Course 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 are discussed. The course also surveys important neuroscience investigative techniques. Students complete in-class critical thinking activities called Brain Teasers (worth 5% of the course grade), weekly homework assignments (15%), a two-hour midterm exam (30%), and a three-hour comprehensive final exam (50%). Several challenging extra credit opportunities are available for motivated students who want to push themselves further.

Meetings:
Class: Thursdays, 7:00 - 10:00 PM, MDCL 1105
Tutorial: Mondays, 4:30 - 5:20 PM, MDCL 1105

Instructor:
Dr. Daniel Goldreich
goldrd@mcmaster.ca
PC 413, ext. 28666

Course website:
http://psych.mcmaster.ca/2XB3/
The website password will be announced in the first lecture, Thursday Sept. 4.

Objectives
Upon successful completion of this course, students will understand the:

- structure and subdivisions of the nervous system.
- organizing principles of functional neuroanatomy, such as contralaterality, topography, and bilateral symmetry.
- scales of the nervous system, such as the numbers and sizes of neurons, and the density of sensory receptors.
- electrochemical properties of the fundamental unit of the nervous system, the neuron.
- mechanisms underlying electrical impulse (action potential) formation and conduction.
- electrochemical events that occur at the site of inter-neuronal communication, the synapse.
- fundamental neurophysiological processes of the sensory systems, such as transduction and adaptation.
- pathways for touch and pain/temperature sensation, from the skin to the somatosensory cortex.
• biochemistry of phototransduction and adaptation in photoreceptors, and neural retinal circuitry.
• central visual pathways, including the retino-geniculo-cortical pathway, and how these contribute to visual perception.
• anatomy of audition, and mechanisms of acousto-electric transduction and sound localization.
• mechanisms of vestibular transduction, central vestibular pathways, and the etiology of common vestibular disorders.
• lower and upper motor control circuits, and the etiology of common motor pathologies.
• brain areas involved in memory acquisition and storage, and associated memory pathologies.
• mechanisms of synaptic plasticity thought to underlie several forms of learning and memory.
• important histological, electrophysiological, and imaging techniques used to study the nervous system.

**Required Materials**


Required Calculator: McMaster standard calculator (Casio FX-991). This calculator is available at the McMaster University Store. Students should bring their McMaster standard calculator to each class, to the midterm exam, and to the final exam. No other calculator is permitted.

**Schedule**

The course meets once per week: Thursdays, 7:00 - 10:00 PM, in MDCL 1105. An optional tutorial is held Mondays, 4:30 - 5:20 PM, in MDCL 1105. The table below shows weekly lecture topics, assigned readings, and homework assignments. Students are encouraged to read the assigned textbook chapters prior to each class period. Prior to each class, the instructor will post the majority of the slides to be shown in lecture. Postings will be in three formats: PDF Small (a PDF file with 4 slides per page), PDF Large (a PDF file with each slide on its own page), and JPG (a self-extracting archive of jpg files, one per slide, convenient for loading individual slides into applications such as Keynote and Powerpoint).

<table>
<thead>
<tr>
<th>Week</th>
<th>Date</th>
<th>Topic</th>
<th>Homework Due</th>
<th>Reading</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sep. 4</td>
<td>Neurons &amp; Nervous Systems</td>
<td>--</td>
<td>Chs. 1, 2, Appendix (p. 717-728)</td>
</tr>
<tr>
<td>2</td>
<td>Sep. 11</td>
<td>The Action Potential</td>
<td>Assignment 1</td>
<td>Chs. 2, 3</td>
</tr>
<tr>
<td>3</td>
<td>Sep. 18</td>
<td>Action Potential Conduction &amp; Synaptic Transmission</td>
<td>Assignment 2</td>
<td>Chs. 4, 5, 6</td>
</tr>
<tr>
<td>4</td>
<td>Sep. 25</td>
<td>Somatosensory Systems</td>
<td>Assignment 3</td>
<td>Chs. 9, 10</td>
</tr>
<tr>
<td>Date</td>
<td>Topic</td>
<td>Assignment</td>
<td>Chapters/Sections</td>
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<tr>
<td>Oct. 2</td>
<td>Eye &amp; Retina</td>
<td>Assignment 4</td>
<td>Ch. 11</td>
<td></td>
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<tr>
<td>Oct. 6</td>
<td>Midterm review session (4:30 - 5:20 PM, MDCL 1105)</td>
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<tr>
<td>Oct. 9</td>
<td>Midterm Exam (2-hours long, 7:00 PM)</td>
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<tr>
<td>Oct. 16</td>
<td>Central Vision</td>
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<td>Chs. 12, 24 (p. 543-549)</td>
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<tr>
<td>Oct. 23</td>
<td>Auditory System</td>
<td>Assignment 5</td>
<td>Ch. 13</td>
<td></td>
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<tr>
<td>Nov. 6</td>
<td>Vestibular and Motor Systems</td>
<td>Assignment 6</td>
<td>Chs. 14, 16, 17</td>
<td></td>
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<tr>
<td>Nov. 13</td>
<td>Synaptic Plasticity &amp; Memory</td>
<td>Assignment 7</td>
<td>Chs. 8, 31</td>
<td></td>
</tr>
<tr>
<td>Nov. 20</td>
<td>Neuroscience Techniques</td>
<td>Assignment 8</td>
<td>Boxes 3A, 4A, 28A, 28C</td>
<td></td>
</tr>
<tr>
<td>Nov. 27</td>
<td>Course review session</td>
<td>Assignment 9</td>
<td></td>
<td></td>
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<tr>
<td>TBA</td>
<td>Final Exam (comprehensive, 3-hours long)</td>
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Note: The course schedule may be modified during the semester, at the discretion of the instructor. Any modifications will be made directly to the table above and announced in class.

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

<table>
<thead>
<tr>
<th>Item</th>
<th>Weight</th>
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</thead>
<tbody>
<tr>
<td>Brain Teasers</td>
<td>5%</td>
</tr>
<tr>
<td>Homework Assignments</td>
<td>15%</td>
</tr>
<tr>
<td>Midterm Exam</td>
<td>30%</td>
</tr>
<tr>
<td>Comprehensive Final Exam</td>
<td>50%</td>
</tr>
</tbody>
</table>

These item weightings are nonnegotiable and will not be modified at the request of the student.
In addition to the above graded components, there are four ways for students to earn optional extra credit points in this course.

**Brain Teasers**

- The brain teasers are in-class exercises designed to encourage critical thinking about neuroscience.
- Unless otherwise specified by the instructor, students are forbidden from using any material whatsoever (e.g., textbook, notes) or any electronic device during the brain teaser exercise. They may have on their desk only a blank piece of paper and a pen or pencil.
- Some of the brain teasers require a calculator; the student should bring the McMaster Standard calculator (Casio FX-991) to class. The instructor will announce whether a calculator is permitted for the brain teaser exercise.
- At least one brain teaser will be given in each class period.
- Unless otherwise announced, each brain teaser exercise is worth 2 points.
- Each answer will typically receive either zero, half, or full-credit (0, 1, or 2 points), though in some cases partial marks (0.5 or 1.5) are also given.
- The student's brain teaser score is reported online in the Check Marks system, and updated weekly.
- The student's brain teaser percentage score, entered into the course grade calculation, is the number of brain teaser points earned divided by the total number of points possible, multiplied by 100%. For example, if the course had 10 brain teasers worth a total of 20 points, and the student earned 15 points, then the student's brain teaser percentage score would be \((15/20) (100\%) = 75\%\).

**Homework Assignments**

- 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 and student number 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.

You may review your marked homework assignments during Dr. Goldreich's office hours. You may also take away any of your marked homework assignments with you to study. If you do choose to take your assignment, you are not allowed later to ask for a reconsideration of the marking.

**Midterm Exam and Final Exam**

- The midterm exam and final exam contain some questions that require a calculator. Only the McMaster standard calculator is allowed.
- Any material covered in class (lectures and brain teasers) and in homework assignments may appear on exams; questions based on this material will account for at least 90% of the exam's points. In addition, each exam will include some 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 exam's points.
- Each exam is given a mark on a scale from 0 - 100%.
- The midterm exam includes material from all course topics covered prior to the exam.
- The final exam is comprehensive; it includes material from all course topics, with approximately equal coverage.

**Extra Credit**

- There are four ways for students to earn extra credit points in this course: Write-a-Riddle, Find-a-Fact, Perplex-the-Prof, and Create-a-Question:

  **Write-a-Riddle (0.5 extra credit point)**

  A useful way to study neuroscience is to come up with mnemonic devices that cleverly express key concepts and facts. In this course, we will specialize in the riddle as a mnemonic device. During tutorial, as part of the lecture review, you will exposed to amusing and memorable riddles created by the teaching team, such as: "About the resting potential you may have confusion; just remember the importance of (diffusion)," and "To nervous system function I am essential. Without me, thoughts would not be. I'm an (action potential)." As you can see from these examples (where the answer is in parentheses), the successful riddle involves at least one rhyme and accurately expresses an important neuroscience fact or concept. Creating such riddles is a challenging but valuable study activity, and we encourage you to try it! If you can create an excellent riddle of your own (with the answer), you may be able to earn half an extra credit point. You must email your riddle to the professor before Sunday morning at 8:00 AM of the weekend preceding the tutorial. The professor, in consultation with the tutorial leader, will determine whether your riddle is to be used in the upcoming tutorial. If your riddle
is approved, it will be shown (with credit given to you by name) during tutorial, and you will receive 0.5 extra credit points. You may submit one Write-a-Riddle per week.

Find-a-Fact (1 extra credit point)
In order to further their understanding of neuroscience, students are encouraged to research each week's neuroscience topic. To earn the Find-a-Fact extra credit point, you must find at least one interesting and well-document neuroscience fact about the most recently delivered lecture topic, a fact that was not mentioned in lecture and is also not discussed in the textbook or homework assignment. The neuroscience fact must fit within the general topic of the lecture and be reported entirely in your own words, in a written statement of no more than 300 words length, and with proper citation of a reputable original source. Popular press articles, news sites, and blogs are not acceptable sources; the source must be a published scholarly article (i.e., a research or clinical neuroscience article published in a peer-reviewed journal) that you have carefully read and understood. You must email your written submission to the professor after the Thursday evening lecture and prior to Tuesday morning at 8:00 AM of the week following the lecture. The prof will decide whether your submission is sufficiently interesting and well-documented to merit mention in the next lecture; if so, it will be mentioned, with credit given to you, at the beginning of class. If (and only if) your submission is selected for mention, you will earn an extra credit point. You may submit one Find-a-Fact per week.

Perplex-the-Prof (2 extra credit points)
If, in class, you raise an excellent question that the professor cannot answer, the professor may nominate you for a Perplex-the-Prof opportunity. If you are able to find the answer to the question in a reputable source article, and email the answer to the professor, summarizing the finding of the source article entirely in your own words, in a written statement of no more than 500 words length, and properly referencing the article, then you will earn two extra credit points. Popular press articles, news sites, and blogs are not acceptable sources; the source must be a published scholarly article (i.e., a research or clinical neuroscience article published in a peer-reviewed journal) that you have carefully read and understood). You may be awarded a maximum of two Perplex-the-Prof opportunities per semester.

Create-a-Question (3 extra credit points)
As an optional exercise, students are encouraged to try to generate an excellent midterm or final exam question of their own. Questions that are carefully and articulately worded, and that probe student understanding of important concepts, will be considered for inclusion. You must email the professor your proposed question and its answer at least one week prior to the exam date. If your question is used on an exam, you will earn three extra credit percentage points on that exam. The professor will not inform you in advance of the exam whether your question will be used, and will not provide feedback as to whether your answer is correct. If
your question is used, 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 professor. You may submit only one Create-a-Question per exam.

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

**Course Percentage Score Calculation Formula**

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

\[
\text{Course percentage score} = (\text{course brain teaser score})(0.05) + (\text{course homework score})(0.15) + (\text{midterm exam score})(0.30) + (\text{final exam score})(0.50)
\]

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

<table>
<thead>
<tr>
<th>Course Letter Grade</th>
<th>Course Percentage Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>A+</td>
<td>90-100</td>
</tr>
<tr>
<td>A</td>
<td>85-89</td>
</tr>
<tr>
<td>A-</td>
<td>80-84</td>
</tr>
<tr>
<td>B+</td>
<td>77-79</td>
</tr>
<tr>
<td>B</td>
<td>73-76</td>
</tr>
<tr>
<td>B-</td>
<td>70-72</td>
</tr>
<tr>
<td>C+</td>
<td>67-69</td>
</tr>
<tr>
<td>C</td>
<td>63-66</td>
</tr>
<tr>
<td>C-</td>
<td>60-62</td>
</tr>
<tr>
<td>D+</td>
<td>57-59</td>
</tr>
<tr>
<td>D</td>
<td>53-56</td>
</tr>
<tr>
<td>D-</td>
<td>50-52</td>
</tr>
<tr>
<td>F</td>
<td>0-49</td>
</tr>
</tbody>
</table>
Missed Work
If a student misses a class period, homework assignment, or exam due to illness, personal circumstances, or for any other reason, it is the student's responsibility to notify the instructor and to follow all universities rules that apply to such circumstances. If you are absent from the university for a minor medical reason, lasting fewer than 5 days, you may report your absence, once per term, without documentation, using the McMaster Student Absence Form (MSAF). Absences for a longer duration or for other reasons must be reported to your Faculty/Program office, with documentation, and relief from term work may not necessarily be granted. When using the MSAF, report your absence to Dr. Goldreich. You must contact Dr. Goldreich as soon as possible (normally within 2 working days) by email at goldrd@mcmaster.ca to learn what relief may be granted for the work you have missed, and relevant details such as time and location of a make-up exam. Please note that the MSAF may not be used for term work worth 30% or more, nor can it be used for the final examination. This means that you cannot use the MSAF for the midterm exam or final exam in this course.

If a student is absent for more than 5 days, has more than one absence in the semester, or misses work worth more than 30% of the course grade, then the student must go to the Faculty Office to discuss the situation. A mark of zero will automatically be entered for all missed brain teaser exercises, homework assignments, and exams until the instructor receives notification from the MSAF system or the student's Faculty Office, and is contacted by the student to discuss how to remedy the missed work situation.

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 (goldrd@mcmaster.ca). 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.

A midterm exam missed due to illness or exceptional personal circumstances 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 midterm exams may differ in format and specific content from the original. The professor's preference for make-up exams 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.

Recording
Photographs and video recordings are strictly prohibited. Students may make audio recordings of the lectures, for personal use only and not to be posted online, emailed, distributed or otherwise shared. Students should inform the instructor in advance if they wish to make an audio recording.

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

Please also read Dr. Goldreich's tutorial Write ethically: avoid plagiarism. You must return print and return the signed acknowledgement of understanding along with your first homework assignment.

**Online Privacy**

This course makes use of an online grade check system. This system is designed to keep private the information you provide to register for and access this system, and to prevent others from accessing your grades. However, you should be aware that the transmission of 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 use of the grade check system will be interpreted to indicate that you accept this risk. If you have any questions or concerns about the privacy of your information, please discuss these with the instructor.

**Note Regarding Course Dates and Deadlines**

The instructor and university reserve the right to modify elements of the course during the term. The university may change the dates and deadlines for any or all courses in extreme circumstances. If such modification becomes necessary, reasonable notice will be given. It is the responsibility of the student to check their McMaster email and course websites weekly during the term and to note any changes.