<th>Somewhat</th>
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#### How would you rate your education in the following areas:

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<th>Area</th>
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<th>Very Good</th>
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Please indicate the quarter and year that you graduated:

<table>
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<th>Year</th>
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<td>Fall</td>
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<td>Spring</td>
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<td>Summer</td>
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Appendix E. The BNS Program began administering an exit survey in Spring 2012. A copy of the survey appears in Appendix D. Of the 60 students graduating with a BA in BNS since Spring 2012, we have completed surveys from 20 students (a return rate of ~33%). Data obtained from the exit survey are summarized in Figures 3-7 below.

**Figure 3.** Average student ratings (1=not at all, 2=somewhat, 3=moderately, 4=quite a bit, 5=very much) as to whether the content of supporting courses met students’ expectations for supporting course required of a BA in BNS, ranged from moderately (~3) to quite (~4) consistent with expectations. Chemistry courses were all rated as quite consistent with expectations and the math course was rated as moderately consistent with expectations. The number of respondents is indicated within each bar; numbers <20 are due to students having completed these courses prior to admission to WWU and students having substituted Chem 351/352 for Chem 251.

**Figure 4.** Average student ratings (1=not at all, 2=somewhat, 3=moderately, 4=quite a bit, 5=very much) of whether the content of basic required courses met students’ expectations for basic requirements of a BA in BNS, ranged from moderately (~3) to very (~5) consistent with expectations. Two courses identified as moderately consistent (~3) with students’ expectations were Biology 204 which focuses on an introduction to evolution, ecology, and biodiversity and Psychology 301 which is an overview of research methods in psychology. The course that students identified as being very consistent (~5) with their expectations for basic requirements of a BA in BNS was Psychology 220 which focuses on behavioral neuroscience.
Figure 5. Average student ratings (1=not at all, 2=somewhat, 3=moderately, 4=quite a bit, 5=very much) of whether the content of breadth required courses met students’ expectations for breadth requirements of a BA in BNS, ranged from somewhat (~2) to very (~5) consistent with expectations. In summary, 7 courses were rated as highly consistent with expectations for a breadth requirement, 3 courses were rated as moderately consistent, and 1 course was rated as somewhat consistent.

Figure 6. Average student ratings (1=not at all, 2=somewhat, 3=moderately, 4=quite a bit, 5=very much) of the relevance of breadth required courses to their educational goals ranged from somewhat (~2) to very (~5) consistent with students’ expectations. In summary, 7 breadth requirements were rated as highly relevant to the students’ educational goals, 3 courses were rated as moderately relevant, and 1 course was rated as somewhat relevant.
Figure 7. Average student ratings (1=unsatisfactory, 2=fair, 3=good, 4=very good, 5=excellent) of their overall education in core areas of BNS. Areas identified as the weakest and strongest, respectively, were neurodevelopment (~3) and signal transduction (~4). As noted above, turnover in faculty positions, resulted in a temporary void in the area of neurodevelopment. This void has recently been filled by a new faculty member who will be reviving a seminar course in neurodevelopment. Revival of this seminar should greatly enhance opportunities for students to develop expertise in this important area.