Cellular Neuroscience Laboratory
NROC60H3F

University of Toronto Scarborough
Fall 2024

Thursdays 2-5pm: SW316 (lecture) + SW148 (lab)

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Instructor: **Dr. Maithe Arruda Carvalho** *(she/her)*   *E-mail:* m.arrudacarvalho@utoronto.ca

<u>Office hours</u>: Mondays 10am-12pm, SW533

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*Your TA is the first point of contact for any questions you may have.

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Course Overview

This course aims to introduce students to a variety of cellular neuroscience techniques used in a neuroscience laboratory to investigate the biological mechanisms underlying complex behaviour. This course is the cellular neuroscience counterpart to NROC63, and will feature a theoretical and a practical component. For the practical component of the course, students will conduct a hands-on mini research project. Specifically, students will learn how to prepare brain slices, perform immunohistochemistry and cell counting. This will allow students to *conduct a research project from start to finish* which will integrate the theoretical and practical components of the course, while pursuing a novel research question. Students will concomitantly learn the theoretical basis behind a variety of cellular and systems neuroscience techniques used to assess neural structure and function at different levels of analysis, including neuronal morphology, gene and protein expression, opto and chemogenetic manipulation of neuronal activity, as well as their applicability and limitations. The technical skills learned in this course are at the core of neuroscience research, and will serve as an important basis for students pursuing graduate school as well as employment in biomedical research outside of academia.

Course Materials

Students will be required to read course materials, which will be posted on Quercus or be available on short-term loan in the library.

Course Learning Objectives

By the end of this course, students will be able to:

- Perform cellular neuroscience techniques commonly used to measure changes in protein expression in the brain.
- Design experimental strategies to answer specific and challenging research questions in a cellular neuroscience setting.
- Improve their interpretation of scientific results by deepening their understanding of the rationale for using each of those techniques, and their limitations.
- Master the use of specific laboratory equipment used for slicing of fixed brain tissue, perform immunohistochemistry and cell counting in different brain regions.
- Investigate the cellular mechanisms underlying behavioural deficits in a model of schizophrenia using those techniques to generate novel findings.
- Write a scientific paper based on the data collected by the students during the lab portions of the course.

Course Evaluation

<u>*Summary of Evaluation:*</u>

	Percent of final grade	Date
Laboratories (3 in total)	5% + 5% + 20%	Sep 26, Oct 10, Oct 24
Quizzes	5 X 3%	Sep 26, Oct 10, Oct 24, Nov 21, Nov 28
Research paper	10% + 5% + 20%	Intro (Oct 10), Methods (Nov 7), Full paper (Nov 28)
Final Exam	20%	Exam Period

<u>*Description of course components:*</u>

1. Laboratories (5% + 5% + 20%):
Students will be evaluated based on their participation in the labs. In Lab 1 (5%), students will learn how to section brain tissue for histological processing. In Lab 2 (5%), students will perform immunohistochemistry on the brain sections they prepared in Lab 1, and mount those immunostained sections in preparation for fluorescence imaging. In Lab 3 (20%), after learning about the fundaments of optical imaging, students will learn and perform cell counts to quantify and compare the number of immunopositive cells in different brain regions in their experimental groups. For lab 3, the participation mark will be dependent on the students concluding their cell counts. This will be done outside of class, and the cell counts will be due on <u>November 14th</u>. Prior to all three labs, <u>students must read the respective lab manual</u>. **Attendance is mandatory for obtaining a participation grade.**

Please note: For Lab 1 (scheduled for Week 4), the class will be divided into three batches of students (groups A-B). Following training on tissue sectioning, each student will be responsible for sectioning one mouse brain. Students will choose among specific time slots for access to the vibratomes in the presence of a TA. Due to equipment constraints, these time slots may be outside of the original class schedule:

<u>**Lab 1:**</u>
<u>September 26th</u>
3-5PM - Group A
5-7PM – Group B

September 27th
9AM-11AM – Group C

Similarly, for Lab 2, given the nature of the technique, there will be two experimental sessions (see below). Students will be divided in groups of 5 (groups α and β), and sign up for the following time slots:

Lab 2:
October 10th
3-5PM – Session 1 - Group α
5-7PM – Session 1 - Group β

October 11th
9-10AM – Session 2 - Group α
10AM-11AM - Session 2 – Group β

12PM-1PM - Session 3 – Group α
1PM-2PM - Session 3 - Group β

Please be flexible in signing up for a specific Lab time slot, and be committed to your selected lab timeslot and group once the schedule is set. Be mindful that you may be asked to switch your timeslot or group to accommodate 5 people MAX per lab. It is the student's responsibility to be present in their chosen time slot and complete the Lab.

For lab 3, the assignment will consist of performing the cell counts as determined during the lab. Students will hand in their assignment on **November 14th by NOON**. Students should submit their excel sheets on Quercus. To submit your assignment, on Quercus click on Assignments: Lab 3 Cell counts. Late submissions will be accepted with a **penalty of 10% for every day late** (5% penalty for same day after noon). We will need to put all of the data collected by all students together for that same day's lecture at 3pm, hence the need to submit your counts on time to maximize output in our data analysis class.

2. Quizzes (5 x 3%)
As noted on the calendar, five of the lectures will be followed by a short answer <u>in class</u> quiz aimed at assessing the student's understanding of the content covered in the previous weeks' lecture. The quiz will be administered in class at the beginning of class and therefore *attendance is mandatory* to complete it.

3. Research paper (10% + 5% + 20%):
In this assignment students will write a research paper following the guidelines of the Journal of Neuroscience: https://www.jneurosci.org/content/information-authors#submitting_a_manuscript
This research paper will feature the data collected during the labs and will consist of the following segments:

Introduction (10%) – Due October 10ᵗʰ by 11:59PM: This section will include a concise literature review providing the background of the research leading to an explanation of the rationale of the study. It must not exceed 650 words. It must include a minimum of 10 citations of published, peer-reviewed research papers, at least half of which must be empirical, not review papers. A list of the references cited in the introduction should be included at this stage. To submit your assignment on Quercus and Turnitin (embedded), click on Assignments: Research Paper: Introduction. The Rubric is visible on Quercus.

Materials and Methods (5%) – Due November 7ᵗʰ by 11:59PM: This section will include a description of the techniques used in the practical component of the course, including a description of the brain sectioning, immunostaining, imaging and cell counting protocols. It must not exceed 1500 words. Students must at that time also include a <u>list of 5 additional (not cited in the introduction), empirical peer-reviewed papers</u> which will be featured in the Discussion section of the paper. To submit your assignments on Quercus and Turnitin (embedded), click on Assignments: Research Paper: Methods and list of discussion papers. You can include your list of papers (with complete references) at the end of your word file containing your methods. The Rubric is visible on Quercus.

Final Research paper (20%) – Due November 28ᵗʰ by 11:59PM:
The final research paper will include the following sections:
  Title page – Containing a title (50-word maximum, be creative!), abbreviated title (50 characters), your name, and word counts for the introduction, methods and discussion, as well as page number (maximum of 5) and number of figures.
  Abstract - This section will clearly and briefly state the background, rationale, methodology and results of the paper, and must not exceed 250 words.
  Introduction – as above.
  Materials and Methods – as above.
  Results – This section will describe the results and statistical analyses you found. It will include a description of the experimental rationale and of the findings.
  Discussion – This section will include a one-paragraph summary of the main findings and a discussion of their significance and potential alternative interpretations. It should discuss how your results compare to closely related articles in the field, and conclude with future directions of the research. 1500 words maximum.
  References - List all the references cited in the text in alphabetical order by first author's last name following Journal of Neuroscience citation style.
      Here is one example of Journal of Neuroscience citation style:

Drew MR, Denny CA, Hen R (2010) Arrest of adult hippocampal neurogenesis in mice impairs single- but not multiple-trial contextual fear conditioning. Behav Neurosci 124:446–454.

For more examples see https://www.jneurosci.org/content/information-authors#organization_of_manuscript

  Figure Legends - These must include a brief description of the figures in the order they appear in the text.
  Figures - These will include 2 bar graph figures with the final data.

Additional instructions for each of these sections will be given in tutorials throughout the course as noted on the calendar.

All assignments will be submitted through Quercus and Turnitin. Submissions are due **by 11:59PM (except for the Lab 3 assignment at noon) on their due date**. Late submissions will be accepted with a **penalty of 10% for every day late**.

4. Final Exam (20%) – Exam period
The final exam will be scheduled during the exam period and will assess the students' ability to integrate the technical knowledge gained during the course within the context of designing experimental strategies to address a specific experimental question. Students will be assigned two research questions and be asked to design theoretical experiments to prove or disprove the scientific hypotheses given to them. The proposed experiments combined must include a minimum of <u>two techniques </u>(i.e. you cannot use the same technique in both proposed experiments). Students will be free to choose any technique but must make a convincing case for their choice of experiments. Experiments will be broken down into the following categories:

> *Rationale*: Justify why this experiment is ideal for the purpose described and what it will measure
> *Methods:* Describe how the technique is used
> *Predicted Outcomes and potential pitfalls:* Describe how the hypothetical results from that experiment will address the given scientific hypothesis and discuss the limitations of the chosen techniques.

More details on the specific format of the exam will be provided on the weeks prior to the exam period. This test will put into practice the students' knowledge of the scientific method and the cellular neuroscience techniques learned in the course, applying critical thinking and problem-solving skills.

Resources
Lecture slides and additional assigned reading will be posted on Quercus prior to the lecture. Students will be provided with a temporary license for the use of the software [Graphpad Prism](#) for the statistical analysis of their data and preparation of graphs for their written assignment. Individual licenses will be distributed to students on the first week of class. Students will have the choice of either downloading the software into their personal computer, or in a computer in SW316. If you'd like to use it in one of the SW316 computers, please email the TA with this request so we can proceed with the installation. Additionally, one copy of the software will be available at the Bladen wing computer lab, BV490 (look for a label saying 'Prism' on the monitor).

Overview of Lecture, Lab, and Tutorial Schedule:
The following table presents the schedule of lectures, labs, and tutorials, as they will occur over the course of the term, and the due dates for assignments. Please note:
- Lab times for Labs 1 and 2 will vary according to student group. A sign-up sheet will be passed along on the first week of class. *Please be sure to write down your respective groups and consult the schedule to make sure you attend the right time slot.*

WEEK	DATE	CONTENT	LOCATION	Advance Reading	TO DO

1	Sep 5	Lecture: Course Introduction and Overview	SW316		
2	Sep 12	2-3PM: Library research workshop (Nicole Slattery) 3-5PM: Lecture: Overview of cellular neuroscience techniques and our mini research project	SW316		
3	Sep 19	2-3PM: Writing Centre workshop: Synthesizing research (Nancy Johnston) 3-5PM: Lecture: Using the brain atlas to navigate brain circuits	SW316		
4	Sep 26	2-3PM: *Quiz* Lecture: Introduction to Lab 1: Brain sectioning 3-7 PM: **Lab 1**, see group distribution and schedule above	SW316 SW148	Lab 1 manual	
	Sep 27	9AM-11AM: Lab1, see group distribution and schedule above	SW148		
5	Oct 3	2-4PM: Lecture: Techniques to measure protein expression 4-5PM: Tutorial: writing a scientific paper: Introduction	SW316		
6	Oct 10	2-3PM: *Quiz* Lecture: Introduction to Lab 2: Immunohistochemistry 3-7 PM: **Lab 2**, see group distribution and schedule above	SW316 SW148	Lab 2 manual	Introduction of research paper due
	Oct 11	9AM-2PM: Lab 2, see group distribution and schedule above	SW148		
7	Oct 17	2-4PM: Lecture: Microscopy 4-5PM: Tutorial: feedback on introduction; how to write methods and discussion	SW316		
8	Oct 24	2-3PM: *Quiz* Demo of fluorescence microscopy and introduction to Lab 3: Cell counting 3-5PM: **Lab 3**	SW316	Lab 3 manual	
9	Oct 31	Reading Week – No Class			
10	Nov 7	2-4PM: Lecture: Methods for imaging neuronal activity 4-5PM: Tutorial	SW316		Methods and list of discussion papers due

11	Nov 14	2-3PM: Stats Tutorial 3-5PM: Lecture: Data analysis and interpretation, writing the results section	SW316		Lab 3 cell counts due
12	Nov 21	2-4PM: *Quiz* Lecture: Methods for manipulating neuronal activity 4-5PM: Tutorial and feedback	SW316		
13	Nov 28	2-4PM: *Quiz* Lecture: Methods for measuring neuronal morphology 4-5PM: Wrap up and course review	SW316		Full research paper due

Course Grading Scheme:

Following the University Assessment and Grading Practices Policy:
(http://www.governingcouncil.utoronto.ca/Assets/Governing+Council+Digital+Assets/Policies/PDF/grading.pdf; http://www.artsci.utoronto.ca/newstudents/transition/academic/grading):

Letter Grade	Grade point value	Numerical Mark	Grade Definition
A+	4.0	90 - 100%	Excellent: 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.
A	4.0	85 - 89%	Excellent
A-	3.7	80 - 84%	Excellent
B+	3.3	77 - 79%	Good: Evidence of grasp of subject matter; some evidence of critical capacity and analytic ability; reasonable understanding of relevant issues; evidence of familiarity with literature.
B	3.0	73 - 76%	Good
B-	2.7	70 - 72%	Good
C+	2.3	67 - 69%	Adequate: Student who is profiting from his/her university experience; understanding of the subject matter; ability to develop solutions to simple problems in the material.
C	2	63 - 66%	Adequate
C-	1.7	60 - 62%	Adequate
D+	1.3	57 - 59%	Marginal: Some evidence of familiarity with subject matter and some evidence that critical and analytic skills have been developed.
D	1.0	53 - 56%	Marginal

D-	0.7	50 - 52%	Marginal
F	0	0 - 49%	Inadequate: Little evidence of even superficial understanding of subject matter; weakness in critical and analytic skills; with limited or irrelevant use of literature.

Note: Consistently poor spelling/grammar will be penalized. Please make use of the resources available at the UTSC writing centre for additional help with writing: http://ctl.utsc.utoronto.ca/twc/.

DEPARTMENT OF PSYCHOLOGY POLICIES

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 procedure outlined below.

Procedure:

1. Complete the Request for Missed Term Work Accommodations Form ("MTW Form").

2. Email **BOTH** your MTW Form and Supporting Documentation to the TAs according to the instructions specified below.

Supporting Documentation Requirements and Deadlines:

Reason for Missed Work	Documentation required for a *first absence* in the term	Documentation required for *subsequent absences* in the term	Deadline for submitting MTW form and supporting documentation
Illness or Injury	ACORN Absence Declaration	UofT Verification of Illness Form	**WITHIN 2 BUSINESS DAYS** of the missed work
Bereavement	ACORN Absence Declaration	A death certificate or funeral announcement	**WITHIN 2 BUSINESS DAYS** of the missed work
University-sponsored athletic or artistic obligation at the varsity/provincial/national level	ACORN Absence Declaration	A note from a university staff member (advisor, coach, residence staff, etc.) who can substantiate the obligation, sent directly to the course email	**10 BUSINESS DAYS IN ADVANCE** of the missed deadline
Disability-related reasons for students registered with AccessAbility Services	For missed *TERM TESTS,* - **Contact your AccessAbility consultant** and have them write to the course email detailing the accommodations needed. For missed *ASSIGNMENTS,* - 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), send your		**PREFERABLY IN ADVANCE OF THE MISSED WORK, OR AS SOON AS POSSIBLE**

	Accommodation Letter to the course email and specify 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), **contact your AccessAbility consultant** and have them write to the course email detailing the accommodations needed.	
Academic Conflict (e.g. two midterms at the same time)	Screenshot from Quercus demonstrating the conflict.	**10 BUSINESS DAYS IN ADVANCE** of the missed work
Religious Conflict	None required	

Notes:

- The following reasons are not considered sufficient for missed term work: social activities, recreational travel, technological issues, avoidance of assessments or deadlines, work commitments
- Missed Final Exams are handled by the Registrar's Office and should be declared on eService.
- For ACORN absence declarations, the date you declare the absence is required to fall within the seven-day declaration period (i.e.) the absence cannot be submitted proactively or retroactively.
- 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.
- If you are unable to submit your request within the specified number of business days, you must still email your instructor within that window to explain the nature of the delay. Exceptions to the deadlines are made only under exceptional circumstances.
- Multiple assignments due on the same day are not considered academic conflicts. Students are expected to manage their time effectively to meet assignment deadlines.
- Back-to-back tests/quizzes are not considered academic 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.

Next Steps:

After submitting your documentation, you will receive a response from your instructor or TA. The course instructor reserves the right to decide what accommodations 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.

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.** Examples: If you were granted an extension for a paper but are still unable to meet the new deadline, or if you miss a make-up term test, you must submit another MTW form and supply documentation according to the "subsequent absences" column in

the chart above. *Note: In the case of a missed make-up test, an opportunity to write a second make-up test may not necessarily be provided.

UTSC POLICIES

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 web site (https://uoft.me/pdt-faq).

Academic Integrity

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 in papers and assignments include 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, cheating includes using or possessing unauthorized aids, looking at someone else's answers during an exam or test, misrepresenting your identity, or falsifying or altering any documentation required by the University.

Equity, Diversity and Inclusion

The University of Toronto 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.

The University of Toronto is a richly diverse community and as such is committed to providing an environment free of any form of harassment, misconduct, or discrimination. In this course, I seek to foster a civil, respectful, and open-minded climate in which we can all work together to develop a better understanding of key questions and debates through meaningful dialogue. As such, I expect all involved with this course to refrain from actions or behaviours that intimidate, humiliate, or demean persons or groups or that undermine their security or self-esteem based on traits related to race, religion, ancestry, place of origin, colour, ethnic origin, citizenship, creed, sex, sexual orientation, gender identity, gender expression, age, marital status, family status, disability, receipt of public assistance or record of offences.

University Land Acknowledgement

I wish to acknowledge this land on which the University of Toronto operates. For thousands of years, it has been the traditional land of the Huron-Wendat, the Seneca, and the Mississaugas of the Credit. Today, this meeting

place is still the home to many Indigenous people from across Turtle Island and we are grateful to have the opportunity to work on this land.

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 feel free to approach me and/or the AccessAbility Services Office as soon as possible.

AccessAbility Services staff (located in Rm AA142, Arts and Administration Building) are available by appointment to assess specific needs, provide referrals and arrange appropriate accommodations 416-287-7560 or email ability.utsc@utoronto.ca. The sooner you let us know your needs the quicker we can assist you in achieving your learning goals in this course.

Use of Generative Artificial Intelligence Tools

Students may use artificial intelligence tools, including generative AI, in this course as learning aids or to help produce assignments. However, students are ultimately accountable for the work they submit.

Students may not use artificial intelligence tools for taking tests, writing research papers, creating computer code, or completing major course assignments. However, these tools may be useful when gathering information from across sources and assimilating it for understanding.

The knowing use of generative artificial intelligence tools, including ChatGPT and other AI writing and coding assistants, for the completion of, or to support the completion of, an examination, term test, assignment, or any other form of academic assessment, may be considered an academic offense in this course.

Recording of Classroom Material by Students

Recording or photographing any aspect of a university course - lecture, tutorial, seminar, lab, studio, practice session, field trip etc. – without prior approval of all involved and with written approval from the instructor is not permitted.