PART II PHYSIOLOGY, DEVELOPMENT AND NEUROSCIENCE 2016-2017

NST Part II Physiology, Development and Neuroscience
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Development and Reproductive Biology
Theme organiser: Professor Nick Brown
Integrative Physiology
Theme Organiser: Dr Michael Mason
Neuroscience
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Part II Physiology, Development and Neuroscience website:
http://www.pdn.cam.ac.uk/teaching/part2/index.shtml

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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.

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 and you are given a free choice as to how you distribute those over the two terms (for example: two in Michaelmas and two in Lent or three in Michaelmas and one in Lent etc.), but be aware that some modules have restricted numbers (see module descriptions on page 10). In your detailed reading you will want to concentrate on the topics that particularly interest you. This year the examination will change to one paper per module. 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 3rd May 2016.** 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 14th and May 2th**.

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[#] P3 Fetal and Placental Physiology P4 Development: Patterning an Embryo (*shared with Part II Zoology*) P9 Cell Assembly and Interactions (*shared with Part II Zoology*)	P1 Cellular Physiology P3 Fetal and Placental Physiology	N1 Developmental Neurobiology[#] N2 Molecular and Cellular Neuroscience[#] N3 Control of Action[#] N4 Sensory Transduction[#]

Lent term

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

Options

[#] Shared with the inter-departmental Part II Psychology, Neuroscience and Behaviour course

Part II PDN: The Neuroscience Theme

The PDN Neuroscience Theme organiser is Prof. Angela Roberts (acr4@cam.ac.uk).

This PDN Neuroscience option is limited to 20 students and 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; attend 4 out of a possible 8 workshops on experimental approaches in brain research and take a two-term lab-based project.

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.

List of neuroscience workshops offered in 2015/16:
(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.

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.

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.

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.

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.

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.

Studying behaviour in translational neuroscience: the do’s and don’ts

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.

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 16 PDN modules as their major subject, under the auspices of Part II PDN.

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

Minor subjects [15 places each]

Two of the eight Neuroscience modules are also offered as BBS minor subjects (106, 111). Major subject 415 may be taken with one of these minor subjects, provided that the student chooses 4 modules which are different to 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 10 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) *maximum of 80 students*

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. We begin 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. The processes of neural induction and formation of the early neural tube in vertebrates is then examined. Once nerve cells have formed they extend axons to their correct targets to wire up the nervous system, and we consider in detail the mechanisms of axon guidance, synapse formation and synapse elimination that generate functional neural networks.

Interspersed with these lectures on processes of general applicability are others that focus on specific systems of key importance. We review 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. We also 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, these are considered 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. Roger Keynes (rjk10@cam.ac.uk)

Module N2: Molecular and Cellular Neuroscience *maximum of 40 students*

While many approaches are applied to analyses of nervous systems, it is obviously important to understand the cellular and synaptic properties underlying sensory, motor, and cognitive functions. The voltage-dependent ion channels that determine the resting and active properties of neurons form a superfamily of at least 143 genes, with further functional diversity resulting from alternative splicing, posttranslational modifications, and the plasticity of varying combinations of subunits that form channels. This results in a massive range of potential cellular properties (e.g. adaptation, tonic spiking, bursting, post-inhibitory rebound, plateau potentials). At the synaptic level there is estimated to be in excess of 200 transmitter substances, each of which can differ in the mechanisms of their release and their effects. These transmitter substances can also interact to evoke effects that cannot be predicted from their individual actions.

This module provides a general basis from which you can investigate various aspects of cellular and synaptic function. The lectures will cover ion channels, oligodendrocytes and glial cells, ionotropic transmitter receptors including NMDA and AMPA-type glutamate receptors, Cys-loop receptors (e.g. nicotinic acetylcholine), G protein-coupled receptors, the role of calcium in synaptic transmission and plasticity, and mechanisms of transmitter release and activity-dependent and neuromodulator-evoked plasticity. Knowledge of these effects will provide a basis for understanding the cellular mechanisms of effects covered in other neuroscience modules.

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

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

Module N3: Control of Action (N) *maximum of 80 students*

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, but also to the more general problems of how motor patterns are generated and how sensory information relates to movement.

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, especially the encoding of auditory information in both vertebrate and invertebrate species. 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) *maximum of 80 students*

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) *maximum of 80 students*

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: Dr Alison Forhead (ajf1005@cam.ac.uk) until Oct. 2016 [Prof. Dino Giussani (dag26@cam.ac.uk) from 1st Oct. 2016]

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 resistant to treatment, with major clinical consequences. 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: Prof. Roger Keynes (rjk10@cam.ac.uk)

Module N6: Central Mechanisms of Motivation, Reward and Emotion (N)

maximum of 80 students

N6 is being revised this year to focus on the interacting neural circuits that underlie motivation, reward and emotion. Whilst the details of the module have not yet been finalised it will focus on the cortical and limbic mechanisms by which sensory stimuli become rewarding and punishing and impact on our motivations and emotions to inform our decision-making and ultimately drive our actions. In addition, consideration will be given to the nature of the imbalance in these circuits that gives rise to maladaptive behaviours ranging from drug addiction and obesity to mood and anxiety disorders.

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

Module N7: Local Circuits and Neural Networks (N) *maximum of 40 students*

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 widely considered to be the major problem facing neuroscience today.

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; outline how cellular and synaptic properties could influence network outputs underlying sensory, motor, and cognitive processes; and illustrate the molecular, anatomical, electrophysiological, imaging, and computational techniques used in network (and other) analyses.

The central role of networks means that this module provides 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 and processes 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. Topics covered include: amnesia in humans and animals; theories of hippocampal function; computational models of memory; emotional memory and the amygdala; higher-level visual cognition, semantic memory, cognitive control of memory and the "executive functions" of the prefrontal cortex; consciousness, functions of the cerebellum; 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) *maximum of 40 students*

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 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: Dr Jenny Nichols (jn270@cam.ac.uk) and Dr Erica Watson (edw23@cam.ac.uk) until Oct. 2016 [Prof. Graham Burton (gjb2@cam.ac.uk) and Prof. Magda Zernicka-Goetz (mz205@cam.ac.uk) from 1st Oct. 2016]

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

This course is the second of two complementary Developmental Biology modules (with M6/P9 and M8) that can also be taken on their own. This module examines a second phase of embryonic development, following the initial steps of defining axes, major cell layers, and broad pattern domains (covered in M6/P9 and M8).

We will begin with a discussion of key techniques, both classic and state of the art, in Developmental Biology. From this a series of topics will be presented, many using a particular tissue or organ to highlight particular developmental mechanisms. Thus, the generation of epithelia addresses principles of cell polarity and tubulogenesis; development of kidney and lung shows how coordination of cells from diverse lineages is used to generate these tubular organs; limb development illustrates how patterning mechanisms are coordinated with cell proliferation, germ cells reveal mechanisms of cell fate determination and stem cell renewal; development of pharyngeal arches, the establishment of craniofacial organizing centres, and the epithelial-mesenchymal interactions that instruct post-migratory neural crest cell differentiation and patterning in the vertebrate head .

Diverse organs reveal the importance of growth and cell competition in establishing organ size and how their misregulation contributes to cancer. A mixture of examples from simpler invertebrate models and vertebrates will show how the mechanisms have diversified with increasing cell number.

This interdepartmental course (with PDN) will consist of three lectures per week, and seven interactive sessions (such as journal clubs) in which we will aim for discussing key references and concepts presented.

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

Module P7: Genes and Physiology (D, P) *maximum of 40 students*

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: Prof. Randall Johnson (rsj33@cam.ac.uk)

Module P8: Systems and Clinical Physiology (P) *maximum of 80 students*

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. Several areas of endocrine physiology are explored in the form of pancreatic islet and gut hormones, the ever increasing problem of diabetes mellitus and the 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)

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

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

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

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

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

Topics of last year's research projects	Supervisor
Two-term Experimental Projects	
The mechanics of neural plate morphogenesis in zebrafish embryos	Richard Adams
Investigating the role of SoxE and Pax3 transcription factors in the development of olfactory ensheathing cells	Clare Baker
Comparing ramp and step exercise protocols in VO2max tests	Richard Barnes/Dan Gordon
Investigating the effect of hypoxia on the physiology of the lung endothelium and its impact on metastatic disease	Cristina Branco
How does the background of patients affect the clinical presentation of meniscal tears?	Cecilia Brassett/Jai Chitnavis/Helen Taylor
Mapping the distribution of kisspeptin neurons in the mouse brain	Bill Colledge
Second-order conditioning of human eyeblink responses: An insight into cerebellar learning	Steve Edgley
Patterning the zebrafish vertebral column: do the chordoblasts contribute to chordacentra mineralisation?	Angie Fleming
The effect of maternal cortisol treatment during pregnancy on hepatic insulin signalling	Abby Fowden
The impact of mechanical signals on axon development	Kristian Franze
The influence of intracellular calcium on skeletal muscle excitability and sodium channel properties	James Fraser
Combined antenatal glucocorticoid therapy with statins: Is it safer for the treatment of preterm birth?	Dino Giussani
How do killer flies hunt? An investigation of behaviour and the contribution of the ocelli during artificially provoked attacks	Paloma Gonzalez-Bellido
Metabolic regulation of retinal stem cell proliferation in zebrafish	Bill Harris
Does Ephrin-A1 alter the interaction between DCC and RPL5 in growth cones?	Christine Holt/Michael Minett
Assessment of action potential conduction in murine model of mitochondrial dysfunction	Chris Huang/Hugh Matthews
Identifying the binding site of KGF in type III collagen	Gavin Jarvis
Investigating the effect of fasting on the synaptic inputs to arcuate nucleus kisspeptin neurons and the role this plays in the regulation of testosterone levels in male mice	Sue Jones/Bill Colledge
An investigation into the expression of an axon repellent glycoprotein in the mammalian grey matter	Roger Keynes/Geoff Cook
The structure and function of the malleus-incus joint in mammals	Matt Mason
Functional importance of the calcium activated chloride conductance in mouse olfactory receptor neurones	Hugh Matthews
Investigating atrial remodelling in PGC-1alpha-/- mice using the loose patch clamp technique	Hugh Matthews/Chris Huang
Reduced REM sleep amount in chronic paroxetine treated R6/2 mice	Jenny Morton/Sandor Kantor
Dietary nitrate and the control of hepatic fat metabolism	Andrew Murray
How is inner cell mass specification in early mouse embryos affected by the provision of supernumerary epiblast cells in the form of embryonic stem cells?	Jenny Nichols
Investigating the function of KLF2 and KLF17 in the resetting and maintenance of human embryonic stem cells from a primed to a naïve pluripotency state	Jenny Nichols/Ge Guo
The hallmarks of habituation and its site of action in the larval sea lamprey	David Parker
A comparison of in vitro gamma oscillations between different regions of the cortex, using the optogenetic technique'	Ole Paulsen/James Butler
Cell-type specific NMDA receptor maturation in primary cortical cell culture	Ole Paulsen/Susanna Mierau
The effect of the trans-membrane protein Crumbs on cell apical domain size	Katja Roeper/Clara Sidor
The inhibitory effect of fibrinogen on calcium recycling in human platelets	Stewart Sage
Differentiating the roles of the dorsal and median raphe nuclei in the regulation of anxiety with a focus on the serotonin transporter	Andrea Santangelo/Angela Roberts
An investigation of the ability of neutrophils to perform spatial sensing of chemokine gradients in vivo	Milka Sarris
Developing an assay system for Drosophila locomotion	Christof Schwiening
During thermoregulatory stress induced by a long-distance run which is more efficient, drinking water or pouring it over your head?	Christof Schwiening
Energetic expenditure of crutch ambulation	Christof Schwiening/Ian Hosking
Maternal skeletal muscle glucose handling in mouse pregnancy under hypoxia	Amanda Sferruzzi-Perri
Psychophysical investigation of stimulus grouping in "crowding" in peripheral vision	David Tolhurst
Refinement of a computational model of the ways in which visual cortex neurons encode the information in natural scenes	David Tolhurst
What navigational cues are most important for Drosophila suzukii?	Trevor Wardill
Determining the spectral sensitivity of Killer flies (C. attenuata) and the blowfly Lucilia	Trevor Wardill/Paloma Gonzalez-Bellido

Heart phenotype of non-pregnant and pregnant mice with abnormal folate metabolism	Erica Watson
Do Hox cofactors increase Hox binding stability in vivo?	Rob White/Damiano Porcelli
Can the methods of inducing aneuploidy in embryos to investigate the chimeric model of chromosome mosaicism be further optimised?	Magda Zernicka-Goetz/Sarah Graham
Two-term Theory Projects	
Could high altitude training be beneficial to athletic performance in racehorses?	Alison Forhead
Does assisted reproductive technology disrupt epigenetic marks on the offspring's DNA causing long term effects on their health?	Alison Forhead
BBS Dissertations	
Factors influencing ovarian reserve in human populations	Catherine Aiken
Circulation of the equine lower limb: can human studies provide insight into strategies for maintaining venous return and lymphatic drainage during box rest?	David Bainbridge
Should people fear vaccination: combined vaccinations, and their side effects	David Bainbridge
Factors affecting fuel mediated teratogenesis	Stephanie Ellington
Maternal diabetes and embryopathy	Stephanie Ellington
Consequences for the offspring of maternal age at conception	Alison Forhead
How might the developmental programming of appetite networks be contributing to the current obesity epidemic?	Alison Forhead
Antenatal depression in mothers and its effects on the offspring	Abby Fowden
How efficient is human fertilisation?	Gavin Jarvis
A critical discussion of current preimplantation genetic screening (PGs) strategies for improving assisted reproduction	Martin Johnson
Is there a coherent and justifiable ethical objection to permitting the modification of nuclear genes in embryos?	Martin Johnson
Is altitude a model for hypoxic disease in humans?	Andrew Murray
Evaluation of different pedagogical approaches to anatomical education in post-1850 Britain	Joshua Nall
Current and potential future therapies for spinal cord injury	David Parker
What makes us thirsty?	Stewart Sage
The epigenetic impact of low dose radiation	Paul Schofield
The role of skeletal proteins in muscle performance	Christof Schwiening
To what extent does the father contribute to developmental programming of offspring?	Erica Watson
How do the polycomb repressive complexes act in X inactivation?	Rob White

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.*, **29(3)**, 1102.1112.

Ashmore, T., Roberts, L.D., Morash, A.J., Kotwica, A.O., **Finnerty, J.**, West, J.A., Murfitt, S.A., Fernandez, B.O., Branco, C., Cowburn, A.S., Clarke, K., Johnson, R.S., Feelisch, M., Griffin, J.L. & Murray, A.J. (2015). Nitrate enhances skeletal muscle fatty acid oxidation via a nitric oxide-cGMP-PPAR-mediated mechanism. *BMC Biol.*, **13(1)**, 110.

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.

Bermudez, M.A., **Gobel, C.** & Schultz, W. (2012). Sensitivity to temporal reward structure in amygdale neurons. *Current Biology*, **22**, 1839-1844.

Burford, C. (2015). Putting the handle back on the hammer: ossicle development in Professor Boyd's embryos. Presented at the Anatomical Society Winter Meeting, December 2015.

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 covert hepatic encephalopathy. *Metabolic Brain Disease*, **30(3)**, 821-828.

De Blasio, M.J., Boije, M., **Bernstein, B., Davies, K.L., Plein, A.**, Kempster, S.L., Smith, G.C.S., Charnock-Jones, D.S., Blance, D., Wooding, F.B.P., Giussani, D.A., Fowden, A.L. & Forhead, A.J. (2015). Developmental expression and glucocorticoid control of the leptin receptor in fetal lung. *PLoS One*, **10(8)**, e0136115.

De Blasio, M.J., Boije, M., Kempster, S.L., Smith, G.C.S., Charnock-Jones, D.S., **Denyer, A., Hughes, A.**, Wooding, F.B.P., Blance, D., Fowden, A.L. & Forhead, A.J. (2016). Leptin matures aspects of lung structure and function in the ovine fetus. *Endocrinology*, **157**, 395-404.

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.

Forhead, A.J., Jellyman, J.K. De Blasio, M.J., **Johnson, E.**, Giussani, D.A., Broughton Pipkin, F. & Fowden, A.L. (2015). Maternal dexamethasone treatment alters circulating and tissue components of the rennin-angiotensin system in the pregnant ewe and fetus. *Endocrinology*, **156**, 3038-3046.

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.

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.

Horscroft, J.A., **Burgess, S.L.**, Hu, Y. & Murray, A.J. (2015). Altered oxygen utilisation in rat left ventricle and soleus after 14 days, but not 2 days, of environmental hypoxia. *PLoS One*, Sep 21, **10(9)**, e0138564.

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.

Kirwan, P., Turner-Bridger, B., Peter, M., Momoh, A., **Arambepola, D.**, Robinson, H.P.C. & Livesey, F.J. (2015). Development and function of human cerebral cortex neural networks from pluripotent stem cells in vitro. *Development*, **142**, 3178-3187.

Lam, J., Wilkinson, J.T., Brown, J., Spear, M. & Brassett, C. (2016). Configurations of colonic segments in undisturbed cadaveric abdomens and the implications for difficulties encountered in colonoscopy. *Journal of Anatomy* (in press).

Lever, R.A., **Hussain, A.**, Sun, B.B., Sage, S.O. & Harper, A.G.S. (2015). Conventional protein kinase C isoforms differentially regulate ADP- and thrombin-evoked Ca^{2+} signalling in human platelets. *Cell Calcium*, **58**, 577-588.

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*, **57(2)**, 76-88.

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.**

Manns, R., Schmandke, A., Schmandke, A., **Jareonsettasin, P.**, Cook, G., Schwab, M.E., Holt, C.E. & Keynes, R. (2014). Protein synthesis dependence of growth cone collapse induced by different nogo-a-domains. *PLoS One*, Jan 29., **9(1)**:e86820.

Mason, M.J., Schaffner, C., Floto, R.A. & **Teo, Q.A.** (2012) Constitutive expression of a Mg^{2+} inhibited K^+ current and a TRPM7-like current in human erythroleukemia cells. *American Journal of Physiology (Cell Physiology),* **302**, C853-C867.

Noorani, I. & Carpenter, R.H.S. (2013). Antisaccades as decisions: LATER model predicts latency distributions and error responses. *European Journal of Neuroscience*, **37(2)**, 330-338.

Richter, H.G., Camm, E.J., **Modi, B.N., Naeem, F.**, Cross, C.M., Cindrova-Davies, T., Spasic-Boskovic, O., Dunster, C., Medway, I.S., Kelly, F.J., Burton, G.J., Poston, L. & Giussani, D.A. (2012). Ascorbate prevents placental oxidative stress and enhances birth weight in hypoxic pregnancy in rats. *Journal of Physiology*, **590.6**, 1377-1387.

Salvage, S.C., King, J.H., Chandrasekharan, K.H., **Jafferji, D.I.**, Guzadhur, L., Matthews, H.R., Huang, C.L-H. & Fraser, J.A. (2015). Flecainide exerts paradoxical effects on sodium currents and atrial arrhythmia in murine RyR2-P2328S hearts. *Acta Physiol (Oxf)*, **214(3)**, 361-375.

Scott, R., Sewart, E.R., Spear, M. & Brassett, C. (2016). Critical evaluation of the depiction of abdominopelvic viscera in the anatomical works of Leonardo da Vinci and Andreas Vesalius. *Journal of Anatomy* (in press)

Sengupta, S., **Barber, T.R.**, Xia, H., Ready, D.F. & Hardie, R.C. (2013). Depletion of PtdIns(4,5)P2 underlies retinal degeneration in Drosophila trp mutants. *Journal of Cell Science*, **126**, 1247-1259.

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Sim, J. & Fraser, J.A. (2014). The determinants of transverse tubular volume in resting skeletal muscle. *Journal of Physiology,* **592**, 5477-5492.

Stoneking, C.J., **Shivakumar, O.**, **Nicholson Thomas, D.**, Colledge, W.H. & Mason, M.J. (2013). Voltage dependence of the Ca^{2+}-activated K^+ channel KCa3.1 in human erythroleukemia cells. *American Journal of Physiology (Cell Physiology)*, **304,** C858-C872.

Svensson, E., **Kim, O.** & Parker, D. (2013). Altered GABA and somatostatin modulation of propriceptive feedback after spinal cord injury in lamprey. *Neuroscience*, **235,** 109-118.

Vaughan, O.R., **Fisher, H.M.**, **Dionelis, K.N.**, **Jeffreys, E.L.C.**, Higgins, J.S., Musial, B., Sferruzzi-Perri, A.N. & Fowden, A.L. (2015). Corticosterone alters materno-fetal glucose partitioning and insulin signalling in pregnant mice. *Journal of Physiology*, **593(5)**, 1307-1321.

Vaughan, O.R., **Phillips, H.M.**, **Everden, A.J.**, Sferruzzi-Perri, A.N. & Fowden, A.L. (2015). Dexamethasone treatment of pregnant F0 mice leads to parent origin-specific changes in placental function of the F2 generation. *Reproduction, Fertility and Development*, **27(4)**, 704-711.

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PROVISIONAL PART II PDN TIMETABLE 2016/17

Neuro modules that are shared with Part II Psychology, Neuroscience and Behaviour are shown in bold.

MICH.	*Monday*	*Tuesday*	*Wednesday*	*Thursday*	*Friday*
9.00	**N1. Dev. Neuro**	**N3. Control of action**	**N2. Mole. cell** P1. Cell-physiol.	**N1. Dev. neuro**	**N2. Mole. cell**
10.00	**N2. Mole. Cell**	P1. Cell-physiol.	**N4. Sensory transduction**	**N4. Sensory transduction** P3. Fetal and placental	**N1. Dev. neuro**
11.00	P1. Cell-physiol. P4/M8. Devel: Patterning	**N3. Control of action**	Practicals	Practicals	**N3. Control of action** P4/M8. Devel: Patterning
12.00	**N4. Sensory transduction** 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 Expt approaches to brain res	
4.00	P9. Cell assembly & interactions 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** P7. Genes & Phys	**N8. Learning & cognition**	**N7. Local circuits**	**N6. Central mechanisms**	**N8. Learning & cognition** P7. Genes & Phys
11.00	**N7. Local circuits** 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