NEUR3121

Molecular and Cellular Neuroscience

Course Outline

Term 1, 2023

School of Medical Sciences

Faculty of Medicine & Health

Table of Contents

1. Staff

Position	Name	Email	Consultation times and locations
Course Convenors	Dr Trevor Lewis	t.lewis@unsw.edu.au	By appointment
Course Co-convenor	AProf Kate Poole	k.poole@unsw.edu.au	By appointment
Lecturers	AProf Andrew Moorhouse	a.moorhouse@unsw.edu.au	By appointment
	Dr Matt Perry	m.d.perry@unsw.edu.au	By appointment
	Prof Gary Housley	g.housley@unsw.edu.au	By appointment
	AProf Nicola Smith	n.smith@unsw.edu.au	By appointment
Demonstrators	Eddie Wise	e.wise@unsw.edu.au	By appointment
	Yi (Jack) Zeng	y.zeng@victorchang.edu.au	By appointment

Students wishing to see the course convenors or lecturers should make an appointment by email.

2. Course information

Units of credit: 6 UOC

Pre-requisite(s): PHSL2101 or PHSL2121 or PHSL2501

Teaching times and locations: https://timetable.unsw.edu.au/2023/NEUR3121.html

2.1 Course summary

This course provides an integrative approach to understanding cellular neuroscience. It begins with an understanding of cell membranes and the mathematical equations that describe the movement of ions. It then builds a repertoire of the key molecules that underlie the processes of signalling in neural cells. These are then combined to understand the behaviour of neural cell signalling and how these may be manipulated experimentally to understand the function. Topic areas include: how electrical signals are generated across cell membranes; the function, properties and structure of ion channels, receptors and transporters; how nerve cells communicate with each other in the brain, including synaptic transmission and receptor-mediated signalling; how alterations in function can lead to disease states; modern experimental techniques in cellular neuroscience; application of molecular biology techniques to manipulate and explore the function of molecules in the nervous system. The course provides an ideal complement to further studies in neuroscience, higher physiological systems and neuropharmacology.

2.2 Course aims

The content of the course provides a deeper understanding of the way excitable neuronal cells function and communicate with each other by exploring the molecular and cellular mechanisms. It builds upon the basic understanding learned in PHSL2101/2121/2501 (Physiology 1A), by considering the biophysical principles, and the molecular, synaptic, and cellular processes that can be used to explain examples of brain function. Thus, the objectives of this course are for you to:

- integrate your understanding of the biophysical principles with the function of molecular components of neuronal signalling, through the learning activities in the practical classes and tutorials.
- build a deeper understanding of these principles and processes by exploring them with respect to an ion channel disease in the collaborative assignment.
- employ and develop your teamwork skills to work collaboratively on the ion channel disease assignment.
- develop skills in the interpretation and analysis of scientific data and literature, problem-solving, and the communication of information in an accessible manner.

2.3 Course learning outcomes (CLO)

At the successful completion of this course you (the student) should be able to:

1. Explain how the properties of ion channels, transporters and receptors contribute to electrical and chemical signalling in neurons.
2. Predict what will happen to an excitable cell with a change in electrochemical gradient or synaptic input by applying your understanding of basic biophysical properties, and concepts of neuronal signalling.
3. Apply your understanding of molecular and cellular neuroscience to a disease state, through critical reading of the scientific literature and integrating information from a variety of different sources.
4. Express your understanding of concepts through clear, concise, and accurate scientific language.

2.4 Relationship between course learning outcomes and assessments

Course Learning Outcome (CLO)	**LO Statement**	**Related Tasks & Assessment**
CLO 1	Able to explain how the properties of ion channels, transporters and receptors contribute to electrical and chemical signalling in neurons.	Concept quizzes Progress test End of session exam
CLO 2	Able to predict what will happen to an excitable cell with a change in electrochemical gradient or synaptic input by applying your understanding of basic biophysical properties, and concepts of neuronal signalling.	Concept quizzes Progress test End of session exam
CLO 3	Able to apply your understanding of molecular and cellular neuroscience to a disease state, through critical reading of the scientific literature and integrating information from a variety of different sources.	Collaborative assignment

Course Learning Outcome (CLO)	LO Statement	Related Tasks & Assessment
CLO 4	Able to express your understanding of concepts through clear, concise, and accurate scientific language.	Collaborative assignment Progress test End of session exam

3. Strategies and approaches to learning

3.1 Learning and teaching activities

The learning activities used in the course are varied and aim to create an active learning environment that interests, challenges and inspires students. Online learning activities are a mixture of pre-recorded presentations (lectures) and interactive learning activities. These provide the core knowledge and insights into techniques and recent research. The course material is presented by several lecturers, each with expertise in the field. Tutorials are designed to develop student expertise in using simple mathematical and biophysical principles to solve physiological problems and develop analytical skills. The tutorials will provide opportunities for expressing your reasoning or thinking and will support your understanding of the core course knowledge. In addition, tutorials will include discussion of primary research papers to develop student capacity for critical reading of scientific literature and to provide an insight into ongoing research. Practical classes are a combination of computer modelling / simulation of neuronal signalling, that allow testing ideas that cannot easily be done by other means, and classes with biological materials that provide insight to experimental techniques in real systems.

3.2 Expectations of students

Students are reminded that UNSW recommends that a 6 units-of-credit course should involve about 150 hours of study and learning activities. The formal learning activities total approximately 54 hours throughout the term, including online material. The completion of the concept quizzes, the collaborative project, plus additional self-directed study will make up the balance. Students are expected (and strongly recommended) to allocate at approx. 15 hours per week (total) for this course.

The practicals and tutorials provide opportunities to support and apply your knowledge (as described above) and to clarify concepts covered in each week's lecture topics. You should review the lecture topics and make notes in advance of the related practicals and tutorials. You should then review your notes and write down any questions you have about these topics and bring them along to the practical or tutorial or post them to the Moodle discussion forum.

In the tutorials, you will work in teams to apply your knowledge from the lecture topics to solving problems in molecular and cellular neuroscience. These will be the same teams you will work in for the collaborative assignment. The tutorials and collaborative assignment provide opportunities to develop your communication, time management and teamwork skills.

Students will be expected to provide a personal laboratory coat and safety glasses for those practical classes where they are required. This will be clearly indicated in the information for the practical class on Moodle.

All students will have completed ELISE in their first year of study at UNSW. You may want to revise this learning activity to refresh your research skills, to enhance your ability to complete the collaborative project in this course.

If you wish to contact the course convenors or staff, you can do so by e-mail, using the details provided in section 1 of this document and on the course Moodle page. We are committed to providing the best experience and outcome for all students and will therefore endeavour to respond to e-mails as soon as possible, but please consider the following:

- Standard work hours are Monday to Friday from 8:30 am to 5:30 pm. E-mail correspondence received outside of this time may be dealt with from the next working day.
- All staff and students have busy schedules and multiple commitments, so while staff will endeavour to answer e-mail correspondence as quickly as possible, please apply appropriate expectations in this regard (i.e., within 48 hours and on a workday).
- All digital correspondence, including e-mail, Teams messages, and messages on discussion forums should be respectful, courteous, and polite.

To help us improve the course, please consider providing us with feedback by acting as a student liaison, and/or by completing the MyExperience survey later in the term.

4. Course schedule and structure

This course consists of 54 hours of class contact hours (lectures, practical classes, and tutorials). You are expected to take an additional 8 hours of non-class contact hours to complete assessments, prepare for tutorials and practicals, complete the collaborative assignment and exam preparation.

Week	Lecture topics	Activity	Related CLO
Week 1	Conventions and terminology of neuroscience [online]. Equilibrium potentials and Nernst equation. Membrane potentials and GHK equation.	Tutorial: Teamwork skills Practicals: A: Recording membrane potentials B: Artificial membrane potentials	1, 2, 4
Week 2	Voltage-gated ion channel families. Mechanisms of voltage-dependent gating.	Tutorial: Team agreement and scoping report Practicals A: Artificial membrane potentials B: Recording membrane potentials	1, 2, 4
Week 3	Action Potential Mechanisms – Classical Biophysics. Mechanisms of ion permeation.	Tutorial: Membrane potentials Practicals A: Voltage clamping a patch B: Collaborative assignment	1, 2, 3, 4
Week 4	Propagation of electrical signals in axons and dendrites. Ligand-gated ion channel families.	Tutorial: Analysis of voltage-gated currents Practicals A: Collaborative assignment B: Voltage clamping a patch	1, 2, 3, 4
Week 5	Transient receptor potential (TRP) channel family. Mechanosensitive channels.	Tutorial: Propagation of electrical signals Practicals Progress test	1, 2, 4
Week 7	GPCR structure – function. Cell-cell communication.	Tutorial: Mechanosensitive channels Practicals A: Collaborative assignment B: Collaborative assignment	1, 2, 3, 4
Week 8	Synaptic structure. Metabotropic receptor signalling.	Tutorial: Cell-cell communication Practicals No practical – Good Friday	1, 2, 4
Week 9	Synaptic modulation (pre-recorded) Synaptic integration (pre-recorded)	Tutorial: GPCRs and metabotropic signalling Practicals A: Synaptic transmission and propagation B: Compound action potential	1, 2, 4
Week 10	Synaptic plasticity. Touch and pain transduction.	Tutorial: Synaptic plasticity Practicals A: Compound action potential B: Synaptic transmission and propagation	1, 2, 4

NOTE: In week 6 (flexibility week) there will be an option to visit some neuroscience research laboratories. Details on how to sign up for this opportunity will be posted on Moodle.

Exam Period: 28 Apr – 11 May 2023

Supplementary Exam Period: 22 May – 26 May 2023

5. Assessment

5.1 Assessment tasks

Assessment task	Length	Weight	Mark	Due date and time
Assessment 1: Concept quizzes	5 quizzes	15%	Each quiz marked out of 10; total of 50 marks	Week 5 and 10
Assessment 2: Collaborative assignment	Report 2500 words Teamwork 500 words	25%	Report, 100 Teamwork, 20	Report Teamwork
Assessment 3: Progress test	1 hour	20%	50	Week 5, Friday 17 Mar 2023, 2:00 pm
Assessment 4: End of session exam	2 hours	40%	100	Exam period: 28 April – 11 May

Assessment 1: Concept quizzes.

The “concept quizzes” will assess your understanding and application of the key concepts that are explored in the practical classes and related online activities. The quizzes will be available online via the course Moodle site. The questions will be multiple choice, short calculations, fill in the blanks, or drag-and-drop type questions. The key concepts are listed on the Moodle page for each activity. The quiz for each practical class will be available online for a limited time and the deadline by which the quizzes need to be completed will be provided on Moodle. The quiz will need to be completed in your own time.

Assessment 2: Collaborative assignment.

The collaborative assignment will require students to work in teams of four students to research and report on the properties of an ion channel, and individually provide a self-assessment and reflection on their teamwork skills. There are one or more diseases that are associated with mutations in the gene for the ion channel. Student teams will use online databases to identify characteristics of the gene and the ion channel for which it codes. A literature search will be required to identify the function of the channel and how this is altered in the disease state. The team will produce a team agreement, a scoping report and a final report, all of which are submitted online. The final report must include a statement on the contribution of each team member. Each member will also provide an individual self-assessment and reflection on the development of one aspect of their teamwork skills and a peer assessment on the teamwork skills of the other team members. The final report is a review style article aimed at a general scientific audience, providing information on the function of the ion channel and the effect of the mutation on the ion channel to cause the disease state. The assessment will be based on identifying relevant information from appropriate sources, with proper references for all sources; analysis and interpretation of experimental data; integration of information (not just summarising the individual components); and effective communication that demonstrates understanding. The assessment rubric for the assignment is provided on Moodle.

Assessment 3: Progress test.

The progress test will be comprised of short answer questions, multiple choice and/or short calculations (a UNSW approved calculator will be required). The questions will be based on the material covered in the online activities, the practical classes, and the tutorials. This will assess your understanding and application of the concepts developed in the course. The test will be online and held during the scheduled practical class. Please see the course schedule for the specific date.

Assessment 4: End of session exam.

The end of session exam will be comprised of short answer questions that will include some mathematical calculations and a UNSW approved calculator will be required. The short answer questions will be based on the material covered in the lectures and tutorials. Material covered in the progress test may be again examined in the final exam. The exam will be online and open book.

Further information

UNSW grading system: https://student.unsw.edu.au/grades

UNSW assessment policy: https://student.unsw.edu.au/assessment

5.2 Assessment criteria and standards

Students are reminded that items submitted for assessment must be their own work, or the collaborative work of the team of which they are a member.

For the **concept quizzes**, the purpose is to demonstrate your understanding of the key concepts and ability to apply these concepts in solving simple problems in molecular and cellular neuroscience.

For the **collaborative assignment**, an assessment rubric is provided in Moodle that describes each of the assessment criteria and the standards of achievement for each criterion. The breakdown of marks for each of the assessment criteria is provided.

When working in a team, all students are expected to contribute in an equitable manner to the learning activities.

For the **progress tests** and the **end of session exam**, questions are designed to assess your understanding of the content, the application of the content to solve problems and your reasoning for the answer provided. Each question will have marking criteria for the correct answer, the approach taken to solve the problem and the reasoning for this approach or answer given. Students should consider each of these aspects when composing their answers.

Practice exam questions will be made available to you in Moodle. Tutorials also provide an opportunity to practice this type of exam question.

5.3 Submission of assessment tasks

All assessment tasks are submitted online via the links provided in Moodle.

Late Submission

UNSW has standard late submission penalties as outlined in the UNSW Assessment Implementation Procedure, with no permitted variation. All late assignments (unless extension or exemption previously agreed) will be penalised by 5% of the maximum mark per day (including Saturday, Sunday, and public holidays). For example, if an assessment task is worth 30 marks, then 1.5 marks will be lost per day

(5% of 30) for each day it is late. So, if the grade earnt is 24/30 and the task is two days late the student receives a grade of 24 – 3 marks = 21 marks.

Late submission is capped at 5 days (120 hours). This means that a student cannot submit an assessment more than 5 days (120 hours) after the due date for that assessment.

Special Consideration

If you experience a short-term event beyond your control (exceptional circumstances) that impacts your performance in a particular assessment task, you can apply for Special Considerations.

You must apply for Special Consideration **before** the start of your exam or due date for your assessment, except where your circumstances of illness or misadventure stop you from doing so.

If your circumstances stop you from applying before your exam or assessment due date, you must **apply within 3 working days** of the assessment, or the period covered by your supporting documentation.

More information can be found on the Special Consideration website.

5.4. Feedback on assessment

Concept quizzes (online)
Feedback will be provided online at the completion of each quiz.

Collaborative assignment
Student teams will receive feedback on the scoping report that provides the scaffolding for the final report. Students will receive marks and feedback on the final report via Moodle 10 days after the submission date.

Progress test
Marks will be provided on the course Moodle site. Individual feedback will be available through the Inspera platform. General feedback on the performance of the class will be provided on the course Moodle site.

End of session exam
Exam marks will be made available on the course Moodle site after the UNSW release or results date. Feedback on the performance of the class will be provided on the course Moodle site.

6. Academic integrity, referencing and plagiarism

Referencing is a way of acknowledging the sources of information that you use to research your assignments. You need to provide a reference whenever you draw on someone else's words, ideas, or research. Not referencing other people's work can constitute plagiarism.

Please use the APA referencing style for this course.

Further information about referencing styles can be located at
https://student.unsw.edu.au/referencing

Academic integrity *is fundamental to success at university. Academic integrity can be defined as a commitment to six fundamental values in academic pursuits: honesty, trust, fairness, respect, responsibility, and courage.*[1] *At UNSW, this means that your work must be your own, and others' ideas should be appropriately acknowledged. If you don't follow these rules, plagiarism may be detected in your work.*

[1] International Center for Academic Integrity, 'The Fundamental Values of Academic Integrity', T. Fishman (ed), Clemson University, 2013.

*Further information about academic integrity and **plagiarism** can be located at:*

- *The Current Students site* https://student.unsw.edu.au/plagiarism*, and*
- *The ELISE training site* https://subjectguides.library.unsw.edu.au/elise

The Conduct and Integrity Unit provides further resources to assist you to understand your conduct obligations as a student: https://student.unsw.edu.au/conduct.

7. Readings and resources

Prescribed Textbook

Blaustein, M.P., Kao, J.P.Y. and Matteson, D.R. (2019). Cellular physiology and neurophysiology, 3rd edition, Philadelphia, PA: Elsevier/Mosby. ISBN 9780323596190
[Copies are held in the UNSW library]

Alternatively:

Blaustein, M.P., Kao, J.P.Y. and Matteson, D.R. (2011). Cellular physiology and neurophysiology, 2nd edition, Philadelphia, PA: Elsevier/Mosby. ISBN 978-0-323-05709-7
[Copies are held in the UNSW library and available as an online text]

Recommended textbooks

Matthews G.G. (2004). Cellular Physiology of Nerve and Muscle. 4th edition. Wiley-Blackwell. ISBN 978-1-4051-0330-5
[Two copies are held in the UNSW library, call number 573.836/1 and available as an online text]

Byrne JH and Roberts JL (2004). From Molecules to Networks: An Introduction to Cellular and Molecular Neuroscience. Elsevier Academic Press, San Diego, USA. ISBN 978-0121486605.
[Copies held in the UNSW library, call number MBQ 612.8/229]

Aidley DJ (1998). The Physiology of Excitable Cells. 4th edition. Cambridge University Press, Cambridge, UK. ISBN 978-0521574218.
[Copies held in the UNSW library, call number MB 573.8/2 and available as an online text]

Aidley DJ and Stanfield PR (1996). Ion Channels: Molecules in Action, Cambridge University Press, Cambridge, UK. ISBN 978-0521498821.
[Copies held in the UNSW library, call number MB 571.64/4]

Kandel ER, Schwartz JH and Jessell TM Kandel, Siegelbaum S and Hudspeth, AJ (2013). Principles of Neural Science, 5th edition. New York: McGraw-Hill. ISBN 9780071390118.
[An advanced textbook for extended reading. Copies held in the UNSW library, call number MBQ 612.8/204]

Moodle

All the learning resources for this course will be provided on Moodle. This will include specific reading lists for topics, lecture notes and recordings, a list of online resources, learning activities for the tutorials, notes for the laboratory classes, the course timetable and outline, and various supplementary articles. Announcements will be made via Moodle and it is the students' responsibility to regularly check this site.

8. Administrative matters

Student enquiries should be submitted via student portal https://portal.insight.unsw.edu.au/web-forms/

Honours

The School of Biomedical Sciences (SBMS) offers an honours course, along with a cross-Faculty honours course in Neuroscience. Any students considering an honours year should become familiar with the requirements for the SBMS Honours and Neuroscience Honours courses, both of which are available from the SBMS web site. Students should consider which research area(s) is/are of interest and then directly approach the relevant academic(s) or researcher(s). Further information can be obtained from the SBMS website, the honours course co-ordinator (somshonours@unsw.edu.au) or the Neuroscience honours co-ordinator (neurhonoursadmin@unsw.edu.au).

Postgraduate Research Degrees

The Department of Physiology offers students the opportunity to pursue a Doctorate (PhD) in Physiology. Further information about this and other postgraduate degrees is available on the SBMS website.

9. Additional support for students

- The Current Students Gateway: https://student.unsw.edu.au/
- Academic Skills and Support: https://student.unsw.edu.au/academic-skills
- *Student Wellbeing and Health* https://www.student.unsw.edu.au/wellbeing
- UNSW IT Service Centre: https://www.myit.unsw.edu.au/services/students
- *UNSW Student Life Hub:* https://student.unsw.edu.au/hub#main-content
- *Student Support and Development:* https://student.unsw.edu.au/support
- *IT, eLearning and Apps:* https://student.unsw.edu.au/elearning
- *Student Support and Success Advisors:* https://student.unsw.edu.au/advisors
- *Equitable Learning Services (Formerly Disability Support Unit):* https://student.unsw.edu.au/els
- *Transitioning to Online Learning* https://www.covid19studyonline.unsw.edu.au/
- *Guide to Online Study* https://student.unsw.edu.au/online-study