

Molecular Neuroscience

NROC36H3S

University of Toronto Scarborough
Winter 2022

Instructor: Maithe Arruda Carvalho

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Weeks 1-3: Online asynchronous; lectures will be posted by Friday of that week

Weeks 4-12 (pending new announcements/restrictions): Tuesdays 1-3pm, MW140*

Office hours: Wednesdays 3-5pm, Zoom: <https://utoronto.zoom.us/j/88997402939>

Meeting ID: 889 9740 2939 Passcode: 394022

*Any changes to course delivery mandated by the University as a response to health and safety measures will be communicated via email/Quercus.

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*Any questions referring to this course must be first addressed to the TAs.

This course will provide students with a thorough background in the molecular and cellular mechanisms underlying neuronal communication in the central nervous system. We will explore concrete examples of that communication within the physiological (e.g. learning and memory) and pathological (e.g. neurodegenerative disorders) realms. We will start with the building blocks of synaptic communication, by learning about intracellular signalling, modulation of neuronal DNA and protein expression, and neurotransmitter systems. We will then use this knowledge to understand the specific molecular and cellular steps necessary for enabling neuronal communication. This will serve as a base to our understanding of how these mechanisms can be used in the brain to encode information in the form of synaptic plasticity in learning and memory. We will close by examining how these same mechanisms can be co-opted in pathological instances to impair cognitive and emotional function.

Course Learning Objectives

By the end of this course, students will:

- Understand the core principles underlying synaptic communication in the central nervous system, and how these mechanisms contribute to synaptic plasticity and learning
- Be provided with an overview of some of the main contemporary concepts and applications of molecular and cellular neuroscience
- Understand how molecular and cellular methods can be applied in research to address the latest challenges within the field
- Practice reading and analysing scientific articles relevant to the area
- Think critically and express themselves about unresolved questions in the field

- Gain the necessary background to critically evaluate the design, analysis, and conclusions of molecular neuroscience research
- Improve their oral and written communication skills through in-class discussions and feedback on written assignments and short-answer questions on exams

Course Materials

Students will be provided with complementary readings for each lecture, which will include textbook chapters and papers (see timetable). Mostly, this course will use selected chapters from two textbooks available online through the UTSC library website:

- **From molecules to networks: an introduction to cellular and molecular neuroscience = (MtN)** Edited by John H. Byrne, James L. Roberts.
<http://www.sciencedirect.com.myaccess.library.utoronto.ca/science/book/9780123971791>
- **Principles of neural science = (PoN)**
 Edited by Eric R. Kandel et al.
<https://search.library.utoronto.ca/details?9548509&uuid=55d35fed-dbbe-4682-9afb-d8169f98181b>

Additional material (including assigned papers) will be available through the e-reserves module of Course Reserves: <https://cr.library.utoronto.ca/>

Although not all content of textbook chapters will be covered in the lectures, it is **highly recommended** you read the accompanying chapter for each lecture. It will help your *understanding* of the topic and will *improve your performance* on the exams. You can also find any additional papers featured in the lectures (if they are not already available on course reserves) through a pubmed search - all references are on the lecture slides. Handouts of lecture slides will be posted on Quercus by midnight at the latest the night before the lecture.

Course Evaluation

Summary of Evaluation:

	<u>Percent of final grade</u>	<u>Date</u>
Writing assignment	15%	Mar 8 th
Term tests 1 and 2	25% each	Feb 8 th , Mar 22 nd *
Student generated MCQs	5%	Jan 21st; Feb 4th; Mar 4th; Mar 18th; Apr 8th
Final Exam	30%	Exam Period

**pending confirmation following in person vs remote delivery updates*

Description of evaluation components:

1. Writing Assignment (15%) – March 8th

This assignment will consist of a critical review of an empirical research paper. You will be given a choice between two assigned papers. Papers will be assigned on February 8th through an announcement on Quercus. Both the assigned papers have been submitted to Biorxiv without prior peer-review, which means you will be doing exactly what the reviewers of this manuscript will be doing when it is submitted to a neuroscience journal such as Journal of Neuroscience, etc – this is the real deal!

You will write a critique of the paper of your choice, which will be broken down in three sections:

1. Brief summary of results – In this 2-4 paragraph section you will briefly summarize the main rationale (what is the main goal of this paper? Which gap in knowledge are they trying to fill?), results and conclusions of the paper
2. Critical review – In this section you will evaluate this article in detail focusing on two parts: (i) its main strengths and (ii) its main weaknesses. This exercise is supposed to emulate the reviewing of a paper by a scientific journal. So think about the paper in terms of its conclusions and interpretations - Does the data support the conclusions? Are the experiments well designed and controlled? Are the techniques appropriate? Does this paper fill an important gap in knowledge? Does it answer the questions it set out to answer? Are you satisfied with the way they chose to answer those questions?

You can explore the weaknesses of the manuscript in any way you prefer, but one suggestion is to frame your concerns relating to what you think the authors should do to improve the manuscript. This will strengthen your decision to recommend accepting or rejecting the manuscript (next section).

Example (here in bullet points solely for illustration purposes):

- Given that (i) estrous cycle blocks the behavioral deficits reported in this manuscript, (ii) TMX is an estrogen modulator and (iii) the known effects of estrogen on memory performance, estrogen seems a likely candidate to mediate the reported effects. Nevertheless, this possibility is not really discussed in the manuscript. Instead, the authors insist on comparing their data to
- Several controls should be included to strengthen the conclusion that Training data, anxiety and motor tests are the minimum necessary controls for these types of experiments, and are not present in this study.
- It would be helpful for the reader if the authors described the drugs used in this study in the main text. As it stands no explanation or description is offered of their targets or function and of how they serve the described experiments.

3. Recommendation – In a few sentences, you will justify whether you would accept or reject this paper based on your critical evaluation in the last section. The options for the majority of journals include *accept, minor revisions, major revisions or reject*. State your recommendation and justify your choice!

This assignment will develop your critical and scientific writing skills. It will also give you a glimpse into the editorial process of any submitted manuscript to a journal. Importantly, you will receive feedback on your assignment identifying areas that require improvement.

The paper must be a maximum of 5 pages, excluding references, double spaced, in Calibri font 11, with 1" margins. In-text citations must follow the Journal of Neuroscience citation style. 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.

This assignment will be submitted through Quercus and Ouroriginal. Submissions are due **by 11:59PM on March 8th**. Late submissions will be accepted with a **penalty of 10% for every day late**. To submit your assignment, click on Assignments: Writing assignment

2. Term Tests 1 and 2 (25% each) – February 8th and March 22nd*, 1h50m each

Tests will be based on the material covered on the lectures (Lectures 1-4 for term test 1, and lectures 5-8 for term test 2). Each term test will consist of multiple-choice and short answer questions. I will provide sample questions. Term tests will take place in person* and will last 1h50m each.

**pending confirmation following in person vs remote delivery updates*

3. Questions about lecture contents (5%) – Jan 21st; Feb 4th; Mar 4th; Mar 18th; Apr 8th

To help keep up with lecture content and allow the instructor an opportunity to check in with students more frequently, students are to submit 1 original question in multiple choice format (4-5 choices each) featuring content covered in each of the 10 lectures.

Example question:

Preventing the switch from GDP-to GTP-binding within a GPCR α subunit will lead to:

- A. Dissociation of the α and $\beta\gamma$ subunit
- B. A conformational change in the α subunit, activating its intrinsic GTPase activity
- C. Lockdown of G protein activity to an inactive state
- D. Recruitment of GTPase-activating proteins (GAPs) to replace GDP with GTP

Students will generate one question per lecture. Questions should cover topics explicitly featured in the respective lecture. Try and be creative but fair, and avoid mere memorization questions (e.g. what is XYZ called, etc). The best questions may be shared (anonymously) with the class to help in their study preparation.

These questions will be submitted in pairs, with each submission featuring 2 lecture questions (one question for each covered lecture) for a 1% combined grade, on the following dates:

Lectures 1 and 2: Jan 21st by 11:59pm

Lectures 3 and 4: Feb 4th by 11:59pm

Lectures 5 and 6: Mar 4th by 11:59pm

Lectures 7 and 8: Mar 18th by 11:59pm

Lectures 9 and 10: Apr 8th by 11:59pm

Late submissions will be accepted with a **penalty of 10% for every day late**. To submit your questions, click on Assignments: Student Questions

I will post sample questions prior to each term test to further help with studying and keeping up with lecture content throughout the term.

4. Final Exam (30%) – Exam period

The final exam will be scheduled during the exam period and will be comprised of two sections:

Section 1 (12.5%)

Short answer and multiple choice questions spanning lectures 9 and 10

Section 2 (17.5%) – Research paper analysis

An empirical research paper will be posted 2 weeks prior to the final exam. Students should carefully read the paper in preparation for the exam. You will be required to answer questions assessing your understanding of the paper, its research topic, conceptual knowledge covered in the lecture materials, as well as providing a critical analysis of its content.

Overview of Course Schedule:

The following table presents the schedule of lectures and term tests as they will occur over the course of the term, and the due dates for the assignment.

Lecture	Date/ Week	Location	Content	Recommended Reading	TO DO
1	Week 1	Online, asynchronous	Course Introduction and Recap of intracellular signaling	Excerpt from Molecular Biology of the cell (on course reserves)	
2	Week 2	Online, asynchronous	Regulation of Neuronal Gene Expression and Protein Synthesis	MtN chapter 5	Qs for lectures 1 and 2: Jan 21 st
3	Week 3	Online, asynchronous	Neurotransmitter synthesis and removal	MtN chapter 7	
4	Feb1	MW140	Neurotransmitter release	MtN chapter 15	Qs for lectures 3 and 4: Feb 4 th
	Feb 8, 1-2:50pm	MW140	Term test 1		Papers assigned
5	Feb 15	MW140	Neurotransmitter receptors I: Ionotropic Receptors	MtN chapter 10	
	Feb 22		Reading Week		
6	Mar 1	MW140	Neurotransmitter receptors II: Metabotropic Receptors	PoN chapter 11	Qs for lectures 5 and 6: Mar 4 th
7	Mar 8	MW140	Molecular basis of implicit memory	PoN chapter 66	Writing assignment
8	Mar 15	MW140	Molecular basis of synaptic plasticity I	PoN chapter 67; Collingridge et al., Nat Rev Neuro 2004 and 2010; Henley and Wilkinson Nat Rev Neuro 2016	Qs for lectures 7 and 8: Mar 18 th
	March 22, 1-2:50pm	MW140	Term test 2		
9	Mar 29	MW140	Molecular basis of synaptic plasticity II	MtN chapter 18; Lisman, Nat Rev Neuro 2002	
10	Apr 5	MW140	Molecular mechanisms of disease	MtN chapter 21	Qs for lectures 9 and 10: Apr 8 th

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>):

<i>Letter Grade</i>	<i>Grade point value</i>	<i>Numerical Mark</i>	<i>Grade Definition</i>
<i>A+</i>	<i>4.0</i>	<i>90 - 100%</i>	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.
<i>A</i>	<i>4.0</i>	<i>85 - 89%</i>	Excellent
<i>A-</i>	<i>3.7</i>	<i>80 - 84%</i>	Excellent
<i>B+</i>	<i>3.3</i>	<i>77 - 79%</i>	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.
<i>B</i>	<i>3.0</i>	<i>73 - 76%</i>	Good
<i>B-</i>	<i>2.7</i>	<i>70 - 72%</i>	Good
<i>C+</i>	<i>2.3</i>	<i>67 - 69%</i>	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.
<i>C</i>	<i>2</i>	<i>63 - 66%</i>	Adequate
<i>C-</i>	<i>1.7</i>	<i>60 - 62%</i>	Adequate
<i>D+</i>	<i>1.3</i>	<i>57 - 59%</i>	Marginal: Some evidence of familiarity with subject matter and some evidence that critical and analytic skills have been developed.
<i>D</i>	<i>1.0</i>	<i>53 - 56%</i>	Marginal
<i>D-</i>	<i>0.7</i>	<i>50 - 52%</i>	Marginal
<i>F</i>	<i>0</i>	<i>0 - 49%</i>	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/>.

Psychology Department Missed Term Work Policy, WINTER 2022

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

- 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: <http://www.utsc.utoronto.ca/registrar/missing-examination>
- Instructors cannot accept term work any later than five business days after the last day of class. Beyond this date, you would need to file a petition with the Registrar's Office: <https://www.utsc.utoronto.ca/registrar/term-work>

Accommodations for Illness or Emergency:

For missed work due to ILLNESS OR EMERGENCY, complete the following **three-step** process:

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

Note: If you are unable to submit your documents within 2-business days, **you must still email your instructor within the 2-business day window** to explain the nature of the delay, and when you will be able to provide your documents. Exceptions to the documentation deadline will only be made under **exceptional circumstances**.

Note: For this semester, we do not require any additional supporting documentation (e.g. medical notes) to support your missed term work accommodation request.

Accommodations for Academic Conflicts:

For missed term work due to an ACADEMIC CONFLICT (i.e. two midterms scheduled at the same time), please complete the following process:

1. Complete the [Request for Missed Term Work Accommodations Form](#), choosing "Other" and explaining the conflict in the space provided.
2. Take screenshots of your course homepages that demonstrate the conflict.
3. Email the form and screenshots to your course instructor **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.

Note: Multiple assignments due on the same day are not considered conflicts. Accommodations may only be possible in the case of quizzes and tests that are both scheduled during the same discrete period. Back-to-back tests/quizzes are not considered conflicts.

Note: Students are responsible for keeping their course timetables conflict-free. Students who choose to register in two synchronous courses with overlapping lecture/tutorial/lab schedules will not be accommodated.

Accommodations for Religious Conflicts:

For missed term work due to a RELIGIOUS CONFLICT, please complete the following process:

1. Complete the [Request for Missed Term Work Accommodations Form](#), choosing "Other" and noting "Religious conflict" in the space provided.
2. Email the form to your course instructor **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.

Accommodations for Students Registered with AccessAbility Services:

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

- **Contact your AccessAbility consultant** and have them email your instructor 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 your instructor, 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 your instructor 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 for accommodation. **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 an instructor response to resume work on your assignment**. Extension accommodations may be as short as one business day, depending on the nature of the illness/emergency. You should complete your assignment as soon as you are able and email it your instructor.

For an anticipated event (e.g. scheduled surgery or an illness with a prolonged recovery period), submit a [Verification of Illness Form](#) completed by your doctor, AND this form to your instructor if you would like to request accommodations in advance of the assignment deadline or midterm date. **Declare your future absence on [ACORN](#) (absences can be declared up to 14 days in the future)**.

Missed Accommodations

If an accommodation is granted but a continued illness/emergency prevents you from meeting the requirements of your accommodation, 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.**

For example, if you are given an extension but are still sick and need more time, or if you miss a make-up midterm, you must submit another request ‘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 be provided.

Mid-terms/exams that are missed without approved justification (see above) will receive a 0% mark.

If accommodation is granted:

- If you miss the first term test, your second term test will be a cumulative exam (based on lectures 1-8)
- If you miss the second term test, there will be one make up exam on the week of March 29th. However, as this exam will be very close to the final exam, please note that this may take away from important preparation for the final exam.

Contesting a grade

Re-grade requests will only be considered within two weeks of the grade being received. 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 change in the grade in either direction, i.e. a grade increase, no change, or decrease. Requests without a solid rationale will not be considered (e.g. higher grade needed for entering grad school, etc.).

Video and Auditory Recording

For reasons of privacy and copyright, unauthorized video or audio recording or copying of lecture files is prohibited. This is in accordance with the Provost's guidelines on Appropriate Use of Information and Communication Technology. Please note 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".

Copyright of lecture material

As protection of copyright, unauthorized copying, use, or uploading on www of any of the lecture slides, lecture handouts or course materials produced by Professor Arruda-Carvalho is **strictly prohibited**.

AccessAbility statement:

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 as soon as possible.

AccessAbility Services staff (located in Rm SW302, Science Wing) are available by appointment to assess specific needs, provide referrals and arrange appropriate accommodations [416-287-7560](tel: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.

Academic integrity

Academic integrity is essential to the pursuit of learning and scholarship in a university, and to ensuring that a degree from the University of Toronto is a strong signal of each 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/Assets/Governing+Council+Digital+Assets/Policies/PDF/ppjun011995.pdf>) 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 or concerns 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 much better and safer to take your draft to the Writing Centre as early as you can. They will give you guidance you can trust. Students for whom English is not their first language should go to the English Language Development Centre.

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.

Please note that all assignments submitted on Quercus will be assessed by a plagiarism detection program (now called Ouriginal), which is a tool that assists in detecting textual similarities between compared works (which includes past student work). Any similarity score/index of >25% will be investigated.
