

The Faculty of Life Sciences has conducted a review of its undergraduate curriculum which has resulted in significant changes to the level 3 course units on offer in 2012-13. Below you will find a list of the new curriculum together with an outline for each course unit (which are subject to change and provided for guidance only).

Code	Title
BIOL31301	Post-Genome Biology
BIOL31311	Protein Assembly, Dynamics & Function
BIOL31321	Glycobiology: Glycobiology in Health & Disease
BIOL31332	Biochemical Basis of Disease
BIOL31341	Macromolecular Recognition in Biological Systems
BIOL31351	Current Topics in Microbiology
BIOL31362	Bacterial Infections of Man
BIOL31371	Advanced Immunology
BIOL31381	Gene Regulation & Disease
BIOL31391	Evolution of Genes, Genomes & Systems
BIOL31411	Protein Sorting
BIOL31421	Control of Cell Division
BIOL31441	Cell Signalling
BIOL31452	Comparative Developmental Biology
BIOL31461	Chemical Communication in Animals
BIOL31471	Advances in Behavioural Ecology
BIOL31482	Conservation Biology
BIOL31492	Current topics in Plant Biology
BIOL31501	Green Biotechnology
BIOL31511	Biotic Interactions
BIOL31522	Bioethics
BIOL31541	Living with Climate Change
BIOL31551	Human Impacts on the Biosphere
BIOL31561	Human Reproductive Biology
BIOL31571	Advanced Endocrinology
BIOL31582	Cardiovascular Systems
BIOL31591	Advanced Ion Transport
BIOL31602	Toxins, Toxicants & Toxicity
BIOL31612	Neuroinflammation in Health & Disease
BIOL31621	Ion Transport in Health & Disease
BIOL31631	Imaging in Biomedical Research
BIOL31642	Advanced Developmental Biology
BIOL31651	Advances in Anatomical Sciences
BIOL31671	Neuropharmacology of Human Health
BIOL31681	Clocks, Sleep & the Rhythms of Life
BIOL31691	Learning, Memory & Cognition
BIOL31721	Hormones & Behaviour
BIOL31731	Developmental Neurobiology
BIOL31742	Molecular Biology of Cancer
BIOL31751	Stem Cells
BIOL31771	Cell Adhesion
BIOL31792	Advanced Parasitology
BIOL31802	Immune Response & Disease

POST-GENOME BIOLOGY

BIOL31301

Unit Coordinator(s): Professor Simon Hubbard
(simon.hubbard@manchester.ac.uk)

Semester 1
Credits 10

Aims

This unit aims to explain how the increase in genome sequencing has underpinned many modern methodological advances in biological research that attempt to understand function, ultimately at a “systems” level. The material tackles the detail of the techniques, with a critical appraisal of their advantages and disadvantages, illustrated by examples from ground-breaking studies on a range of organisms from microbes to humans. The flow of the unit is from genome to systems, beginning with the complete genome itself, covering transcriptome, proteome, metabolome and integrated systems approaches including consideration of biological networks.

Intended learning outcomes

Upon completion of this unit, students will gain an understanding of:

- Modern approaches to genome sequencing and annotation of genes and gene function.
- Methods to study the dynamic transcriptome and proteome, including applications to prediction of gene function and genome annotation.
- Non-coding RNA annotation and function in gene expression regulation.
- Systems-based approaches to modelling and understanding biological function, including network biology and protein-protein interactions.
- The self-directed learning in the Discussion classes will help develop critical analysis in these areas – reviewing the latest developments in the field.
- The two practical classes will provide hands-on skills, to help students appreciate how data is presented and analysed in the context of the genome.

Lecture content

Lectures begin with an introduction to the post genome world, before covering genome sequencing itself, including the latest technological advances, and then genome annotation and comparative genomics. This leads into post-genomics, where we introduce transcriptomics via arrays and next generation sequencing, illustrated with applications which show how new discoveries can be made. Proteomics follows this, explaining how the proteins encoded in the genome can be studied, and how they may be quantified and networks of interactions characterised. This leads on to systems biology, from basic principles to full kinetic models, which can predict and model biological function. Finally, structural biological context is added, considering how structure is integrated into biological function on the genome scale. This is all backed-up via 4 discussion classes and 2 computer labs (on genome browsers and proteomics).

Feedback

This is provided in the two Computer Practical classes and four Discussion classes, as well as via a mid-semester essay. In the two labs, students receive direct verbal from teaching staff feedback as they work through practicals. In the discussion classes, you will present key research articles and receive feedback from staff and colleagues. We also offer a mid-semester essay, where written feedback is provided.

Assessment

2 hour essay-style examination (100%). Answer 2 from 5.

Prerequisites

- BIOL21152 'Omic Technologies and Resources (Recommended)

Recommended Reading

All our material is supported by journal articles and recent reviews, recommended by lecturers

Teaching Staff

Dr Casey Bergman, Dr Sam Griffiths-Jones, Professor Simon Hubbard, Dr Simon Lovell, Dr Jean-Marc Schwartz

PROTEIN ASSEMBLY, DYNAMICS & FUNCTION

BIOL31311

Unit Coordinator(s): Professor Andrew Doig
(andrew.doig@manchester.ac.uk)

Semester 1
Credits 10

Aims

The unit aims to provide students with an introduction to modern Protein Science, covering a representative range of high profile, contemporary topics, from folding and assembly through to dynamics and membrane transport.

Intended learning outcomes

Knowledge of the way in which proteins fold, assemble, self-polymerise, move and can be observed.

Lecture content

A) Protein folding:

- *in vitro*: including techniques used to study it. Protein folding landscapes and pathways.
- *in vivo*: misfolding and implications for disease (prions)

B) Protein dynamics: methods used to study it, including NMR and simulations. Role in protein function.

C) Protein assembly:

- chaperones: proteins which help other proteins to fold
- assembly of multiprotein complexes e.g. viruses, ribosome

D) Structures of macromolecular machines e.g. F1F0 ATPase, proteasome, flagellum

E) Structures of membrane protein transporters. Sym and Antiporters. ABC transporters. Ion channels.

Feedback

Online discussion

Feedback on essay and data handling problems

Assessment

Protein folding group problem (2%); Assembly of protein complexes problem (3%); Properties of subunits within a multiprotein complex problem (3%); Coursework essay (12%); Examination (80%) 1 ½ hours, 2 questions from 5.

Prerequisites

- BIOL21111 Proteins (**Compulsory**)

Recommended Reading

- Lesk, AM Introduction to Protein Science Architecture, Function & Genomics (ISBN 987-0-19-954130), Oxford University Press (2010)
- Petsko, G & Ringe, D Protein Structure and Function: Primers in Biology (ISBN 978-1-4051-1922-1), Wiley-Blackwell (2003)
- Whitford, D Proteins: Structure and Function (ISBN: 0-471-49894-7), John Wiley & Sons Ltd (2005)
- Papers will additionally be recommended by individual lecturers.

Teaching Staff

Professor Jeremy Derrick, Professor Andrew Doig, Professor Bob Ford, Dr Steve Prince, Dr Steve Rigby, Professor Jon Waltho

GLYCOBIOLOGY: GLYCAN FUNCTION IN HEALTH & DISEASE BIOL31321

Unit Coordinator(s): Professor Dave Thornton
(dave.thornton@manchester.ac.uk)

Semester 1
Credits 10

Aims

Glycans provide important mechanisms for cell recognition, cell adhesion, growth factor signalling and extracellular matrix organisation. The overall aim of this unit is to introduce students to the biology and pathobiology underlying these processes. The unit will introduce students to the cellular mechanisms of synthesis of glycans and an understanding of the range of biological roles they play in cell and tissue functions in health and disease.

Intended learning outcomes

To have a clear understanding of:

- The molecular diversity and widespread expression of glycans
- The structure and biosynthesis of the major groups of glycans
- How glycosylation modulates the structure, properties and functions of proteins
- The concept that glycans are key factors in biological recognition
- The critical roles glycans play in fundamental cellular processes
- Problem-solving sessions will enhance the students' analytical skills.

Lecture content

- Structural diversity in glycans, polysaccharides, glycoproteins, proteoglycans.
- Mechanisms of biosynthesis and how manipulating biosynthesis gives insight into glycan function
- The range of biological functions to which glycosylation contributes.
- Mucosal protection (innate immunity)
- Trafficking of immune cells to sites of injury/infection and migration of tumour cells
- Cellular action, location and organization of glycosyltransferase enzymes for O-linked and N-linked glycan biosynthesis.
- Disease models involving gene mutation and knockout in the N-linked glycan biosynthesis pathway
- Critical function of co-translational glycosylation on protein folding and secretion.
- Specificity in glycosaminoglycan biosynthesis
- Generation and identification of selective protein binding sequences in glycosaminoglycans
- Roles in growth factor signalling
- Lessons to be learnt from knockouts and mutations in the developmental biology of humans, mice and fruit flies

Feedback

Feedback will be provided directly via online discussion boards and through comments on directed self-assessments carried out by each student as part of e-learning activities and in-lecture problem solving sessions.

e-Learning Activity

The course will be supported by a Blackboard e-learning module, online quizzes and discussion boards.

Assessment

2 hour written examination (100%)

Prerequisites

- BIOL21111 Proteins (Recommended)
- BIOL21162 Chemistry of Biomolecules (Recommended)

Recommended Reading

No text book covers the entire unit. However, 'Introduction to Glycobiology' provides a good general background to many aspects of Glycobiology. 'Essentials in Glycobiology' provides more in-depth coverage of some aspects of the course.

Additional references will be given in lectures.

Teaching Staff

Professor John Aplin, Professor Tony Day, Dr Catherine Merry, Professor David Thornton

BIOCHEMICAL BASIS OF DISEASE

BIOL31332

Unit Coordinator(s): Professor Ray Boot-Handford
(ray.boot-handford@manchester.ac.uk)

Semester 2
Credits 10

Aims

Major diseases of man such as diabetes, obesity, atherosclerosis, and those associated with aging such as osteoporosis and delayed wound healing, are increasingly significant contributors to morbidity and fatality in the western world. Developing treatments for these diseases is a major challenge to the pharmaceutical industry and there is therefore great interest in the biochemistry underlying their pathogenesis. This unit aims to describe the biochemistry of these common diseases and highlight how understanding disease mechanisms are necessary to develop novel rational therapies.

Intended Learning Outcomes

Students should have an understanding of the biochemical basis of a number of major diseases of man and appreciate how and why specific disease mechanisms are being targeted in treatment to develop treatments.

Lecture Content

A significant proportion of this course will be delivered in the form of directed reading supported by lectures and will focus on biochemical aspects of disease mechanisms and potential therapies relating to:

- **Diabetes and Obesity:** metabolic syndrome, beta cells and insulin secretion, insulin resistance, type II diabetes, secondary complications of diabetes.
- **Vascular disease:** Atherosclerosis, dyslipidemia, vascular calcification, aberrant angiogenesis
- **Ageing and oestrogen deficiency:** Chronic wound healing, osteoporosis
- **Protein folding/misfolding diseases:** Alzheimer's, type II diabetes, dwarfisms

Feedback

Students have the opportunity to submit via Blackboard an exam-style essay answer based on relevant question from a past paper. The deadline for submission will be one week after the last lecture and feedback on essay content and style will be returned to the students within 15 days. In addition, an online discussion forum on Blackboard is available to facilitate communication amongst students and teaching staff.

Assessment

2 hour written exam answering two essay questions (100%)

Prerequisites

- BIOL21132 Cell Metabolism and Metabolic Control (Recommended)

Recommended Reading

Review papers and some primary literature will be provided on Blackboard to compliment the lecture topics

Teaching Staff

Dr Dave Boam, Professor Ray Boot-Handford, Professor Ann Canfield, Professor Andrew Doig, Dr Matt Hardman

MACROMOLECULAR RECOGNITION IN BIOLOGICAL SYSTEMS

BIOL31341

Unit Coordinator(s): Dr Johanna Avis
(johanna.m.avis@manchester.ac.uk)

Semester 1
Credits 10

Aims

The unit aims to provide an introduction to macromolecular recognition at the structural level, encompassing the widest range of examples, from small molecule recognition and drug design, through to recognition of proteins and nucleic acids, and how this drives biological function. Drug intervention of molecular interactions is a recurring theme and, where appropriate, interactions are set in the broader context of a cellular 'system'. The unit also aims to invoke greater understanding and depth of knowledge through the use of a molecular graphics interface.

Intended Learning Outcomes

Students will be able to:

- describe the molecular basis for recognition of small molecule ligands, and how this knowledge can be applied to drug discovery
- describe the molecular basis for protein-protein interactions, giving specific examples, plus also relating such interactions to a cellular 'system'
- describe the molecular basis for DNA recognition by proteins, the roles of specific and non-specific interactions and the structural motifs involved
- describe the structural features of RNA, identify these from a secondary structure diagram and discuss how they can be specifically recognised by certain proteins
- describe the chemical features of RNA which enable it to act catalytically
- use molecular graphics software in an interactive manner and use it to draw appropriate conclusions concerning macromolecular recognition
- develop organisational and presentational skills to prepare an assessed essay

Lecture content –

1. Protein recognition of small molecules (3 lectures, 1 graphics workshop)

Induced fit and conformational flexibility • Allosteric binding • Mechanisms of inhibition and applications to structure-based drug design 8 Drug discovery (including successful examples in pharmaceutical chemical biology)

2. Protein-Protein Recognition (3 lectures, 1 graphics workshop)

Molecular basis of protein-protein interactions • Physical and evolutionary features of protein interaction sites • Regulatory protein complexes and signal transduction modules

3. Recognition of Nucleic Acids (8 lectures and 2 graphics workshops)

DNA/RNA recognition – general principles • Tools and techniques • nucleic acid recognition from a genomics perspective • Examples of protein-DNA recognition • Examples of protein-RNA recognition (hairpin loop, tRNA) • RNA-RNA interactions and ribozymes • The ribosome

Feedback

Formative feedback will be provided in molecular graphics sessions and through annotated essay scripts. Students will also receive summative feedback on completed eLearning assignments.

Assessment

2 hour written examination (80%), 2500 word essay using Kinemage (15%), eLearning (5%)

Prerequisites

- BIOL10212 Biochemistry (**Compulsory**)
- BIOL21111 Proteins (**Compulsory**)
- CHEM10021 Chemistry for Bioscientists 1 (Recommended)
- CHEM10022 Chemistry for Bioscientists 2 (Recommended)

Recommended Reading

No single textbook covers the whole of this unit but lecturers will make recommendations where a book covers a specific area. The primary reading material will be sourced from articles published in research journals. Lists of key articles will be distributed for each of topic on delivery in lectures.

Teaching Staff - Dr Johanna Avis, Dr Simon Lovell, Dr Lydia Tabernero, Dr Jim Warwicker

CURRENT TOPICS IN MICROBIOLOGY

BIOL31351

Unit Coordinator(s): Dr Nicola High
(nicky.high@manchester.ac.uk)

Semester 1
Credits 10

Aims

To provide students with an insight into some of the most recent advances in Microbiology.

Intended learning outcomes

At the end of the course students will have an appreciation of;

- The molecular mechanisms used by microorganisms to detect and respond to environmental change.
- The role of quorum sensing in bacterial pathogenesis.
- The importance of biofilm formation in pathogenesis and antibiotic resistance
- The role of horizontal gene transfer in the evolution of bacterial pathogens and the spread of drug resistance.
- The mechanisms used by microorganisms to protect themselves from foreign DNA
- The use of modern genomic techniques to advance our understanding of bacteria and bacterial ecosystems.

Lecture content

- Environmental sensing:
 - How bacterial pathogens adapt to life in the host;
 - Alternative Sigma factors - a rapid response to change
 - H-NS, a bacterial thermometer and virulence regulation
 - How Eukaryotic microbes tell night from day - circadian rhythms I
 - How Eukaryotic microbes tell night from day - circadian rhythms II
- Bacterial cell to cell communication and virulence
- Inter-kingdom quorum sensing: bacterial conversations with the host
- Biofilms and bacterial virulence
- Biofilms and antibiotic resistance - the problem with persisters
- Horizontal gene transfer and the evolution of multi drug resistant bacteria
- Horizontal gene transfer and the evolution of bacterial pathogens
- CRISPRs - A bacterial immune response to foreign DNA
- Surveying the genome; how eukaryotic microbes detect and eliminate foreign DNA
- Sequencing microbial genomes, past present and future
- Synthetic microbiology- the birth of a new science
- Synthetic bacterial genomes

Feedback

Two, optional multiple choice quizzes will be available on Blackboard towards the middle and end of the course. These will provide an opportunity for students to assess their understanding of the learning objectives of the course.

Assessment

A magazine-style article on a current microbiology topic (20%); 2 hour examination (80%)

Prerequisites

- BIOL21181 Prokaryotic Microbiology (Recommended)

Recommended Reading

Primary papers and review articles selected by Dr High

Teaching Staff:

Dr Sue Crosthwaite, Dr Christian Heintzen, Dr Nicky High

BACTERIAL INFECTIONS OF MAN

BIOL31362

Unit Coordinator(s): Professor Ian Roberts
(i.s.roberts@manchester.ac.uk)

Semester 2
Credits 10

Aims

The aim of this unit is to provide students with an in depth, up to date understanding of the molecular biology of bacterial infections of man. Specifically, the mechanisms by which bacteria are able to colonise and establish infections will be addressed as well the bacteria/host interactions that subvert/modify the ability of the host to respond to infections. These processes will be illustrated by studying selected infections in details that will serve as paradigms to illustrate the principles of microbe/host interactions.

Intended Learning Outcomes

To understand in detail:

- The mechanisms by which pathogens colonise and subsequently establish invasive infections of man
- The strategies used by bacteria to circumvent host defences by modification of the host's cellular physiology
- The mechanisms used by pathogens to survival inside host-cells
- The impact of genomics on the treatment and prevention of bacterial infections
- The problem of multiple antibiotic resistance and nosocomial infections

Lecture Content

- Introduction to the concepts of infectious diseases.
- Bacterial attachment-the first step in any infection. The detailed molecular mechanisms by which bacteria adhere to and colonise host epithelial surfaces. Urinary tract infections and STD will be used as paradigms.
- Survival strategies in the host-resistance to host defences. The role of the cell surface in conferring resistance to host defences.
- Survival strategies in the host-acquisition of nutrients. The ability of bacteria to acquire nutrients in hostile environments, with an emphasis on Fe uptake.
- Survival strategies in the host-intracellular survival. The ability of bacteria such as *Listeria* and *Salmonella* to acquire nutrients growing inside host cell.
- The impact of genomics on the treatment and prevention of bacterial infections.
- The use of pathogens as bio-warfare agents.

Assessment

2 hour written examination (90%) and a 10 minute oral presentation on a selected topic related to the course (10%).

Feedback

The students will receive feedback on their oral presentations both in terms of the content and the presentational skills. There is an open surgery one hour per week when students can come and see Prof Roberts to discuss topics raised by the lectures.

Prerequisites

- BIOL21192 Principles of Infectious Disease (Recommended)

Recommended Reading

A limited number of review articles will be recommended to support the course.

Teaching Staff

Dr Jen Cavet, Professor Ian Roberts

ADVANCED IMMUNOLOGY

BIOL31371

Unit Coordinator(s): Professor Werner Muller
(werner.muller@manchester.ac.uk)

Semester 1
Credits 10

Aims

The Immune system is very important to constantly keep our body system healthy by protecting us from environmental challenges like infections and wounds but also from challenges within our body like keeping check of pre cancerous cells and to fight cancer. The Aims of the unit are to learn the language of Immunologist, to learn about the building blocks of the immune system from cells to cell-cell interactions, from innate to adaptive immune system. Immunology is a fast evolving field. Therefore in the Unit we try to deliver the basics based on a very well developed textbook and also discuss the latest developments in the field. The unit is most appreciated when build on the second year unit Introduction to Immunology or the students in the undergraduate medical or dental courses.

Intended learning outcomes

This unit concentrates on the building blocks of the immune system like cells of the immune system, proteins of the immune system, receptors recognising danger, histocompatibility antigens, just to name a few. It will describe the innate immune system, it will explain how the adaptive immune system develops from haematopoietic stem cells, and it will discuss signalling events in lymphocytes and cell-cell interactions. The Unit complements the Unit on Immune Response and Disease, which demonstrated how appropriate immune responses against pathogens are generated but also how inappropriate responses may lead to disease.

Lecture content

The course will cover major pathways and components of the immune system. The first lectures concentrate on the innate immune system, how pathogens interact with the innate immune system, how pathogens are recognised and how these interactions can sometimes lead to tissue damages. Then the cellular compartment of the innate immune system and the antigen presenting cells are discussed including the mechanism of antigen presentation. It is followed by detailed discussions on the development and effector functions of T-lymphocytes in immune responses. Immune response regulation will also be covered. These lectures are then followed by lectures on the development and effector functions of B-lymphocytes. We then discuss immunological concepts of Memory, Tolerance and Ignorance. The lecture series closes on a presentation of the in vivo view of the immune system and include more complex processes like cell migration, autoimmune diseases and cancer defence.

Feedback

The students will have the possibility to submit one answer to a test essay question given after the second lecture and will get feedback until the 9th lecture of the unit. In a final question and answer session attended by all lectures of the unit a general feedback will be given to all students based on the feedback given on the test essays.

Assessment

2 hours written examination (100%) - answer 2 questions from a choice of 5.

Prerequisites

- BIOL21242 Immunology (Strongly recommended)
- BIOL21252 Parasitology (Recommended)
- BIOL31792 Advanced Parasitology (Recommended)

Recommended Reading

The unit will closely follow the material in the textbook Janeway's Immunobiology (ISBN number 0-8153-4290-X). The current edition is the 7th edition; the 8th edition will come out later in 2011.

Additional material to that present in the textbook will be used in the lectures when new important material becomes available elsewhere.

Teaching Staff

Professor Richard Grencis, Dr Werner Muller, Dr Mark Travis, Dr Peter Wood

GENE REGULATION & DISEASE

BIOL31381

Unit Coordinator(s): Dr Graham Pavitt
(graham.pavitt@manchester.ac.uk)

Semester 1
Credits 10

Aims

Changes in gene expression are major factors underlying human diseases. This Unit aims to provide advanced level training and understanding of the molecular mechanisms underlying a wide variety of genetic and infectious diseases, focussing on those that alter specific factors that have direct roles in the gene regulation-from chromatin remodelling and mRNA transcription, to RNA splicing, stability and translation. There will also be examples provided of basic research into fundamental mechanisms of control, including mouse models, where this enables a more complete understanding of the molecular processes underlying the diseases described. Where practical, primary research findings will be used to support the derived disease mechanisms with events described at the molecular level as well as whole organismal consequences. This unit is ideal for Biochemistry, Genetics and Molecular Biology students as well as those taking more medically focussed degrees and options (eg Medical Biochemistry, Biomedical Sciences).

Intended learning outcomes

Students should be able to:

- Understand the importance of gene regulation for health and disease. Be familiar with molecular defects underlying specific diseases and the consequences of these for cells, tissues and the whole organism
- Understand the application of research methods used to investigate these processes and uncover molecular mechanisms
- Be able to understand and interpret primary research findings and how these are used to develop model explanations for disease processes, tests and/ or treatments
- Understand how to find, identify and interpret key data, concepts and ideas and to pass these on to others

Lecture Content

- The lectures will cover aspects of both common multi-factorial disorders that afflict increasing numbers in the population (**diabetes, obesity, cancer**) and several specific 'orphan' **genetic diseases** selected from the increasing range uncovered as well as common **infectious viral diseases**.
- The consequences of disease mutations for protein-nucleic acid interactions and functions at the molecular level will be coupled with studies of consequences for tissues, organs and the whole animal.
- The latest research findings will reveal the diversity of control mechanisms uncovered and show common themes where they exist.
- Where available, information concerning therapeutic approaches will be described.
- A self-directed eLearning module will supplement lecture material.

Feedback

Students have the opportunity to submit exam-style essay answers based on relevant questions from a past paper. Feedback on essay content and style will be returned to the students within 15 days from the submission deadline. In addition, an online discussion forum on Blackboard is available to facilitate communication amongst students and teaching staff.' Furthermore a Blackboard self-directed e-learning module supports various aspects of the lectures and the Final Lecture is a feedback/exam preparation lecture. After the examination, during semester 2, an exam performance session will allow students to view their scripts, marks and comments made.

Assessment

2 hour exam (100%)

Prerequisites

- BIOL21101 Genome Maintenance & Regulation (Strongly Recommended)
- BIOL21152 'Omic Technologies & Resources (Recommended)

Recommended Reading

Primary articles and review articles given in lectures.

Teaching Staff

Dr Mark Ashe, Dr Catherine Millar, Dr Ray O'Keefe, Dr Graham Pavitt, Dr Paul Shore

Unit Coordinator(s): Professor David Robertson
(david.robertson@manchester.ac.uk)

Semester 1
Credits 10

Aims

To convey how comparisons between genetic sequence data can be used to study the evolution of genomes, cells and organisms. To explain how changes in DNA, proteins and their interactions contribute to evolutionary change. Using examples from single genes, genomes, viruses, microbes, plants and animals, demonstrate how studying evolution can help us understand complex biological systems.

Intended learning outcomes

Understanding of: how changes in DNA alter the structure and coding capacities of genes and genomes and hence enable populations and species to evolve. How the evolution of developmental processes has resulted in changes in the expression and function of highly conserved genes that control animal development. How evolution of the genome is linked to the evolution of proteins, protein interactions and signalling networks.

Lecture content

- Molecular evolution, the neutral theory, the molecular clock and coalescence theory.
- Using changes in DNA and genomes to provide evidence of selection, for example in human evolution.
- Molecular phylogenetics: inference of evolutionary history, gene versus species trees and the tree of life.
- Rates and patterns of molecular evolution in genomes.
- Evolution of proteins and biological function. Functional constraints and specificity of protein interactions.
- The evolution of genome structure and complexity. Genome rearrangement: inversions, transposition and translocations.
- The role of duplication in genome evolution: small versus large-scale duplication and whole genome duplications, and how they contribute to functional evolution.
- Evolution of molecular complexity in proteins: linking gene duplication and protein evolution.
- Evolution of the developmental genetic tool kit: insights from the Hox genes and the common ancestor of bilateral animals.
- Linking genome evolution to the evolution of organisms and species.
- Evolution of complex biological systems: protein interaction networks and the link to systems biology.

Feedback

Individual feedback on student presentations and discussion session with all lecturers.

Assessment

2 hour examination, 2 essay questions out of 5 (95% of marks) and course work, the production of two short presentations based on primary literature (5% of marks).

Prerequisites

- BIOL21232 Fundamentals of Evolutionary Biology (Recommended)

Recommended Reading

- Dan Graur and Wen-Hsiung Li, Fundamentals of Molecular Evolution.

Teaching Staff

Dr Douda Bensasson, Dr Simon Lovell, Professor David Robertson, Dr Matthew Ronshaugen, Dr Cathy Walton, Dr Simon Whelan

PROTEIN SORTING

BIOL31411

Unit Coordinator(s): Dr Martin Pool
(martin.r.pool@manchester.ac.uk)

Semester 1
Credits 10

Aims

Eukaryotic cells are characterised by specialised sub-cellular compartments. This compartmental organisation demands that newly synthesised proteins are accurately and efficiently targeted to their appropriate sub-cellular locations. Compartmentalisation also ensures that unique post-translational modifications can occur to a subset of synthesised proteins. The aim of this unit is to examine the molecular mechanisms of protein sorting in eukaryotes, and will review recent data demonstrating that some of these processes are fundamental to all living cells. A substantial part of the course will involve discussion of recently published papers.

Intended learning outcomes

To understand the mechanisms which target proteins to a number of compartments (including the nucleus, mitochondria, plastid and the secretory pathway), the major post-translational modifications occurring throughout the secretory pathway, and the basis of the molecular specificity of vesicular transport. The biogenesis of lipids will be examined together with a review of their role in protein sorting. Lectures will emphasise the applications and limitations of specific experimental approaches. The problem sessions are designed to enhance cognitive skills, and to develop the ability to assess and critically interpret experimental data.

Lecture content

Protein targeting to the nucleus:

- The nature of nuclear localisation signals and nuclear pores.
- The role of soluble factors in nuclear import.

Protein targeting to mitochondria & plastids:

- Mitochondrial & chloroplast targeting signals.
- Sorting of proteins to specific compartments within mitochondria and plastids.

The secretory pathway:

- Protein targeting to the endoplasmic reticulum.
- Protein translocation into and across the ER membrane.
- Post-translational modification and protein folding at the ER
- Global changes to the secretory capacity during differentiation and stress

Mechanisms of vesicular transport:

- Formation of transport vesicles
- Targeting and fusion of transport vesicles

The endocytic pathway:

- Receptor-mediated endocytosis.
- Ubiquitin-dependent receptor downregulation

Feedback

This will be via the discussion board, a mock exam comprising a data interpretation problem, which will be marked and annotated and a 'post-exam clinic'.

Assessment

2 hour written examination (100%), including both short essay answers and data interpretation problem.

e-Learning

There will be an ePBL exercise, complementary to the lecture material to further consolidate the course's experimental/problem-driven approach to the topic of protein sorting.

Prerequisites

- BIOL21141 Cell Membrane Structure and Function (Recommended)

Recommended Reading

Reference lists of primary and review articles will be given in lectures

- Alberts B, Johnson A, Lewis J, Raff M, Roberts K & Walter P (2008) *Molecular Biology of the Cell (5th edition)*. Garland Science

Teaching Staff

Professor Stephen High, Dr Martin Pool, Professor Philip Woodman

CONTROL OF CELL DIVISION

BIOL31421

Unit Coordinator(s): Dr Janni Petersen
(janni.petersen@manchester.ac.uk)

Semester 1
Credits 10

Aims

The aim of the unit is to provide an insight into the complex and highly co-ordinated events that result in the correct duplication of a cell. Students will be introduced to the different experimental approaches used to study these events and will learn why correct control of the cell division cycle is essential for preventing the formation of cancers in mammalian cells.

Intended learning outcomes

To understand the molecular mechanisms controlling cell cycle progression and how directionality can be imposed upon an otherwise fully reversible set of complex biochemical reactions. Students will appreciate how internal and external factors can disturb the normal cell cycle, the mechanisms that cells have developed to deal with such disturbances and how inability to deal with disturbances can lead to diseases such as cancer. Finally, they will recognise how these key questions have been addressed using genetic, biochemical and molecular approaches in different model systems to give a unified view of highly complex biological process.

Lecture content

- Background, conceptual problems, approaches to studying the cell division cycle
- The G2/M transition; genetic and biochemical analysis, phosphorylation and proteolysis
- Mitosis; structural rearrangements, microtubule structure, dynamics and function, kinetochores, MAPS, motor proteins, phosphorylation cascades and proteolysis, cohesins, spindle checkpoint
- START; controls acting at START, identification of START, regulation of START
- DNA replication; ARS binding proteins, ORC components and function, co-ordination with mitosis, dependency
- Checkpoints; DNA synthesis and DNA damage checkpoints, detectors, transducers, effectors
- Cancer and the cell cycle

The course will consist of 15 lectures interspersed with 3 'journal clubs'. In these sessions groups of students will be given a research article and asked to give a presentation to their peers. In the presentation they will summarise the context in which the paper was written, the methodology of the paper the finding of the paper and lead a general discussion about research.

Feedback

Feedback is provided on journal club presentations. The students have the option of doing marked essays on a range of generic topics covering the lectures.

Assessment

2 hour examination (100%)

Prerequisites

- BIOL21101 Genome Maintenance & Regulation (Recommended)
- BIOL21121 The Dynamic Cell (Recommended)

Recommended Reading

- Morgan, DO. The Cell Cycle; New Science Press Ltd (2007)
- Hunt T, Murray A. An Introduction to the Cell Cycle Background Oxford University Press (1993)

Teaching Staff

Dr David Hughes, Dr Janni Petersen, Professor Andrew Sharrocks

Unit Coordinator(s): Dr Alan Whitmarsh
(alan.j.whitmarsh@manchester.ac.uk)

Semester 1
Credits 10

Aims

- provide an understanding of the mechanisms by which cells communicate
- illustrate the commonality of mechanisms using examples of various signalling molecules
- provide a basis for understanding disease processes in which signalling is compromised
- give insight into the experimental methods used for studying cell signalling

Intended learning outcomes

- be able to describe the various types of signalling molecules including receptors, adapter proteins, second messengers, kinases and phosphatases
- understand how the physical properties of signalling molecules influence their behaviour
- be able to describe the major intracellular signalling pathways in cells and have an understanding of their complexity and the interactions between them
- have an understanding of the link between extracellular signals and intracellular events, including the regulation of gene expression and apoptosis
- be able to discuss the relevance of cell signalling in a variety of physiological and pathological situations
- appreciate the experimental techniques associated with the study of cell signalling

Lecture content

- Introduction to cell signalling: signalling networks, protein-protein interactions, protein phosphorylation/de-phosphorylation.
- Receptors: types of receptor (RTK, GPCR, TGF β , cytokine, Wnt receptors), their mechanism of action and their regulation.
- Second messengers: calcium signalling and phospholipid signalling.
- Intracellular signalling pathways: covering the major pathways in cells (MAPK, PI3K-AKT, JAK-STAT, SMAD, IKK-NF- κ B), their components and key roles of protein kinases and phosphatases.
- Transcriptional regulation by signalling pathways at the level of both transcription factor and chromatin modifications.
- Techniques used to research cell signalling

Feedback

Students will have the opportunity to submit an exam-style essay answer via Blackboard. They will receive detailed feedback on essay content and style. In addition, an online discussion forum is available on Blackboard to facilitate communication amongst students and teaching staff.

Assessment

2 hour written examination (100%), answering two essay questions chosen from a total of five.

Prerequisites

- BIOL21101 Genome Maintenance and Regulation (Recommended)
- BIOL21121 The Dynamic Cell (Recommended)
- BIOL21141 Cell Membrane Structure and Function (Recommended)
- BIOL21261 Endocrinology (Recommended)
- BIOL21351 Cells and Tissues in Human Disease (Recommended)

Recommended Reading

- Hancock, JT (2005) Cell Signalling (2nd edition), Oxford University Press. ISBN 0199264678
- Gomperts, BD et al. (2002) Signal Transduction, Elsevier Academic Press. ISBN 0122896327

Teaching Staff - Dr Katherine Hinchliffe, Dr Lindsay MacDougall, Dr Gino Poulin, Dr Cathy Tournier, Dr Alan Whitmarsh

COMPARATIVE DEVELOPMENTAL BIOLOGY

BIOL31452

Unit Coordinator(s): Dr Matthew Ronshaugen
(matthew.ronshaugen@manchester.ac.uk)

Semester 2
Credits 10

Aims

To explain how genes function to direct development and how their evolution has resulted in variation. This course provides a foundation for understanding how studies of a particular tissue or organism can provide insight into development and disease in other animals including humans.

Intended learning outcomes

- Understand the molecules and pathways that establish the anterior/posterior and dorsal/ventral axis in animals
- Gain familiarity with the components of major signalling pathways and transcriptional networks deployed during development
- Appreciate how organismal development is controlled and evolves through molecular changes resulting in variation in the expression and function of gene networks
- Learn how understanding developmental processes and gene functions within a particular tissue or organism can provide insight into function in many other tissues and other organisms
- Understand the fundamental similarities and differences in the developmental processes used to establish structures in plants and animals
- Gain an understanding of how comparative developmental biology in combination with genetic and genomic technologies allow the use of model and non-model organisms to study human disease and healing
- To develop the capacity to evaluate and critically discuss primary literature in the context of comparative developmental biology

Lecture content

The course will be split into 6 blocks that introduce and discuss in depth key examples of comparative developmental biology. This will be followed by a seminar style discussion of the issue in the context of classic or current primary papers.

- Conservation, function and evolution of developmental signalling pathways
- Variation in the establishment of the dorsal ventral axis in animals.
- The anterior/posterior axis and evolution of the Hox determinants of identity.
- Mechanisms in the development and evolution of flowers and leaves
- Understanding regeneration and healing from model and non-model organisms
- Development of disease models facilitated by the conservation of genes

Feedback

The seminar style lecture following each topic will provide an opportunity for formative feedback to the students regarding the depth and breadth of their understanding of the topic. Students will have the opportunity to answer and receive feedback on a mock essay question.

Assessment

2 hour examination (100%), answer 2 essay questions out of 6.

Prerequisites

- BIOL21172 Principles of Developmental Biology (**Compulsory**)

Recommended Reading

- Gilbert, S.F. (2010) Developmental Biology (9th edition). Sinauer
- Wolpert, L. (2007) Principles of Developmental Biology. Oxford University Press
- Gerhart, J. et al. (1997) Cells, Embryos and Evolution. Blackwell Science
- Carroll, S.B. et al. (2004) From DNA to Diversity. Wiley-Blackwell

Teaching Staff

Dr Hilary Ashe, Dr Keith Brennan, Dr Kathryn Hentges, Dr Minsung Kim, Dr Tom Millard, Dr Matthew Ronshaugen

CHEMICAL COMMUNICATION IN ANIMALS

BIOL31461

Unit Coordinator(s): Professor Matthew Cobb
(matthew.j.cobb@manchester.ac.uk)

Semester 1
Credits 10

Aims

To study the mechanisms, functions and consequences of chemical communication in a range of animals in order to provide students with a full understanding of this fundamental mode of communication, with particular emphasis on a critical understanding of the primary research literature.

Intended learning outcomes

- To understand the key concepts underlying the detection and processing of chemical signals in a range of biological systems - from receptor cell biology to the function of insect societies
- To be able to critically evaluate published research
- To develop the ability to discuss and analyse research in both oral and written form

Lecture content

Peripheral processing: Chemical signals and their receptors. Processes that take place external to the cell membrane, at the membrane and within the receptor leading to the response of the receptor neuron. Receptor structure, receptor-ligand relations, the number of receptor molecule types per receptor neuron, and the distribution and phylogeny of receptor genes. Smell vs Taste. The evolution of the chemical senses and the qualitative difference in olfaction between vertebrates and invertebrates.

Central Processing: How does the brain form a molecular "image" of an odour, a taste or a pheromone? We will examine and contrast the two major approaches: combinatorial models vs synchronic neuronal activity. Examples will be taken from a range of organisms including *Drosophila* and rodents.

Pheromones: Sex, aggregation and social pheromones in invertebrate and vertebrate systems, including humans. Emphasis will be put on the biological context in which these pheromones function, and the way in which they may have evolved. The key example of social insects will be the focus of a separate lecture.

Chemical ecology: The role of chemical communication within and between species. Striking examples of inter-specific communication will be discussed, as will the effect of chemical communication on phenotypic plasticity in a number of species.

Modelling the nose: "Electronic noses" and the various approaches used in developing artificial sensors and sensory networks. The way in which these systems mimic organic systems and the insight artificial detection and processing systems can provide for models of animal communication.

The unit combines three forms of teaching; traditional lectures, two seminar-style discussions of research papers and a "virtual seminar" in which students have to contribute via Blackboard to a discussion of a research paper.

Feedback

- a) Detailed feedback will be provided on the 1500 word extended essay that students write during the course
- b) Each student will provide detailed written feedback on their exam performance
- c) A drop-in session will enable students to get detailed verbal feedback on their exam performance.

Assessment

1.5 hour examination (60%); extended essay to be handed in during the course - no more than 4 pages of text excluding the title page and list of references (see section 13.4 of final year handbook for submission requirements) (36%); compulsory participation in an online discussion of a research paper (4%)

Prerequisites - None

Recommended Reading

- Bradbury JW & Vehrencamp SL, Principles of animal communication Sinauer Associates (2011)
- Wyatt TD, Pheromones and Animal Behaviour Cambridge University Press (2003)

Teaching Staff - Professor Matthew Cobb, Professor Krishna Persaud

ADVANCES IN BEHAVIOURAL ECOLOGY

BIOL31471

Unit Coordinator(s): Dr Reinmar Hager
(reinmar.hager@manchester.ac.uk)

Semester 1
Credits 10

Aims

This course provides the fundamentals of behavioural ecology and animal behaviour in an evolutionary context by combining central concepts with in-depth current research topics. The aim is to give a broad overview of the field as a whole, tracing its historical origins and, at the same time, identifying the most important fundamental and applied questions in areas such as epigenetics, conservation biology and bioinformatics. This is complemented by seminars on the most recent major advances in the field, updated every year.

Intended Learning Outcomes

- History of animal behaviour and behavioural ecology
- Key concepts and related theoretical and empirical studies, e.g., sexual selection, cooperation, comparative approach, social learning
- In-depth focus on areas of current interest through seminars and guest research lectures
- Application of behavioural ecology and animal behaviour studies (e.g. conservation biology)
- Examples of current research methods in animal behaviour that combines genetics, phenotyping and bioinformatics analysis of behavioural phenotypes. This is achieved through online demonstration during seminars on genotype-phenotype mapping

Lecture content

After introducing principles of evolutionary biology and animal behaviour, the history of the field will be described from its roots in ethology to modern behavioural ecology. We will then explore the genetic and epigenetic basis of variation in behaviour before focusing on several key concepts in behavioural ecology. These include:

- sexual selection and mating systems
- cooperation
- communication
- morality and fairness
- mechanisms and organization of behaviour

This is complemented by a discussion of how behavioural ecology is applied to conservation biology and by seminars on identifying current hot topics, updated every year. We finally take a broader look at human evolution and trace the ecological and social transitions to modern humans.

eLearning Activity

1. Online mapping of behavioural traits and system genetics analysis (L15)
2. Online discussion and problem solving session

Feedback

Feedback on student performance and participation is central to achieving the learning outcomes and will be given during all seminars and online after forum discussion. This is in addition to formal feedback given on essays and exams.

Assessment

- a) 2 hour written examination (60%)
- b) One essay to be written over 2 weeks during the course - no more than 5 pages of text excluding the title page and list of references (see section 13.4 of final year handbook for submission requirements) (36%)
- c) compulsory participation in online discussion / forum (4%)

Prerequisites

- BIOL10521 Genes, Evolution and Development (Recommended)
- BIOL21232 Fundamentals of Evolutionary Biology (Recommended)

Recommended Reading

- Alcock J. 2009. *Animal Behaviour*. 9th ed. Sinauer
- Krebs JR, Davies NB, West SA. 2011. *An Introduction to Behavioural Ecology*. 4th ed; Oxford UP
- Danchin E, Giraldeau LA, Cezilly F. 2008. *Behavioural Ecology*. Oxford UP
- Szekeley T et al. (eds). 2010. *Social Behaviour*. Cambridge UP

Teaching Staff

Dr Caroline Bettridge, Professor Matthew Cobb, Dr Reinmar Hager, Dr Chris Thompson

CONSERVATION BIOLOGY

BIOL31482

Unit Coordinator(s): Dr Cathy Walton
(catherine.walton@manchester.ac.uk)

Semester 2
Credits 10

Aims

The biodiversity of our planet is increasingly at risk due to the activities of man. This unit aims to provide the conceptual background to enable students to understand the main concerns in the loss of biodiversity and how appropriate conservation strategies could help to ameliorate man's impact. The theoretical basis of conservation biology is multidisciplinary involving population genetics, ecology, evolution, population biology, etc. Students will be expected to have some basic knowledge in these areas (see prerequisites), which will be extended and applied to conservation using a wide range of examples of conservation research and management. Lectures will be interspersed with Case Studies exemplifying the lecture material.

Intended Learning Outcomes

- A rational understanding of the importance of conserving biodiversity and current priorities
- A conceptual understanding of the broad base of theory and scientific methodology underlying conservation biology
- An appreciation of how biodiversity can be conserved using appropriate management strategies and the problems involved in successful implementation

Lecture Content

Introduction to Conservation: Effect of man on the environment and biodiversity. Millenium ecosystem assessment. What is conservation biology?

Biological Diversity: What is biodiversity? How is biodiversity quantified? geographical distribution of biodiversity, biodiversity of different ecosystems

Biodiversity Value: Ecosystem services, resource management. **Case study 1**

Non-environmentally related conservation problems: invasive species, hybridisation, disease (in endangered species and zoonoses in humans)

Problems of small populations: loss of genetic diversity, inbreeding depression, captive breeding, reintroduction. **Case Study 2:** grey wolves

Problems of fragmented populations: population structure and gene flow, habitat corridors, translocations. **Case Study 3:** Orang-utans in Borneo

What should we conserve? Populations? Species? Ecosystems? Ecoregions?

Ecosystem management: managing protected areas, managing unprotected areas, potential importance of agricultural landscapes

Restoration Ecology and Bioremediation

Conservation and sustainability: what does the future hold?

Feedback

Individual feedback will be provided on a preliminary outline of the coursework. Based on this, students can modify their coursework for final submission.

Assessment

2 hour examination, combined short answer and essay style paper (80%); coursework essay based on a Case Study - no more than 4 pages excluding the title page and list of references (see section 13.4 of final year handbook for submission requirements) (20%)

Prerequisites

- BIOL21232 Fundamentals of Evolutionary Biology (**Compulsory**)

Recommended Reading

- Primark, R.B. (2010) Essentials of Conservation Biology, 5th Edition.

Teaching Staff - Dr Richard Preziosi, Dr Cathy Walton

CURRENT TOPICS IN PLANT BIOLOGY

BIOL31492

Unit Coordinator(s): Professor Simon Turner
(simon.turner@manchester.ac.uk)

Semester 2
Credits 10

Aims

To use the study of recent high profile scientific papers to give students a clear understanding of the cutting edge research in the area of plant biology. An essential feature is to incorporate student choice into the topics covered within several broad subject areas.

Intended learning outcomes

The unit is research paper based and students will learn to critically examine key papers from the scientific literature. Students will learn to analyse research papers and extract the main findings. They will gain a sound grasp of some of the most important advances in understanding plant growth and how this is modified by interactions with the environment and other organisms, together with knowledge of the experimental approaches that have been used. The emphasis is on recent breakthrough published in top journals such as Nature and Science. Consequently, topics covered will depend to some extent on papers published just prior to the start of the course. Full details will be available on the course website prior to the start of the course.

Lecture content

The content is specifically designed to ensure student participation and within practical limits give students input into the lecture content. Consequently, within several defined but broad subject areas students will have a choice of subjects covered.

- The importance of the regulation of plant growth in agriculture: *the influence of climate change on crop yield.*
- Exploring the genome: *either the use of next generation sequence information to dissect plant growth or evolution of multicellularity: chlamydomonas vs volvox*
- Evolution and morphogenesis: *either caught in the act – regulatory genes controlling morphological differences between species or keeping flat – how to make a leaf*
- We are not alone - The importance of interactions: *either how do flowers allure or repel pollinators or Trojan horses- mimicry in fungal plant interactions.*
- Updating Darwin - the importance of the environment in regulating plant growth: *either the importance of light sensing in regulating growth and responding to stress or surviving the cold - when vernalization makes sense.*
- Signals in plant development: *how to make a jigsaw- auxin controls interdigitated growth of leaf epidermal cells or nucleic acid as a mobile silencing signal between plant cells*

Feedback

All lectures will be based upon question and answer sessions, so any queries will be addressed in each lecture. Feedback will be given on the course work and topics selected for the final exam will be vetted by staff. Links will be provided on the website to review and commentaries that are relevant to the topics discussed to provide sufficient background.

Assessment

Course work will constitute 25% of the mark and this will be assessed based upon a Faculty of 1000 style analysis of a paper that is related to one of the topics covered in the course. The remaining 75% will be based on an exam in which students write an essay based upon in their own in depth research of an area of plant biology relevant to the course (75%).

Prerequisites

No specific units – every effort will be made to make the information accessible to a wide audience of students, but some understanding of molecular biology and genetics would be beneficial.

Recommended Reading

Primary papers and selected by staff members concerned together with review articles and commentaries to provide further insight and background.

Teaching Staff

Dr Patrick Gallois, Dr Minsung Kim, Dr Thomas Nuhse, Dr Jon Pittman, Professor Simon Turner

GREEN BIOTECHNOLOGY

BIOL31501

Unit Coordinator(s): Dr Jon Pittman
(jon.pittman@manchester.ac.uk)

Semester 1
Credits 10

Aims

Green Biotechnology is a rapidly expanding field within modern biotechnology and involves the exploitation of plants not only for the sustainable production of food, but also their utilisation as a source of renewable energy as a biofuel, and as a novel means to generate pharmaceuticals and other novel products. In addition, Green Biotechnology is aimed at developing more environmentally friendly processes than traditional industrial agriculture or chemical industry. This unit will examine the technologies of plant genetic engineering and explore how these are used to generate more efficient crop plants, healthy and nutritious foods, and other commercially attractive products.

Intended learning outcomes

Students will gain in depth knowledge and understanding of:

- How sustainable biotechnology can be achieved using plants
- How plants can be genetically manipulated
- Solutions that biotechnology can provide for improved food production, healthy and nutritious foods, renewable energy, and pharmaceutical production using plants
- How the knowledge of fundamental plant processes can be applied for biotechnological developments
- Appreciate some of the aspects of commercialisation of plant biotechnology and some of the ethical issues of the technology including environmental impact.

Lecture content

Course content will be provided in the form of lectures, material on Blackboard, and student-led seminars where groups of students will present recent advances related to each topic.

- **Precision plant engineering:** methods and mechanisms of plant genetic transformation and transgene integration; endogenous gene silencing and its applications
- **Engineering plants for improved nutrition:** generating plants with improved vitamin and nutrient content – the golden rice story; alteration to sugar or starch metabolism
- **Biotic stress tolerant crops:** strategies for weed control – engineering glyphosate resistance; new approaches to controlling insects – engineering Bt toxin
- **Biofuels from plants:** biofuel potential, problems and solutions and ethical considerations
- **Plants for biopharmaceuticals:** plants as expression systems for pharmaceutical products; chloroplast engineering
- **Plants for health:** generation of healthier plants; generation of safer plants – elimination of harmful mycotoxins and reduced allergenicity

Feedback

Collective feedback on group presentation; performance in e-learning revision test; individual feedback on marked coursework; question/answer course round-up and revision session.

Assessment

Two hour essay-based examination (70%), participation in discussion group and student-led presentation (5%), coursework assignment: a 3-page discussion of one of the presentations (25%).

Prerequisites

- BIOL21152 'Omic Technologies & Resources (Recommended)
- BIOL21202 Plants for the Future (Recommended)

Recommended Reading

- Mostly primary research literature based with articles and links provided on Blackboard
- Slater A., Scott N.W., Fowler M.R. Plant Biotechnology – the Genetic Manipulation of Plants. 2008 Second Edition, Oxford

Teaching Staff:

Dr Caroline Bowsher, Dr Anil Day, Dr Patrick Gallois, Dr Jon Pittman, Professor Simon Turner

BIOTIC INTERACTIONS

BIOL31511

Unit Coordinator(s): Dr Thomas Nuhse
(thomas.nuhse@manchester.ac.uk)

Semester 1
Credits 10

Aims

All species live in an environment shared with many other species of microbes, animals and plants. Our reductionist approach to biology leads us to underestimate the influence that biotic interactions have on the physiology, development, ecology and evolution of a given organism. This advanced ecology unit will introduce the different types of organismal interactions between animals, plants and microbes. Particular emphasis will be placed on an integrated understanding of those interactions from the molecular to the ecological level, as well as an appreciation of parallels between similar processes across different kingdoms. We will discuss how knowledge of biotic interactions can be applied to agro-ecosystems, sustainable farming and food security.

Intended learning outcomes

Understand in depth as well as in a broader context:

- The different types of biotic interactions and the whole spectrum of molecular, developmental and ecological processes associated with them
- How biotic interactions shape ecosystem structures and steer evolutionary processes
- The relevance of biotic interactions for traditional and sustainable agriculture

In addition, students will be able to evaluate and discuss original research articles; summarize and contextualise it for a non-specialist audience; work as part of a team in the preparation of short reviews.

Lecture content

- Competition - Predation - Food web - Herbivory - Seed predation and dispersal
- Mutualism - Microbial communities in eukaryotic hosts - Plant/pollinator interactions - Mycorrhizal and rhizobial symbioses
- Parasitism and pathogenicity - Epidemiology and population dynamics - Cross-kingdom comparison of parasitic/ pathogenic strategies for animal and plant hosts
- Biotic interactions in agro-ecosystems - pest control - invasive species

In addition to lectures covering all aspects of biotic interactions, three workshops will recapitulate the material covered so far using original research articles. Students will be asked to write short "Faculty of 1000"-style reviews for non-specialists, covering background, novel findings and wider significance. For the first two workshops, the essays are submitted online as group work; online discussion within each team is encouraged and moderated by the lecturer(s). For the last workshop, each individual student will submit a review of an assigned paper in the same style.

Feedback

Formative feedback from online quizzes and for the two "F1000" group reviews (Lecturers are available for discussion online). Lecture topics are recapitulated and discussed during workshops.

Assessment

Blackboard online quizzes (5%). "Faculty of 1000"-style research paper review (15%), 2 hour examination (80%), comprising 5 short-answer questions, one essay (choice of 5 questions).

Prerequisites

- BIOL21212 Ecology & Ecosystems (Recommended)
- BIOL21202 Plants for the Future (Recommended)

Recommended Reading

- Begon, Townsend and Harper. Ecology: from individuals to ecosystems. Wiley-Blackwell, 4th edition 2006 (Reference and Further Reading)

Teaching Staff

Dr Minsung Kim, Dr Thomas Nühse, Dr Richard Preziosi, Dr Daniel Rozen

BIOETHICS

BIOL31522

Unit Coordinator(s): Dr Caroline Bowsher
(caroline.bowsher@manchester.ac.uk)

Semester 2
Credits 10

Aims

To provide a stimulating, structured logical approach to ethical issues and to provide a context for practising this. To allow students to appreciate the importance of the public's perceptions; to be aware of scientific investigations of impact, to relate knowledge of modern biology to wider issues, and to apply good thinking and grasp ethical principles.

Intended learning outcomes

A greater ability to think in a structured way. Knowledge of the different ethical principles with which different people may approach the same issues and ability to use these to provide a basis for understanding current issues and novel issues of the future.

Lecture content

An informal seminar type approach forms the bulk of the unit. Students will be given reading to do before and after each session and encouraged to criticise, discuss material and ask questions during the seminar. Lecture topics will vary depending on current scientific issues but could include the following.

- Introduction to ethics and bioethics
- Ethical framework – The value of life
- Reproduction: Beginning life
- Gene therapy and enhancement
- Stem cells
- Enhancing evolution
- Genomics
- Genethics
- Euthanasia and Assisted dying: End of life
- Violence and Responsibility
- GM crops
- GM and Malaria
- Research Ethics

Feedback: The oral presentation will receive peer evaluation, verbal generic feedback and written feedback on individual group performances. The proposed essay titles identified by individuals will receive written comments. The final essays will receive written feedback.

Assessment: Group oral presentations on specific topics (15%), essay of not more than 5 pages (excluding references) on topic of student's choice (55%), short answer question on a topic requiring application of the principles of ethics (30%).

Prerequisites: None

Recommended Reading

- Harris, J. Enhancing Evolution: The ethical case for making better people 2007, Princeton.
- Harris, J. The value of life 2003, Routledge.
- Mepham, B. Bioethics. An introduction for the biosciences 2005, Oxford University Press.

Teaching Staff

Dr Caroline Bowsher, Professor Terry Brown, Dr Sarah Chan, Dr John Coggan, Professor John Harris, Professor Dean Jackson, Dr Catherine Rhodes, Dr Liz Sheffield, Dr Cathy Walton

LIVING WITH CLIMATE CHANGE

BIOL31541

Unit Coordinator(s): Dr Amanda Bamford
(amanda.bamford@manchester.ac.uk)

Semester 1
Credits 10

Aims

Anthropogenic global climate change presents a wide range of impacts and challenges for the organisms that live on this earth. This unit will explore the challenges and uncertainties climate change presents in terms of its potential impacts on living systems, terrestrial, aquatic and urban environments. Students will develop the ability to gather and process information from scientific papers, the web & the media, in the field of climate change. This unit will encourage independent thinking and an analytical approach to this environmental issue of global importance.

Intended learning outcomes

Students will be able to

- Identify how a rapidly changing climate can affect individual organisms, populations and ecosystems and assess the possibilities and potentials of adaptation.
- Have an understanding of the impact of climate change on crop production, food security, and urban vegetation
- Have an understanding on the impact of climate change on aquatic ecosystems and terrestrial animals
- Appreciate the impact of media on presentation of science.

Lecture content

- **Climate change at a global level:** Climate system components/indicators and changing climate patterns. Shifting biomes and species migration, ecosystem level responses – effects on species competition, effects on the carbon cycle within ecosystems, positive and negative feedback loops
- **Food security: capability of agriculture to deal with climate change:** Challenges for food security & sustainability, impacts on the development, yield and quality of crops; adaptation, management and breeding.
- **Impact of climate change on aquatic ecosystems:** Direct impacts on hydrology and ecology of freshwaters; indirect effects on eutrophication and pollutant mobilisation and behaviour; impact of ocean acidification; temperature-induced shifts in marine populations and communities
- **Impact of climate change on terrestrial animals:** Tropical case studies of direct and indirect effects of climate change on amphibian populations.
- **Climate proofing our cities:** The potential for using trees, parks, green roofs and living walls to adapt our cities to future climate change and mitigate their impact on it; dealing with the likely impact of climate change on urban vegetation.

Feedback

Written feedback on Livebinder eportfolio coursework, formative feedback in class during seminars via discussions and/or verbal feedback on presentations, feedback on media story analysis

Assessment

A personal Livebinder eportfolio (10%), a written analysis of the research behind a story on an aspect of biological impact of climate change in the general media '*The research behind the story*' (3 pages, 20%) and 2 hr written exam at the end of the semester (70%).

Prerequisites

- BIOL21212 Ecology and Ecosystems (Recommended)

Recommended Reading

Mainly case studies and research literature based course, in addition to:

- Climate Change Biology. Newman *et al* 2011

Teaching Staff

Dr Amanda Bamford, Dr Roland Ennos, Dr Giles Johnson, Dr Richard Preziosi

HUMAN IMPACTS ON THE BIOSPHERE

BIOL31551

Unit Coordinator(s): Dr Keith White
(keith.white@manchester.ac.uk)

Semester 1
Credits 10

Aims

To provide a knowledge and understanding of:

- How humans impinge on the biosphere through an examination of the impact of key anthropogenic stressors arising from resource exploitation and use, agriculture and urbanisation on selected ecosystems and biomes.
- Methods and approaches - from molecular to community level - used in the assessment and prediction of human impacts on ecosystems.

Intended learning outcomes

Students should gain an understanding of:

- The impact of natural resource exploitation and pollution on populations and communities through the study of important human activities, specifically resources utilisation (metal mining); agriculture; urbanisation; transport
- Methods and approaches used in the assessment and prediction of anthropogenic impacts on key ecosystems and biomes.

And be able to:

- Appreciate the importance of connecting and integrating knowledge regarding human impacts, including on the whole biosphere and not only one sector.
- Appreciate the importance of field and laboratory studies in understanding and solving environmental problems arising from human activities
- Critically appraise and discuss research literature regarding contemporary and controversial issues related to human impacts on the environment.

Lecture content

- **Introduction** Population pressure and resource utilization; pollutants of land, water and air; acute and chronic pollution; standards and guidelines.
- **Environmental impact of metal extraction and use** Sources, behaviour and impacts; bioaccumulation and toxicity; treatment and bioremediation of land and freshwater with particular reference to mine waste.
- **Environmental impact of agriculture** Impacts on biodiversity; potential conflicts with productivity; chemical inputs and the 'green revolution'; irrigation and salinization.
- **Urbanisation** Impact of sewage on water quality and ecology; role of planning in pollution control and enhancing biodiversity; urbanisation and terrestrial biodiversity; role of green infrastructure in minimising environmental impacts and enhancing urban biodiversity.
- **Environmental impact of air pollution from road transport** Sources and monitoring; impact of ozone, volatile organic compounds, nitrogen dioxide and particulates on ecosystems.

Feedback

Performance in e-learning revision assessment; written comments assignment and poster; overview of student posters; question/answer session in final session

Assessment

Two hour written examination (60%), assignment (30%), individual poster (10%).

Prerequisites

- BIOL21212 Ecology and Ecosystems (Recommended)

Recommended Reading

Mainly case studies and research literature based course so recommended reading will be provided online.

Teaching Staff

Dr Amanda Bamford, Dr Roland Ennos, Dr Giles Johnson, Dr Jon Pittman, Dr Keith White

HUMAN REPRODUCTIVE BIOLOGY

BIOL31561

Unit Coordinator(s): Professor John Aplin
(john.aplin@manchester.ac.uk)

Semester 1
Credits 10

Aims

This is an integrative biology unit open to students from a wide range of backgrounds. The unit explores how reproduction is controlled in males and females, how it is affected by disease, and how reproductive processes can be changed by medical and pharmacological intervention. We discuss impacts of current research in reproduction, including recent findings that indicate an important relationship between events in fetal life and health in the adult.

Intended learning outcomes

Through the lecture course and guided outside reading, students will gain a broad knowledge of human reproduction, the technologies associated with reproduction, and reproductive disorders. Students will appreciate the mechanisms of action of steroids and contraceptives. They will study gamete production in male and female, fertilisation, the pre-implantation embryo, implantation, placental function and parturition. They will appreciate how imaging techniques can reveal embryonic and fetal growth. They will gain some knowledge of how genetics has been exploited in mouse and human to understand key aspects of reproductive physiology.

Lecture content

The hypothalamic-pituitary-gonadal axis is introduced as well as steroids and their receptors. Spermatogenesis is explained and how stem cell and other technologies are impacting on male infertility. Lectures on ovarian and uterine function in the menstrual cycle lead to fertilisation and pre-implantation development and a series of eight sessions on pregnancy. Implantation, placental development and fetal imaging are followed by an examination of the vascular changes that occur in normal pregnancy. We discuss the major diseases of pregnancy including miscarriage, pre-eclampsia and fetal growth restriction. Mechanisms of parturition are explored and finally fetal programming.

Feedback

Feedback will be provided directly via online discussion boards and other Blackboard entries, as well as in-lecture feedback methods. Also there is a post-exam clinic.

Assessment

2 hour written examination (100%)

Prerequisites

No compulsory units

Recommended Reading

References for compulsory, recommended, background and further reading are provided by each lecturer. No text-book covers the entire unit.

- Johnson M (2007) *Essential Reproduction (6th edition)*. Blackwell Science covers several aspects of the course.
- Jones RE (2006) *Human Reproductive Biology (3rd edition)* Academic Press. A US college text that does not reach the level of detail required but is suitable for revision and refresher reading.

Two excellent, more detailed sources are:

- Knobil E & Neill J (1994) *The Physiology of Reproduction (2nd edition)*. Raven Press
- Knobil E and Neill J D (eds) (1998) *Encyclopaedia of Reproduction*. Academic Press

Teaching Staff

Professor John Aplin, Dr Rebecca Jones, Professor Sue Kimber, Dr Clare Tower, Dr Melissa Westwood

ADVANCED ENDOCRINOLOGY

BIOL31571

Unit Coordinator(s): Dr Donald Ward
(donald.t.ward@manchester.ac.uk)

Semester 1
Credits 10

Aims:

To explore the impact of cell and molecular biological techniques on our understanding of endocrine control mechanisms and endocrine disease.

Intended learning outcomes:

A student completing this unit will have an:

- Understanding of the molecular and cellular processes which determine the function and control of the human endocrine system.
- Appreciation of the defects in these mechanisms that underlie the development and progression of endocrine disease.
- Awareness of current strategies for the surgical and pharmacological intervention in the clinical management of endocrine malfunction.

Lecture Content

- Endocrine control of extracellular calcium homeostasis. PTH, vitamin D3 & calcitonin: their production, receptors & roles. Clinical abnormalities of calcium metabolism: Hyper- and Hypoparathyroidism, Osteoporosis, Rickets, and mutations of the PTH & Ca²⁺-sensing receptors.
- Thyroid adenomas & carcinogenesis: underlying mechanisms, diagnosis & management. Thyroid hyperplasia and goiter - diagnosis and management. Autoimmune thyroid disease - Graves' disease and Hashimoto's thyroiditis.
- Growth hormone and prolactin; the molecular basis of peptide production, secretion and actions. The biology and physiological role(s) of Growth Hormone: interaction with the IGF-I axis. Disorders of growth hormone action; the clinical role of growth hormone replacement therapy. Disorders in the control of IGF bioavailability, & their clinical consequences.
- Pituitary-adrenal axis: The principal pathologies of the pituitary gland and their molecular basis; the clinical and surgical management of pituitary tumours. The principal diseases and disorders of the pituitary-adrenal axis – underlying causes. The diagnosis and management of adrenal pathologies. Disorders of glucocorticoid signalling; their consequences, diagnosis & management.
- Clinical investigations, consequences of & management of diabetes mellitus and hyperinsulinism.
- CLINICAL CASE PRESENTATIONS (2): the interactive roles of the patient, clinician and clinical biochemist in the clinical diagnosis and management of an endocrine disorder.

Feedback

- Formative Blackboard assessments after each lecture block to test & assist understanding.
- Blackboard Discussion Board - checked regularly by Unit Coordinator
- 2 interactive Blackboard packages - inc. How to diagnose & treat a virtual patient.
- FEEDBACK SURGERY - Marked scripts available for inspection at a 2-hour drop-in surgery to be held in February.

Assessment

2 hour written examination (100%), comprising 2 essays from a choice of 5.

Prerequisites

- BIOL21261 Endocrinology (Recommended)

Recommended Reading

There are no specific textbooks for this unit, though "Essential Endocrinology and Diabetes" by Richard Holt & Neil Hanley (Wiley-Blackwell, 5th Edition) may be found useful. Key references and review articles to extend the lecture material will be recommended by individual lecturers. There will be links on the Blackboard site to significant sources of key material.

Teaching Staff

Dr Steve Bidey, Dr Karen Cosgrove, Professor Julian Davis, Professor David Ray, Dr Donald Ward, Dr Melissa Westwood, Dr Andrew Whatmore, Professor Anne White.

CARDIOVASCULAR SYSTEMS

BIOL31582

Unit Coordinator(s): Dr Nick Ashton
(nick.ashton@manchester.ac.uk)

Semester 2
Credits 10

Aims

To provide an understanding of the normal physiology of the cardiovascular system and the mechanisms underlying its major pathologies.

Intended learning outcomes

Students will have gained an understanding of (i) the complex control processes which regulate the cardiovascular system and (ii) the major diseases of the cardiovascular system, including heart failure, coronary heart disease, stroke and hypertension.

Lecture content

Introduction to Unit

- Overview of cardiovascular system

Electrophysiology of the heart

- Cardiac action potential; excitation-contraction coupling; cardiac inotropy
- Heart failure, ageing and arrhythmias

Blood vessels

- Blood vessel physiology – regulation of vessel tone
- Specialised circulations – inc. skeletal muscle, coronary, cerebral & pulmonary
- Atherosclerosis – pathology & clinical approaches to treatment

Hypertension

- Epidemiology, risk factors and socio-economic costs of hypertension
- Secondary hypertension – renal, adrenal and other rare forms of hypertension
- Primary hypertension – vascular hypertrophy, the kidneys and the renin-angiotensin system
- Developmental origins of cardiovascular disease

Stroke

- Cerebrovascular disease: role of inflammation; treatment & future perspectives

e-Learning Activity

Online, formative self-assessment tests designed to test both factual recall and deeper understanding of more complex concepts. Detailed essay plans will be provided to help students understand what is required of a first class answer.

Feedback

Formative feedback will be provided through online self-assessment tests and comments on one page essay plans. Feedback will also be provided verbally in lectures, in response to email enquiries and comments posted on the Blackboard discussion board.

Assessment

2 hour examination (100%)

Prerequisites

- BIOL21141 Cell Membrane Structure and Function (**Compulsory**)
- BIOL21272 Human Physiology (Recommended)

Recommended Reading

Review and primary research papers will be recommended by individual lectures. The following textbooks will provide helpful background material.

- Katz, A.M. (2010) *Physiology of the Heart*. Lippincott Williams & Wilkins, Philadelphia. (Recommended)
- Cheriyan, J., McEniery, C.M & Wilkinson I.B. (2010) *Hypertension*. Oxford University Press, Oxford (Recommended)
- Swales, J.D. (1995) *Manual of Hypertension*. Blackwell Scientific, Oxford (Background)

Teaching Staff

Dr Stuart Allan, Dr Nick Ashton, Dr Cathy Holt, Professor Alison Gurney, Professor Andy Trafford

ADVANCED ION TRANSPORT

BIOL31591

Unit Coordinator(s): Dr Liz Fitzgerald
(elizabeth.m.fitzgerald@manchester.ac.uk)

Semester 1
Credits 10

Aims

Ion channels and transporters are ubiquitous membrane proteins that transport ions and other small molecules in cells. They are crucial to cellular definition and function. This unit will explore how these proteins are studied, explain their structural diversity and illustrate their importance in electrically active and non-electrically active cells, using physiological examples.

Intended Learning Outcomes

Students should understand how ion channels and transporters are assembled into unique complexes to enable control of discrete cellular functions. Students will develop transferable skills in evaluating published material, information gathering and problem solving.

Lecture Content

Ion channels and transporters - Introduction Students will be introduced to the advanced principles of ion (Ca^{2+} , Cl^- , Na^+ and K^+) and solute transport through these proteins and the techniques that are used to study them. The general structures and properties of these proteins will be described.

Transporters and aquaporins The structures, functions and regulation of acid-base transporters, solute transporters and aquaporins will be addressed through specific examples of physiological systems. The co-operative interactions of channels and transporters in epithelial ion transport will be evaluated at an advanced level.

Ion channel trafficking The advanced principles of ion channel biosynthesis, assembly, trafficking, degradation and targeting/distribution will be described using voltage-gated K^+ and Ca^{2+} channels as examples.

Voltage-gated ion channels A description of basic structures of membrane potential sensitive channels will be exemplified by a review of voltage-gated Ca^{2+} , Na^+ and K^+ channels. Their roles in controlling cell function will be addressed by specifying examples in neuronal, cardiovascular and endocrine cells.

Ligand-gated ion channels Ligand-gated channels are key proteins in the conversion of chemical signals into immediate responses. The families of ligand-gated channels will be reviewed and their roles and pharmacological regulation discussed.

Ion channel integration and cell function How channels work together to regulate cell function is key to understanding their physiological roles. Control of cell function via integration/ crosstalk between different channels will be discussed in a specific context, e.g. excitation-contraction-coupling in muscle.

Feedback

eLearning modules including online problem solving and questions related to lecture material. Online Discussion Board (Unit Blackboard site).

Assessment

2 hour Examination (90%), continuous assessment online/in class (10%)

Prerequisites

- BIOL10832 Excitable Cells (Strongly recommended)
- BIOL21321 Membrane Excitability: Ion Channels & Transporters in Action (Strongly recommended)

Recommended Reading

- Alberts B, Johnson A, Lewis J, Raff M, Roberts K & Walter P *Molecular Biology of the Cell (5th edition)* New York: Garland Science, 2008: Ch. 11
- Boron, W.F. and Boulpaep, E.L. *Medical Physiology (2nd edition)*. Saunders, 2009, Ch 5-7

Students will be directed to additional reading material during lectures.

Teaching Staff - Professor Mark Dunne; Professor Alison Gurney, Dr Gillian Edwards; Dr Liz Fitzgerald; Dr. Owen Jones; Dr Richard Prince; Dr Craig P Smith; Dr Martin Steward; Dr. Paolo Tammaro

TOXINS, TOXICANTS & TOXICITY

BIOL31602

Unit Coordinator(s): Dr Katherine Hinchliffe
(katherine.a.hinchliffe@manchester.ac.uk)

Semester 2
Credits 10

Aims

This course provides an insight into the molecular mechanisms by which toxic molecules cause cellular damage and death. It will foster understanding of the ways in which exposure to xenobiotics can cause adverse health effects, of how the toxic properties of certain compounds can be exploited for clinical and/or research benefit, and of the challenges faced by the pharmaceutical industry in the development of novel, safe therapeutic drugs.

Intended Learning Outcomes

On completion of the course, it is expected that students will:

- understand the concept of toxicity.
- be able to describe the molecular mechanisms of apoptosis.
- understand physiological and pathophysiological mechanisms by which reactive oxygen species are generated, and the consequences of oxidative stress.
- appreciate mechanisms by which damage to the genome and epigenome occurs, and the consequences of such damage.
- possess an overview of the sensitivity of major body systems to toxic molecules.
- be familiar with the concept of the exploitation of toxicity for beneficial purposes.

Lecture Content

- Mechanisms of cell death
- Mitochondrial toxicity, free radicals and oxidative stress
- Genotoxicity
- Toxicity towards major body systems
- Microbial exotoxins and their uses
- Hazard and risk assessment

Assessment

Online Short Answer Questions (10% of total)

2 hour exam consisting of:

4 Short Answer Questions (out of 6) (45% total marks)

1 essay (out of 4) (45% total marks)

Feedback

An online discussion forum will be available.

Feedback from answers to assessed online short answer questions will be provided. Students will also be offered the opportunity submit an exam-style essay answer. Feedback on essay content and style will be provided via Blackboard.

Prerequisites

- BIOL10832 Excitable Cells (Optional)
- BIOL21302 Clinical Drug Development (Recommended)

Recommended Reading

No single textbook provides a complete overview of the subject matter covered by this Unit. Individual lecturers will provide reading lists to support the material covered in their lectures.

Teaching Staff

Dr Jen Cavet, Dr Rebecca Dearman, Dr Andrew Gilmore, Dr Katherine Hinchliffe, Dr Owen Jones, Professor Ian Kimber, Professor Richard Walmsley

Unit Coordinator(s): Dr Emmanuel Pinteaux
(emmanuel.pinteaux@manchester.ac.uk)

Semester 2
Credits 10

Aims

The aim of the unit is to provide an extensive knowledge of the role of inflammation in nervous system health and disorders. Inflammation is involved in many central nervous system (CNS)-regulated physiological processes (including energy balance, sleep, memory and synaptic plasticity), and is a key host defence response to acute and chronic peripheral and central disorders. Research into neuroinflammation is a major field which aims to develop new therapeutic interventions to treat all major nervous system disorders including stroke, brain trauma, epilepsy, Alzheimer's and Parkinson's diseases and neuropathies (for which there is currently no or limited treatments). This unit will cover the important role of inflammatory molecules as key mediators of CNS functions and will provide basic knowledge of pathogenesis and inflammatory responses to acute and chronic nervous system disorders.

Intended learning outcomes

Students will be able to:

- Understand the role of inflammation in key biological functions and pathological conditions
- Describe the main inflammatory mediator families and the role of some key inflammatory molecules
- Describe CNS-regulated physiological functions that are mediated by inflammatory mediators
- Describe the pathogenesis and inflammatory response to acute and chronic central and peripheral nervous system disorders.
- Understand the principle and clinical application of brain imaging techniques
- Acquire knowledge in clinical assessment and management of neuroinflammation, and therapeutic approaches

Lecture content

Introduction to neuroinflammation – These lectures will provide a general introduction to neuroinflammation, including description of inflammatory mediators (cytokines, chemokines and adhesion molecules), mechanisms of production and action in the brain (receptors, signalling pathways and downstream effects) and cell-cell interactions.

Neuroimmune interactions and normal brain functions – These lectures will describe the function of inflammatory mediators during sleep, memory, long-term potentiation, synaptic plasticity, and host defence response to infection and injury. Communications from the immune system to the brain and associated behavioural changes including fever, anorexia, lethargy, depression and sickness behaviour will also be covered.

Inflammation in chronic brain disorders – These lectures will describe the mechanisms of inflammation during chronic brain disorders including epilepsy, Alzheimer's disease and multiple sclerosis, with an emphasis on disease pathogenesis and current therapeutic approaches.

Neuronal control of immunity and neuropathies – These lectures will describe direct nerve-immune cell interactions in lymphoid organs (bone marrow, lymph nodes, spleen), and functional implications of nerve fibre-immune cell connections during neural control of inflammation in health and disease. Mechanisms of neuropathic pain with focus on neuroimmune interactions in peripheral nerve will also be covered.

Inflammation in acute brain injury– These lectures will describe the acute neuroinflammatory response that occurs during acute brain injury including stroke, subarachnoid haemorrhage and brain trauma. The mechanisms of neurovascular unit dysfunction, neuronal plasticity, glial scar, neurogenesis and angiogenesis will be addressed. Finally, these lectures will provide knowledge of the use on brain imaging (MRI, PET, CT) and clinical assessment of neuroinflammation (CSF and plasma markers) used in patient management and therapeutic applications.

Feedback

Students will access 1 online neuroscience seminar on related matters, and will subsequently write up 1 essay (1000 words), and individual feedback will be provided in the form of formative and summative assessment. In addition, there will be 4 eLearning activities (cases related to 4 themes of lectures). Students will read/research on topics (enquiry-based learning), and will answer MCQs through Blackboard. Feedback session will provide answers and students will be able to receive immediate feedback on their activity and performance by talking to teaching staff. In addition, students will receive feedback on overall performance in the form of the final mark for the unit and will receive individual feedback from their advisor.

Assessment

2 hour examination including 4 short answer questions (out of 6) and 1 essay title (out of 5) (85%); MCQs on e-learning topics (5%); Essay on online seminar (1000 words limit) (10%)

Prerequisites

- BIOL10832 Excitable Cells (**Compulsory**)
- BIOL21312 Drugs and the Brain (Recommended)

Recommended Reading

- Understanding immunology, Peter Wood, Second Edition, ISBN 0-13-196845-9, Pearson Education Ltd.
- Up-to-date relevant review articles recommended in lectures (available on Blackboard).

Teaching Staff

Dr Denes Adam, Dr Stuart Allan, Dr Herve Boutin, Dr David Brough, Dr Natalie Gardiner, Dr Catherine Lawrence, Dr Jaleel Miyan, Dr Emmanuel Pinteaux, Dr Craig Smith

ION TRANSPORT IN HEALTH & DISEASE

BIOL31621

Unit Coordinator(s): Dr Gillian Edwards
(gillian.edwards@manchester.ac.uk)

Semester 1
Credits 10

Aims

Ion channels and transporters have important roles in the control of cellular activity. This unit aims to acquaint students both with drugs that selectively target these proteins (and their therapeutic potential) and also with clinical conditions (such as cardiac arrhythmias or diabetes), which occur when ion channels and transporters malfunction (e.g. due to genetic defects).

Intended Learning Outcomes

The student should appreciate the pivotal role of ion channels and transporters in cellular activity and the consequences of disturbance to normal activity (resulting from genetic aberration, disease or drug action); the student will have developed skills in information gathering and evaluation of published material.

Lecture Content

- *Pharmacology*: Site of action and effects of drugs which modify the activity (ie. stimulating opening or inhibiting) of specific potassium, calcium and sodium channels; therapeutic use/potential of such drugs.
- *Cardiac ion channels*: Physiological role of the different ion channels involved in each phase of atrial and ventricular action potentials. Benefits and hazards of changes in channel activity (genetic or drug-induced).
- *Channels involved in signalling*: Role of intracellular calcium channels (inositol trisphosphate and ryanodine receptors) in the release of calcium from intracellular stores and the mechanisms for store refilling. The concept of channels as sensors for pH, temperature, taste or mechanical stress will be introduced.
- *Anion channels and transporters*: physiological role and regulation of channels and transporters involved in the movement of chloride ions across plasma membranes. Therapeutic use/potential of drugs which modify chloride channel activity.
- *Channelopathies*: throughout the module, diseases caused by gene mutations which modify ion channel or transporter activity will be described.

Assessment

2 hour examination (100%)

Feedback

Verbal feedback during lectures; Discussion Board; on-line assessments.

Prerequisites

- Any ONE of the RSM units i.e. BIOL 20922, BIOL 20932 or BIOL 20942 (**Compulsory**);
- BIOL10832 Excitable Cells (Strongly Recommended)
- BIOL31591 Advanced Ion Transport (**Compulsory**)

Recommended Reading

References specific to individual lectures will also be recommended by the lecturers.

- Alberts B, Johnson A, Lewis J, Raff M, Roberts K & Walter P (2008) *Molecular Biology of the Cell (5th edition)*. Taylor & Francis Chapter 11. (Background).
- Boron, W.F. & Boulpaep, E.L. *Medical Physiology (2nd ed.)*. Saunders, 2009. Chapters 5 - 7. (Background).
- Rang HP, Dale MM, Ritter JM & Flower, R (2007) *Rang & Dale's Pharmacology (6th Edition)*. Churchill Livingstone. (Background).
- Ashcroft, F.M. *Ion Channels and Disease* 2003 Academic Press. (Reference).

Teaching Staff

Dr Peter Brown, Dr Jason Bruce, Dr Gillian Edwards, Dr Liz Fitzgerald, Professor Alison Gurney, Dr Paolo Tamaro

IMAGING IN BIOMEDICAL RESEARCH

BIOL31631

Unit Coordinator(s): Dr Ingo Schiessl
(i.schiessl@manchester.ac.uk)

Semester 1
Credits 10

Aims

To provide students with an understanding of how cutting edge imaging methods are used in medical, anatomical and life science research. Guided by recent publications the students will learn about the type of research that can be addressed with each of the presented imaging techniques. The course will provide an understanding of the nature of the signal as well as spatial and temporal constraints.

Intended learning outcomes

- Understand the differences in functional and anatomical imaging approaches
- Be able to describe the nature of the signal and how it is detected and measured with each of the imaging techniques
- Understand the spatial and temporal constraints of different imaging techniques
- Appreciate the advantages and drawbacks of different imaging techniques
- Be able to discuss which of the imaging methods covered in the course are suitable to address a given research problem

Lecture content

After a general introduction of terms and properties important to most imaging modalities the initial lectures will discuss research at the sub-millimetre scale investigating cells and tissues in health and disease. This will include light microscopy, electron microscopy and fluorescence based imaging. From there, with increasing spatial scale, we will look at imaging of anatomical and functional structures in biomedical research. The course will finish with imaging methods that look at function and metabolism of the whole brain and the human body. Some of the methods covered are computed tomography, radiography, magnetic resonance imaging and positron emission tomography. The knowledge provided will form an essential foundation to many of the lab-based projects that rely on imaging in biomedical research.

Feedback

Time is provided at the end of each lecture for questions and feedback from students. There is a dedicated discussion forum in Blackboard where students can address questions about the lecture material. The final session in the semester is a dedicated question and answer session that wraps up all the lectures and gives the opportunity for exam specific feedback. **A mock essay exam with model answers available.**

eLearning activity

An e-learning quiz in the form of multiple choice questions will supplement each research paper discussed to aid the students in understanding the significant contribution of these seminal pieces of research have made.

Assessment

2 hour examination (100%) - essay questions

Prerequisites

None

Recommended Reading

The course utilises review and research papers but the following texts can provide useful background information:

- Dhawan, AT (2003) Medical Image Analysis. John Wiley and Sons Ltd
- Guy, C & Ffytche, D (2005) An Introduction to the Principles of Medical Imaging (Revised Edition). Imperial College Press
- Hibbs, AR (2004) Confocal Microscopy for Biologists. Plenum
- Toga, M (eds.) (2002) Brain Mapping: The Methods. Academic Press

Teaching Staff

Dr Herve Boutin, Dr Shazia Chaudhry, Dr Stefan Gabriel, Dr Ingo Schiessl

ADVANCED DEVELOPMENTAL BIOLOGY

Unit Coordinator(s): Dr Andreas Prokop
(andreas.prokop@manchester.ac.uk)

BIOL31642

Semester 2

Credits 10

Aims

To understand of how multiple developmental mechanisms regulate the stepwise and reproducible formation of specific body parts, such as the limb, the head and internal organs.

Intended learning outcomes

Students will gain basic knowledge and understanding of:

- how a single fertilised egg cell develops gradually into a complex, 3D, multicellular organism composed of highly organised tissues, such as bone, cartilage, skin, muscles, nerves, and blood vessels
- essential concepts of developmental biology, such as pattern formation, positional information, induction and cytoplasmic determinants, and how they lead to the specification and positioning of different cell types within tissues and organs
- principles of molecular mechanisms, such as signalling pathways and transcription factor determination, and their relevance for applied research into stem cells, cancer and disease
- how different cellular or molecular mechanisms integrate at the systems level of whole tissues and organs, and how they are being repeatedly employed to contribute to distinct developmental processes.

Lecture content

This lecture series highlights mechanistic principles of Developmental Biology by focussing on the multiple processes that contribute to the development of a few selected organs.

Part 1: How to make a limb? An integrated view. How does a limb bud know where to form? How are the axes of the limb determined? How does the limb acquire its appropriate size? How do skeletal muscles, cartilage and bone, blood vessels and cells, nerve cells and functional synaptic contacts and skin appendages form?

Part 2: How to make a head? Specific aspects of cranial development. How do head specific features, such as head skeleton, ears and teeth develop? What are the commonalities with and deviations from principles learned from limb development?

Part 3: How to make internal organs? How do tubular organs, such as lung and kidney, develop? How are glandular organs, such as pancreas, mammary and salivary glands, formed? Does the development of internal organs differ from peripheral structures?

Part 4: How can mechanisms of development be re-employed? A brief overview over the biology of regeneration.

Feedback

- Discussion board on Blackboard
- 2 multiple-choice assessments on Blackboard taking place after the first and second third of the course and contributing 5% to the final course mark

Assessment

2 hr essay-based written examination (95%), 2 multiple-choice assessments on Blackboard 9 (5%)

Prerequisites

- BIOL21172 - Principles of Developmental Biology (Recommended)

Recommended Reading

- Wolpert, L *Principles of Developmental Biology (3rd edition)* 2007 Oxford University Press
- Gilbert, SF *Developmental Biology (8th edition)* 2006 Sinauer
- Arias, AM, Stewart A *Molecular Principles of Animal Development* 2002 Cambridge University Press

Teaching Staff

Enrique Amaya, Adam Hurlstone, Kimberly Mace, Andreas Prokop

ADVANCES IN ANATOMICAL SCIENCES

BIOL31651

**Unit Coordinator(s): Dr Ingrid Gouldsbrough
(niggy.gouldsbrough@manchester.ac.uk)**

**Semester 1
Credits 10**

Aims

The unit aims to build on students existing knowledge of human anatomy and allow them to apply this knowledge to the clinical and research settings. Clinicians lecturing on this unit will demonstrate the relevance of anatomy in modern clinical practice. Alongside this, students will be exposed to current research methodology in the field of Human Anatomy.

Intended learning outcomes

Students will be able to

- Describe the anatomy of the cardiorespiratory and gastrointestinal systems and the skull
- Use their anatomical knowledge to discuss current research and clinical developments in these areas
- Identify important anatomical structures of the thorax, abdomen and skull on prosections and models
- Use relevant scientific literature to enhance their knowledge and further develop their critical thinking skills

Lecture content

- Anatomy of cardiovascular & respiratory systems review lecture
- Anatomy of cardiovascular & respiratory systems practical session
- Anatomy of asthma - examines the disease related changes of the microscopic structure of the respiratory system that are associated with asthma and reviews current research in the field.
- Left-Right Asymmetry in Cardiac Development - covers research into developmental errors of the heart
- Surgical anatomy of the aorta and contemporary management of aortic diseases - this clinical lecture will examine the how the structure of the aorta is reflected in the management of aortic disease. It will review the latest methods of treatment.
- Anatomy of the skull review lecture - this interactive lecture aims to refresh student knowledge in order to prepare for the clinical and research lectures.
- Anatomy of the skull review practical session - this session will allow students to examine skulls of different ages in order to explain developmental changes in skull structure
- Morphing skulls: how human heads evolve - this lecture examines morphometric issues related to the skull
- Ontogenic changes in the human cranio-mandibular apparatus 1 - this lecture covers the different embryological origins of cranial bones (mesoderm vs. neural crest; endochondral vs. membranous bone) and the three developmental regions of the skull (chondrocranium, dermatocranium and splanchnocranium). It goes on to discuss composite bones and the reasons that they exist.
- Ontogenic changes in the human cranio-mandibular apparatus 2 - this lecture will reinforce the concept that post natal changes should also be considered as part of the development process. It discusses the factors (suckling, chewing, neural development, senescence, etc) that promote or inhibit changes in morphology and affects the relative timing of the changes
- Skull-fest - this session, held at the Manchester museum, will be an interactive session concerned with comparative anatomy of the skull.
- Anatomy of the gastrointestinal system review lecture - interactive lecture to refresh student knowledge in order to prepare for the clinical and research lectures.
- Anatomy of the gastrointestinal system practical session.
- The role of the gastrointestinal system in obesity - this lecture considers the problem that obesity poses in the 21st century, it examines possible targets for treatment, the role of gut hormones, weight loss surgery and future therapies.
- Clinical anatomy of the large and small bowel - the diseases of the small and large bowel. Relating anatomical structure to the cause, diagnosis and treatment.
- Ontogeny & disease of the Pancreas

Feedback

The review lectures and practicals will be interactive and formative feedback will be given verbally during these sessions. Formative online activities will compliment the review lectures and feedback will be provided accordingly. Feedback of exam script can be obtained from the unit coordinator on request.

Assessment

2 hour summative exam:

- Part 1 - essay section, 1 essay to be chosen from a choice of 3 (50%)
- Part 2 – short answer section, 3 compulsory short answer questions (50%)

Prerequisites

- BIOL20912 Human Anatomy RSM (Recommended)
- BIOL21291 Human Anatomy & Histology (**Compulsory**)
- BIOL21402 Anatomy of the Special Sense Organs (Recommended)

Recommended Reading

- Clinical Anatomy – Snell – *8th Edition, Lippincott, Williams & Williams, 2008*
- Clinically Orientated Anatomy – Moore & Dalley - *6th Edition, Lippincott, Williams & Williams, 2010*

Teaching Staff

Dr Bipasha Choudhury, Dr Mark Dunne, Dr Stefan Gabriel, Dr Ingrid Gouldsbrough, Dr Chris Klingenberg, Dr Sarah Herrick, Dr Kathryn Hentges,

Unit Coordinator(s): Professor Richard Baines
(richard.baines@manchester.ac.uk)

Semester 1
Credits 10

Aims

The aim of this unit is to present key topics at the forefront of modern neuropharmacology. The emphasis of this unit is on the molecular and cellular basis of function of the major excitatory, inhibitory and modulatory neurotransmitter receptor systems, how these systems function under physiological and pathophysiological conditions, and how their actions can be targeted therapeutically to treat clinically-prevalent diseases.

Intended learning outcomes

To recognize key concepts, strategies and techniques in modern neuropharmacology. Specifically, to understand how neurotransmitter receptors work at the molecular and cellular level, their roles in healthy excitable cells, their contribution to the generation and therapy of diverse neuropathological disorders, the successes achieved, and challenges faced, in designing drugs to tackle such disorders.

Lecture Content

For most areas, there will be two/three lectures detailing the basic principles. The topicality and importance of these areas will then be underscored by a third lecture designed to foster critical thinking.

Introductory lecture - This lecture will set the scene for what will come. It will also cover the advantages and disadvantages of drug-treatment for neural disease and will particularly focus on drug mode of action. This section will also introduce students to the type of model systems and screens currently used to develop novel drugs.

Dopamine, Schizophrenia and Reward - The biosynthesis and role of dopamine as a neuromodulator acting through D1/D2 type receptors. The dopamine hypothesis of schizophrenia: The major classes of drugs (standard and atypical antipsychotics) will be described along with their side-effects (esp on the motor system). Discussion of mode of action of drugs and long-term consequences of use will be covered (inc relevance to Parkinson's). The role of dopamine in reward (inc. drugs of abuse) will also be covered.

Affective disorders - Specific link with 5HT/NA_{dr} to describe nature and theories of depression. Description of HPA axis, inc. role of said transmitters in brain signalling, biosynthesis and receptor subtypes. Description of diagnosis and treatment of depression – typical and atypical antidepressants. Side effects, mode of action. Alternative treatments eg. ECT. Description of potential for future 'mood-altering' drugs. How such drugs are developed using animal models - advantages/pitfalls.

Acetylcholine and Alzheimer's disease - The biosynthesis and receptor types for ACh (nicotinic / muscarinic). The possible causes of Alzheimer's (tau vs. amyloid) to include diagnostic techniques, drugs and their actions/ side effects. Emphasis on anti-cholinesterases. Future perspectives inc. animal models.

GABA, anxiety and epilepsy - The synthesis and activity of GABA inc. receptor subtypes and early excitatory role / later inhibitory role in signalling. Deficiency in GABAergic signalling will be used to introduce epilepsy, diagnostic techniques, treatments, side effects thereof.

Metabolism - The neural signalling underlying control of metabolism (focus on anorexia / obesity) to be presented. Description of neurotransmitters (inc neuropeptides), brain regions, receptors. Description of diagnostic techniques, research approaches (e.g. progress with KO mice). Drugs in use / development and potential for such compounds. Link with neural control of the GI tract /insulin signalling.

Rhythms in mental health and disease - Brief overview of circadian cycle with emphasis on daily changes in body physiology and behaviour. How cycles impact key mental disorders (eg. psychiatric disorders: depression, bipolar disorder, seasonal affective disorder, schizophrenia) and how Chronopharmacokinetics and Chronopharmacodynamics are emerging fields for effective treatments of such diseases.

Feedback

Blackboard activities based on each block of lectures will be provided. These will include a summary of lecture material, key reference material and an exemplar clinical case study relating material delivered to the clinical setting. Each 3-lecture block will have an associated series of MCQ questions to allow for formative assessment of learning.

Assessment

2 hour examination (100%) consisting of:

Section A (1 hour) - answer 4 out of 6 short questions (15mins each)

Section B (1 hour) - answer 1 essay question from a choice of 4

Prerequisites

- BIOL21312 Drugs & the Brain (Recommended)

Recommended Reading

- E.J. Nestler, S.E. Hyman, R.C. Malenka. *Molecular Neuropharmacology: A foundation for Clinical Neuroscience*.
- H.P. Rang, M.M. Dale, J.M. Ritter, P.K. Moore. *Pharmacology*.

Further recommended reading lists will be provided by each contributor as listed on Blackboard and in their lectures.

Teaching Staff

Professor Richard Baines, Dr Maria Canal, Dr Owen Jones, Professor Simon Luckman, Professor David Sattelle

CLOCKS, SLEEP & THE RHYTHMS OF LIFE

BIOL31681

**Unit Coordinator(s): Professor Hugh Piggins
(hugh.d.piggins@manchester.ac.uk)**

**Semester 1
Credits 10**

Aims

Principally, to (a) introduce students to the study of biological timekeeping, (b) examine how neural mechanisms of circadian rhythms, arousal, and sleep interact to coordinate behaviour and physiology.

Intended Learning Outcomes

Students should be able to:

- Understand the neural and molecular bases for circadian rhythmicity in both simple and complex neural systems
- Explain how physiology and behaviour changes from day to night, from summer to winter.
- Describe how brain state changes across the sleep-wake cycle and the importance of these different states in cognitive performance and brain health.
- Describe the neural and genetic bases for sleep and arousal disorders.
- Describe how environmental light information is captured by the eye and relayed to circadian centres in the brain and the influence of this light information on sleep and physiology.
- Describe how circadian clocks develop in the brain and how they decline with age.
- Develop an understanding of how biological timekeeping mechanisms evolved and how they influence many facets of physiology and behaviour.

Lecture Content

In this unit, students are introduced to biological rhythms (ultradian, circadian, and infradian) and the basic principles of biological timekeeping. The molecular basis for the circadian clock in animals and its major 'clock' genes/proteins and their roles are defined. Particular focus is placed on the neuronal basis for the circadian timing system in the mammalian and insect brain and how specific photoreceptors capture environmental light information to regulate these brain clocks. The neurochemicals used to communicate timing information to the brain and body are identified as are the effects of transgenic knockdown/out of these signaling systems on physiological and behavioural rhythms. The impact of the circadian timing system on cognition and sleep is evaluated with emphasis on how rhythmic electrical activity varies with brain states such as waking and dreaming. To gain understanding of how the real world affects biological clocks, the effects of light and daylength on seasonal physiology are explored. Finally, the question of whether biological clocks deteriorate with age is addressed by investigation of the influence of lifespan on circadian rhythms in insects and mammals.

Assessment

2 hour written examination (100%) - choose 2 from 5 essay titles.

Feedback

References to specific studies relevant to each lecture, announcements via Blackboard 9, post-exam guidance.

Prerequisites

- BIOL21332 Motor Systems (Strongly Recommended)
- BIOL21341 Sensory Systems (Strongly recommended)

Recommended Reading

- Refinetti R Circadian Physiology 2nd Ed. 2006
- Dunlap, Loros, and Decoursey Chronobiology: Biological Timekeeping 2003

Teaching Staff

Dr Maria Canal, Dr John Gigg, Dr Nick Glossop, Professor Andrew Loudon, Professor Robert Lucas, Dr Qing-Jun Meng, Professor Hugh Piggins

LEARNING, MEMORY & COGNITION

BIOL31691

Unit Coordinator(s): Dr John Gigg
(j.gigg@manchester.ac.uk)

Semester 1
Credits 10

Aims

To introduce students to the discipline of cognitive neuroscience and examine how CNS regions from invertebrates to mammals interact to produce behaviour.

Intended Learning Outcomes

Students should be able to understand the neural bases for learning and memory in neural systems and explain how different types of memory are supported by different brain systems. Students will also gain insight into how neurological cases and experimental approaches extend our understanding of normal brain function and how those functions are localised across animal species. The course will also focus on how synaptic changes provide the cellular bases for learning and how these processes can be modelled computationally.

Lecture Content

Introduction to Cognition - Early models for animal behaviour versus the more recent rise of cognitive neuroscience. Introduction to learning, memory formation and memory retrieval.

Learning, memory and amnesia - Discussion of song acquisition, navigation and food-storing in birds. Evidence from mammals that different forms of learning are supported by discrete neural systems. Consideration of the neural bases for memory loss across species. How memory is used to direct and control behaviour with particular focus on the role of prefrontal cortex.

Cerebral localization of cognitive function - Discussion of language/communication as an example of lateralization of cognitive function in humans and other species. Importance of split-brain patients in understanding hemispheric lateralization.

Neuronal circuitry and the cellular mechanisms for memory acquisition and storage - How synaptic plasticity provides a model for memory processes within cell assemblies. This will help students link these cellular processes to learning and behaviour topics covered in earlier lectures.

Modelling learning and memory using neural networks - Students will gain insight into how simple artificial neural networks provide insight into biological learning mechanisms. Further, how this research has been applied and extended to more complex and biologically-realistic models.

Feedback

MCQ exam will provide feedback on students' progress and key areas for improvement.

eLearning

We will offer a number of eLearning resources, including topics such as synaptic plasticity and a simple interactive modelling tool to examine learning (e.g., Hopfield networks).

Assessment

2 hour written examination - students choose 2 essay titles (90%); MCQ eLearning exam in week 6 of the course (10%).

Prerequisites

- BIOL21332 Motor Systems (Strongly Recommended)
- BIOL21341 Sensory Systems (Strongly Recommended)

Recommended Reading

- Eichenbaum, H. *Learning and Memory* Wiley
- Rudy, JW. *The Neurobiology of Learning and Memory* Sinauer Assoc

Teaching Staff

Dr John Gigg, Dr Marcelo Montemurro, Professor Hugh Piggins, Dr Jon Turner

HORMONES & BEHAVIOUR

BIOL31721

Unit Coordinator(s): Professor Andrew Loudon
(andrew.loudon@manchester.ac.uk)

Semester 1
Credits 10

Aims: This course defines how endocrine and brain circuits control sexual, affiliative and aggressive behaviour. Students are introduced to comparative examples from the animal kingdom and underlying genetic mechanisms, as well as neuroendocrine circuits and peptide relays in the brain. Where possible, examples are drawn from the medical literature to indicate the common nature of these processes in our own species, and governing our behaviour.

Intended learning outcomes

To teach student how brain circuits and evolutionary forces have moulded the social and sexual behaviour of man and animals

Lecture content synopsis:

Setting the scene: Sexual Dimorphism of the Brain and the role of sex steroids. Discovery of aromatization mechanisms and local oestrogen concentrating neurons. Implications of mutations in these pathways in animals and man. The hypothalamus as a key regulator of the endocrine system. Hypothalamic peptides as releasing hormones and as neurotransmitters – examples of GnRH (sexual behaviour) and Oxytocin/Vasopressin (affiliative behaviour). We then move on to define how sexual differentiation mechanisms define sexual behaviour, from the concept of switches on chromosomes, consequences of sex reversal in man and animals and gender identity. We next move to Africa and studies in animals of sexual mimicry, including the famous example of the spotted hyena, and the strange case of the enlarged clitoris and false testis (!), and how mutations in steroid metabolism pathways may drive this process. In birds, we enter the looking glass world where females are the heterogametic sex, and consider hormonal and primary genetic mechanisms controlling sexual behaviour, plumage development and brain differentiation. Hot tempered alligators are animals without sex chromosomes, so we look at reptiles and how the environment controls brain and behaviour. We also look at weapons of war, and sexual aggression and its control by hormones.

In mammals, we move to the story of how two closely related peptide hormones control sexual and affiliative behaviour in females and males – the endocrinology of love and consider their role in man. The early environment matters, and we consider the remarkable evidence that maternal behaviour affects the wiring and organisation of chromosomes in mammals, with long-term effects on stress, including man. We move to Australia to consider the remarkable story of the marsupial mouse, Antechinus, where the males all die within a week or so of mating, and link this to brain stress pathways. We then move to strange world of genomic imprinting, where genes are suppressed or activated depending on which parent you inherited them from – the study of epigenetics and behaviour. Lastly, we move back to Africa, and look at our nearest relatives the Great Apes, and consider similarities and differences in their sexual behaviour and that of man. To finish, we go underground, and explore the extraordinary sex life of the naked mole rat.

This course has consistently been one of the top-rated courses by students in the Faculty over the past 10 years, and a good sense of humour is a help. Have fun!

Feedback

Online questionnaires, and in the form of question/answer sessions throughout the course.

Assessment

2 hour examination (100%) - answer two questions from a choice of six

Prerequisites

- BIOL21261 Endocrinology (Recommended)

Recommended Reading

- Becker, Breedlove, Crews and McCarthy (2002) Behavioural endocrinology: Second edition.

Teaching Staff: Dr Maria Canal, Professor Andrew Loudon

DEVELOPMENTAL NEUROBIOLOGY

BIOL31731

**Unit Coordinator(s): Dr Nicholas Glossop
(nicholas.glossop@manchester.ac.uk)**

**Semester 1
Credits 10**

Aims

To introduce students to the basic principles that underlie the generation of a functional 'wired' nervous system. This unit will focus on major aspects of neurodevelopment in model invertebrate (*C. elegans*, *Drosophila*) and vertebrate (frog, chick, mouse, cat, primate) systems. In addition, the role of cerebrospinal fluid and neurodevelopment defects in humans will be covered.

Intended learning outcomes

Students will gain an understanding of key molecules and cellular events that shape the development of the nervous system. Major events will include: Neural Induction; Polarity and Segmentation; Neuro-/Glio-genesis; Migration; Fate and Lineage Determination; Axon Pathfinding; Map Formation; Target Selection; Refinement, Survival and Apoptosis; Synapse Formation and Function; Cerebrospinal Fluid and Human Disorders; and, Behavioural Development.

Lecture content

Introduction; this lecture will provide background anatomy of nervous systems in model organisms and the 'upside-down' relationship between invertebrates and vertebrates. The origin of cells that form the vertebrate CNS, PNS and ANS will also be introduced.

Induction, patterning and neurogenesis; these lectures will compare and contrast induction and patterning of the neural tissue using *Drosophila* and chick/mouse as model invertebrate and vertebrate systems, respectively. The process of neurogenesis will also be introduced.

Migration and lineage determination; these lectures will cover the major migrations of neural stem cells in vertebrate CNS and PNS (i.e. neural crest) before revisiting neurogenesis to explain the lineages that stem cells produce (i.e. neurones, oligodendrocytes and astrocytes). Major migrations of post-mitotic neurons in the vertebrate brain will also be covered to explain how the basic architecture of the mature cortex and cerebellum are generated.

Axon pathfinding; these lectures will start at the reductionist level (i.e. initial identification of guidance molecules) before moving on to the holistic understanding of how multiple mechanisms interact in the growth cone. Key cellular events will include commissural axon and retinal ganglion cell crossing at the midline - both of which are central for the establishment of bilateral processing.

Map formation, target selection, refinement and synapse formation; these lectures will cover the different types of organisation present in the system (i.e. somatotopic vs olfactotopic); course mapping of connections; and, the refinement of connections based on functional activity.

Cerebrospinal fluid and human disorders; these lectures will focus on the importance of cerebrospinal fluid during cortex development and defects that occur during human development.

Behavioural development; this lecture will cover spontaneously programmed behaviour, such as central pattern generation and sexual dimorphism of the hypothalamus.

Assessment

2 hour examination (95%); Coursework (5%).

Feedback

Feedback is provided in a question and answer session in the final lecture and in response to email queries from students. A Blackboard-based eLearning module and progress test will be held after lecture 12 (week 4) to provide formative feedback during the course.

Prerequisites

- BIOL10521 Genes, Evolution and Development (Recommended)
- BIOL21172 Principles of Developmental Biology (Recommended)
- BIOL31642 Advanced Developmental Biology (Recommended)

Recommended Reading

- Price, Jarman, Mason and Kind (2011) *Building Brains: An Introduction to Neural Development (1st edition)*. Wiley-Blackwell
- Sanes, Reh and Harris (2011) *Development of the Nervous System (3rd edition)*. Elsevier Academic Press

Teaching Staff

Dr Nicholas Glossop, Dr Jon Turner, Dr. Jaleel Miyan

MOLECULAR BIOLOGY OF CANCER

BIOL31742

Unit Coordinator(s): Professor Andrew Sharrocks
(andrew.d.sharrocks@manchester.ac.uk)

Semester 2
Credits 10

Aims

To provide students with a general understanding of the molecular events which lead to cancer.

Intended learning outcomes

The students will; (a) have an understanding of the specific molecular events leading to the formation of specific tumours; (b) be able to relate the processes of apoptosis, cell cycle, gene regulation and signal transduction to tumorigenesis; (c) be acquainted with the latest developments in basic cancer research; (d) to be able to apply molecular knowledge in developing cancer therapies.

Lecture content:

Tumour formation

- Overview of lecture course. Introduction to cancer and its molecular causes. Concept of multi-step progression and the multiple-hit hypothesis.
- Introduction to the cellular changes and the stages in cancer progression.
- Mechanisms of chemical carcinogenesis. Methods of identifying carcinogens.
- Checkpoints and telomere maintenance
- DNA repair mechanisms, drug metabolism and their relationship to cancer.
- Translocations and cancer.
- Viruses and cancer. DNA viruses, Retroviruses, tumour suppressor genes and oncogenes.
- Predisposition to cancer. e.g. in retinoblastomas and breast cancers.

Molecular basis

- Tumour suppressor proteins including p53 and RB and relationship to cell cycle
- Introduction to MAP kinase signal transduction pathways
- Nuclear targets of MAP kinase signal transduction pathways. e.g. c-Fos and c-Jun.
- Transcriptional regulation of the c-fos gene.
- Relationship to oncogenes and signal transduction pathways.
- Other signal transduction pathways and relationship to tumourigenesis.
- Apoptosis and its relationship to cancer.
- Tissue invasion and metastasis

Therapies

- Cancer cures and possible therapies.

Self-directed learning

- Research into specific cancers and identification of specific molecular changes associated with individual tumours.
- Research into the following topics; Telomeres and cancer, Cancer Stem Cell Hypothesis, Tumour Angiogenesis, additional signalling pathways disrupted in Cancers.

eLearning activity

Online interactive quiz, illustrating the molecular defects found in cancer cells in the context of diagnosing and treating a patient with lung cancer.

Assessment

2 hour written examination (100%)

Feedback

The online eLearning resource provides instant feedback. In addition students can write optional assessed essays on core topics covered by the unit. An online discussion forum is available for communication between students and staff.

Prerequisites

- BIOL21101 Genome maintenance and regulation (Recommended)
- BIOL21121 The dynamic cell (Recommended)

Recommended Reading

- Weinberg RA, *The Biology of Cancer*. Garland Science (Recommended).

Teaching Staff

Professor Andrew Sharrocks, Dr Paul Shore, Professor Charles Streuli, Dr Claudia Welbrock

STEM CELLS

BIOL31751

Unit Coordinator(s): Dr Sue Kimber
(sue.kimber@manchester.ac.uk)

Semester 1
Credits 10

Aims

Stem cells are generally rare cells with unique potential for both self renewal and which form progenitors that can differentiate into mature cells of one or more lineages. The ability of stem cells to repair tissues has significant therapeutic potential for the regeneration of damaged tissues such as bone marrow, skin, pancreas, neurons and many others. The aim of this unit is to describe the properties of stem cells and to explain the mechanisms underlying the control of self renewal, specific lineage commitment and repair. Recent reports on common pathways in cancer cells and stem cells will be used to illustrate the current thinking on the close association between stem cells and cancer.

Intended learning outcomes

Students should have acquired a detailed understanding of the features of both embryonic, embryonic-like and adult stem cells, how their activity is assayed, the pathways involved in the intrinsic and extrinsic (environmental) control of their phenotype and the association between stem cells and cancer. As stem cell biology is a rapidly progressing field, any current "hot" areas in stem cell biology will also be covered.

Lecture content

Lecture 1 will be an introduction to the field including definitions of what stem cells are and what they are not; definitions of potency and other key terms. It will introduce the history of the field and include a broad view of stem cells mentioning some of the hype and clear indications of misinformation in the wider press.

Lecture 2 will explain the different stem cell types (embryonic, fetal, adult/tissue and cancer) in general terms and how they differ from one another. It will examine what natural stem cells do and the different techniques which can be used to investigate stem cell properties and test whether stem cells are present. Neural stem cells will be introduced as an example.

Lectures 3 and 4 will cover Embryonic Stem (ES) cells; both mouse and human ES cells will be discussed and their similarities and differences compared. The characteristics and properties of ES cells of pluripotency and self renewal will be discussed as well as how to test these; how pluripotency is regulated at different levels will be addressed. There will be discussion of the molecular interactions by which ES cell transcription factors maintain the stem state.

Lecture 5 will cover induced pluripotent cells (IPS). How these were originally generated by Yamanaka and the newer methods by which they can now be generated; what are their properties; their similarities and differences from ES cells and their problems; methods to bypass the pluripotent state and generate progenitors. Potential for use of these cells for disease modelling toxicology/drug testing and potentially cell therapy will be discussed with follow up in L7.

Lecture 6 How to control ES and IPS cell differentiation? History: embryoid body formation and how this has been adapted to channel stem cells into single lineages/differentiated cell types. The challenges in recapitulating development and developing defined conditions to induce ES and IPS cells to develop along a prescribed line of development to a desired differentiated cell type (e.g.s from pancreatic Beta cells, cardiomyocytes neural lineages and chondrocytes)

Lecture 7 Clinical applications of stem cells. Reference to mention of established HSC (KM) and prototype MSC (CK) therapies. What is needed for cell therapy? How far have groups got and what are the problems. Discussion of some of the most advanced ES generated phase 1 clinical trials (e.g. ACT and London Eye project: retinal pigmented epithelium)

Lecture 8 will cover Mesenchymal Stem Cells: Their discovery and early analysis; tissue localisation; potential for tissue repair (local recruitment, differentiation; anti-inflammatory effects; immunosuppressive properties); latest strategies for isolation/cell surface markers/characterisation; applications in tissue regeneration (e.g. cartilage and bone, neovascularisation).

Lectures 9 and 10 on haematopoietic stem cells will cover (1) a description of the haematopoietic system and the properties of its components, including the concept of the HSC niche, (2) the markers and techniques used to isolate HSCs and the in vitro and vivo assays used to assess them, and (3) the ontogeny of HSCs, their regulation, and their therapeutic use in human disease.

Lecture 11 on skin stem cells will cover (1) the structure of skin and its development, (2) the experimental evidence for different types of stem cells that contribute to skin homeostasis, (3) the effects of injury and disease on skin stem cells, and potential therapeutic applications

Lectures 12-13: The 2 lectures on cancer stem cells will discuss: (i) the role of tissue stem cells in accumulating gene mutations that lead to cancer, (ii) the concept and evidence that cancers are aberrantly developed tissues that contain infrequent stem-like cells with self-renewal activity, (iii) the role that developmental and other signalling pathways have in regulating cancer stem cells and how understanding this offers new opportunities for cancer therapies.

Lectures 14-17: will cover Identifying stem cells and their niches in vivo; regulation of stem cells in vivo by niche derived signals: Interaction between niche derived extrinsic signals and intrinsic factors in stem cell regulation in vivo and age-related decline of niche function.

Lecture 18: will be a revision session including feedback on optional essays so that the whole class can benefit (some of this will also go on BB) and worked examples for exam prep.

Feedback

Optional essay and Core knowledge multiple choice eLearning test

Assessment

2 hour examination (100%)

Prerequisites

- BIOL21121 The Dynamic Cell (Recommended)
- BIOL21172 Principles of Developmental Biology (Recommended)
- BIOL21351 Cells & Tissues in Human Disease (Recommended)

Recommended Reading

Reading material will be current reviews and primary papers

Teaching Staff

Dr Martin Baron, Dr Robert Clarke, Professor Cay Kielty, Professor Sue Kimber, Dr Kimberly Mace

CELL ADHESION

BIOL31771

Unit Coordinator(s): Professor Charles Streuli
(cstreuli@manchester.ac.uk)

Semester 1
Credits 10

Aims

Cell adhesion is critical for all aspects of cell function in multicellular organisms. Cell interactions with the extracellular matrix and with each other are required for building patterned tissues, maintaining their architecture, and regulating their differentiation and behaviour. Alterations in normal adhesion mechanisms are also central in the progression of many of the major diseases affecting mankind, including inflammation and cancer. The aim of this unit is to consider the molecular details of how different classes of adhesion receptors work, to explore established concepts and the latest advances of how they control basic cellular functions, and to examine what happens when adhesion systems become defective.

Intended learning outcomes

A detailed understanding of the central role of cell adhesion in animal biology; the molecular biology of cell adhesion systems; how adhesion links to cell migration, proliferation, apoptosis, differentiation, and to development; how these controls break down in human diseases.

Lecture content

The first 4 lectures will be introductions to the concepts of adhesion. This will be followed by 8 specialist topics, each covering the relevant areas of cell-matrix and cell-cell adhesion, signalling, development, animal models and human diseases; 2 guest lectures; and 4 class presentations on self-directed learning. The order may be changed.

- Adhesion and a multicellular existence.
- Turning adhesion on and off.
- Principal mechanisms of adhesion strength regulation.
- Principles of adhesion signalling.
- Integrin structure.
- Cell movement.
- Cell guidance.
- Cell polarity and tissue morphogenesis.
- Crosstalk between adhesion signalling and growth factors.
- Sensing biomechanical forces.
- Resistance to mechanical stress.
- Environmental sensing and control of homeostasis.
- Guest lectures.
- Class presentations.

Feedback

a) Written feedback on essay; b) verbal feedback on class presentation; c) feedback on exam scripts after the January exams.

Assessment

1,500 word essay based on self-directed learning (20%); 2.5 hour examination (80%)

Prerequisites

- BIOL21121 The Dynamic Cell (Recommended)

Recommended Reading

- Lodish, H. et al., Molecular Cell Biology (6th edition), 2007, Freeman
- Lewin, B. et al. Cells (2nd edition), 2010, Jones & Bartlett
- Alberts, B. et al., Molecular Biology of the Cell (5th edition), 2008, Garland

Teaching Staff

Dr Andrew Gilmore, Professor Martin Humphries, Dr Andreas Prokop, Professor Charles Streuli

ADVANCED PARASITOLOGY

BIOL31792

Unit Coordinator(s): Professor Richard Grencis
(richard.grencis@manchester.ac.uk)

Semester 2
Credits 10

Aims

The aim of the unit is to provide an in-depth understanding of contemporary parasitology concentrating on the complex relationship between parasite and host. Emphasis will be on the major parasites that cause human and animal disease covering molecular, cellular, *in vitro* and *in vivo* experimental approaches for the study of host parasite relationships. The strategies used by the hosts to control parasites and that the parasites use for immune evasion will form central themes together with an exploration of the consequences of parasitic disease for global health and current approaches of parasite control including vaccination. The emphasis of the course will be research led highlighting recent breakthroughs in the field.

Intended learning outcomes

The students should gain an appreciation the importance of parasitic infection in terms of global health. Have a good knowledge of contemporary approaches used to study the major parasites of human importance. Have an understanding of the different immune evasion strategies used by selected human protozoan and metazoan parasites. Have knowledge of the broader consequences of parasite infection at both the individual host and host population level. Have an appreciation of the current challenges of parasite control and the progress of anti-parasitic vaccines. They should also able to integrate data and information gained from different parasite species and from different experimental approaches to gain a clear overview of our current knowledge of parasitic disease and the major challenges that remain.

Lecture content

Protozoan and metazoan parasites are ubiquitous in both man and animals worldwide. The course will cover a variety of parasitic diseases concentrating on human disease as they constitute some of the great neglected diseases of the world as defined by WHO. Lectures will cover different parasites at the molecular, cellular and population level concentrating on the active areas of contemporary research such as malaria vaccines, the mechanisms underlying chronic parasite infections such as filariasis and schistosomiasis and the debilitating pathology that they cause. The lectures will also examine the importance of parasitic infection to our current understanding of the hygiene hypothesis and how this impacts on global health in general. Finally, the course will consider new radical approaches to treatment of many chronic illnesses such as inflammatory bowel disease and autoimmunity using parasites as therapeutic agents and discuss the ethical issues it raises.

Feedback

Feedback will be given in the form of a question and answer session and a marked and annotated sample exam essay.

Assessment

2 hour written examination (100%)

Prerequisites

- BIOL21242 Immunology (Recommended)
- BIOL21252 Parasitology (Stongly recommended)
- BIOL31371 Advanced immunology (Recommended)

Recommended Reading

Reading will be primarily based upon up to date expert reviews from the literature

Teaching Staff

Dr Sheena Cruickshank, Dr Kathryn Else, Professor Richard Grencis

IMMUNE RESPONSE & DISEASE

BIOL31802

Unit Coordinator(s): Dr Peter Wood
(peter.j.wood@manchester.ac.uk)

Semester 2
Credits 10

Aims

To apply knowledge of basic immunology to the understanding of diseases involving the immune system. Students will be introduced to contemporary approaches to manipulating the immune system which are of relevance to the pharmaceutical and biotechnology industries.

Intended learning outcomes

To know about various diseases in which the immune system is involved, including allergy, autoimmunity, congenital and acquired immunodeficiency and transplantation. Students should understand how immune responses are normally regulated and how knowledge of this regulation can be utilised to increase, decrease or change the nature of immune responses in the context of disease, vaccination and tumours.

Lecture content

- **Immune regulation** Fate of CD4 T cells after encounter with antigen: stimulation, anergy, apoptosis. CD4 Th subsets. Regulatory T cells.
- **Autoimmunity** The spectrum of autoimmune diseases. Animal models of autoimmunity. Autoimmune disease mechanisms. Aetiology of autoimmune disease. Treatments for autoimmune disease.
- **Vaccines old and new.** Traditional vaccines: attenuated, killed, subunit. New age vaccines: recombinant, DNA/RNA, virus-like particles, anti-idiotypic vaccines
- **Peptides as vaccines and immunosuppressants.** Design of a peptide vaccine: protective antigens, B and T cell epitopes, building peptide vaccines. Adjuvants. Using peptides to suppress the immune system.
- **T cell signalling and its modification.** Regulation of gene transcription using IL-2 as a prototype. Signalling molecules: kinases, phosphatases, adaptor proteins. Formation and regulation of transcription factors. Drugs that modify T cells signalling and their clinical use.
- **Allergy - basic principles.** The immunological basis of the allergic response. Genetics of allergy. Current and developing treatments for allergy.
- **Allergy - clinical aspects.** Changes in the incidence of allergy. The hygiene hypothesis? Old and new versions of the hygiene hypothesis: evidence and clinical implications.
- **Congenital immunodeficiency.** The spectrum of congenital immunodeficiency diseases. Genetic basis for immunodeficiency diseases. Treatments for congenital immunodeficiency.
- **Tumour immunotherapy.** Active and passive tumour immunotherapy. Tumour antigens. Anti-tumour antibodies: modes of action and clinical use. Types of tumour vaccines. Cell based therapies.
- **Transplantation - basic aspects.** Types of transplants. Transplantation antigens. Immune responses against transplants. Preventing graft rejection.
- **Transplantation - clinical aspects.** The clinical use of transplantation. Clinical approaches to preventing graft rejection. Clinical benefits and problems of using immunosuppressive drugs.
- **Xenotransplantation.** Choice of donor species for human xenotransplantation. Problems with xenotransplantation: physiological, infections, ethical, immunological. Approaches to overcoming hurdles to xenotransplantation.
- **AIDS.** History of AIDS. Human immunodeficiency virus (HIV). Clinical, virological and immunological aspects of HIV infection. Genetics of HIV infection. Treatment of HIV. HIV vaccines..

Feedback

e-based test with feedback during unit. Exam feedback clinic after Semester 1 exams.

Assessment

2 hour exam (100%) – Essay based, 2 out of 5 questions.

Prerequisites

- BIOL21242 Immunology (**Compulsory**)
- BIOL31371 Advanced Immunology (Recommended)

Recommended Reading

A reading list of reviews, original articles and websites will be available on Blackboard at the beginning of the unit.

Teaching Staff

Dr Peter Arkwright, Dr Declan de Freitas, Dr Douglas Miller, Dr Peter Wood