FACULTY OF MEDICINE
SCHOOL OF MEDICAL SCIENCES

NEUR3121

MOLECULAR AND CELLULAR NEUROSCIENCE

SESSION 1, 2014

CONTENTS

COURSE INFORMATION

Molecular and Cellular Neuroscience (NEUR3121) is a stage three course worth six units of credit (6 UOC) administered by the School of Medical Sciences. It is delivered across 12 teaching weeks in session 1, with six contact hours per week. NEUR3121 can be undertaken upon successful completion of Physiology 1A (PHSL2101 / 2121 / 2501). The course can contribute to a major or minor study plan in Physiology, Neuroscience and/or Pharmacology for the Bachelor of Science or Bachelor of Medical Sciences.

In 2014, Molecular and Cellular Neuroscience (NEUR3121) will commence in the week beginning 3 March.

The content of the course provides an understanding of the way excitable cells function and communicate with each other, how this may be manipulated in the experimental situation and altered in disease. Hence, this provides a strong foundation to the study of many areas in neuroscience. This course is a useful forerunner to Neurophysiology (PHPH3131). Students will also find that this course complements Molecular Pharmacology (PHAR3102).

Summary of course structure

Lectures are scheduled for Wednesday 1-2 pm and Thursday 4-5 pm, both in Wallace Wurth LG02. Practical classes are Friday 2-5 pm in Wallace Wurth G06/G07. Tutorials are Thursday 3-4 pm in Wallace Wurth LG02 and LG03. Students are expected to attend all rostered activities for their full duration. Students are reminded that UNSW recommends that a six units-of-credit course should involve about 150-180 hrs of study and learning activities. The formal learning activities for this course are 72 hours throughout the semester. The completion of the concept summaries and group project assessment tasks, plus additional self-directed study will make up the balance of at least 78 hours. Students are strongly recommended to allocate at least six hours per week for these assessment tasks and additional study.

COURSE CONVENER AND TEACHING STAFF

Course convener: Dr. Trevor Lewis (t.lewis@unsw.edu.au)
School of Medical Sciences, Wallace Wurth Building, room 302. Tel: 9385 1102
Email is the best method for communicating with the course convenor or for arranging a consultation.

Course co-convener: Dr. John Power (john.power@unsw.edu.au)
School of Medical Sciences, Wallace Wurth Building, room 303. Tel: 9385 2910

Teaching Staff (Lecturers / Tutors)

Note: Communication with the teaching staff is most appropriate via email.

Dr. Trevor Lewis (t.lewis@unsw.edu.au)
Senior Lecturer, School of Medical Sciences, Department of Physiology

Dr. John Power (john.power@unsw.edu.au)
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Prof. Gary Housley (g.housley@unsw.edu.au)
Head of Department, School of Medical Sciences, Department of Physiology

Dr Asheeta Prasad (asheeta.prasad@unsw.edu.au)
Postdoctoral researcher, School of Psychology

COURSE DETAILS

This course aims to provide students with an integrated approach to understanding cellular neuroscience, including current research and techniques. It looks at the key molecules that underlie the processes of signalling in neural cells, the behaviour of neural cells and how these may be manipulated experimentally to understand function. Given the variety of molecules involved in neural signalling and the continued accumulation of scientific knowledge in this field, students will be introduced to some key online database tools that provide links between genes, the gene product and functional information that is relevant to cellular neuroscience. The ability to use such online databases and search the scientific literature is a key element of this course. The course also aims to develop skills in analytical thinking and problem solving in the context of electrical signalling in neurons. This requires an understanding of the fundamental electrical properties of excitable membranes. Communication is also a key element, as this course aims to develop skills in expressing reasoning and integration of information, rather than just conveying an 'answer'.

Student learning outcomes

At the completion of this course, it is expected that you will have achieved the following outcomes:

1. Able to describe how the properties of ion channels, transporters and receptors contribute to electrical and chemical signalling in neurons.
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.
3. Able to apply your understanding of molecular and cellular neuroscience to a particular disease state, through critical reading of the scientific literature and integrating information from a variety of different sources.
4. Able to express your understanding of concepts through clear, concise and accurate scientific language.

Graduate attributes developed in this course

The Faculty of Science has compiled a list of graduate attributes that students should develop during the program of study for a degree. These provide a context for the UNSW graduate attributes. This course will contribute to:

1. *Research, inquiry and analytical thinking abilities*
    - Your competence with the discipline specific knowledge presented in the course is assessed by the two progress tests during the session and the end of course exam. Your competence is developed through the supporting tutorials, to assist in formulating and explaining the reasoning for a solution to a problem, and applying your understanding to new situations.
    - Your ability to build upon the core knowledge of the course by creating an understanding of a particular disease state and the molecular mechanism for the disease is specifically assessed in the group project on Ion Channels, Transporters and Disease. This project provides the opportunity to demonstrate your competence in critical analysis, research and inquiry.
    - Technical competence and discipline specific knowledge. Ability to construct new concepts or create new understanding through the process of critical analysis, problem solving, research and inquiry.
2. *Capability and motivation for intellectual development*
    - The laboratory classes particularly support intellectual development in the concepts of molecular and cellular neuroscience. The activities have an open ended structure that provides an opportunity for creative, curiosity driven learning. This understanding of the concepts is assessed by 'concept summaries'.
    - Further opportunity for intellectual development is also provided with the open ended nature of the group project on Ion Channels, Transporters and Disease.
3. *Ethical, Social and Professional Understanding*
    - Working within a team requires mutual respect, commitment and ethical practice. There is an opportunity to develop some of these attributes further and to critically reflect upon your performance in these attributes with the group project on Ion Channels, Transporters and Disease.

- You are assessed on your reflection of how the team worked together and the ability to achieve a common goal.

4. *Teamwork, collaborative and management skills.*
    - The group project on Ion Channels, Transporters and Disease Ability requires strong collaborative effect to achieve the common goal. This is assisted by encouraging groups to establish agreed work practices and commitments. This will provide an opportunity to develop teamwork, collaborative and management skills individually, and to learn from the skills of others in the group. In particular, how the group manages the time line of the project, how decisions are made, the reasoned analysis for the structure and composition of the group report and recognition that all team members bring different strengths to the group. This is assessed by a reflection upon how the group worked as a team and how effective were the collaborative and management skills in achieving the common goal.
5. *Communication*
    - Effective scientific communication is a skill that is explicitly developed in this course. The 'concept summaries' activity provides an opportunity for practice in scientific writing, with expert feedback from tutors. Further opportunity to learn from the work of others is provided by requiring you to peer review concept summaries from other students. Having several concept summaries to submit over the duration of the course means there is opportunity to consider the feedback received and put it into practise.
    - Effective communication is also a key part of the final written report and the oral presentation from the group project on Ion Channels, Transporters and Disease.
6. *Information literacy*
    - Your ability to search the scientific literature to find appropriate information, and to collate information from online databases relevant to molecular and cellular neuroscience, will form the basis for the group project. While these skills are not formally assessed, the ability to make appropriate and effective use of these skills will contribute to your success in achieving the goals of the group project.

Major topics

Topic areas include: how electrical signals are generated across cell membranes; the function, properties and structure of ion channels, receptors and transporters; how individual nerve cells function; how cells communicate with each other in the brain, including synaptic transmission and receptor-medicated signalling; how alterations in function can lead to disease states; modern experimental techniques in cellular physiology; application of molecular biology techniques to manipulate and explore the function of molecules in the nervous system.

RATIONALE AND STRATEGIES UNDERPINNING THE COURSE

Teaching strategies

The learning activities used in the course are varied and aim to create an active learning environment that interests, challenges and inspires students. Lectures provide knowledge of the core material 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 biological problems and develop analytical skills. The tutorials will provide opportunities for expressing your reasoning or thinking and will support your understanding of the course material presented in the lectures. 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 some insight to experimental techniques in real systems.

The laboratory classes are provided to support the lecture material and to practice applying analytical skills to biological problems. The material covered in the practical classes will be assessed in the progress exams and by providing written summaries explaining some of the major concepts from the practical classes. The summaries need to describe the concept, describe how it was demonstrated in the practical class and explain the meaning, mechanism or consequence of the concept. The explanation of concepts will be assessed on whether there is clear description of the concept and clear scientific reasoning in the explanation provided. It should be expressed in appropriate scientific language. The first summary task will be a formative assessment, with the feedback provided giving you the opportunity to understand the requirements of the task and to resubmit the summary for marking. Two more summaries will be submitted during the course: the second one will be peer reviewed and a mark will be provided on the third (final) one, with feedback. Topics that are suitable for summaries will be nominated for each practical class. The deadlines for each of the summaries will be provided on Moodle.

The group assignment will require students to work in groups of four students, researching the properties of a gene product, which will be allocated to the group. Each gene product is either an ion channel or transporter and there are one or more diseases that are associated with mutations in the gene. Groups will use online databases to identify characteristics of the gene and the ion channel / transporter for which it codes. A literature search will be required to identify the function of the channel / transporter and how this is altered in the disease state. The group will produce a progress report, a summary of normal function and a final report, all of which are submitted online. A statement on the contribution of each group member must be included in the final report. Each member will also provide a reflection on how they have worked together as a team. Each group will make an oral presentation summarising the work to the class. The assessment will be based on the ability of the group to identify relevant information from appropriate sources and provide proper references for all sources; the group needs to be able to analyse the variety of information collected and communicate this in a manner that demonstrates an integration of the material, not just summarising the individual components. They need to identify the likely molecular mechanism for how the mutation in the ion channel / transporter is able to cause the disease state.

Assessment

Concept summaries	15%
Group assignment	25%
Progress exams	20%
End of session exam	40%

There will be two progress exams throughout the course. These exams will be comprised of short answer questions, multiple choice and/or short calculations. The questions will be based on the material covered in the lectures and practical classes and tutorials. The purpose of these progress exams is to provide feedback to students on their understanding and application of the concepts developed in the course. The exams will be held during the scheduled tutorial sessions.

The end of session exam will be comprised of short answer questions that will include some simple calculations. The short answer questions will be based on the material covered in the lectures and tutorials. Material covered in the progress exams may be again examined in the final exam. The lecturer who provided the question will mark the short answer questions. Students are advised to use the list of previous exam questions provided to self-evaluate their progress during the course, although questions from year to year may vary as the content of the course is developed.

COURSE EVALUATION AND DEVELOPMENT

NEUR3121 Molecular and Cellular Neuroscience has been developed as part of a broader process to provide a study plan for students wishing to follow a neuroscience path. Student feedback is gathered periodically by various means to assist in the continuing development of this course. Such feedback is obtained from the Course and Teaching Evaluation and Improvement (CATEI) survey and the direct feedback from student representatives. Student feedback is always welcome and is considered carefully with a view to acting on it constructively wherever possible.

In response to the CATEI course evaluation in 2012, the assessment tasks in the course were streamlined. The number of concept summaries submitted has been reduced and the first summary submitted is now a formative task to provide feedback and guidance on completing the task. Additional examples illustrating the marking criteria are now provided. The number of progress tests was reduced from four to two and the timing of these tests has been selected to minimize the overlap with assessments in other courses. More details of the depth of information needed for the group project is now provided.

Students enrolled in the course will be invited to elect two student representatives who will meet with the course convener and teaching staff on two occasions during the session, in a student feedback forum. The representatives need to seek feedback from their colleagues on the content, delivery and relevance of the course and any other issues that arise. The information gathered from this process will be used to inform any future improvements to the course.

REQUIRED EQUIPMENT, TRAINING AND ENABLING SKILLS

Students will be expected to provide a personal laboratory coat and safety glasses for those laboratory classes where they are required.

All students will have completed ELISE in their first year of study at UNSW. The ELISE Plus online tutorial provided by UNSW Library is designed to help you learn more about searching for information and self-directed learning. You may find this provides enabling skills that will enhance your ability to complete the group project in this course.

RESOURCES

Prescribed Textbook

Matthews G.G. (2004). Cellular Physiology of Nerve and Muscle. 4th edition. Wiley-Blackwell.
[Two copies are held in the UNSW library, call number 573.836/1, and it is available from the UNSW Bookshop. There is also a copy of the third edition in the UNSW library.]

Recommended textbooks

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.
[UNSW library call number MBQ 612.8/229. Copies are also available from the UNSW Bookshop.]

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]

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 (2000). Principles of Neural Science, 4th edition. New York : McGraw-Hill. ISBN 0838577016.
[An advanced textbook for extended reading. Copies held in the UNSW library, call number MBQ 612.8/204]

Other Resources

A number of other resources for this course will be provided on Moodle. This will include: specific reading lists for different lectures, lecture notes (when provided by the lecturer), a list of online resources, learning activities for the tutorials, the course timetable and outline, as well as various supplementary articles. Announcements will be made via Moodle and it is the students' responsibility to regularly check this site.

ADMINISTRATIVE MATTERS

The Department of Physiology is located in the School of Medical Sciences (SoMS), Wallace Wurth building (C27), Faculty of Medicine. General inquiries can be made at the SoMS reception, located in room 313 on level 3 of the Wallace Wurth building (office hours are 8:30am – 5:00pm).

Prof. Gary Housley is the Head of Department and appointments may be made through the administrative assistant located at the SoMS reception, room 313.

The School Student Advisor is **Ms. Carmen Robinson** and she is able to provide additional information on any courses offered by the School. Ms. Robinson is located in the BABS-SoMS-BEES Students Office, room G27, Biosciences Building. Ms. Robinson may also be contacted either by telephone on 9385 2464 or by email: Carmen.robinson@unsw.edu.au

Attendance Requirements

Attendance at laboratory classes is compulsory and must be recorded in the class roll on the day of the class. It is your responsibility to ensure that the demonstrator records your attendance and no discussions will be entered into after the completion of the class. Satisfactory completion of the work set for each class is essential. It should be noted that non-attendance for other than documented medical or other serious reasons, or unsatisfactory performance, for more than one class per course may result in an additional practical assessment exam or in ineligibility to pass the course.

Attendance at all examinations is required, including the two progress exams held during the scheduled tutorial sessions.

Assignment submissions

All assessment tasks that require submission of work will be completed as an online submission via Moodle and are due before the end of the day on which it is due (ie. before 11:59 pm). Where relevant, you must complete the online declaration of originality (equivalent of the submission coversheet in a hard copy submission) before submitting the work.

Computing Facilities

Computer facilities are available to students in the School of Medical Sciences for access to various course-specific teaching programs in Room 106/108 and G2/G4. Swipe card access will be given to all students. Hours of access are 8:30am – 6:00pm. However, priority is given to scheduled classes and meetings.

The use of computing facilities and IT services is governed by the UNSW policies and guidelines that can be found at: https://www.it.unsw.edu.au/students/policies/index.html
All students need to arrange a zPass to be able to login to the computers. This can be arranged at the UNSW Identity Manager: http://idm.unsw.edu.au

Workplace health and safety

As stated in the UNSW Workplace Health and Safety Policy, students are responsible for following the Workplace Health and Safety Policy and procedures and ensuring that their conduct does not endanger themselves, others or the environment. All laboratory activities to be undertaken by students in this course have been assessed for the risks involved and a student risk assessment is provided in the laboratory manual for each activity. This student risk assessment must be read, understood and signed prior to commencing any laboratory activity. There will also be a brief induction for each different activity and students must be present at the start of the class for this induction or they will not be allowed to continue with the laboratory activity.

Special Consideration

If you believe that your performance in a course, either during session or in an examination, has been adversely affected due to illness or misadventure, you must make formal application for Special Consideration for the course/s affected as soon as practicable after the problem occurs and within three working days of the assessment to which it refers. You must also inform the course convenor. **Special considerations sought outside the three day time period WILL NOT be accepted except in TRULY exceptional circumstances.**

The application must be made via Online Services in myUNSW. You must obtain and attach all possible supporting evidence (e.g. medical certificates) before submitting the application. Failure to do so may result in the application being rejected. Log into myUNSW and go to:
My Student Profile tab > My Student Services channel > Online Services > Special Consideration.

Originals or certified copies of your supporting evidence must be submitted to UNSW Student Central (Student Central can certify your original documents), along with a completed Professional Authority form. This supporting documentation must be submitted to Student Central for verification within three working days of the assessment or the period covered by the supporting documentation. Failure to do so may result in the application being rejected.

If you miss an assessment and have applied for Special Consideration, this will be taken into account when your final grade is determined. You should note that marks derived from completed assessment tasks may be used as the primary basis for determining an overall mark; for example, by extrapolating from your percentile rank on those tasks. Where appropriate, supplementary examination may be offered, but only when warranted by the circumstances. It is intended that supplementary exams for the School of Medical Sciences in Semester 1, 2014 will be held on the 15, 16 and 17 July, 2014.

Normally, if you miss an exam (without medical reasons) you will be given an absent fail. If you arrive late for an exam no time extension will be granted. It is your responsibility to check timetables and ensure that you arrive with sufficient time.

Please refer to the A-Z Student Guide at myUNSW for further details regarding special consideration.

Equity and Diversity

Students who have a disability that requires some adjustment in their teaching or learning environment are encouraged to discuss their study needs with the course convener prior to, or at the commencement of the course, or with the Equity Officer (Disability) in the Student Equity and Diversity Unit (9385 4734 or www.studentequity.unsw.edu.au). Issues to be discussed may include access to materials, signers or note-takers, the provision of services and additional exam and assessment arrangements. Early notification is essential to enable any necessary adjustments to be made.

Official Communication by Email

Students are advised that email is the official means by which the School of Medical Sciences at UNSW will communicate with you. All email messages will be sent to your official UNSW email address (e.g., z1234567@student.unsw.edu.au). If you do not wish to use the University email system, you MUST arrange for your official email to be forwarded to your chosen address. The University recommends that you check your email at least every other day. Facilities for checking email are available in the UNSW Library. Further information and assistance is available from the IT Service Desk, in person on the ground floor of the library annexe (near the post office), by telephone (9385 1333) or via email (ITServiceCentre@unsw.edu.au).

Student complaint procedure

A step by step guide for students about how to make a complaint is available on the Current Student Gateway website. If you have any problems or grievance about the course, you should try to resolve it with the course convener in the first instance. If the grievance cannot be resolved in this way, you should contact the School of Medical Sciences Grievance Officer, Dr Priti Pandey (p.pandey@unsw.edu.au , 9385 2483), the Head of School (Prof Nick Hawkins, hos.soms@unsw.edu.au, 9385 2531) or a Student Participation Adviser at the Hub. If this informal process does not resolve the complaint, or where the complaint is of a serious nature, a formal complaint must be lodged in writing with the Student Conduct and Appeals Office, in accordance with the UNSW Student Complaint Procedure.

Honours

The School of Medical Sciences offers an honours program, along with a cross-Faculty honours program in Neuroscience. Any students considering an honours year should become familiar with the requirements for the SoMS Honours and Neuroscience Honours programs, both of which are available from the SoMS web site. Students should consider which research area(s) is/are of interest and then directly approach the relevant academic(s) or researcher(s). Outstanding students may be considered for honours scholarships offered annually by the School. Further information can be obtained from the SoMS website, the honours program co-ordinator (Dr Andrew Moorhouse, a.moorhouse@unsw.edu.au) or the Neuroscience honours co-ordinator (Dr John Power, john.power@unsw.edu.au).

Postgraduate Research Degrees

The Department of Physiology offers students the opportunity to enter into a Doctorate (PhD) in Physiology. Further information about this and other postgraduate degrees is available on the 'Students' menu item of the SoMS website.

UNSW ACADEMIC HONESTY AND PLAGARISM

The School of Medical Sciences will not tolerate plagiarism in submitted written or oral work. The University regards plagiarism as Academic Misconduct (see: https://my.unsw.edu.au/student/atoz/Plagiarism.html).

Evidence of plagiarism in submitted assignments, etc. will be thoroughly investigated and dealt with according to the Student Misconduct Procedure. Academic Misconduct carries penalties. If a student is found guilty of academic misconduct, the penalties include warnings, remedial educative action, being failed in an assignment or excluded from the University for two years.

The following information comes from the UNSW A-Z Student Guide entry on plagiarism.

What is plagiarism?

Plagiarism is using the words or ideas of others and presenting them as your own. Plagiarism is a type of intellectual theft. It can take many forms, from deliberate cheating to accidentally copying from a source without acknowledgement. The University has adopted an educative approach to plagiarism and has developed a range of resources to support students. UNSW has produced a booklet to assist you with essential information for avoiding plagiarism (pdf).

Details of what plagiarism is can be found on the Learning Centre's Plagiarism & Academic Integrity website and in Appendix A of the Student Misconduct Procedure (pdf).

Examples of plagiarism include:

- Direct duplication of the thoughts or work of another, including by copying work, or knowingly permitting it to be copied. This includes copying materials, ideas or concepts from a book, article, report or other written document (whether published or unpublished), composition, artwork, design, drawing, circuitry, computer program or software, website, internet, other electronic resource, or another person's assignment, or the student's own assignment from a previous course, without appropriate acknowledgement;
- Quotation without the use of quotation marks;
- Paraphrasing another person's work with very minor change keeping the meaning, form and/or progression of ideas of the original;
- Citing sources which have not been read, without acknowledging the 'secondary' source from which knowledge of them has been obtained;
- Piecing together sections of the work of others into a new whole;
- Presenting an assessment item as independent work when it has been produced in whole or part in collusion with other people, for example, another student or tutor;

- Claiming credit for a proportion of work contributed to a group assessment item that is greater than that actually contributed;
- Submitting your own assessment item that has already been submitted for academic credit at UNSW or elsewhere may also be considered plagiarism;
- Using another person's ideas or words in an oral presentation without crediting the source.

The basic principles are that you should not attempt to pass off the work of another person as your own, and it should be possible for a reader to locate information and ideas you have used by going to the original source material. Acknowledgement should be sufficiently accurate to enable the source to be located quickly and easily. If you are unsure whether, or how, to make acknowledgement, consult your lecturer or visit The Learning Centre.

The Learning Centre website is the main repository for resources for staff and students on plagiarism and academic honesty. These resources can be located at: www.lc.unsw.edu.au/plagiarism

The Learning Centre also provides substantial educational written materials, workshops and tutorials to aid students, for example, in:

- Correct referencing practices;
- Paraphrasing, summarising, essay writing and time management;
- Appropriate use of and attribution for, a range of materials including text, images, formulae and concepts.

Individual assistance is available on request from The Learning Centre.

Students are also reminded that careful time management is an important part of study and one of the identified causes of plagiarism is poor time management. Students should allow sufficient time for research, drafting, and the proper referencing of sources in preparing all assessment items.

SUMMARY OF LECTURES

1. Welcome. Course overview and information.
An introduction to the course, covering the lecture outline, tutorials and practical classes. An overview of the assessment procedure and the breakdown of the marks will be provided.

2. Equilibrium and Gibbs-Donnan potentials [P. Barry]
This lecture starts with the expression for electrochemical potential, the energy of a mole of ions in solution, and how it can be used to derive the Nernst equation, the foundational equation for understanding electrophysiology. The Nernst equation gives the potential at which a distribution of a particular permeant ion would be in equilibrium across a membrane.
The lecture then describes the three conditions for Gibbs-Donnan equilibrium: (1) Gibbs-Donnan equilibrium itself; (2) macroscopic electroneutrality and (3) osmotic equilibrium, and its applications in physiology.

3. Membrane potentials and GHK [P. Barry]
This lecture initially uses the Planck equation to illustrate the role of selective ion permeabilities with two or more permeant ions and salt diffusion gradients in generating membrane potentials across thick membranes. It then discusses the use of the Goldman-Hodgkin-Katz equation to apply these principles to thin biological membranes (6 to 10 nm thick). It also discusses the issue of using activities or concentrations with these equations and any contribution of active transport to membrane potentials. In addition, the concept of unstirred-layers and their relevance to solute and water transport across membranes is briefly introduced. The tutorial and practical class (ArtMem and MemPot) on membrane potentials addresses this material.

4. Electrophysiological techniques [A. Moorhouse]
This lecture will introduce students to different electrophysiological techniques to study electrical and chemical signalling in the brain. The lecture will describe how action potentials, synaptic potentials and ion channel activity can be measured and quantified. It is important to understand the techniques used to elucidate the cellular and molecular study of neuronal function, and it is also hoped this lecture will assist students in their group project and other coursework.

5. Electrotonic properties of axons and dendrites [P. Barry]
This lecture provides a description of the physical basis for the passive electrical properties of axons and dendrites. It describes the time-course for the change in membrane potential in response to a square pulse injection of current. The length constant and the time constant are introduced and used to describe the cable properties of the axons or dendrites and action potential propagation.
The tutorial on electrotonic potentials addresses material from this lecture, as does the practical class on the Voltage Responses to Membrane Currents (MemCable).

6. Overview of ion channel, receptor and transporter families [T. Lewis]
This lecture provides a revision (from Physiology 1A) of the role of ion channels, receptors and transporters in neuroscience. It addresses the major families of ion channels and the roles they perform; the types of transporters and the role they perform; and introduces the roles of G-protein coupled receptors. The goal of this lecture is too appreciate the diversity and the differences of the ion channels transporters and receptors, and how this contributes to the specificity of the role they perform.

7. Mechanisms of ion permeation [A. Moorhouse]
Selective permeation of ions across the cell membrane is critical for neuronal function. This lecture will initially consider some of the basic biophysical principles that determine ion selectivity, focusing on the contribution of properties of both the ions themselves and of the ion channel pores. The lecture will then describe how the structure of the KcSA K^+ channel pore (resolved in 1998) allows this channel to select for K^+ ions over Na^+ ions while still allowing a fast rate of K^+ permeation. Some of the techniques used to determine the molecular basis of ion selectivity of glycine receptor channels will also be described.

8. Voltage-gated ion channel families [S. Mann]
A basic knowledge of voltage gated ion channels is essential for understanding the physiology of neuronal and other excitable cells. This lecture will give a historical perspective of the key discoveries during the last 50 years that led to our current understanding of voltage gated ion channels, starting with the work of Hodgkin and Huxley in squid axons. After briefly outlining the concept of voltage dependent gating, this lecture will provide an overview of the voltage gated ion channel superfamily. We will discuss how drugs and toxins can be used to differentiate between different types of voltage gated channels, and then examine common and distinct structural features of different channel families and their nomenclature.

9. Mechanisms of voltage-dependent gating [M. Perry]
Electrical signalling in nerve and muscle cells is dependent on the intricately timed opening and closing (gating) of several different types of voltage-gated ion channels. This lecture will outline the basic principles of voltage-dependent gating, first by describing how ion channels sense a change in membrane voltage and then by discussing the molecular and structural basis by which the voltage sensor triggers the opening and

closing of channels. Finally the lecture will outline some of the kinetic differences that allow ion channels of different types to open and close at precise time points during the electrical signalling of excitable cells.

10. Action potential generation in axons [A. Moorhouse]
This lecture builds upon your understanding of the action potential from Physiology 1A. It will describe the ionic currents that underlie the action potential and the voltage and time-dependent nature of these currents. It will introduce and define the terms: activation, inactivation, driving force for current flow, and conductance. The Hodgkin-Huxley equations provide a biophysical description of these currents and provide a means for explaining and understanding how the action potential 'works'. Some of the classical experiments of Hodgkin and Huxley will be described.

11. GPCR structure – function [A. Finch]
This lecture will introduce the members of the G-protein coupled receptor (GPCR) superfamily. The structural features conserved across the superfamily and those that differ between families A, B, C and F will be examined. Our current understanding of the molecular basis for Family A GPCR activation, derived from mutagenesis, biophysical and crystal structure data will be discussed.

12. Metabotropic receptor signalling [A. Finch]
Signalling through G-protein coupled receptors (GPCRs) and receptor enzymes (for example receptor tyrosine kinases) leads to the generation of intracellular signalling molecules. These "second messengers" can act on ion channels and modulate their function. This is termed metabotropic signalling. The focus of this lecture will be the second messengers produced by GPCRs and receptor enzymes and how they modulate channel function. The differences between metabotropic and inotropic signalling in terms of temporal regulation of ion channel function will also be discussed. Examples of how both metabotropic and inotropic signalling is used to "fine tune" a physiological response will be given.

13. Ligand-gated ion channel families [M. Windley]
Ligand-gated ion channels are the key ion channels that underlie the process of chemical neurotransmission in the nervous system. This lecture will provide a revision on the different ligand-gated ion channel families and introduce the structural information that is available on each of these families. This includes the molecular topology and quaternary structure of the receptors. The function of these channels is made possible because the ligand binding site is integral to the ion channel. The specificity of the ligand, the specificity of the ion selectivity and the specific arrangement of subunits provides the means for the different functions of the channels.

14. Ligand recognition and signal transduction [M. Windley]
One of the key questions in the field of ligand-gated ion channels is how the binding of the ligand is able to cause the channel to open. The channel protein appears to work like a miniature machine and there are some good hypotheses as to how the channel protein changes conformation to open the pore. This process is called 'signal transduction'. We will explore the likely events that underlie this process in the nAChR and the evidence that supports the hypothesis. Single channel recordings are an important source of evidence to test the hypothesis.

15. Transient receptor potential channels [G. Housley]
- Be able to describe the structure and function of the Transient Receptor Potential (TRP) ion channels.
- Be able to provide examples of the physiological roles these ion channels play in the nervous system

16. Cell-cell communication [J. Power]
Communication between cells in the nervous system primarily occurs via electrical or chemical synapses. The differences in these two mechanisms will be explored, in terms of the directionality, the time lag of the response and the mechanism. Chemical synaptic transmission will be further explored to describe the steps involved in the process, from synaptic vesicle release to activation of the post-synaptic ligand-gated ion channels. Further, we will see how ionotropic receptors (ligand-gated ion channels) are responsible for the fast synaptic transmission, while metabotropic receptors (GPCRs) are responsible for slow synaptic transmission.

17. Receptor response shapes post-synaptic signalling [T. Lewis]
This lecture explores the factors that determine the shape and time course of the post-synaptic current. Two key contributors considered are the mechanism for clearance of the neurotransmitter from the synaptic cleft and the kinetic response of the post-synaptic ligand-gated ion channels. Three examples are explored: the nicotinic acetylcholine receptors at the muscle endplate, excitatory glutamate receptors, and inhibitory glycine and GABA receptors at central synapses.

18. Synaptic transmission – synaptic modulation [J. Power]
This lecture builds upon your understanding of chemical neurotransmission to explore the mechanisms by which the process can be modulated at the pre-synaptic terminal, to either increase or decrease the post-

synaptic response. The terms synaptic depression, facilitation and post-tetanic potentiation will be introduced and defined. The role of the availability of synaptic vesicles for release and the concentration of calcium in the pre-synaptic terminal to trigger release to modulate the synaptic response will be investigated.

19. The Postsynaptic Architecture - From Structure to Function [T. Fath]
The lecture provides an overview on the structural and functional organisation of the postsynaptic scaffold. The major neurotransmitters at excitatory synapses are discussed in the context of their integration in the protein scaffold that underlies the postsynaptic membrane. The major components of the postsynaptic scaffold and the complex interactions between these components are explained. A major focus is the conceptual idea of the postsynaptic scaffold as a dynamic anchoring framework for the attachment of a broad range of regulatory proteins that control synaptic function including kinases, phosphatases and actin cytoskeleton-regulating proteins. This introduction to the structural nature of the postsynapse forms the basis for understanding the molecular events that occur during long term potentiation (LTP) and long term depression (LTD) which are fundamental for processes of learning and memory in the central nervous system. The history and current advances in the study of LTP and LTD are using the hippocampal area as example

20. Synaptic transmission – postsynaptic integration [J. Power]
Following on from the lecture on pre-synaptic modulation, this lecture now looks at the events on the post-synaptic membrane that can alter the synaptic response. These are key to the mechanisms by which information can be 'processed' by the nervous system. The post-synaptic response depends upon the ligand-gated ion channel that is present on the post-synaptic membrane and will determine the time-course of the response. A neuron may receive many different synaptic inputs and these are able to sum together, to produce either a larger or a smaller post-synaptic response. The mechanisms of spatial, non-linear and temporal summation will be explored. Ion gradients across the cell membrane can change during development so this will also change the post-synaptic response of ionotropic receptors.

21. Synaptic Failure in Disease [T.Fath]
This lecture builds on the material provided in the previous lecture discussing the postsynaptic scaffold. The lecture focuses on the role of the actin cytoskeleton at the postsynapse. Current concepts of cytoskeletal stability and dynamics at the postsynapse are elaborated on. Research tools that are used to study the biology of cytoskeletal dynamics at the synapse are introduced. The second part of this lecture discusses the synaptic dysfunction in disease in response to cytotoxic stimuli such protein aggregates and their soluble precursors on the example of Alzheimer's disease pathology.

22. Introduction to optogenetics [A. Prasad]
Optogenetic technology combines genetic targeting of specific neurons or proteins with optical technology for imaging or control of the targets within intact, living neural circuits. This lecture provides an overview of the molecular tools for optogenetics, the molecular mechanisms of how the different opsin genes affect neuronal excitability and the strategies for how they are implemented in animal models.

23. Changing neuronal function with optogenetics [A. Prasad]
This lecture will explore the application of optogenetics to investigate the role of particular neuronal populations in determining behaviour. It will introduce the experimental setup, the validation of the technique and the relative advantages and disadvantages of optogenetics as a tool

24. Targeting receptor function with transgenic mice [G. Housley]
- To know how receptor function can be investigated by using conditional knockout or transgenic mouse models.
- Exemplars of knock-out and knock-in transgenic mouse models.

COURSE SCHEDULE S1, 2014

Week	Week Starting	Lecture 1 Wednesday 1-2 pm Wallace Wurth LG02	Tutorial Thursday 3-4 pm Wallace Wurth LG02 / LG03	Lecture 2 Thursday 4-5 pm Wallace Wurth LG02	Practical classes Friday 2-5 pm Wallace Wurth G06/G07
1	3 Mar	1. Welcome. Course overview and information. [T. Lewis + J. Power]	Tutorial – introduction to group projects [T. Lewis]	2. Equilibrium and Gibbs-Donnan potentials [P. Barry]	Introduction to Neurons in Action. NIA: The Na action potential [T. Lewis + casual]
2	10 Mar	3. Membrane potentials and GHK [P. Barry]	Tutorial – practical class summaries and group project [T. Lewis]	4. Electrophysiological techniques [A. Moorhouse]	Membrane Potentials (MemPot, ArtMem). [T. Lewis + casual]
3	17 Mar	5. Electrotonic properties of axons and dendrites [P. Barry]	Tutorial – membrane potentials [P. Barry]	6. Overview of ion channel, receptor and transporter families [T. Lewis]	Voltage responses to membrane currents (MemCable). [T. Lewis + J. Power + casual]
4	24 Mar	7. Mechanisms of ion permeation [A. Moorhouse]	Tutorial – electrotonic potentials [P. Barry]	8. Voltage-gated ion channel families [S. Mann]	NIA: Voltage clamping a patch [T. Lewis + casual]
5	31 Mar	9. Mechanisms of voltage-dependent gating [M. Perry]	Progress test 1 [T. Lewis]	10. Action potential generation in axons [A. Moorhouse]	Compound action potential from the toad sciatic nerve [T. Lewis + J. Power + casual]
6	7 Apr	11. GPCR structure – function [A. Finch]	Tutorial – analysis of voltage-gated currents [T. Lewis]	12. Metabotropic receptor signalling [A. Finch]	NIA: Chattering ion channels [T. Lewis + casual]
7	14Apr	No class	No class	No class	GOOD FRIDAY (no class)
Mid-session Break					
8	28 Apr	13. Ligand-gated ion channel families [M. Windley]	Tutorial – GPCRs [A. Finch]	14. Ligand recognition and signal transduction [M. Windley]	Research Laboratory Visits [T. Lewis + J. Power + casual]
9	5 May	15. Transient receptor potential channels [G. Housley]	Tutorial – analysis of ligand-gated currents [S. Mann]	16. Cell-cell communication [J. Power]	NIA: The neuromuscular junction [J. Power + casual]
10	12 May	17. Receptor response shapes post-synaptic signalling [T. Lewis]	Progress test 2 [J. Power]	18. Synaptic transmission – synaptic modulation [J. Power]	NIA: Postsynaptic inhibition [J. Power + casual]
11	19 May	19. The Postsynaptic Architecture - From Structure to Function [T. Fath]	Tutorial – molecular biology for neuroscience [T. Lewis]	20. Synaptic transmission – postsynaptic integration [J. Power]	NEURON: Synaptic Integration [J. Power + casual]
12	26 May	21. Synaptic Failure in Disease [T.Fath]	Tutorial – neuronal integration [J. Power]	22. Introduction to optogenetics [A. Prasad]	Group project oral presentations [T. Lewis + J. Power + casual]
13	2 Jun	23. Changing neuronal function with optogenetics [A. Prasad]	Tutorial- Transgenic models [T. Lewis]	24. Targeting receptor function with transgenic mice [G. Housley]	Group project presentations [T. Lewis + J. Power + casual]

ASSESSMENT TASKS AND FEEDBACK

Note: All assessment tasks that require submission of work will be completed as an online submission via Moodle and are due before the end of the day on which it is due (ie. before 11:59 pm). Where relevant, you must complete the online declaration of originality (equivalent of the submission coversheet in a hard copy submission) before submitting the work.

Task	Knowledge & abilities assessed	Assessment Criteria	% of total mark	Date of Submission	Feedback		
					WHO	WHEN	HOW
Team agreement	• Management and planning skills	• Not formally assessed; feedback only	0%	14 Mar 2014	Dr Lewis	21 Mar 2014	Moodle
First concept summary	• Scientific writing and communication skills • Understanding of the concept	• Formative assessment • Scientific style, accuracy and clarity	0%	17 Mar 2014	Dr Lewis, Dr Power and Prac tutors	24 Mar 2014	Moodle
Group project: Progress report	• Information literacy • Research, inquiry and critical evaluation of information	• Not formally assessed; feedback only	0%	28 Mar 2014	Dr Lewis	4 Apr 2014	Moodle
First concept summary: revised submission	• Scientific writing and communication skills • Understanding of the concept	• Scientific style, accuracy and clarity	5%	31 Mar 2014	Prac tutors	11 Apr 2014	Moodle
Progress test 1	• Material from lectures 2 to lecture 8, and related material from the laboratory classes of weeks 1 to 4.	• Short answer style questions assessing knowledge, understanding and ability to apply concepts	10%	3 Apr 2014	Dr Lewis	11 Apr 2014	Moodle
Group project: Normal function report	• Understanding of normal function of allocated ion channel or transporter • Critical evaluation of relevant scientific literature • Integration of information from multiple sources	• Not formally assessed; feedback only	0%	14 Apr 2014	Dr Lewis	28 Apr 2014	Moodle
Second concept summary	• Scientific writing and communication skills • Understanding of the concept	• Scientific style, accuracy and clarity	5%	28 Apr 2014	Peer review	9 May 2014	Moodle
Progress test 2	• Material from lectures 9 to lecture 18, and related material from the laboratory classes of weeks 5 to 9.	• Short answer style questions assessing knowledge, understanding and ability to apply concepts	10%	15 May 2014	Dr Lewis	23 May 2014	Moodle

Task	Knowledge & abilities assessed	Assessment Criteria	% of total mark	Date of Submission	Feedback		
					WHO	WHEN	HOW
Group project: Final report	• Logical presentation of ideas • Research, inquiry and information literacy • Critical evaluation of the literature; integration of information; understanding of the experimental results • Demonstrated understanding of the molecular mechanism likely to cause the disease	• Presentation of the ideas; language used; logical order • Describe the function of the ion channel / transporter in normal tissue and in the disease state; key experiments • Selected most appropriate literature and experimental work; understand the importance / meaning of results • Successfully collated information from online databases; searched scientific literature; correct referencing	15%	19 May 2014	Dr Lewis, Dr Power	6 Jun 2014	Moodle
Group project: Teamwork summary	• Reflective practice • Professional understanding	• Evaluate the teamwork, collaborative and management skills of the group	5%	23 May 2014	Dr Lewis	6 Jun 2014	Moodle
Third concept summary	• Scientific writing and communication skills • Understanding of the concept	• Scientific style, accuracy and clarity	5%	26 May 2014	Dr Lewis, Dr Power and Prac tutors	2 Jun 2014	Moodle
Group project: Oral presentation	• Demonstrated understanding of how conclusions reached from experimental results • Ability to convey a reasoned scientific argument • Clear description of molecular mechanism of the disease • Knowledge of the particular ion channel or transporter	• Knowledge and content • Language use • Presentation of ideas • Critical evaluation of evidence	5%	30 May and 6 Jun 2014	Dr Lewis, Dr Power and other tutors	13 Jun 2014	Moodle