# PART II PHYSIOLOGY, DEVELOPMENT AND NEUROSCIENCE 2015-2016

**NST Part II Physiology, Development and Neuroscience**
Course Organiser: Dr Stewart Sage

**Development and Reproductive Biology**
Theme organiser: Professor Nick Brown
**Integrative Physiology**
Theme Organiser: Dr Michael Mason
**Neuroscience**
Theme Organiser: Professor Angela Roberts

**NST Part II Physiology & Psychology**
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**Department of Physiology, Development and Neuroscience website**:
http://www.pdn.cam.ac.uk/

**Part II Physiology, Development and Neuroscience website**:
**http://www.pdn.cam.ac.uk/teaching/part2/index.shtml**

## Contents

# INTRODUCTION

Part II in Physiology, Development and Neuroscience offers a broad range of teaching and project opportunities covering the full spectrum of interests within the Department. Our Part II teaching is organised into modules to offer the greatest possible flexibility to design a course to match your own interests. We also offer a joint Part II course in Physiology & Psychology.

The Department of Physiology, Development and Neuroscience is concerned with material central to the life sciences. It addresses questions about the way that cells, tissues and organs develop and function in people and animals. Physiology, Development and Neuroscience are broad but interlinked subjects with many different areas of specialisation. A good grounding in these subjects opens the way to a wide variety of careers: these range from those where you use your knowledge directly, to those in which the understanding you will acquire of complex organisms is put to work less directly, such as in managing equally complex human organisations. The knowledge and skills gained on this Part II course will particularly provide a valuable basis for the practice of human and veterinary clinical medicine, where a critical understanding of scientific advances are essential in designing and evaluating new treatments. Many parts of the course concentrate on important research areas where recent discoveries have changed our perception of disease and have posed new questions to be answered. The sixteen modules are organised into three themes, allowing you to spend the whole of your third year studying in depth Development & Reproductive Biology, Integrative Physiology or Neuroscience. Alternatively, those of you seeking a broader overview can select to follow a more general course, combining modules across these themes.

One major benefit of studying Part II Physiology, Development and Neuroscience will be in gaining an in-depth knowledge of key core areas of the life sciences. You will also gain important knowledge and skills that graduates *in any subject* should these days have. These skills include:

- critically assessing information you read or hear
- keeping accurate records
- writing reports and reviews, and effectively presenting and communicating your ideas
- efficiently using libraries and information databases
- selecting appropriate statistical procedures to verify hypotheses
- using modern computer software

Teaching of the course involves most members of staff of the Department of Physiology, Development & Neuroscience and is supplemented by invited specialists from across the University, and from the Royal Postgraduate Medical School, University College London, the National Hospital for Nervous Diseases in London, and Addenbrooke's and Papworth Hospitals. We also offer a growing number of modules taught in collaboration with other Departments, allowing us to call upon the broadest range of expertise within the University.

Taking Part II in Physiology, Development & Neuroscience gives you the many advantages of a *home base* on the Downing Site. You will immediately feel an important contributing part of the vibrant research community. The social cohesion with your fellow Part II students will be enjoyable and valuable throughout the year and your academic and other questions can be informally dealt with when you happen to meet members of staff about the Department. The Department has numerous resources available to you though the year, including a well-stocked library, where you will be able to find many of the books and journals you need in a *single* place. The Department also maintains computers and printers, which you will be able to access both in the library and a dedicated Part II computer room. Our friendly and supportive Part II technical staff will become well known to you and our excellent tearoom, frequented by all members of the Department, further fosters cohesion.

## *The scope of the course*

You will probably already have an overview of some or all of physiology, development and neuroscience from your Part I courses and we will therefore build upon these basics by offering an **in depth** course in which we will not attempt to cover the whole of these subjects. We offer teaching on topics of current interest that we discuss to a much higher level than in Part I. This means that you can devote your time to those areas you find particularly interesting. While we expect that the majority will have done the Part IA and IB courses in physiology, neurobiology or developmental and/or reproductive biology, we will also

welcome those who have done only one of these courses, as well as those who approach physiology, development and neuroscience from other directions, such as biochemistry, genetics or animal biology.

### *The organisation of the course*

All students study 4 modules. The course offers a wide choice from sixteen modules that are described in the following pages. The modules are divided into three themes: **Development & Reproductive Biology**, **Integrative Physiology** and **Neuroscience**. Many students will want to study one theme; however, others enjoy the opportunity to follow a more general course, combining modules across themes. Guidance will be given by your Departmental Advisor, a member of the staff whom you may know already as a member of your College. You will be asked to concentrate on **four** modules (two in Michaelmas and two in Lent). In your detailed reading you will want to concentrate on the topics that particularly interest you. The examination will be designed to give you an adequate choice of questions as long as you are prepared to answer questions on **four** of the course modules, two from the Michaelmas term and two from the Lent term. Much of your formal teaching will take place during the morning, with the exception of some shared modules. Many modules also offer two or three-hour workshops, journal clubs or seminars in the afternoons. These give opportunity for a more interactive style of teaching that many students enjoy and find helpful in consolidating the lecture material. Most afternoons, during Michaelmas and Lent terms, are free for project or practical work and private study. The Easter Term is kept largely free from formal commitments to allow time for reading and for discussion.

### *Projects*

All students do either an experimental research project or a theory-based project, under the supervision of an appropriate member of staff. The findings are written-up in the form of an 8,500-word report. You may choose the topic of your project from those provided by members of staff, and will have the opportunity to discuss the projects with the relevant staff members at the end of Easter term. Some projects require that you first take particular practical classes as training in essential experimental techniques. You will have the opportunity to present your progress to the Department as a poster presentation. The times that you work on your project can be negotiated with your supervisor to some extent so that you will have time available for other work and outside interests, but in general students are expected to spend about 10 hours a week on their project. The titles of a number of recent research projects are listed towards the end of this booklet, as are some of the publications arising from projects.

### *Practicals*

Students may choose to take some optional practical classes. These classes are chosen in consultation with your project supervisor. Five practical classes, which mostly last for two and a half days, are offered in the Michaelmas term. These classes are designed to allow students to experience some of the advanced techniques used in the investigation of particular aspects of physiology, development or neuroscience. Some projects will require you to take particular practical classes in order to gain initial training and background. There will be a limit on the number of places in the practical classes. Priority will be given to students that are required to attend by their project supervisor, other space will be allocated on a first-come first-served basis. Due to timetable constraints, certain practicals are incompatible with some modules and workshops.

## *The small print:*

This booklet describing the Part II Physiology, Development and Neuroscience course has to be produced in early-March. Some small details are likely to change. Some lecturers may change because of timetabling or leave commitments.

# PART II PHYSIOLOGY, DEVELOPMENT AND NEUROSCIENCE:
# A STRATEGIC ANALYSIS

## *Our aims*

- To provide a broad multidisciplinary course in Physiology, Development & Neuroscience.
- To teach you a variety of scientific skills that will equip you for future careers in a wide range of areas: health sciences (e.g. the pharmaceutical industry and environmental physiology), medicine and veterinary medicine, research in the life sciences and related disciplines, teaching, publishing and management.

## *How we expect to achieve them*

- By offering a modular course of lectures, workshops, seminars and informal discussions, research projects and practical classes, supplemented by personal contact with members of the academic staff.
- By training you in the use of practical and conceptual tools required in many sub-disciplines: from molecular biology, through membrane and cellular physiology, to the study of systems physiology and the disorders of physiology associated with disease.
- By providing constructive feedback on your progress through personal discussion and assessment of experimental notebooks and project work.

## *What you can expect by the end of the course*

- Think and write critically and creatively about what you have read, learnt and discovered.
- Analyse, both qualitatively and quantitatively, data collected during practical classes and research projects.
- Use available resources to conduct research into scientific problems, e.g. libraries and computer databases, together with academic and technical expertise.
- Assess and implement practical techniques necessary to solve a particular scientific problem.
- Communicate with expert and non-expert audiences through presentations, project reports and essays.

## *What to do if you are interested in Part II PDN:*

**Two application forms** must be completed:

1. **The Departmental Application:** If you think you are likely to want to take the Part II Physiology, Development and Neuroscience course **it is essential** that you complete of the application form and return it in person to Paul or Vicky in room C2 of the Physiology building **by 5th May 2015.** An application form is enclosed with hard copies of this brochure and the form is also available on the PDN website. **We cannot allocate a place if this form is not completed.**
2. **The University Application:** Formal application to take the course must also be made through CamSIS. After consultation with your Director of Studies you should make your Part II application on CamSIS between **March 13th and May 4th**.

**Application forms are available on the Departmental website: http://www.pdn.cam.ac.uk**

# SUMMARY OF PART II PDN THEMES AND MODULES

### Michaelmas term

| Development and Reproductive Biology | Integrative Physiology | Neuroscience[§] *(4 modules + Experimental approaches in brain research)* |
|---|---|---|
| N1 Developmental Neurobiology[#]<br>P3 Fetal and Placental Physiology<br>P4 Development: Patterning an Embryo (*shared with Part II Zoology*)<br>P9 Cell Assembly and Interactions (*shared with Part II Zoology*) | P1 Cellular Physiology<br>P3 Fetal and Placental Physiology | N1 Developmental Neurobiology[#]<br>N2 Molecular and Cellular Neuroscience[#]<br>N3 Control of Action[#]<br>N4 Sensory Transduction[#] |

### Lent term

| | | |
|---|---|---|
| N5 Neural Degeneration and Regeneration[#]<br>P2 Pluripotency and Differentiation<br>P6 Development: Cells & Organs (*shared with Part II Zoology*)<br>P7 Genes and Physiology | N5 Neural Degeneration and Regeneration[#]<br>P2 Pluripotency and Differentiation<br>P7 Genes and Physiology<br>P8 Systems and Clinical Physiology | N5 Neural Degeneration and Regeneration[#]<br>N6 Central Mechanisms of Sensation & Behaviour[#]<br>N7 Local Circuits & Networks[#]<br>N8 Learning, Memory & Cognition[#] |

### Options

[#] Offered from the inter-departmental Part II Neuroscience course

## Special considerations if considering Neuroscience at Part II

For students interested in neuroscience and wanting to pursue this interest at Part II, there are a number of possible options across the biological departments:

**1. Part II Neuroscience** (**inter-departmental course)** offers a possible 8 Modules in neuroscience topics (N1-8). Students choose 2 modules in Michaelmas and 2 in Lent. In addition to the Modules, students will carry out a one-term research project, a critical review of a paper, a presentation of paper, and attend a number of workshops. More information on the Part II Neuroscience course can be found on the Part II Neuroscience website. The course organiser for Part II Neuroscience is Dr David Parker, based in the Department of Physiology, Development and Neuroscience (djp27@cam.ac.uk).

All of the 8 Modules that make up the inter-departmental course will be shared with the PDN Neuroscience Theme (see below).

**2. Part II PDN: The Neuroscience Theme**

This PDN Neuroscience option is limited to 20 students. The option is particularly designed for those students with a keen interest in research. It combines the study of specific topics in neuroscience with an exploration of the process of research itself. Acquaintance with the scientific method will not only be gained through hands on research experience in the form of a two-term research project but also through participation in a series of workshops on 'experimental approaches in brain research'. The aim is to introduce you to biomedical research (through the study of the brain) and to enable you to formulate and address your own questions about living systems from molecules to behaviour.

All students must choose four neuroscience modules (from N1-8) within PDN (2 in Michaelmas, 2 in Lent); attend 4 out of a possible 8 workshops on experimental approaches in brain research and take a two-term lab-based project. The PDN Neuroscience Theme organiser is Prof. Angela Roberts (acr4@cam.ac.uk).

**3. Part II PDN Cross Theme Modules**

Students can take up to three of the neuroscience Modules combined with other non-neuroscience Modules if they wish to be based in PDN and cover a broader range of material.

**4. Part II Physiology and Psychology**

In this course, organised jointly by the Departments of Physiology, Development & Neuroscience and Experimental Psychology, you study a combination of those topics offered in the Part II courses of both Departments that deal with sensory and motor processing and the higher functions of the brain, from a psychological as well as a neurophysiological perspective.

**5. Other departmental courses in neuroscience**

Students interested in neuroscience should also consider Part II courses on offer from the Departments of Experimental Psychology, Pharmacology and Zoology.

**6. Part II BBS – Option 417, Neuroscience.**

BBS students can offer 4 of the 8 Neuroscience modules as their major subject, under the auspices of Part II Neuroscience. Students will choose 2 modules in Michaelmas and 2 in Lent, and write a dissertation.

The neuroscience modules N5 & N6 are also offered as BBS minor subjects (106 & 111 respectively). Major subject 417 may be taken with either of these minor subjects, provided that it does not correspond to one of the four modules that the student chooses in 417. In the examination for the major subject 417, candidates will not be allowed to answer questions on the module that is offered as their minor subject.

# PART II BBS: OPTIONS IN PDN

Course Organiser: Dr Stewart Sage (sos10@cam.ac.uk)

The Part II BBS course is for students who want a course based entirely on lecture and library work, with no practical component. Students take a major subject (consisting of four lecture modules) and a minor subject (one lecture module), and write a dissertation.

**Major subject 415: Physiology and Development [22 places]**

BBS students can offer 4 of the 8 Physiology modules as their major subject, under the auspices of Part II PDN. Students will choose 2 modules in Michaelmas and 2 in Lent.

Michaelmas term modules:

P1: Cellular Physiology

P3: Fetal and Placental Physiology

P4: Development: Patterning the Embryo

P9: Cell Assembly and Interactions

Lent term modules:

P2: Pluripotency and Differentiation

P6: Development: Cell Differentiation and Organogenesis

P7: Genes and Physiology

P8: Systems and Clinical Physiology

Some modules will schedule extra seminars or workshops for PDN and for P2NS students. BBS students would not have to attend these, but would be informed of any papers to be discussed.

***For those of you wishing to follow Neuroscience modules, you need to select major option 417, which comes under Part II Neuroscience.***

**Minor subjects [15 places each]**

Two of the eight Neuroscience modules are also offered as BBS minor subjects (106, 111). Major subjects 415 and 417 may be taken with one of these minor subjects, provided that a student taking 417 must choose 4 modules which are different from their minor subject. In the examination for the major subjects 415 and 417, candidates will not be allowed to answer questions on the module which is offered as their minor subject.

106: Module N5 Neural Degeneration and Regeneration

111: Module N6 Central Mechanisms of Sensation and Behaviour

Module descriptions can be found from page 9 onwards.

### *Home Office Licences and Training Courses.*

All laboratory experiments that involve any use of animals are strictly regulated by Act of Parliament (Animals (Scientific Procedures) Act 1986) and anyone who takes part in them must first have obtained a Personal Licence from the Home Office. Licences are issued only to applicants who have attended an accredited training course, passed a test on it and been awarded a certificate of competence. This course and test cover legal and ethical aspects of the use of animals in research, as well as the care and handling of animals in the laboratory.

Only those Part II students who will use animals in certain projects will require Personal Licences; this will only be a very small number of students. Importantly, it takes a long time for licence applications to be processed by the Home Office; therefore, student applicants have to sign the necessary form by June before going down for the Long Vacation. If you express an interest in a project that requires a Home Office Licence, the project supervisor will ask you to sign a Home Office form and to provide the personal information the Home Office requires, but licence applications will *only be processed for those who are successful in gaining a place on the course and are allocated to such a project*. Students requiring licences will be notified about this as soon as possible after places and projects are allocated.

Those who do require licences will have to attend and be tested on the obligatory Home Office Training Course (arrangements will be made in conjunction with the project supervisor). Additionally you will be required to attend University Occupational Health for an interview <u>before</u> undertaking this training course.

# THE PDN COURSE MODULES

The themes to which individual modules belong are indicated as follows: (D) Development and Reproductive Biology, (P) Integrative Physiology, (N) Neuroscience.

## *Michaelmas Modules*

### Module N1: Developmental Neurobiology (D, N)

This module addresses how nerve cells in an embryo manage to assemble into the sophisticated information-processing system that is the brain. We now understand a considerable amount about these processes, while many fascinating questions remain. Professor Bill Harris begins the module by discussing how genetically-encoded information specifies the origins of different types of nerve cells and different parts of the nervous system, and giving examples of the sophisticated experimental approaches that are now used. Once nerve cells have formed, they have to extend axons to the correct targets to 'wire up' the nervous system, as will be considered by Professor Christine Holt and Dr Geoff Cook. Axons then have to make synapses, in a manner that will generate functional neural networks, as Drs Matthias Landgraf and Matthew Oswald will explain.

Interspersed with these lecture courses on processes of general applicability are others that focus on specific systems of key importance. Dr Steven Moore reviews the development of the cerebral cortex, showing how all the mechanisms considered so far combine to generate the most advanced part of the human brain, which enables the sophistication of human thought – and which leads to developmental abnormalities if these processes go wrong. Professor Ole Paulsen will discuss the mechanisms of synaptic plasticity that operate in the mature cortex and underlie learning and memory. Dr Stephen Eglen gives a computational scientist's view of how topographic maps are formed and tuned, with special reference to the visual system. Finally, to illustrate how the processes of development and evolution interact, Dr Clare Baker reviews this in relation to electroreception.

The course is best suited for students who have studied some neurobiology in Part IB, either in MVST or in NST, but others will be able to take it if they are prepared to do some background reading.

*Module organiser: Prof. Christine Holt (ceh33@cam.ac.uk) until Easter 2015 [Prof. Roger Keynes (rjk10@cam.ac.uk) from Easter 2015]*

### Module N2: Molecular and Cellular Neuroscience

This module was previously run by Pharmacology and is no longer running. However, PDN plans to offer a similar replacement.

This module **cannot** be taken with Cellular Physiology (P1).

*Module organiser: Dr David Parker (djp27@cam.ac.uk)*

## Module N3: Control of Action (N)

As captured in Sherrington's statement 'to move is all mankind can do, whether in whispering a syllable or in felling a forest', the control of movement is central to our lives. The control of movement is diverse and is as delicate and as subtle as the analysis of sensation. We use the same arm and hand to post a letter, to thread a needle, to pull our bodies up while climbing and to lift a suitcase. Furthermore, although we use different muscles to write on paper and on a blackboard, our handwriting is very similar in the two cases. A key concept in the control of movement is the organization of the system as a whole to make the outcome successful. The motor systems module looks at the key areas in motor systems control in depth to seek an understanding of the key problems and the ways forward in solving them, covering material extending from the circuits that underlay neural information processing to the performance of the movement itself. The module as a whole focuses particularly on the principles of motor control and also on the experimental evidence as to how specific supraspinal systems (Motor cortex, cerebellum and basal ganglia) contribute to the neural implementation of these control principles.

This module **cannot** be taken with Development: Patterning the Embryo (P4).

*Module organiser: Dr Steve Edgley (sae1000@cam.ac.uk)*

## Module N4: Sensory Transduction (N)

The process of transduction within individual sensory receptors has consequences for, and imposes limits on, the perception of sensory events. Considerable advances have been made in recent years in elucidating the means by which primary sensory stimuli are transduced and processed. The module begins by examining the molecular mechanisms which enable vertebrate photoreceptors to respond with incredible sensitivity to individual photons of light, yet which also allow the cells to recover rapidly and to respond effectively at high light intensities. This will be followed by consideration of invertebrate phototransduction, which will include the ever-more-widespread roles of TRP channels which were originally discovered in this system. The modality then shifts to the chemical senses, to discuss transduction and coding in olfactory receptors, which share some fascinating features in common with phototransduction, as well as exhibiting some marked differences. The focus then switches to mechanotransduction, considering the encoding of auditory information in both vertebrate and invertebrate species, and proprioceptive signals from the mammalian muscle spindle. These special senses will be contrasted with the molecular and cellular mechanisms responsible for the transduction of pain.

You are also likely to find the module on Central Mechanisms of Sensation & Behaviour (N6) interesting and relevant.

This module **cannot** be taken with Fetal and Placental Physiology (P3)

*Module organiser: Dr Hugh Matthews (hrm1@cam.ac.uk)*

## Module P1: Cellular Physiology (P)

Cells detect and respond to changes in their external environment through a cornucopia of signalling pathways. Many of the pathways involve complex biochemical reactions, but some are more amenable to study by the physiologist – in particular membrane potential, calcium and pH. Thus, in this module we look at cellular signalling from a Physiological viewpoint rather than 'stamp collecting' all of the signalling pathways. The three main signalling mechanisms we have selected here are used by both excitable and in-excitable cells to transmit information from the cell surface to effector systems. We start the module by looking at the basic ionic regulation mechanisms that allow signalling to exist. We then move to looking at the ion channels that allow calcium into cells. This is followed by a series of lectures on intracellular calcium signalling. The calcium signals also result in pH microdomains, which are also potential signals. We then focus on the membrane, and consider how ligands can result in potential changes and how these potential changes can be modified by signalling pathways. We end the series of lectures by bringing together membrane potential changes and calcium signalling with lectures on skeletal muscle and meta plasticity. The module contains a series of workshop/seminars on mathematical modelling, molecular techniques, fluorescence measurements and microelectrode techniques.

This module **cannot** be taken with Molecular and Cellular Neuroscience (N2) or Development: Patterning the Embryo (P4).

*Module organiser: Dr Christof Schwiening (cjs30@cam.ac.uk)*

## Module P3: Fetal and Placental Physiology (D, P)

The study of the fetus and placenta is a unique aspect of physiology with relevance for basic and clinical sciences. This module will explore a wide range of topics, including the normal development of the fetus and placenta, adaptations to the intrauterine environment, responses to challenges *in utero*, mechanisms of parturition and the transition at birth. The scientific basis underlying the aetiology of miscarriage, preeclampsia and sudden infant death syndrome, and the consequences of prematurity, maternal diabetes and intrauterine growth retardation will be discussed. In addition, the course will give insight to current ideas on the developmental programming of health and disease.

This module **cannot** be taken with Sensory Transduction (N4).

*Module organiser: Prof. Dino Giussani (dag26@cam.ac.uk)*

## Module P4: Development: Patterning the Embryo (D)

This course is the first of two complementary modules (with P6), which can also be taken on their own. Our aim is to explore a fundamental biological question: how does a single cell, the fertilized egg, have all the information to make an animal? Our current knowledge of the underlying molecular mechanisms that create cell diversity and pattern in the early embryo will be examined in depth. We will discuss how the experimental advantages of different model organisms have aided the discovery of the principles of development, and the insights provided by comparing the developmental strategies of vertebrates and invertebrates. In this first module we will address key aspects of early development, including how development is regulated, how the patterning of spatial information is established and how morphogenetic mechanisms shape the embryo. At each stage we will discuss the cellular mechanisms required and the molecular networks that drive them. By comparing the development of different animals we aim to come to an understanding of conserved strategies of animal development.

These themes will be covered from the establishment of polarity in the egg, and its elaboration after fertilisation, to a consideration of how these events set the body axes. We will then see how axial patterning directs the morphogenetic movements of gastrulation and the grouping of cells into segments with differing identities.

This interdepartmental course (with Zoology) will consist of three lectures per week, and five journal club sessions in which we will aim for interactive sessions discussing key references.

This module **cannot** be taken with Control of Action (N3) or Cellular Physiology (P1). No practical classes can be taken with this module.

*Module organiser: Dr Richard Adams (rja46@cam.ac.uk)*

## Module P9: Cell Assembly and Interactions (D)

Cells are highly organised and dynamic structures. In this module we will explore how the architecture of the cell is constructed and how cells interact with each other and their environment in order to fulfil their myriad roles in animals. Our current knowledge of these vital topics will be presented in depth, with a focus on the molecular mechanisms that regulate cell behaviour. We will examine how cells use basic cell biological mechanisms in their complex activities within animals, including cellular behaviour during development and how cellular activities provide key physiological functions in the adult.

We will begin with a discussion of the interplay between subcellular structures and cellular function including the key role of the cytoskeleton. Continuing this theme we focus on the construction, and dynamics of transfer between, membrane compartments in the cell. We also investigate how nuclear organisation and architecture of the genome reflects and regulates gene function. The polarisation of cells is a crucial organisational process and we discuss how this is brought about.

Cells operate in a complex environment and we study this from several viewpoints. We look at how intercellular adhesion is used to form higher order multicellular assemblies and we study the physics of the interactions of cells with their surroundings. At this point we also have a session on the use of modelling to understand cell biology. Finally we look at long range signalling between cells by examining how cells integrate and respond to the diverse signals that arrive at their surface, exploring how the spatial organisation of intracellular signals has a profound influence on the nature of signalling.

This is an interdepartmental course (with Zoology). In addition to lectures there are several interactive sessions (such as journal clubs) in which there will be discussions of key papers, experimental techniques and major concepts in the field.

*Module organiser: Prof. Nick Brown (nb117@cam.ac.uk)*

## *Lent Modules*

### Module N5: Neural Degeneration and Regeneration (D, N, P)

Diseases and injuries of the human brain and spinal cord are tragically resistant to treatment. This lecture module investigates the cellular causes of these diseases and injuries, the reasons why regeneration does not take place, and the research that is now under way to permit regeneration therapies in the future. First we consider how neural damage occurs due to acute ischaemic injury (stroke), a complex processes which has implications for other forms of neural degeneration. Then we look at chronic neurodegenerative diseases including Alzheimer's, Huntington's, and Pick's diseases, examining their origins in genetic and/or biochemical anomalies. Progress has also been made recently in revealing the molecular genetics underlying some forms of intellectual disability, including autistic spectrum diseases, and this topic will be covered next. Returning to neurodegenerative diseases, we look at the possibility of treatment by cellular grafting or other novel approaches, particularly in Parkinson's and Huntington's diseases. A subsequent course covers the rapidly developing field of neural stem cells, considering both the presence of stem cells able to generate new neurons in some parts of the adult brain, and the potential of stem cells from other sources.

Serious lifelong disability can also be caused by an injury which interrupts axon pathways, most prominently, spinal cord injury. We look at the physiological and clinical aspects, and why axon regeneration fails to occur, and how re-wiring can be promoted experimentally. Glial cells are also vital, and are the focus of demyelinating diseases such as multiple sclerosis; so finally, we look at the degeneration and possible regeneration of glial cells.

The lecturers will all discuss research which could lead to new therapies, including development of molecular inhibitors, gene therapy, neural grafting, stem cells, and remyelination. This course is mostly given by researchers from the Clinical School, Vet School, Brain Repair Centre, and Stem Cell Institute.

*Module organiser: Dr John Rogers (jhr11@cam.ac.uk) until Easter 2015 [Prof. Roger Keynes (rjk10@cam.ac.uk) from Easter 2015]*

### Module N6: Central Mechanisms of Sensation and Behaviour (N)

The distinction between 'sensory' and 'motor' has little meaning at the higher levels of the brain. The purpose of movement is to allow interaction with the environment and to bring the organism into contact with sensory stimuli; the purpose of sensory processing is to inform action. In this module we look at these higher levels – predominantly but not entirely cortical – from the point of view of trying to understand the transformations between stimuli and responses. The specific topics covered include the central mechanisms by which both visual and auditory stimuli begin to be encoded in ways that reflect their final purpose – of recognition of possible goals, and locations, so that actions can be directed towards them. David Tolhurst discusses the first stages of object recognition by the visual cortex; Roy Patterson considers how complex sounds are represented at higher levels of the auditory system. Simone Schnall and Paul Fletcher then illustrate how our perceptions can be biased by our internal state and by our prior experiences. Finally, Wolfram Schultz, John Apergis-Schoute and Angela Roberts consider the limbic and cortical mechanisms by which sensory stimuli become rewarding or punishing and impact on our motivations and emotions to inform our decision making and ultimately drive our actions. By the end of the course you should have a better sense of one of the most exciting and active areas of brain research in this decade, that is at the heart of what the brain is all about, and whose success is largely due to taking a firmly quantitative approach to neural modelling. Those who are interested in more mathematical aspects of neuroscience will find many opportunities for applying them in this module, but the course does not require or expect a particular aptitude for maths.

*Module organiser: Prof. Angela Roberts (acr4@cam.ac.uk)*

## Module N7: Local Circuits and Neural Networks (N)

Neural networks form the middle ground in approaches to understanding the nervous system. They assemble the molecular and cellular components needed to process sensory inputs, perform cognitive functions, and pattern motor outputs. Insight into the organisation and function of these networks is essential to understanding how cellular and synaptic properties influence nervous system function and behaviour. This is currently considered to be the biggest problem facing neuroscience.

This module will examine the principles of neuronal network function using invertebrate, lower vertebrate, and mammalian model systems. It will outline the minimal requirements that need to be satisfied in order to claim understanding of a network and the extent to which these criteria have been met; highlight the factors that influence network design; outline how cellular and synaptic properties influence network outputs underlying sensory, motor, and cognitive processes; and illustrate the molecular, anatomical, electrophysiological, imaging, and computational techniques used in network analyses.

The central role of networks means that this module can provide general insight that links to modules that focus on molecular and cellular mechanisms (e.g. how can these properties influence higher functions), or to higher-level aspects of sensory, motor, or cognitive functions (e.g. what cellular mechanisms could underlie these effects).

This module **cannot** be taken with Systems and Clinical Physiology (P8).

*Module organiser: Dr David Parker (djp27@cam.ac.uk)*

## Module N8: Learning, Memory and Cognition (N)

This module (organised by the Dept. of Psychology and shared with that Part II) takes a broad approach to the neural basis of learning, memory and cognition. The module is organised according to levels of analysis, from the anatomical level to the network, cellular and molecular levels. The first 17 lectures cover learning, memory, and higher functions, at the anatomical level. Topics covered include: amnesia in humans and animals; theories of hippocampal function; computational models of memory; the amygdala (emotional memory); higher-level visual cognition, semantic memory, cognitive control of memory and the “executive functions” of the prefrontal cortex; consciousness. The final 7 lectures ‘drop down’ to the network, cellular and molecular levels. Topics include functions of the cerebellum; learning in simple systems such as the invertebrate Aplysia; cellular-level consolidation and reconsolidation.

This module **cannot** be taken with Genes and Physiology (P7).

*Module organisers: Dr Tim Bussey (tjb1000@cam.ac.uk) and Dr Lisa Saksida (lms42@cam.ac.uk)*

## Module P2: Pluripotency and Differentiation: the origin and function of the extraembryonic lineages (D, P)

The transformation of a fertilised egg into an embryo encompasses a series of fundamental cellular events that culminate in the divergence of the embryonic and extra-embryonic cell lineages. During this process the initial totipotent egg generates first pluripotent cells that, progressively, become restricted to different fates. The first differentiation event is a separation between extra-embryonic trophectoderm and the pluripotent embryonic inner cell mass, and the second, within the inner cell mass, between the embryonic epiblast and the extra-embryonic primitive endoderm. In this module we will explore how these cell fate decisions are taken and what transcriptional networks and epigenetic modifications reinforce them. We will also consider subsequent functions of the extra-embryonic lineages, and how interactions between the trophectoderm and the maternal tissues lead to implantation and establishment of a successful pregnancy.

The module will start by examining the development of cell polarisation and the effects of subsequent symmetrical and asymmetrical cell division and cell position in creating unique cell populations. The subsequent differentiation of the inner cell mass, the concept of embryonic stem cells and their therapeutic potential in regenerative medicine will then be explored, with comparisons being made between the mouse and human.

We will then investigate how the extra-embryonic lineages interact with the maternal tissues to establish a human pregnancy. This will include consideration of endometrial receptivity, implantation, decidualisation and the factors that regulate trophoblast invasion, including interactions with the maternal immune system, and the role of oxygen and cytokines. The role of the extravillous trophectoderm in spiral arterial remodelling, and establishing the maternal circulation to the placenta will be considered. Correlates will be drawn between normal pregnancies and the common complications, including miscarriage and preeclampsia, in which trophoblast invasion is impaired.

The module will involve a mix of lectures, journal clubs and interactive sessions.

Useful combination modules include: P3 Fetal and placental physiology (M), P4 Development: Patterning the embryo (M), P6 Development: Cell differentiation and organogenesis (L).

*Module organisers: Prof. Graham Burton (gjb2@cam.ac.uk) & Prof. Magda Zernicka-Goetz (mz205@cam.ac.uk)*

## Module P6: Development: Cell Differentiation and Organogenesis (D)

This module is focused on developmental processes occurring later in embryogenesis and throughout life, after the initial steps of embryogenesis that are covered in Module P4. The main aim of P6 is to explore the mechanisms that establish groups of specialised, differentiated cells and coordinate their arrangement into functional organs.

A series of topics will be presented, many using a particular tissue or organ to highlight specific developmental mechanisms. Thus, the generation of airways and vasculature addresses principles of tubulogenesis; the progressive determination of cell lineages and establishment of stem cells shows how organs are derived; neural crest and placodes illuminate mechanisms of cell allocation and migration; limb development illustrates how patterning mechanisms are coordinated with cell proliferation; diverse organs reveal the importance of growth and cell competition in establishing organ size and how their misregulation contributes to cancer; and the development of pharyngeal arches and establishment of craniofacial organizing centres demonstrates how epithelial-mesenchymal interactions instruct post-migratory neural crest cell differentiation and patterning in the head.

A mixture of examples from simpler invertebrate models and vertebrates will show how developmental mechanisms have diversified with increasing cell number. Throughout we will consider how the disruption of these mechanisms leads to congenital malformations and disease, including cancer. We will take a critical look at how our current ideas have become established and the current limitations in our knowledge.

This interdepartmental course (with Zoology) will consist of three lectures per week, and seven interactive sessions (such as journal clubs) in which we will aim to discuss key references, the experimental approaches that can be used to solve problems and the general concepts that have arisen. It will be beneficial to have taken P4 and/or P9 prior to P6, but it is not required.

*Module organiser: Prof. Nick Brown (nb117@cam.ac.uk)*

## Module P7: Genes and Physiology (D, P)

Recently a new era of the investigation of physiological processes has been developing with the integration of physiology with genetics and genomics. The integration of these approaches is becoming increasingly important and informative for understanding physiological processes in both health and disease. This course will explore this exciting research field by looking at some of the many successful examples where integrated approaches are leading to new discoveries; we will take examples from a range of physiological processes including the integration of signalling pathways, the response to hypoxia, the regulation of puberty, the generation of biological rhythms and the regulation of some of the major physiological systems. The lecture course will be supported by workshops to provide an understanding the key approaches including the use of animal models and transgenic systems and genetic and genomic analysis to provide insights into normal processes and pathophysiology. We will use interactive journal sessions to examine key scientific papers to develop an understanding of how research is conducted at the forefront of this fast moving field. The course is suited to both NST and MVST students.

This module **cannot** be taken with Learning, Memory and Cognition (N8).

*Module organiser: Dr Rob White (rw108@cam.ac.uk)*

## Module P8: Systems and Clinical Physiology (P)

Systems physiology is central to the practice of scientific medicine. The idea behind this module is to give you a more detailed view of some aspects of systems physiology and to include some clinically oriented material that is of particular importance to the practising doctor. Cardiovascular topics include cardiac arrhythmias, the genetics and energetics of heart failure and a look at the pulmonary circulation from a clinical viewpoint. Renal physiology includes autoregulation, osmoregulation and acute and chronic renal failure. Two areas of endocrine physiology are explored in the form of the ever increasing problem of diabetes mellitus and physiology and pathophysiology of bone.

This module **cannot** be taken with Local Circuits and Neural Networks (N7).

*Module organiser: Dr Stewart Sage (sos10@cam.ac.uk)*

## Neuroscience workshops: Experimental Approaches in Brain Research

These workshops have restricted numbers. All students registering for the Neuroscience theme in Part II PDN must attend four of these workshops in addition to four modules chosen from N1-N8. Any spaces left may be filled by students not registered for the Neuroscience theme.

Each workshop will be composed of a one-hour teaching session in which the advantages and limitations of different research techniques available to the neuroscientist will be discussed in the context of specific neurobiological research topics (e.g. neuronal fate, information processing in neuronal networks, how the brain makes decisions). Students will then be given the opportunity to work in groups to follow up particular questions arising from that teaching session and to present a summary and lead a discussion of the issues in student-led presentation sessions a week later. These workshops are structured in such a way as to develop not only your intellectual abilities, but also your skills in communicating ideas effectively to others, both orally and in writing, and in working with others collaboratively. Thus you will develop skills that are of value not only in biomedical research but in many other careers as well.

It may not be possible to attend some practical classes if participating in these workshops.

*Workshop organiser: Prof. Angela Roberts (acr4@cam.ac.uk)*

**List of neuroscience workshops offered in 2014/15:**
**(Most or all of these will be repeated for the coming year)**

Understanding neuronal networks: current progress and future promises
Professor Bill Harris
Neuronal networks assemble the cellular components needed to process sensory inputs, perform cognitive functions, and pattern motor outputs. However, despite their central role in the nervous system, our understanding of neuronal networks is limited at best. This workshop will examine the conceptual and experimental approaches to examining the organisation and function of local neuronal circuits, highlighting the claims of new experimental and analytical techniques and the questions that are likely to remain.

Shedding light on brain function: Optogenetics and beyond
Professor Ole Paulsen
This workshop will explore new optogenetic approaches to the study of neurons and their circuit functions. We will describe the basic principles of cell-type-specific expression of light-activated channels, and how they can be used to activate or silence neurons. We will discuss the opportunities offered by this new technology, and also some possible problems and caveats.

Experimental approaches to axon guidance
Dr Geoff Cook
Experimental techniques used to characterize the mechanisms of axon guidance will be discussed and examples given of their application to specific biological systems. Those taking this workshop will be encouraged to consider the advantages and limitations of each of the experimental approaches.

What cellular imaging can do for neuroscience
Dr Paloma Gonzalez-Bellido & Dr Trevor Wardill
This workshop will explore the range of cellular imaging techniques currently employed to visualize neuronal responses and the impact that such techniques have on our understanding of neurobiological mechanisms. The advantages of functional imaging (i.e. reduced mechanical damage) and drawbacks (i.e. slow reporting speed) will be compared to those of classic electrophysiology. We will highlight improvements in the processing of fixed tissue and imaging technology which allow deep neural tissue imaging. We will discuss the current limits to the effective use of such data sets, the challenge of mining them for meaningful information and how they are shifting our conceptual understanding of brain function.

Discovering endophenotypes: the connection between genes and neuropsychiatric syndromes

Dr Jeff Dalley

This workshop will review the concept of endophenotypes in experimental Psychiatry. The notion that genes and environment combine to confer susceptibility to the development of complex, polygenic brain disorders such as schizophrenia, attention-deficit hyperactivity disorder (ADHD) and drug addiction was first proposed by Gottesman and Shields in 1973. We will explore the utility of measuring intermediate phenotypes (e.g., based on neurophysiological, biochemical, endocrinological, neuroanatomical and cognitive components) to the discovery of gene influences in brain syndromes and discuss how this approach can aid disease diagnosis and the development of animal models.

Behavioural Neuroscience: only as good as the behavioural measure it's based on

Dr Andrea Santangelo & Dr N. Horst

This workshop will consider a range of psychological tests that are available to the Behavioural Neuroscientist for studying the brain mechanisms that underlie cognition and emotion in animals. An intrinsic problem with all psychological tests is that they never just measure the one particular psychological process that you are interested in. So, how do you gain the specificity that you are looking for? Moreover, how relevant are the results in animals to our understanding of the brain mechanisms underlying human behaviour? This workshop will consider issues of specificity, sensitivity and translatability, focussing on reward learning, cognitive flexibility and long term memory.

Designing behavioural neurophysiological studies

Professor Wolfram Schultz

This workshop will present a range of key experiments and consider the principal factors that go into a useful study. We will look at the constraints imposed by behaviour, electrophysiology and specific species and discuss example experiments in which these have been successfully taken into consideration. We will try to identify future appropriate research questions and techniques and assess how they differ from less promising ones.

Functional Magnetic Resonance Imaging (fMRI): Uses and abuses

Dr Marieke Mur

This workshop will highlight fMRI experimental designs and paradigms that can be applied to a range of fields in cognitive neuroscience. The assumptions underlying different analysis methods will be discussed, as well as the limitations resulting from the nature of the response measured by fMRI.

## Common courses

There are some skills, which we think that everyone doing Part II PDN needs to acquire, regardless of their area of specialisation. For this reason, a number of teaching sessions open to all PDN students are offered.

Some of these sessions will be held during the orientation day before lectures begin and others will be held during the year.

Topics to be included:

- *Reading and evaluating a scientific paper*
- *How to write a Part II essay*
- *Reference Management*
- *How to tackle experimental design questions*
- *Project write-up guidance/Preparing a poster presentation*
- *Information regarding the Part II PDN Examination*

# PRACTICALS

Your project supervisor may want you to take one or more of the following practicals as an introduction to techniques to be used in your project.

## The Microelectrodes Classes

The experiments performed in the two Microelectrode practical classes directly relate to topics in Cellular Physiology (P1). The practical techniques and data analysis introduced are relevant to numerous other modules, most notably Control of Action (N3) and Sensory Transduction (N4). Students doing one of the many experimental projects offered each year in this area of physiology are advised to attend one or both of these classes.

## Microelectrodes I: Basic Intracellular Recording from Murine Skeletal Muscle

The objectives are to provide a hands-on introduction to basic microelectrode techniques used in cellular neurophysiology and to introduce the recording and analysis of basic electrophysiological phenomena in striated muscle. The class will introduce you to basic equipment used in measuring bioelectric potentials, and to the setting up of murine striated muscle preparations as an experimental model on which to perform such work. You should acquire sufficient confidence and skill during the class to apply these techniques in recording, and analysing electrical activity in excitable cells.

Prof. Chris Huang

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## Microelectrodes II: Recording of Excitable Activity from Murine Skeletal Muscle

**It is essential that you have attended Microelectrodes I in order to take part in these experiments**. This set of experiments takes the studies represented by the Microelectrodes I class further. You will record and analyse the factors that modify the action potential, extending these to an analysis of the factors that determine voltage spread and conduction velocity.

Prof. Chris Huang

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## Loose Patch Clamp Recording

This practical will give you an improved understanding of the classic Nobel prize-winning experiments of Hodgkin and Huxley on the conductances underlying the action potential. In addition it provides hands-on experience of a simplified forerunner of the now-ubiquitous (and also Nobel prize-winning) patch clamp technique, which has revolutionised all areas of cellular physiology.

You will investigate the voltage and time dependent sodium and potassium conductances which underlie the action potential of murine skeletal muscle. You will record the ionic currents flowing across the muscle membrane under voltage clamp using the loose patch clamp technique. From these records you will be able to study the voltage-dependent gating of the sodium and potassium conductances underlying the action potential. You will also use a computer model incorporating the Hodgkin-Huxley equations to simulate some of the experiments which you carry out, in order to improve your understanding of the way in which these conductances depend on membrane potential.

This Practical relates directly to material covered in Cellular Physiology (P1), but the concepts underlying the loose patch clamp technique are relevant to numerous others of the more reductionistic physiological and neurobiological modules. Attendance at the practical will also provide important training for certain electrophysiological projects.

Dr Hugh Matthews

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## Photoreceptors: Electroretinogram

You will measure the responses of rod and cone photoreceptors in your own eyes, by recording the a-wave of the electroretinogram (ERG), using recent developments in methodology and analysis. A very fine DTL fibre electrode will be placed on a subject's eye, and the a-wave of the ERG will be recorded in response to brief flashes delivered full-field. Families of responses will be built up, and rod and cone signals will be isolated by using appropriate stimuli. You will fit the recorded responses using the predictions of a recent molecular model, so as to extract the parameters of phototransduction in your own rods and cones. You will also be able to investigate the "dark adaptation" recovery of your photoreceptors, following exposure to intense bleaches.

This practical class is relevant to material covered in Sensory Transduction (N4).

Dr Omar Mahroo

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## Embryonic development and physiology

During the course of this practical students will explant 9.5 day rat embryos from the uterine tissue and examine them to assess their current stage of development. The embryos will then be put into culture for about 40 hours after which they will be re-examined. Students thus will have the opportunity to observe directly the increase in size and morphological complexity that occurs in under two days during organogenesis. With such rapid morphological changes the embryos are very vulnerable to damage and this practical investigates the effect of embryonic exposure to higher than normal oxygen concentrations prior to the development of the embryonic anti-oxidant enzymes.

This class should be of interest to those students taking developmental options since it provides students with a rare opportunity to directly observe developmental changes that normally occur *in utero.* It emphasises the vulnerability of embryos to damage during the period of organogenesis and demonstrates how initially small lesions can develop into major congenital abnormalities as normal inductive mechanisms fail.

The practical is based on the embryo-culture experiments that are the basis for many of the experiments described by Dr Ellington in her module P3 lectures. During the course of the practical students will learn fine dissection techniques and semi sterile practises, both of which could be useful preparation for some projects.

This practical is relevant to material covered in Pluripotency and Differentiation (P2), Fetal and Placental Physiology (P3) and Development: Cell Differentiation and Organogenesis (P6).

Dr Stephanie Ellington

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| Topics of last year's research projects | Supervisor |
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| **Two-term Experimental Projects** | |
| Neural plate morphogenesis in zebrafish with reduced epiboly movements | Richard Adams |
| Investigating the developmental roles of olfactory ensheathing glia | Clare Baker |
| Colonic looping patterns and ancillary colonoscopy techniques in the proximal colon | Cecilia Brassett/Michelle Spear |
| A comparison of the representation of the abdominal viscera in the anatomical works of Leonardo da Vinci and Andreas Vesalius | Cecilia Brassett/Michelle Spear |
| The role of the Notch target gene CG9650 in drosophila muscle stem cells | Sarah Bray/Hadi Boukhatmi |
| Investigating the Vinculin-Paxillin connection in focal adhesion dynamics | Nick Brown/Aiden Maartens |
| Can disruption of placental endocrine function disrupt placental morphogenesis? | Graham Burton/ H Yung |
| Effect of hypoxia on placental morphogenesis | Graham Burton/ H Yung |
| Does the placenta remodel its metabolism in pre-eclampsia? | Graham Burton/Andrew Murray/Tereza Cindrova-Davies |
| Immunolocalisation of COMT in human placental and decidual tissue | Graham Burton/Teresa Cindrova-Davies |
| The molecular profiling of kisspeptin neurons | Bill Colledge |
| Is Reversibly Cooling the Cerebral Cortex An Effective Method of Investigating Transcortical Pathways? | Steve Edgley |
| The effect of depletion of calcium from the sarcoplasmic reticulum on the excitability of mammalian skeletal muscle | James Fraser/Samantha Salvage |
| Mechanical signals during neuronal network formation | Kristian Franze |
| Targeting mES cells for conditionally inducible NSun2 over-expression | Michaela Frye |
| Developmental programming of cardiovascular disease: the role of xanthine oxidase | Dino Giussani |
| Selection and pursuit of prey and neural encoding of visual information in the predatory killer fly *Coenosia attenuate* | Paloma Gonzalez-Bellido |
| Depth perception in robber flies, relating eye morphology and head movements to perception of size and distance of prey | Paloma Gonzalez-Bellido |
| Exploring the role of reward variance in foraging decisions | Fabian Grabenhorst/Wolfram Schultz |
| Phototransduction mechanisms of Drosophila cells R7,R8 | Roger Hardie |
| Who are the sister cells of Müller glia? | Bill Harris |
| Interspecies transplantations to investigate the influence of intrinsic vs extrinsic factors on retinal development | Bill Harris |
| Investigating the potential role of endosomes in RNP trafficking in the Xenopus laevis retinal axon | Christine Holt |
| Wavelength restitution: a method for arrhythmia risk stratification in heart failure? | Chris Huang |
| The effect of dantrolene sodium on Epac-mediated ventricular arrhythmia | Chris Huang |
| Effects of dantrolene on sodium currents in the murine PGC1Beta-/- model of cardiac failure | Chris Huang/Hugh Matthews |
| Quantifying release of platelet dense granule contents using analytical HPLC | Gavin Jarvis |
| The effect of pulmonary microvascular thrombosis and cell-specific HIFalpha on cancer cell extravasation | Randall Johnson/Colin Evans |
| Factor Inhibiting HIF-1alpha, an oxygen sensor with essential roles in liver metabolic regulation | Randall Johnson/Jingwei Sim |
| Characterising the pulmonary endothelial cell response to varying oxygen concentrations | Randall Johnson/Cristina Mendes-Branco-Price |
| Investigation of a growth cone repellent protein in human astrocytes | Roger Keynes/Geoff Cook |
| A model of memory recall in spiking neurons with bounded metaplastic response | Mate Lengyel |
| Squirrel ears: isometry or allometry? | Matt Mason |
| A patch-clamp investigation of the biophysical properties of a magnesium inhibited potassium channel in a leukaemia cell line | Michael Mason |
| The applicability of the turnover "bathtub model" to the acceleration of the photoresponse during light adaptation in amphibian cones | Hugh Matthews |
| Suction pipette recordings using intrapipette perfusion: measuring current responses to salt stimuli from entire mouse fungiform papillae | Hugh Matthews |
| Properties of spike firing in mouse olfactory neurons | Hugh Matthews |
| A computational model of calcium-dependent adaptation mechanisms in vertebrate olfactory receptor neurons | Hugh Matthews |
| An event-related potentials study of human facial recognition in sheep | Jenny Morton/Amadeu Quelhas Martins |
| Sleep and EEG changes in Huntington's disease mice after chronic paroxetine treatment | Jenny Morton/Sandor Kantor |
| Regulation of cardiac energy metabolism in hypoxia: matching oxygen supply and demand | Andrew Murray |

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| Dietary nitrate lowers brown adipose tissue oxygen consumption in a PPARalpha dependent manner | Andrew Murray |
| Exploring a role for Nanog in gastrulation, ex vivo and in vitro | Jenny Nichols |
| Homeostatic synaptic plasticity: in silico predictions for scale and locus | David Parker |
| Neuromodulatory effects of serotonin on reticulospinal neurons of the lamprey following complete spinal cord transaction | David Parker |
| Development of left-right asymmetry in mouse hippocampal CA3-CA1 synapses | Ole Paulsen |
| Characterizing sleep patterns and basal cortisol in trait anxiety in marmoset monkeys | Angela Roberts/Yoshiro Shiba |
| NMDA receptor signalling in a mouse model of invasive pancreatic neuroendocrine tumour (PNET) | Hugh Robinson |
| Investigating the orientation of cell divisions in developing epithelia | Benedicte Sanson |
| Fibrinogen – evoked inhibition of thrombin stimulated calcium elevations in human platelets | Stewart Sage |
| To what extent does the topical application of antiperspirant substances cause local increases in skin temperature during exercise? | Christof Schwiening |
| Investigating the mechanism of carbon dioxide anaesthesia using adult drosophila | Christof Schwiening |
| Measuring and modelling heart rate to ascertain exercise efficiency during a variety of stair climbing methods | Christof Schwiening/James Fraser |
| Identifying the presence of voltage-gated proton channels along the axon of snail neurones using electrophysiology and fluorescence imaging | Roger Thomas/Christof Schwiening |
| Characterizing Tet2 protein expression in the mouse placenta | Erica Watson |
| Determining the transgenerational effects of defective folate metabolism on placental development in mice | Erica Watson |
| Investigating the stability of Hox transcription factor binding in *Drosophila melanogaster* | Rob White |
| Characterising the role of Wnt signalling in the pre-implantation mouse embryo | Magda Zernicka-Goetz/Monika Bialecka |
| **Two-term Theory Projects** | |
| Are T lymphocytes the key to fetal survival in the face of the material immune system? | David Bainbridge |
| The striatal beat frequency model Of interval timing: can it be used to explain time illusions | David Bainbridge |
| Mechanisms underlying sex-specific growth responses to stress in utero | Alison Forhead |
| **One-term Experimental Projects (Joint Course)** | |
| Effect of hypoxia on T-Cell metabolism for cancer immunotherapy | Randall Johnson |
| Investigating motion dazzle: interaction of target and background patterning on speed perception | David Tolhurst/Anna Hughes |
| Psychophysical investigations of the effect of dazzle patterning on perception of motion speed and direction | David Tolhurst |
| **BBS Dissertations** | |
| Are mosaic and regulative development mutually exclusive? | Richard Adams |
| The concept of a morphogen has been very powerful in developmental biology. How well do we understand how morphogens function? | Richard Adams |
| Why do women aspire to be a certain body shape? Is it a healthy shape? | David Bainbridge |
| Why does obesity, and what types of obesity, cause diabetes and cardiovascular disease? | David Bainbridge |
| Diabetes | David Bainbridge |
| The evolution of multicellularity | Nick Brown |
| The role of cell adhesion in the evolution of mullicellularity | Nick Brown |
| Why might the high-altitude fetus be growth restricted? | Graham Burton |
| What are the mechanisms by which the activity of the mammalian reproductive axis is influenced by adiposity and metabolic status | Bill Colledge |
| Developmental programming of reproductive function | Alison Forhead |
| Consequences for the offspring of maternal obesity during pregnancy | Alison Forhead |
| Consequences for the offspring of maternal diabetes | Alison Forhead |
| The effects of maternal exercise on fetal development | Alison Forhead |
| The consequences of maternal anaemia on fetal and placental development | Alison Forhead |
| Developmental programming of type 2 diabetes by maternal obesity | Sue Ozanne |
| How do cells “read” calcium signals | Stewart Sage |
| How does the macula densa influence renin secretion? | Stewart Sage |
| Regulation of spatiotemporal Ca2+ signals | Stewart Sage |
| Channelopathies in calcium signalling | Stewart Sage |
| Did the human hand evolve for manipulation or violence? | Michelle Spear |
| Ischaemic postconditioning induced neuroprotection | Robert Tasker |

**Recent published papers resulting from or including work from Part II projects include (with student's name in bold):-**


Almeida, A.D., Boije, H., Chow, R.W., He, J., **Tham, J.**, Suzuki, S.C. & Harris, W.A. (2014). Spectrum of fates: a new approach to the study of the developing zebrafish retina. *Development*, **141**, 1971-1980.

Ashmore, T., Fernandez, B.O. Evans, C.E., **Huang, Y.**, Branco-Price, C., Griffin, J.L. Johnson, R.S., Feelisch, M. & Murray, A.J. (2015). Suppression of erythropoiesis by dietary nitrate. *FASEB J.* (in press).

Baudet, M.L., Zivraj, K.H., Abreu-Goodger, C., **Muldal, A.**, Armisen, J., Blenkiron, C., Goldstein, L.D., Miska, E.A. & Holt, C.E. (2012). miR-124 acts through CoREST to control onset of Sema3A sensitivity in navigating retinal growth cones. *Nature Neuroscience*, **15(1)**, 29-38.

Camm, E.J., Martin-Gronert, M.S., **Wright, N.L.**, Hansell, J.A., Ozanne, S.E. & Giussani, D.A. (2011). Prenatal hypoxia independent of undernutrition promotes molecular markers of insulin resistance in adult offspring. *FASEB Journal*, **25(1)**, 420-427.

**Chandna, A., Chandrasekharan, D.P., Ramesh, A.V.** & Carpenter, R.H.S. (2012). Altered interictal saccadic reaction time in migraine: a cross-sectional study. *Cephalalgia*, **32**, 473-480.

Charalambous, M., Ferron, S.R., da Rocha, S.T., Murray, A.J., **Rowland, T.**, Ito, M., Schuster-Gossler, K., Hernandez, A. & Ferguson-Smith, A.C. (2012). Imprinted gene doasage is critical for the transition to independent life. *Cell Metabolism*, **15(2)**, 209-221.

**Cherukad, J., Wainwright, V** & Watson, E.D. (2012) Spatial and temporal expression of folate-related transporters and metabolic enzymes during mouse placental development. *Placenta*, **33(5)**, 440-448.

Cook, G.M.W., **Jareonsettasin, P.** & Keynes, R. (2014). Growth cone collapse assay. In *Axon Growth and Regeneration: Methods and Protocols Methods in Molecular Biology*, vol. 1162, Springer Science and Business Media, New York.

**Cunniffe, N.**, **Munby, H.**, **Chan, S.**, Saatci, D., Edison, E., Carpenter, R.H.S. & Massey, D. (2015) Using saccades to diagnose minimal hepatic encephalopathy. *Metabolic Brain Disease* (in press)

Duehmke, R.M., **Pearcey, S.M.**, Stefaniak, J.D., Guzadhur, L., Jeevaratnam, J., Costopoulis, C., Pedersen, T.H., Grace, A.A. & Huang, C.L-H. (2012). Altered re-excitation thresholds and conduction of extrasystolic action potentials contribute to arrhythmogenicity in murine models of long QT syndrome. *Acta Physiologica*, **206**, 164-177.

Ferron, S., Charalambous, M., Radford, E., McEwen, K., Wildner, H., **Hind, E.**, Morante-Redolat, J., Laborda, J., Guillemot, F., Bauer, S., Farinas, I & Ferguson-Smith, A.C. (2011). Postnatal loss of Dlk1 imprinting in stem cells and niche-astrocytes regulates neurogenesis. *Nature*, **475**, 381-385.

Giussani, D.A., Camm, E.J., Niu, Y., Richter, H.G., Blanco, C.E., **Gottschalk, R.**, **Blake, E.Z.**, Horder, K.A., Thakor, A.S., Hansell, J.A., Kane, A.D., Wooding, F.B.P., Cross, C.M. & Herrera, E.A. (2012). Developmental programming of cardiovascular dysfunction by prenatal hypoxia and oxidative stress. *PLoS ONE*, **7(2)**, e31017.

Guzadhur, L., Jiang, W., **Pearcey, S.M.**, Jeevaratnam, K., Duehmke, R.M., Grace, A.A. Lei, M. & Huang, C.L-H. (2012). The age-dependence of atrial arrhythmogenicity in Scn5a+/- murine hearts reflects alterations in action potential propagation and recovery. *Clinical and Experimental Pharmacology and Physiology*, **39(6)**, 518-527.

**Hänzi, S., Copley, H.** & Carpenter, R.H.S. (2011). Saccadic latency and information foraging. *Journal of Physiology Proceedings*, **23**, PC299.

Herrera, E.A., Camm, E.J., Cross, C.M., **Mullender, J.L.**, Wooding, F.B. & Giussani, D.A. (2012). Morphological and functional alterations in the aorta of the chronically hypoxic fetal rat. *Journal of Vascular Research*, **49(1)**, 50-58.

Jeevaratnam, K., **Rewbury, R.**, Zhang, Y., Guzadhur, L., Grace, A.A., Lei, M. & Huang, C.L-H. (2012). Frequency distribution analysis of activation times and regional fibrosis in murine *Scn5a+/-* hearts: the effects of ageing and sex. *Mechanisms of Ageing and Development*, **133**, 591-599.

King, J.H., **Wickramarachchi, C., Kua, K.,** Du, Y., Jeevaratnam, K., Matthews, H.R., Grace, A.A., Huang, C.L-H. & Fraser, J.A. (2013). Loss of Nav1.5 expression and function in murine atria containing the RyR2-P2328S gain-of-function mutation. *Cardiovascular Research*, **99**, 751-759.

**Lavender, D.**, Taraskin, S.N. & Mason, M.J. (2011). Mass distribution and rotational inertia of "microtype" and "freely mobile" middle ear ossicles in rodents. *Hearing Research*, **282**, 97-107.

**Littlechild, R.**, **Zaidman, N.**, **Khodaverdi, D.** & Mason, M.J. (2015). Inhibition of KCa3.1 by depolarisation and 2-aminoethoxydiphenylborate (2-APB) during $Ca^{2+}$ release activated $Ca^{2+}$ (CRAC) entry in human erythroleukemia (HEL) cells: Implications for the interpretation of 2-APB inhibition of CRAC entry. *Cell Calcium* (in press).

Lu, L. & Fraser, J.A. (2014). Functional consequences of NKCC2 splice isoforms: insights from a Xenopus oocyte model. *American Journal of Physiology. Renal Physiology,* **DOI 10.1152/ajprenal.00369.2013.**

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**PROVISIONAL PART II PDN TIMETABLE 2015/16**

**Neuro modules, shared with Part II Neuroscience, are shown in bold.**

| **MICH.** | *Monday* | *Tuesday* | *Wednesday* | *Thursday* | *Friday* |
|---|---|---|---|---|---|
| 9.00 | **N1. Dev. Neuro** | **N3. Control of action** | **N2. Mole. cell**<br>P1. Cell-physiol. | **N1. Dev. neuro** | **N2. Mole. cell** |
| 10.00 | **N2. Mole. Cell** | P1. Cell-physiol. | **N4. Sensory transduction** | **N4. Sensory transduction**<br>P3. Fetal and placental | **N1. Dev. neuro** |
| 11.00 | P1. Cell-physiol.<br>P4/M8. Devel: Patterning | **N3. Control of action** | Practicals | Practicals | **N3. Control of action**<br>P4/M8. Devel: Patterning |
| 12.00 | **N4. Sensory transduction**<br>P3. Fetal and placental | P4/M8. Devel: Patterning | | | P3. Fetal and placental |
| | | Practicals | | | |
| 2.00 | | P4/M8. Devel: Patterning | | P9 Journal Club | *N4. Sensory transduction* |
| 3.00 | | 2 - 4 | Expt approaches to brain res | 2 - 4<br>Expt approaches to brain res | |
| 4.00 | P9. Cell assembly & interactions<br>Adrian Seminar in Neuroscience | | P9. Cell assembly & interactions | Foster Club Talk | P9. Cell assembly & interactions |

| **LENT** | *Monday* | *Tuesday* | *Wednesday* | *Thursday* | *Friday* |
|---|---|---|---|---|---|
| 9.00 | **N5. Neural degen & regen** | **N6. Central mechanisms** | **N5. Neural degen & regen** | **N5. Neural degen & regen** | **N7. Local circuits** |
| 10.00 | **N8. Learning & cognition**<br>P7. Genes & Phys | **N8. Learning & cognition** | **N7. Local circuits** | **N6. Central mechanisms** | **N8. Learning & cognition**<br>P7. Genes & Phys |
| 11.00 | **N7. Local circuits**<br>P8. Systems & clinical | **N6. Central mechanisms** | P8. Systems & clinical | *P2. Pluripotency (some sessions)* | P8. Systems & clinical |
| 12.00 | | P2. Pluripotency | P2. Pluripotency | P2. Pluripotency | |
| 2.00 | P6. Devel: Cells & organs | P6. Devel: Cells & organs 2 - 4 | P6. Devel: Cells & organs | P7. Genes & Phys | P6. Devel: Cells & organs |
| 3.00 | | Expt approaches to brain res | Expt approaches to brain res | | |
| 4.00 | Adrian Seminar in Neuroscience | | | Foster Club Talk | |

**Applicants for Part II Physiology, Development and Neuroscience MUST submit an application to the Department AND apply via CamSIS. Application forms are available on the Department web site: http://www.pdn.cam.ac.uk**