

# Fundamentals of Neuroscience (PSYCH 2F03)

Term 1, 2009

## Description

Following an introduction to the organization of the nervous system, this course describes the electrical and chemical properties of the fundamental unit of the nervous system, the neuron, and how neurons communicate with one another. It then surveys the physiology and functional anatomy of touch, vision, audition, vestibular sensation, movement, and memory. Both the normal functioning and particular pathologies of these systems will be discussed. The course also surveys important neuroscience investigative techniques.

This course meets once per week in the evenings (Mondays, 7:00 - 10:00 PM, in HSC / 1A1). An optional tutorial is held each week (Mondays, 6:00 - 6:50 PM, in TSH / B128). Students are encouraged to attend the tutorials in order to clarify their understanding of the course material.

Lectures will be interspersed with critical thinking activities called Brain Teasers, which collectively account for 15% of the course grade. In addition, students will be graded on weekly homework assignments (15% of the course grade), a midterm test (30% of the course grade), and one comprehensive final exam (40% of the course grade).

## Objectives

Upon completion of this course, the student will understand the:

- structure and subdivisions of the nervous system, and fundamental organizing principles of functional neuroanatomy, such as contralaterality, topography, and bilateral symmetry.
- anatomical and functional scales of the nervous system, such as the numbers and sizes of neurons, the density of sensory receptors, etc., and how to generate order-of-magnitude estimates using back-of-the-envelope calculation to explore these scales.
- special electrical properties of the fundamental unit of the nervous system, the neuron, and how these properties result in electrical impulse formation and conduction
- electrochemical events that occur at the site of inter-neuronal communication, the synapse.
- the modification of the synaptic strength (synaptic plasticity) by the processes of habituation, sensitization, and long-term potentiation
- fundamental neurophysiological processes of the sensory systems, such as transduction and adaptation, and the relevance of these processes to perception.
- functional neuroanatomy of the somatosensory system, including pathways for light touch and pain/temperature sensation.
- functional neuroanatomy and neurophysiology of the retina, including the biochemistry of phototransduction and adaptation in the rod and cone systems, and how these contribute to various attributes of human vision.
- functional neuroanatomy of the central visual pathways, how these pathways are thought to contribute to the perception of form, color, and motion, and the functional deficits that arise from injuries to and abnormal development of these pathways.
- functional neuroanatomy of the auditory system, including mechanisms of acoustoelectric transduction and azimuthal sound localization.
- functional neuroanatomy of the vestibular system and the etiology of common vestibular disorders

- functional neuroanatomy of lower and upper motor control circuits, and the etiology of common motor pathologies.
- neuroanatomy of language comprehension and production, evidence for language lateralization revealed by split-brain and other patients, and common language deficits (aphasias) that result from stroke.
- brain areas involved in memory acquisition and storage, and mechanisms of synaptic plasticity suspected to underlie learning and memory.
- most important histological, electrophysiological, and imaging techniques used to reveal the anatomy and functioning of the nervous system.

### **Materials**

Required Textbook: Purves, D. et al. (2007) *Neuroscience, 4th Ed.* Sunderland, MA: Sinauer

Required Calculator: The McMaster Standard Calculator (Casio FX-991) is permitted in exams and for in-class Brain Teaser exercises. This calculator is available at the McMaster Bookstore. No other calculator is permitted.

Textbooks for optional reading on course reserve (Mills Library):

Neuroscience : Exploring the Brain / Mark F. Bear, Barry W. Connors, Michael A. Paradiso.  
 Principles of Neural Science / edited by Eric R. Kandel, James H. Schwartz, Thomas M. Jessell.  
 From Neuron to Brain / John Nicholls et al.

### **Schedule**

The table below shows weekly topics, assigned readings, and homework assignments. Students are encouraged to read the assigned textbook chapters prior to each class period. The day before each class, the instructor will link the topic description to pdf files containing the majority of the slides to be shown in lecture.

<b>Week</b>	<b>Date</b>	<b>Topic</b>	<b>Homework</b>	<b>Reading</b>
1	Sept. 14	The Nervous System and the Neuron at Rest	--	Chs. 1, 2, 26 (p. 664-666);
2	Sept. 21	The Action Potential		Chs. 3, 4
3	Sept. 28	Synaptic Transmission		Chs. 5, 6
4	Oct. 5	Somatosensory Systems		Chs. 9, 10
5	Oct. 19	Eye & Retina		Ch. 11
6	Oct. 26	<b>Midterm Test</b>	--	
7	Nov. 2	Central Vision	--	Chs. 12, 24 (p. 616-629)

8	Nov. 9	Auditory & Vestibular Systems		Chs. 13, 14
9	Nov. 16	Motor Systems		Chs. 16, 17
10	Nov. 23	Synaptic Plasticity & Memory		Chs. 8, 31
11	Nov. 30	Neuroscience Techniques		p. 16-21, 42, 63, 163-4, 297, 715-17
		<b>Final Exam (comprehensive)</b>		

### **Evaluation**

Any material covered in class (lectures and brain teasers) and in homework assignments may appear on tests. Questions based on this material will account for at least 90% of each test's points. In addition, each test will include several questions drawn from material in the assigned textbook chapters that is not covered in class or homework. These questions will be worth no more than 10% of the test's points.

The student's course percentage score is a weighted average of the following five items:

<b>Item</b>	<b>Weight</b>
Homework Assignments	15%
Brain Teaser Exercises	15%
Midterm Test	30%
Comprehensive Final Exam	40%

Note: The course schedule and/or evaluation scheme may be modified during the semester, at the discretion of the instructor. Modifications will be made directly to the tables above and announced in class.

### Homework

- Homework assignments will be linked from the schedule table (above).
- Each homework assignment is due at the beginning of the corresponding class period. Late homework returns will not be accepted.
- Students are encouraged to type their answers whenever possible.
- Students may collaborate on homework assignments, if they wish, and collaborating students may choose to submit a single, group answer (maximum group size: three students). If this is done, then the name (typed) and signature of each contributing student must appear on the homework submission. Each student in the group will receive the same mark on that homework assignment. Students may change groups throughout the semester, or choose to submit their assignments individually.
- The relative point value of each question will be indicated on the homework assignment. The score for the entire homework assignment will always be reported on a 0-to-100% scale. For example, suppose an assignment has three questions, worth 10, 10, and 20 points. If a student

earns half credit on the first question, full credit on the second, and half credit on the third, then the student's score will be  $5 + 10 + 10 = 25$ , and the score will be reported as 62.5% (i.e.,  $25 / 40$ ).

- The student's homework assignment scores are reported online in the Check Marks system.
- At the end of the term, the student's lowest homework assignment score will be dropped. The average of the student's remaining homework assignment scores will then be calculated. This is the student's course homework score.

### Brain Teasers

- The brain teasers are in-class exercises designed to encourage critical thinking about neuroscience.
- Some of the Brain Teaser exercises will require a calculator; the student should bring the McMaster Standard calculator (Casio FX-991) to class.
- At least one brain teaser will be given in each class; the number of brain teasers will not usually exceed 3 per class period.
- Unless otherwise announced, each brain teaser exercise is worth 2 points. Each answer will receive either zero, half, or full-credit (0, 1, or 2 points).
- The student's brain teaser percentage score is the number of brain teaser points earned divided by the total number of points possible. For example, suppose that, in the first two weeks of the course, 4 brain teaser exercises are given, worth 2 points each. If a student earned 1, 2, 2, and 1 on these four brain teasers, respectively, then the student's brain teaser percentage score after two weeks will be 6 out of 8, or 75%.
- The student's brain teaser score is reported online in the Check Marks system.

### Tests and Exams

- The tests and exams contain multiple choice questions, as well as some questions requiring drawings and short written answers.
- A few questions will require calculations; the student should bring the McMaster standard calculator (Casio FX-991) to all exams. Only the McMaster standard calculator will be allowed.
- Any material covered in class (lectures and brain teasers) and in homework assignments may appear on tests. Questions based on this material will account for at least 90% of each test's points. In addition, each test will include several questions drawn from material in the assigned textbook chapters that is not covered in class or homework. These questions will be worth no more than 10% of the test's points.
- The final exam is comprehensive; it covers material from all course topics.
- Each test / exam is given a mark on a scale from 0 - 100%.
- The test marks are reported online in the Check Marks system.
- Create-a-Question: As an optional exercise, students are encouraged to try to generate an excellent test or exam question of their own. Please email the instructor your proposed question and answer. Questions that are carefully and articulately worded, and that probe student understanding of important concepts, will be considered for inclusion. The instructor will not inform you in advance of the test whether your question will be used, and will not provide feedback as to whether your answer is correct. If it is used on a test, your name will not be attached to the question, but a note will indicate that the question was student-generated. If it is used, your question may be edited and/or otherwise modified by the instructor.

### Extra Credit

Students have two ways to earn extra credit points in this course.

### 1) Help a Peer

- Students who provide an excellent, original answer on the Heads-Together forum, in response to another student's question regarding the course material, will earn an extra credit point.
- An excellent answer is one that correctly and articulately explains a conceptually challenging topic. The answer is original if no similar answer has yet been posted by another student.
- A student may earn a maximum of two Help-a-Peer extra credit percentage points per week.

### 2) Stump the Prof

- If, in class, a student raises an excellent question that the professor cannot answer, the professor may nominate the question for a Stump-The-Prof exercise.
- If the student who asked the question is able to find a documented answer to the question, and email the answer to the professor, the student will earn two extra credit points.
- A student may earn a maximum of two Stump-The-Prof extra credit points per week.

The student's extra credit points, if any, are reported online in the Check Marks system. Any extra credit points a student earns will be applied to the student's next test score. For example, a student with 3 extra credit points who scores 80% on a test will receive a test mark of 83%. Extra credit points are added to the test score up to a maximum of 100%. Any remaining points are then held over to the next test or exam. For example, if a student with 3 extra credit points scores 98% on the second midterm test, then the test score will be recorded as 100%, and the student's remaining extra credit point will be held over for the final exam.

### Course Percentage Score Calculation Formula

Each student's course percentage score will be calculated according to the formula:

$$\text{Course percentage score} = (\text{course homework score})(0.15) + (\text{course brain teaser score})(0.15) + (\text{midterm test score})(0.3) + (\text{final exam score})(0.4)$$

Students' letter grades will then be determined from their course percentage scores, as follows:

<b>Course Letter Grade</b>	<b>Course Percentage Score</b>
A+	90-100
A	85-89
A-	80-84
B+	77-79
B	73-76
B-	70-72

C+	67-69
C	63-66
C-	60-62
D+	57-59
D	53-56
D-	50-52
F	0-49

### **Missed Work**

If a student misses a class period, homework assignment, or test due to illness, personal circumstances, or late registration, it is the student's responsibility to notify the instructor and to submit appropriate documentation (e.g. physician's note documenting the student's illness) to the appropriate Faculty/Program office. A mark of zero will be entered for all missed Brain Teaser exercises, homework assignments, and tests until the Faculty/Program office verifies that the absence was for valid reasons.

If a student is unable to attend a class, but has been able to complete the homework assignment, then the student should submit the homework assignment by email, prior to the start of the class period, to the instructor. Late email submissions will not be accepted.

It is the student's responsibility to learn all material that the student has missed for any reason. This can be done by reading the posted lecture notes and assigned textbook chapters, by consulting with classmates, and by attending office hours and tutorial.

Tests missed due to illness or exceptional personal circumstances (as verified by the Faculty/Program office) may be made up, or the course grade may be redistributed such that more weight is applied to the final exam, at the discretion of the instructor. Make-up tests may differ in format and specific content from the original. For example, an original test that includes both multiple choice and written answers may be replaced by a make up test with written answers only, or with both written and oral components.

**The professor's preference for make-up tests is a two hour format: a one-hour written test followed immediately by a one-hour oral question / answer period in the professor's office.**

### **Academic Integrity**

As a student, you are expected to behave honestly and ethically at all times.

According to [McMaster University's Academic Integrity Policy](#), you are engaging in academic dishonesty if you "knowingly act or fail to act in a way that results or could result in unearned academic credit or advantage" (Academic Integrity Policy, p. 6).

This behaviour can result in serious consequences, such as a grade of zero on an assignment, loss of credit with a notation on the transcript that reads "Grade of F assigned for academic dishonesty," and/or suspension or expulsion from the university.

It is your responsibility to understand what constitutes academic dishonesty. The following are just three forms of academic dishonesty:

1. Plagiarism.

2. Improper collaboration.
3. Copying or using unauthorized aids in tests and examinations.

For more information on academic dishonesty and academic integrity, please read the Academic Integrity Policy: <http://www.mcmaster.ca/academicintegrity>

### **Online Privacy**

This course makes use of an online discussion forum. You should be aware that your chosen forum user name will be apparent to all other students in the course. The technology used in the course web pages is designed to keep private all additional information you provide (your name, email address, password, etc.). However, you should be aware that submission of such information on this or any other web site always carries some risk that the information will become public (for example, if the web site is "hacked" unlawfully). Your continuation in this course will be interpreted to indicate that you consent to the disclosure of your chosen user name in the online forum, and that you accept the risk of submitting the additional requested information. If you have any questions or concerns about the privacy of your information, please discuss these with the instructor.