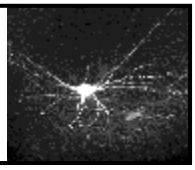
PN4235: Motoneurons: from physiology to pathology



Module organiser: Dr Gareth Miles
(Prerequisite: Neuroscience PN3313)

Module summary:

This module aims to provide in depth knowledge of key aspects of neuronal function and potential dysfunction by focussing on one of the most studied and best characterised classes of neurons in the CNS, motoneurons.

The first intracellular recordings of neurons in the mammalian central nervous system (CNS) were performed on motoneurons (Brock, Coombs and Eccles, 1951). Following these first recordings, extensive studies of motoneurons have uncovered many of the fundamental properties of neurons and synaptic transmission. Motoneurons have served as ideal model neurons for several reasons: they are large and readily accessible, their function is well defined in comparison to most other CNS neurons; and their output and its behavioural consequences can be measured with relative ease. In addition, motoneurons are selectively vulnerable to neurodegenerative processes such as those involved in Motor Neurone Disease (MND).

Learning objectives:

By the end of the module students should be familiar with:

- Molecular and genetic mechanisms which give rise to multiple classes of motoneurons.
- Key ion channels expressed by motoneurons and their specific roles in motoneuron output.
- Some of the various types and sources of inputs received by motoneurons and their functions.
- Principles underlying the recruitment of motoneurons during motor behaviour.
- Disease mechanisms which are thought to contribute to the selective degeneration of motoneurons in Motoneuron Disease.

Transferable skills:

During the course you will be given the opportunity to develop a range of skills that will have many applications within and beyond the field of neuroscience.

Student-led seminars will require you to engage directly with current research, developments and skills. You will critically analyse and evaluate complex primary material in order to produce your own original coherent arguments. This will enable you to identify relevant techniques and concepts to solve advanced and complex problems. You will then have to communicate your independent thought and reasoning with clarity and accuracy, via oral presentations. For lab sessions you will learn and utilise research skills needed to engage in complex quantitative methods of analysis. The lab exercises should enable you to identify relevant techniques and concepts to solve advanced and complex problems. You will then need to clearly and accurately communicate your findings in written format.

Contributing staff:

Module organiser – Dr Gareth Miles (GBM), gbm4@st-andrews.ac.uk
Other contributors – Prof Keith Sillar (KTS), kts1@st-andrews.ac.uk
– Dr Wen-Chang Li (WCL), wl21@st-andrews.ac.uk
– Dr Bill Heitler (WJH), wjh@st-andrews.ac.uk

Main topics:

The course is divided into the following 6 main sections:

1) Historical overview including why motoneurons are the prototypic neuron – first intracellular recording of a CNS neuron was a MN… (KTS)
2) Synaptic inputs to motoneurons – sensory input and reflexes, descending and local drive, anatomical organisation of inputs in dendritic tree (KTS).
3) Intrinsic properties of motoneurons – ion channels and how they relate to patterns of motoneuron output (GBM).
4) Motoneuron development – genetics and activity-dependent mechanisms underlying differentiation of multiple motoneuron subtypes (GBM).
5) Motoneuron recruitment - from Henneman's size principles to more recent findings (WL).
6) Motor Neurone Disease (MND) – proposed mechanisms of selective degeneration of motoneurons in MND (GBM).

Each section will begin with an introductory lecture and be followed by a session in which students present relevant primary literature. Papers for presentations will be selected by the member of staff running each section.

Labs:

Two labs will be conducted during the course.

1) Modelling and simulation of single motoneurons (WJH)
   This lab will utilise computer modelling and simulation to investigate the roles of various ion channels in motoneuron function.
2) Techniques for studying the anatomy and physiology motoneurons (KTS & GBM)
   This lab will demonstrate a range of current techniques used to reveal the morphology and function of motoneurons in different model systems.

Assessment:

Paper commentaries for non-presenting students (200 words). [10%]

All non-presenting students will be required to write a short (200 word) synopsis of papers that are presented in each section of the course. These synopses will take the form of a "*Nature* summary paragraph". Guidelines on this format will be provided in class and on MMS.

Class hand-out to be prepared by presenting students (presentations not directly assessed). [10%]

Each student will give at least 1 presentation based on a primary research article (which will be given to them). Presentations will not be marked; instead presenting students will produce a hand-out for the class which will be assessed. This hand-out should be no more than 2 A4 sides in length (including references). Hand-outs should summarise your presentation and must contain enough detail that they can be understood as an individual piece of work. Hand-outs should demonstrate your independent investigation into the topic - beyond the single paper you have be asked to present.

Lab write up (x1). [20%]

A lab write-up will be required for the Modelling and Simulation laboratory but not the Anatomy & Physiology laboratory. The exact format of the lab write-up will be provided in class.

Exam, 2 essay questions. [60%]

The exam will contain at least 4 essay questions from which two must be answered. The duration of the exam will be 2 hours.

Specific School regulations relating to absence reporting, penalties and rules for late submission of work, extensions for coursework, academic misconduct policy and Academic Alert can be found in the School of Psychology and Neuroscience Honours Handbook.

For further information see the University Handbook: http://www.st-andrews.ac.uk/studenthandbook

Timetable:

	Bute Neuroscience Lab (C28) *(unless stated otherwise)*	**Bute Neuroscience Lab (C28)** *(unless stated otherwise)*
	Mon (classes 2–3pm)	**Fri (classes 9-10:30am)**
Week 1 (Sep 12)	GBM/KTS: Intro & History of MN research	x
Week 2 (Sep 19)	KTS: Synaptic inputs (intro)	KTS: Synaptic inputs (student led)
Week 3 (Sep 26)	GBM: Intrinsic properties (intro)	GBM: Intrinsic properties (student led)
Week 4 (Oct 3)	WCL: Recruitment (intro)	WCL: Recruitment (student led)
Week 5 (Oct 10)	GBM: MN anatomy & physiology lab **(venue and times TBA)**	
Week 6 (Oct 17)	**Independent learning week**	
Week 7 (Oct 24)	GBM: Development (intro)	GBM: Development (student led)
Week 8 (Oct 31)	WJH: Simulation lab (intro)	WJH: Simulation lab **(Bute PC lab)**
Week 9 (Nov 7)	GBM: MND (intro)	GBM: MND (student led)
Week 10 (Nov 14)	Revision	Revision
Week 11 (Nov 21)	GBM (and others): Revision/Q&A	GBM (and others): Revision/Q&A