

NROB61H3: Neurophysiology

University of Toronto Scarborough, Winter 2023 edition

Lectures SW319: Tuesday 15h00 – 17h00

Practicals SW148: various weekdays, various times

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Office hours: Thursday 15h00 – 16h00

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PRACTICAL SECTIONS & TEACHING ASSISTANTS

PRA0001	MON	09h00-12h00	Jennifer Wilkin	jennifer.wilkin@mail.utoronto.ca
PRA0002	MON	12h00-15h00	Liv Engel	liv.engel@mail.utoronto.ca
PRA0003	TUE	09h00-12h00	Ahmad Israwi	a.israwi@mail.utoronto.ca
PRA0004	TUE	12h00-15h00	Ahmad Israwi	a.israwi@mail.utoronto.ca
PRA0005	TUE	17h00-20h00	Arely Cruz-Sanchez	a.cruz.sanchez@mail.utoronto.ca
PRA0006	WED	09h00-12h00	Arely Cruz-Sanchez	a.cruz.sanchez@mail.utoronto.ca
PRA0007	WED	12h00-15h00	Emily Wong	emilyhiuyuet.wong@mail.utoronto.ca
PRA0008	THR	12h00-15h00	Liv Engel	liv.engel@mail.utoronto.ca
PRA0009	THR	15h00-18h00	Emily Wong	emilyhiuyuet.wong@mail.utoronto.ca
PRA0011	FRI	09h00-12h00	Jennifer Wilkin	jennifer.wilkin@mail.utoronto.ca
PRA0012	FRI	12h00-15h00	Hanista Premachandran	hanista.premachandran@mail.utoronto.ca

COURSE DESCRIPTION

Neurons are the fundamental information processing cells in the brain. It is estimated that the cerebral cortex of humans has 21 billion neurons, blue whales 15 billion, raccoons 453 million, brown bears 251 million, cats 250 million, starlings 226 million, mice 14 million, and honeybees 170,000. These estimates reveal that a species' number of neurons is not necessarily a reliable predictor of body size, brain size, richness of behavioural repertoire, or cognitive ability. Despite the scientific puzzle this variability represents, a stable feature across the animal kingdom is the structure and function of neurons.

This consistency allows scientists to transfer neuronal principles learned about how bees navigate to a tulip patch, to how crows learn to crack walnuts, to how cats flush toilets, and to how people throw frisbees. This semester, we will learn the chemical and ionic bases of neuronal activity, synaptic transmission, synaptic integration, sensory coding, and neuroplasticity. This course will provide a foundational understanding of neurophysiology during lectures and practicals that will emphasize classic experiments, fundamental principles, modern neuroscience techniques, laboratory skills, and scientific scholarship. The goal is that by the end of the term you can generate a hypothesis for one of the multitude of puzzles in the field of neurophysiology.

COURSE OBJECTIVES

Understand the structural and functional properties of neurons

Explain the landmark experiments that identified the biophysical properties of membranes and proteins that lead to the generation of neuronal transmission

Describe and contrast *in vivo* and *ex vivo* recording techniques that are used to study the electrophysiological properties of cells

Describe the circumstances that lead to neuroplasticity at the cellular and network levels

Synthesize the course materials to make predictions about how perturbations in neural circuits modify neural communication

Become familiar with searching for primary research articles and critically analyze the content to determine if the results support the conclusions

Generate testable hypotheses, record neural activity, analyze timeseries data, and communicate experimental results

COURSE CONSIDERATIONS

Content: Many students find neurophysiology to be a challenging topic because it requires an understanding of neuroanatomy, molecular biology, neurochemistry, and electricity. For these reasons, this course may require more time and effort than other courses. The content was curated to equip you with only the fundamentals of neurophysiology, sensory systems, and synaptic plasticity. Although not exhaustive, with this knowledge you will be prepared for a variety of upper-level neuroscience courses.

The subject matter we cover is not conceptually difficult. What surprises some students is that they are expected to truly understand what is taught in the lecture. Rather than memorizing a series of terms, you will be required to synthesize and apply the fundamentals of neurophysiology. You can all perform at this level, but you may be learning new study skills at the same time as you are learning about neurophysiology. With a concerted effort, you will finish the semester truly understanding the physiological principles that govern how your brain works. Rise to the challenge and enjoy!

Preparation: It is critical that you attend lectures. During lecture, I will present information that goes beyond the content in the textbook and what is contained in the lecture slides posted on Quercus. The lecture slides are an outline of the topics, but you are responsible for the information that is presented during the lecture and in the assigned readings. I cannot emphasize enough that it is important to read the assigned textbook chapters prior to attending class.

Exams: The midterm and final exams will be composed of multiple choice and short answer questions. The multiple choice questions will have at least four options, some of which may be “all of the above” or “none of the above”. For the short answer questions, you may be required to diagram a biological phenomenon, perform a calculation, write several sentences to explain a concept, or any combination of the aforementioned. Points for short answer questions are allocated based on importance; for this reason, a question worth five points will not necessarily require you to list five things. As noted above, emphasis is not placed on memorizing the names of proteins, receptors, genes, etc., but instead on understanding

how things work. The goal is to know why a concept is important and demonstrate your ability to interact with the concept by applying it in novel ways to solve problems.

Opportunities: If you are even vaguely thinking about applying to a PhD program in neuroscience or to medical school, I strongly recommend that you find an opportunity to receive research experience in one of our neuroscience labs at UTSC. Research training is one of the most important educational tasks we accomplish here, and few undergraduates avail themselves of the opportunity. Why is extensive research experience critical? It is important to both assess your own interests in the field and to enhance the competitiveness of your applications to graduate and medical programs. Feel free to come to my office hours to get advice on all aspects of research experience and on graduate school, medical programs, and life sciences careers in general.

WORKLOAD AS PERCENTAGE OF FINAL GRADE

1. Midterm exam:	30%
2. Practical assignments:	15% (6 x 1% for tutorials + 3 x 3% for labs)
3. Final lab report:	20%
4. Final exam:	35%

WORKLOAD DETAILS

1. Midterm exam (total 30%): exam date to be determined during Week 07

This exam will cover material from the lectures and practicals during weeks 1-5.

2. Practical assignments (total 15%): due within 48 hours of your practical session:

Attendance at the weekly practicals is mandatory. You may only attend the practical session for which you are registered. Practical assignments will be held in SW148 where you will work in small groups of ~4 students on tutorial- or lab-based assignments. Most assignments can be finished during the practical, but you are still given 48 hours to submit on Quercus (i.e. if the practical ends at 18h00 on Thursday, it is due by 18h00 on Saturday). Late submissions are accepted, but with a 10% reduction per day late. Regardless of the format, practicals are an excellent opportunity to further engage with class material, interact with your classmates, and receive assistance from your TA.

Tutorials (6 x 1%): There are six tutorial sessions that will emphasize essential research skills in the life sciences, including intellectual self-defence, hypothesis construction, referencing, and professional development. The TAs will lead these tutorials and you will work in small groups to complete exercises. Following the tutorial, you must submit the assignment individually on Quercus in your own words.

Labs (3 x 3%): There are three hands-on-based practicals that will explore a breadth of neurophysiology topics spanning resistor-capacitor electric circuits to collection of extracellular spiking activity. To complete some of these labs you may be required to spend time beyond the practical session. Assignments must be submitted individually on Quercus in your own words.

3. Final lab report (total 20%): due 10 April by 11:59PM EST

For this assignment, you will work individually to write a formal lab report based upon data collected in the extracellular recording lab. The sections of your lab report will closely follow the standard formatting of a research article. This assignment combines skills accumulated throughout the semester including hypothesis generation, experimental methods, data analysis, literature referencing, and scientific

communication. Prior to assignment submission, you must submit your report to the University's plagiarism detection tool embedded in Quercus. Late submissions are accepted, but with a 10% reduction per day late. Additional details will be provided on Quercus.

4. Final exam (35%): exam date to be schedule by Registrar during 13-27 April

The final exam is cumulative in the sense that the core principles from the beginning of term are essential to understand the lecture and lab content from weeks 6-12. However, the exam will emphasize material covered from weeks 6-12.

COURSE MATERIALS

Students are responsible for reading all assigned lecture notes, textbook readings, and research articles. Weekly reading assignments are from the required textbook: *From Neuron to Brain* 6th Edition by R. Martin, et al. ISBN: 978-1605354392, Oxford University Press. Alternatives to purchasing this hardcopy: (1) a physical copy of the textbook is in the Library's Course Reserves, (2) the 5th edition is acceptable, (3) eBook that is available for purchase through Quercus course page. This book is abbreviated as N2B in the syllabus.

TENTATIVE COURSE SCHEDULE

WEEK	DATE	TOPIC	READINGS
01	10 JAN	LEC: Course intro and fundamentals	Syllabus
		PRA: None	
02	17 JAN	LEC: Ion channels and signaling	N2B chapter 4 JOVE: Patch clamping
		PRA: Intro and scientific arguments	
03	24 JAN	LEC: Ionic basis of resting membrane potentials	N2B chapter 6
		PRA: Resistor-capacitor (RC) circuit lab	Background and Protocol
04	31 JAN	LEC: Ionic basis of action potential	N2B chapter 7
		PRA: Literature review and referencing in science	
05	07 FEB	LEC: Passive electrical spread in neurons	N2B chapter 8
		PRA: Professional development and building community	
06	14 FEB	LEC: Sensory coding and measuring extracellular activity	Kandel chapter 21
		PRA: Neuronify circuit lab	Background and Protocol
		Reading Week 18-24 FEB	
07	TBD	Midterm: Registrar will schedule between FEB 27 and MAR 4.	

		PRA: None	
08	07 MAR	LEC: Post-synaptic mechanisms of synaptic transmission	N2B chapter 11
		PRA: Extracellular Recording lab I	Background and Protocol
09	14 MAR	LEC: Pre-synaptic mechanisms of synaptic transmission	N2B chapter 13 JOVE: FM dyes, calcium imaging
		PRA: Extracellular recording lab II	
10	21 MAR	LEC: Synaptic plasticity	N2B chapter 16
		PRA: Article deconstruction I	Article 1
11	28 MAR	LEC: Synaptic integration	N2B chapter 8
		PRA: Article deconstruction II	Article 2
12	04 APR	LEC: Targeted methods to control and record neuronal activity	
		PRA: Optional drop-in for additional help	
	10 APR	Final lab report due	
	TBD	Final exam: The Registrar will schedule during APR 13-27.	

COURSE POLICIES

Piazza discussion: For course content-based questions and clarifications, use the Piazza discussion board embedded in Quercus. This is the most efficient strategy for knowledge transmission. If an aspect of an assignment or lab is unclear to you, it is likely that several others in the class are in the same boat. Before you post a question on Piazza, search to see if another student posted a similar question. It is highly encouraged that you contact the instructor or TAs via questions on Piazza. There is a guide in Pages section of Quercus. Use of the Quercus messaging system is categorically discouraged.

Email: Email correspondence is reserved only for personal questions/matters. It should be sent from a UofT email address to the instructor or TA's email address listed on the first page of the syllabus. Please use professional email etiquette as outlined in the document "General Thoughts on Email Etiquette" that is available in the Files folder on Quercus.

Video and audio recording: For reasons of privacy as well as protection of copyright, unauthorized video or audio recording in the classroom is prohibited. This is outlined in the Provost's guidelines on *Appropriate Use of Information and Communication Technology*. Note, however, that these guidelines include the provision that students may obtain consent to record lectures and, "in the case of private use by students with disabilities, the instructor's consent must not be unreasonably withheld."

Availability of lecture material and copyright: Lecture slides will be posted on Quercus. Note, the posted slides do not represent the totality of the course. The lecture will cover material that is not

explicitly contained in the slides. For this reason, the slides are not a substitute for attending lecture. As protection of copyright, unauthorized copying, use, or uploading onto the internet of any of the lecture slides, handouts, or course materials produced by Professor Rozeske is strictly prohibited.

Attendance: Although lecture attendance is not an assessment for your final grade, attending class will provide you with the fullest picture of the course content. However, attendance at the practicals is assessed and contributes to your grade. Regarding attendance in general, please make it a point of pride that you are punctual. Understandably, circumstances periodically arise and tardiness cannot be avoided. But habitual tardiness demonstrates a lack of respect for the entire class as it disrupts the flow of the lecture and practical. As the adage goes, “to be early is to be on time, to be on time is to be late”.

Classroom conduct: Students and faculty are responsible for maintaining an appropriate learning environment in all instructional settings, whether in person or online. Professional courtesy, respectful language, and sensitivity will help to create a welcoming and safe learning environment for everyone. Students are expected to be attentively engaged during lecture/practicals and resist the temptation to use their mobile device or laptop to engage in non-course related activities.

Office hours: Students are encouraged to attend drop-in office hours if they want to discuss the course content, their lab report, and their performance in class. Students are also welcomed to attend office hours if they would like guidance on how they can become involved in neuroscience. If the office hours outlined on page one of the syllabus conflict with your schedule we can arrange an alternative time.

Contesting a grade: Re-grade requests will only be considered within two weeks of grade posting. These will only be considered if adequate written justification is provided by the student. If granted, re-grading will consist of re-evaluation of the complete assignment, potentially leading to a grade increase, no change, or decrease. Requests without a solid rationale will not be considered (e.g. I need a higher grade to apply to medical or graduate school).

Midterm exam consultation: Following the grading of the midterm exam, students with questions about their grade should contact the TA that leads their practical section. The student will have the opportunity to view their exam and consult with their TA. Depending on when the exam is scheduled, this consultation period will be held following the practical section on either week 08 or 09.

Syllabus modifications: The instructor reserves the right to make minor changes to the syllabus. These changes will be communicated with the class via Quercus Announcements and Piazza. Most often alterations to the syllabus will be related to lecture and practical sequencing.

GRADING SCALE & DEFINITIONS

<https://advice.writing.utoronto.ca/general/grading-policy/>

PERCENT	LETTER	GRADE VALUE	GRADE DEFINITION
90-100	A+	4.0	<i>Excellent:</i> Strong evidence of original thinking, good organization; capacity to analyze and synthesize; superior grasp of subject matter with sound critical evaluations; evidence of extensive knowledge base.
85-89	A	4.0	<i>Excellent</i>
80-84	A-	3.7	<i>Excellent</i>

77-79	B+	3.3	<i>Good</i> : Evidence of grasp of subject matter; some evidence of critical capacity and analytic ability; reasonable understanding of relevant issues; evidence of familiarity with literature
73-76	B	3.0	<i>Good</i>
70-72	B-	2.7	<i>Good</i>
67-69	C+	2.3	<i>Adequate</i> : Student who is profiting from the university experience; understanding of the subject matter and ability to develop solutions to simple problems in the material.
63-66	C	2.0	<i>Adequate</i>
60-62	C-	1.7	<i>Adequate</i>
57-59	D+	1.3	<i>Marginal</i> : Some evidence of familiarity with the subject matter and some evidence that critical and analytic skills have been developed.
53-56	D	1.0	<i>Marginal</i>
50-52	D-	0.7	<i>Marginal</i>
0-49	F	0.0	<i>Inadequate</i> : Little evidence of even superficial understanding of subject matter; weakness in critical & analytical skills; limited or irrelevant use of literature.

QUERCUS

This course uses the University's learning management system, Quercus, to post information about the course. This includes posting readings and other materials required to complete class activities and course assignments, as well as sharing important announcements and updates. The site is dynamic and new information and resources will be posted regularly as we move through the term, so please make it a habit to log in to the site on a regular, even daily, basis. To access the course website, go to the U of T Quercus log-in page at <https://q.utoronto.ca>. Once you have logged in to Quercus using your UTORid and password, you should see the link or "card" for [Neurophysiology NROB61].

You may need to scroll through other cards to find this. Click on the [Neurophysiology NROB61] link to open our course area, view the latest announcements and access your course resources. There are Quercus help guides for students that you can access by clicking on the "?" icon in the left side column. **SPECIAL NOTE ABOUT GRADES POSTED ONLINE:** Please note that any grades posted are for your information only, so you can view and track your progress through the course. No grades are considered official, including any posted on Quercus at any point in the term, until they have been formally approved and posted on ACORN at the end of the course. Please contact me as soon as possible if you think there is an error in any grade posted on Quercus.

ACADEMIC INTEGRITY

Academic integrity is essential to the pursuit of learning and scholarship, and to ensure that a degree from the University of Toronto is a strong signal of a student's individual academic achievement. As a result, the University treats cases of cheating and plagiarism very seriously. The University of Toronto's Code of Behaviour on Academic Matters (<http://www.governingcouncil.utoronto.ca/policies/behaveac.htm>) outlines the behaviours that constitute academic dishonesty and the processes for addressing academic offences. Potential offences include, but are not limited to:

In papers and assignments:

- Using someone else's ideas or words without appropriate acknowledgement
- Submitting your own work in more than one course without the permission of the instructor
- Making up sources or facts
- Obtaining or providing unauthorized assistance on any assignment

On tests and exams:

- Using or possessing unauthorized aids
- Looking at someone else's answers during an exam or test
- Misrepresenting your identity; and
- When you knew or ought to have known you were doing it.

In academic work:

- Falsifying institutional documents or grades
- Falsifying or altering any documentation required by the University, including but not limited to, doctor's notes; and
- When you knew or ought to have known you were doing so.

All suspected cases of academic dishonesty will be investigated following procedures outlined in the Code of Behaviour on Academic Matters. If students have questions about what constitutes appropriate academic behaviour or appropriate research and citation methods, they are expected to seek out additional information on academic integrity from their instructors or from other institutional resources.

Note: You may see advertisements for services offering grammar help, essay editing and proof-reading. Be very careful. If these services take a draft of your work and significantly change the content and/or language, you may be committing an academic offence (unauthorized assistance) under the *Code of Behaviour on Academic Matters*.

It is safer to take your draft to the Writing Centre whose services can be accessed through the Centre for Teaching and Learning at <http://uoft.me/AcademicLearningSupport>. They will give you guidance that you can trust. Students for whom English is not their first language should go to the English Language Development Centre also available at the Centre for Teaching and Learning. If you decide to use these services in spite of this caution, you **must keep a draft** of your work and any notes you made before you got help and be **prepared to give it to your instructor** on request.

UNIVERSITY'S PLAGIARISM DETECTION TOOL

Normally, students will be required to submit their course essays to the University's plagiarism detection tool for a review of textual similarity and detection of possible plagiarism. In doing so, students will allow their essays to be included as source documents in the tool's reference database, where they will be used solely for the purpose of detecting plagiarism. The terms that apply to the University's use of this tool are described on the Centre for Teaching Support & Innovation website (<https://uoft.me/pdt-faq>).

MASKS IN THE CLASSROOM

While the mask mandate has been paused as of 1 July 2022, the use of medical masks continues to be strongly encouraged at U of T Scarborough in indoor settings where physical distancing is not possible. We ask everyone to respect each other's decisions, comfort levels, and health needs. Masks are available at all building entrances at U of T Scarborough and in all classrooms.

EQUITY, DIVERSITY, INCLUSION

The University is committed to equity, human rights and respect for diversity. All members of the learning environment in this course should strive to create an atmosphere of mutual respect where all members of our community can express themselves, engage with each other, and respect one another's differences. U of T does not condone discrimination or harassment against any persons or communities.

DISABILITY-RELATED ACCOMMODATIONS

Students with diverse learning styles and needs are welcome in this course. In particular, if you have a disability/health consideration that may require accommodations, please free to approach me and/or the Accessibility Services Office (<http://www.utoronto.ca/ability/>) as soon as possible. Accessibility Services staff (located in Rm AA142, Arts & Administration Building) are available by appointment to assess specific needs, provide referrals and arrange appropriate accommodations. Please contact 416-287-7560 (tel/TTY) or email ability@utoronto.ca for more information. The sooner you let us know your needs the quicker we can assist you in achieving your learning goals in this course.

DEPARTMENT OF PSYCHOLOGY MISSED TERM WORK POLICY

For missed term work (assignments and term tests) due to illness, emergency, or other mitigating circumstances, please follow the procedures outlined below.

Note:

- The following reasons are not considered sufficient for missed term work: travel for leisure, weddings, personal commitments, work commitments, human error.
- [Missed Final Exams](#) are handled by the Registrar's Office and should be declared on eService.
- Instructors cannot accept term work any later than five business days after the last day of class. Beyond this date, accommodations are only possible via the Registrar's Office [petition process](#).

The email address to submit missed term work accommodation requests in NROB61 is:
hanista.premachandran@mail.utoronto.ca

ILLNESS OR EMERGENCY accommodations:

For missed work due to ILLNESS OR EMERGENCY, complete the following process:

1. Complete the [Request for Missed Term Work Accommodations Form](#).
2. Declare your absence on [ACORN](#) (Profile & Settings > Absence Declaration)
3. Email **both** of the following items to the course email **WITHIN 2 BUSINESS DAYS** of the missed work:
 - a. the [Request for Missed Term Work Accommodations Form](#)
AND
 - b. a screenshot of your Self-Declared Absence on ACORN

Note:

- *If you are unable to submit your request within 2 business days, you must still email your instructor within the 2 business day window to explain the nature of the delay. Exceptions to the 2 business day deadline will only be made under exceptional circumstances.*
- *If your absence is declared on ACORN, we do not require any additional supporting documentation (e.g. medical notes) to support your missed term work accommodation request.*

ACADEMIC CONFLICT accommodations:

For missed term work due to an ACADEMIC CONFLICT (e.g. two midterms at the same time):

1. Complete the [Request for Missed Term Work Accommodations Form](#).
2. Take screenshots of your course Quercus pages that demonstrate the conflict.
3. Email the form and screenshots to the course email **at least two weeks (10 business days) before the date of the activity**, or as soon as possible if it was not possible to identify the conflict earlier. Requests sent after the activity deadline may not be accommodated.

Note:

- *Multiple assignments due on the same day are not considered conflicts. Students are expected to manage their time effectively to meet assignment deadlines.*
- *Back-to-back tests/quizzes are not considered conflicts. Only overlapping activities are conflicts.*
- *Students are responsible for keeping their course timetables conflict-free. Students who register in two courses with overlapping lecture/tutorial/lab schedules will not be accommodated.*

RELIGIOUS CONFLICT accommodations:

For missed term work due to a RELIGIOUS CONFLICT:

1. Complete the [Request for Missed Term Work Accommodations Form](#).
2. Email the form to the course **email at least two weeks (10 business days) before the date of the activity**, or as soon as possible if it was not possible to identify the conflict earlier. Requests sent after the activity deadline may not be accommodated.

ACCESSABILITY SERVICES accommodations:

For missed **TERM TESTS** due to ACCESSABILITY REASONS:

- **Contact your AccessAbility consultant** and have them email the course email detailing accommodations required.

For missed **ASSIGNMENTS** due to ACCESSABILITY REASONS:

- If your desired accommodation is **within the scope** of your Accommodation Letter (e.g. your letter includes “extensions of up to 7 days” and you need 3 days):
 1. Complete the [Request for Missed Term Work Accommodations Form](#).
 2. Email the form ***AND*** your **Accommodation Letter** to the course email specifying how many days extension you are requesting.
- If your desired accommodation is **outside the scope** of your Accommodation Letter (e.g. your letter includes “extensions of up to 7 days” but you need more time than that):
 1. **Contact your AccessAbility consultant** and have them email the course email detailing the accommodations required.

Accommodation Procedure:

After submitting your documentation, you will receive a response from your instructor or TA. This form does not guarantee that you will be accommodated. The course instructor reserves the right to decide what accommodations (if any) will be made. Failure to adhere to any aspect of this policy may result in a denial of your request. **You are responsible for checking your official U of T email and Quercus course announcements daily**, as accommodations may be time-critical.

For missed assignments, **do not wait for the instructor’s response to resume work on your assignment**. Extensions may be as short as one business day, depending on the nature of the illness/emergency. Complete your assignment as soon as you’re able, and email it to your instructor.

For an **anticipated absence** (e.g. a scheduled surgery or an illness with a prolonged recovery period), if you would like to request accommodations in advance, submit a [Verification of Illness Form](#) completed by your doctor AND the [Request for Missed Term Work Accommodations Form](#) to the course email. Absences can be declared up to 14 days into the future on ACORN.

Missed Accommodations

If an accommodation is granted but a continued illness/emergency prevents you from meeting its requirements, you must repeat the missed term work procedure to request additional accommodations.

Please make it clear in your subject line that you are requesting a second accommodation. E.g. If you are given an extension but are still sick and need more time, or if you miss a make-up term test, you must submit *another* [Request for Missed Term Work Accommodations Form](#) and declare your extended absence on ACORN. *Note: In the case of a missed make-up test, an opportunity to write a second make-up test may not necessarily be provided.