LEVEL 3 BIOL & HSTM UNITS

The following course unit descriptions are provisional at this stage and any details contained therein may be subject to change for the 2013/14 academic year.

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
BIOL31402 Human Genetics & Evolution
BIOL31411 Protein Sorting
BIOL31421 Control of Cell Division
BIOL31441 Cell Signalling
BIOL31451 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 Neuroinflamation in Health & Disease
BIOL31622 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
BIOL31692 Learning, Memory & Cognition
BIOL31732 Developmental Neurobiology
BIOL31742 Molecular Biology of Cancer
BIOL31751 Stem Cells
BIOL31771 Cell Adhesion
BIOL31792 Advanced Parasitology
BIOL31802 Immune Response & Disease
BIOL31812 Chemistry of Biological Processes
HSTM30832/HSTM40332 Madness and Society in the Modern Age, 1780-2000
HSTM31212/HSTM31712 The Nuclear Age: Hiroshima to Nuclear Terrorism
HSTM32011/HSTM32511 Baker Street to CSI: History of Forensic Medicine
HSTM33201/HSTM33501 History of Climate Change
HSTM36202/HSTM36702 Key Issues in Contemporary Medicine

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 and protein structure.

Intended learning outcomes

Upon completion of this unit, students will be able to describe:

- Modern approaches to genome sequencing and annotation of genes and gene function.
- Methods to study the dynamic transcriptome and proteome, in order to gain insight into biological function, including prediction of gene function and genome annotation.
- The range of non-coding RNAs in the genome, including their annotation and function in gene expression regulation.
- Systems-based approaches to modelling and understanding biological function, including network biology and protein-protein interactions.
- How protein structure and protein interactions can be predicted on a genome scale.

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). The discussion classes help develop critical analysis in these areas – reviewing the latest developments in the field – and the 2 labs provide hands-on computational skills, to help appreciate how data is presented and analysed in the context of the genome.

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 feedback from teaching staff as they work through practicals. In the discussion classes, you will present key research articles and receive feedback from staff and colleagues. We also set a mid-semester essay, where written feedback is provided. Finally, MCQs on the first three themes (genomics, transcriptomics, proteomics) will test your understanding, with feedback provided. These are assessed (see below).

Employability Skills

Oral communication - All students (in groups) are asked to read and review a paper from the latest research (usually Nature or similar) in 4 discussion group sessions. They then present PowerPoint talks to the whole class and answer questions.
Written communication - Apart from the exam, there is also an assessed essay mid-way through the unit. This is marked and feedback is provided on essays.
Group/Team working - As part of the discussion class exercise students are split into groups and have to work together to read their paper, understand the key point, construct a talk and then present it as a team.
Leadership - Opportunity for someone to lead group presentation activity
Research - Students read and present research papers. They are also exposed to research methods in the two computer practical labs.
Analytical skills - Data analysis in the two computer practical labs
Problem solving - In computer practical labs students need to “solve” a problem, using the information provided in the handout and the associated webtools. For example, in the proteomics lab they need to figure out which protein isoforms are present given the mass spec search results.

Assessment
2 hour essay-style examination (90%), Answer 2 from 5. Multiple Choice Questions (10%).

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 Jean-Marc Schwartz, Professor Simon Lovell

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

Employability Skills

Written communication - Coursework essay and data analysis problems
Group/Team working - Protein folding data analysis problem is for groups of 4. Work is judged based on discussion boards.
Analytical skills - Data analysis coursework
Problem solving - Data analysis coursework

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)
Williamson, M How Proteins Work (ISBN: 0815344465), Taylor & Francis
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
Cytoplasmic O-glycosylation, synthesis and function
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.

Employability Skills

Oral communication - Students answer questions during the lecture and in ‘problem solving’ lectures.
Written communication - Essays in final exam.
Group/Team working - Answering questions in special problem solving lectures.
Innovation/Creativity - These skills are needed for solving problems.
Research - Course associated extra reading.

Analytical skills - Problem solving - either in lecture or online.
Problem solving - Either in lecture or online.

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): Dr Matthew Hardman
(matthew.j.hardman@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

The final lecture of course will include a review of the previous year's exam paper. Students will than have the opportunity to submit via Blackboard an exam-style essay outline based on relevant questions from past papers. The deadline for submission will be one week after the last lecture and feedback on essay plan and content will be returned to the students within 15 days. In addition, an online discussion forum on Blackboard will be available to facilitate communication amongst students and teaching staff.

Employability Skills

Written communication - Students have the opportunity to submit and receive feedback on an exam style essay outline which is based on relevant questions from past papers. Exam is comprised of 2 essay questions
Research - Students are encouraged to read around the lecture material including recommended primary literature and review papers.

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 though 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 by proteins, 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 and functional genomics of protein-DNA interaction, differentiate between specific and non-specific interactions, and describe 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 their associated eLearning quizzes) and via annotation of the coursework assessed essay.

Employability Skills

Written communication - Written examination and 2500 word coursework essay
Research - Students should read around the lecture material including primary research articles. Students should also inspect atomic structures of molecules using the Protein Data Bank.
Analytical skills - eLearning quizzes and essay, both requiring use of computer graphics. The essay requires illustration with prepared atomic structures of molecules to explain key points of relevance to the set essay topic.

Problem Solving - eLearning quizzes, analysis of atomic structures to solve set problems in computer graphics workshops
Other - Develop organisational and presentational skills to prepare essay

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

Prerequisites

BIOL21111 Proteins **(Compulsory)**
CHEM10021/2 Chemistry for Bioscientists 1 and 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 **Semester 1**
(nicky.high@manchester.ac.uk) **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 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.

Employability Skills

Oral communication - Students will present a 6 minute talk on a suggested topic related to the course.
Innovation/Creativity - Opportunity to deliver talks with a creative use of powerpoint and verbal communication.
Research - Students will have to research the topic and extract the most pertinent details for their 6 minute talk.

Assessment
A 5 minute talk on a Current Microbiology topic (10%); 2 hour examination (90%)

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.

Employability Skills

Oral communication - Each student gives a presentation of eight minutes plus two minutes of questions. Delivered in groups of 6 in the last lecture slot, each assessed by an academic. The presentation will be marked (10% of final course mark) on scientific content, clarity of presentation, use of PowerPoint and importantly keeping to time.

Research
Research topic for presentation

Analytical skills
Analytical skills will be developed when preparing and researching presentations.

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 Cave!, Professor lan 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 option to submit an answer to a test essay question, which will be set after the second lecture in the course and feedback will be returned by the ninth lecture. There will also be a question and answer session at the end of the unit, where students will be given general feedback on the test essays.

Employability Skills

Written communication - Written essays in exam.

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

Prerequisites

BIOL21242 Immunology (Strongly recomended)
BIOL21252 Parasitology (Recommended)
BIOL31791 Advanced Parasitology (Recommended)

Recommended Reading

The unit will closely follow the material in the textbook Janeway's lmmunobiology (ISBN number 0-8153-4290-X). The current edition is the ih edition; the 8[1]h 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

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 organism 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 will be able to:

Understand the importance of gene regulation for health and disease.

Describe the molecular defects underlying specific diseases and the consequences of these for cells, tissues and the whole organism

Describe the application of research methods used to investigate these processes and uncover molecular mechanisms

Understand and interpret primary research findings and describe 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 and 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

Individual feedback on 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.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.

Employability Skills

Oral communication - Students are encouraged to answer questions during lectures.
Written communication - Students write a timed essay in a lecture.
Research - Lecturers show the primary research experiments that back up the biology. Students are encouraged to read other similar papers.
Analytical skills - Students have an E-learning module that requires interpretation of experimental data.
Problem solving - E-learning module requires problem solving skills.

Assessment
2 hour exam (95%), Timed assessed essay, completed in week 6 (5%).

Prerequisites

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

Recommended Reading
Primary articles and review articles given in lectures and on Blackboard.

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

EVOLUTION OF GENES, GENOMES & SYSTEMS BIOL31391

Unit Coordinator: Professor David Robertson **Semester 1**
(david.robertson@manchester.ac.uk) **Credits 10**

Aims
To convey how comparisons between genetic sequence data can be used to study the evolution of genomes, organisms and species. 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: Evolutionary process in genes and genomes. 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, function and disease.

Lecture content

Introduction to molecular and genome evolution.

Molecular evolution – the neutral theory; detecting adaptive evolution; molecular phylogenetics.

Genome evolution – the evolution of genome structure and complexity; genome rearrangement: inversions, transposition and translocations; the central role of gene duplication in genome evolution.

Evo-devo – 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.

Protein evolution – evolution of proteins and function; functional constraints and specificity of protein interactions; evolution of molecular complexity in proteins, linking gene duplication and protein evolution.

Evolution of complex biological systems – protein interaction networks and evolutionary systems biology; evolution and origins of disease.

Feedback
Individual feedback on student presentations and the exam, and discussion session with all lecturers present. Students can also submit practice essays (from past papers) for assessment prior to the exam and receive feedback on these.

Employability Skills

Research - Much of the unit is based around the primary research literature.
Oral communication - Three lecture slots are set aside for student presentations.
Written communication - Students are required to write two essay questions in the exam.

Assessment
2 hour examination: 2 essay questions out of 5 (95% of marks). Course work: presentation 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, Prof Simon Lovell, Prof David Robertson, Dr Matthew Ronshaugen, Dr Cathy Walton

HUMAN GENETICS & EVOLUTION BIOL31402

Unit Coordinator(s): Kathy Hentges
(kathryn.hentges@manchester.ac.uk)

Semester 2
Credits 10

Aims

The study of human genetic complexity and disease is a rapidly expanding field driven by advances in new technologies which facilitate large-scale projects to catalogue human genetic variation. However, understanding the link between genetic variation and the resulting phenotype presents challenges, as is apparent from large-scale association studies. This unit will explore how studying human gene sequences can inform our understanding of disease and evolution.

Intended learning outcomes

Students will be able to explain how human populations evolved using evidence supported by the fossil record as well as advances in sequencing technologies. Students will be able to describe the many diverse fields that encompass human genetics including genomics, clinical genetics, biochemical genetics, pharmacogenetics. Students will also be able to engage in an informed discussion of the ethical considerations for genetics research on humans.

Lecture content

Introduction; course overview, assessments and feedback, the human as an experimental system.
Genome Sequencing and Human Evolution – comparisons between modern humans and extinct hominins, evidence of interbreeding and gene transfer.
Archaeogenetics - the fossil record, Y chromosome and mitochondrial evolution, population migration.
Analysis of genetic diversity in modern humans – sequence variation, copy number variation, large scale population analysis.
Your Genome; your rights? Ethical considerations of genomics research.
Dynamic mutations – trinucleotide repeat expansions and associated diseases.
Molecular pathology of Mendelian diseases.
Genetic imprinting and human diseases. Inheritance pattern of imprinted alleles.
Genetic susceptibility to infectious disease – HIV case study.
Chromosomal abnormalities and developmental diseases.
Association studies and genetic basis of common diseases – multifactorial and polygenic diseases.
Population screening and pharmacogenetics; personalised medicine.
Genetics Careers workshop

Feedback

Feedback on mini-reports will be posted on blackboard for further discussion. Students will receive feedback on their understanding of the course material by the completion of 2 ePBL exercises including multiple choice questions and answer explanations. Students will be given the opportunity to complete a mock exam question, which will be annotated by staff and returned via blackboard.

Employability Skills

Oral communication – Students get the opportunity to ask questions of professionals working in genetics careers at the final lecture
Written communication - Students write 5 mini-reports, as well as essay based exam.
Innovation/Creativity - Students have to search for answers to questions posed as mini-report topics.
Analytical skills - Students complete 2 scenarios using databases to solve problems.
Problem solving - Students complete 2 scenarios using databases to solve problems.

Assessment
Weekly mini-reports (5% total); ePBL assessment (5% total), 2 hour examination (90%)

Prerequisites

BIOL10521 Genes, Evolution & Development (Strongly Recommended)
BIOL21232 Fundamentals of Evolutionary Biology (Recommended)
BIOL21371 Organismal Genetics (Strongly Recommended)

Recommended Reading

Strachan and Read, Human Molecular Genetics 4th Edition. Garland Science.
Jobling, Hurles, and Tyler-Smith, Human Evolutionary Genetics. Garland Science.

Teaching Staff
Prof Terry Brown, Dr Sarah Chan, Dr Kathy Hentges, Prof David Robertson, Dr Miriam Smith, Prof Gillian Wallis, Dr Tao Wang

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

Student will be able to:

understand the mechanisms which target proteins to a number of compartments (including the nucleus, mitochondria, plastid and the secretory pathway)

comprehend the maturation of proteins in the endoplasmic reticulum and their subsequent movement through the secretory pathway

appreciate the mechanisms of endocytosis and the regulatory role of lipid-mediated signals

understand the applications and limitations of specific experimental approaches (both classical and 'cutting edge') to dissect and understand the different mechanisms of protein sorting

possess cognitive skills to assess and critically interpret experimental data and primary papers relating to protein sorting

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 down-regulation

Feedback

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

Employability Skills

Oral communication - Students take part in an active discussion of a primary research paper
Written communication - Students undertake a mock written exam which is then marked and annotated.
Analytical skills – Critical interpretation of experimental data is a major focus of the unit, developed through the lecture material, primary paper discussion session and the problem-based exercise.
Problem solving - A problem-based exercise is a major part of the exam for this unit. This is discussed in the lectures and the students attempt several practice problems.

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

eLearning
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.

Control of Cell Division provides an insight into the complex and highly co-ordinated events that result in the correct duplication of a cell. The 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 cancer.

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

Employability Skills

Oral communication - Journal club presentation.
Group/Team working - Journal club presentation.
Research - Journal club presentation reading primary literature.
Analytical skills - Journal club presentation reading, understanding and presenting primary literature.

Assessment
2 hour examination (95%); essay (5%) - essay should be no more than 3 pages, excluding the title page (references are not needed).

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

CELL SIGNALLING BIOL31441

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 , 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, mTOR, JAK-STAT, SMAD, IKK-NF- 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 submit a one page essay plan via Blackboard. They will receive detailed feedback on content and structure. In addition, an online discussion forum is available on Blackboard to facilitate communication amongst students and teaching staff.

Employability Skills

Written communication - Students write essay plans that provide training in logically organising ideas.
Research and analytical skills - Students are encouraged to search for and analyse the scientific literature associated with the lectures.

Assessment

2 hour written examination (95%), answering two essay questions chosen from a total of five. The essay plan detailed above will contribute 5%.

Pre-/co-requisites

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 BIOL31451

Unit Coordinator(s): Dr Matthew Ronshaugen Semester 1
(matthew.ronshaugen@manchester.ac.uk) 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

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, leaves and shoots.

Understanding organ generation and regeneration from model and non-model organisms

Examination of regulative and mosaic development in early embryogenesis

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 and from eLearning exercises.

Employability Skills

Oral communication - Seminar style course will provide significant opportunity for developing oral communication skills
Written communication - Collaborative presentation and essay questions in examination
Group/Team working - Group presentation preparation and presentation
Project management - Organising small group presentation
Leadership - Opportunity for leadership during team work in developing presentation

Innovation/Creativity - Development of presentation and opportunity for novel synthesis derived from multiple primary literature sources
Research - Group poster and presentation
Analytical skills - Development of presentation and opportunity for novel synthesis derived from multiple primary literature sources
Problem solving - Development of presentation and opportunity for novel synthesis derived from multiple primary literature sources

Assessment
2 hour examination (90%): answer 2 essay questions out of 6. eLearning modules (10%): 2 sets of 5 questions.

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 Karel Dorey, Dr Berenika Plusa, Dr Kathyrn Hentges, Dr Minsung Kim, 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 neutron, 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. The effect of climate change on chemical communication and its consequences for biodiversity are also dealt with.

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 1200 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.

Employability Skills

Written communication - a) On-line seminar in which students have to make 2 x 100 word contributions discussing an article b) 1200 word essay
Research - Essays above
Analytical skills - Writing and researching essays and summarising the research

Assessment
1.5 hour examination (60%); extended essay to be handed in during the course - no more than 1200 words 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 firstly to the entire course through a general 1h feedback lecture after the course on the essay that also includes advice on exams, secondly online after forum discussion to groups of student and thirdly to individual students on their essay performance.

Employability Skills

Oral communication - Active lectures with student participation. Students are encouraged to answer questions during lectures.
Written communication - Essay during course and written examination. Further, online contribution to seminar.
Group/Team working - Study groups are possible for essay but students need to be aware to submit their very own piece of work.
Project management - Essay requires students to a) Find and organize relevant literature (e.g. google scholar, ISI Web of Knowledge, Pubmed etc). b) Be selective and motivate their focus. c) Develop an argument rather than list descriptively and in no order assorted facts. d) Show attention to detail, do not remain superficial but be specific. e) Be clear about what constitutes plagiarism: Do not plagiarize inadvertently or friends' work
Innovation/Creativity - Students are free to develop and motivate upon essay topic.
Research - Literature research is required for essay and online seminar contribution.
Analytical skills - Needed for essay.
Problem solving - Needed for essay.
Other - Organizational skills, communication, writing and editing.

Assessment

2 hour written examination (60%)
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%)
compulsory participation in online discussion / forum (4%)

Pre-/co-requisites

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

Recommended Reading

Alcock J. 2009. *Animal Behaviour*. 9th ed. Sinauer
Danchin E, Giraldeau LA, Cezilly F. 2008. *Behavioural Ecology.* Oxford UP
Gini B, Hager R. 2012. Behavioural Ecology. Encyclopaedia of Life Sciences. Chichester:Wiley.
http://onlinelibrary.wiley.com/doi/10.1002/9780470015902.a0003217.pub2/full
Krebs JR, Davies NB, West SA. 2012. *An Introduction to Behavioural Ecology.* 4th ed; Oxford UP
Szekeley T et al. (eds). 2010. Social Behaviour. Cambridge UP

Teaching Staff

Dr Reinmar Hager, Professor Matthew Cobb, Dr Susanne Shultz, 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 prerequisite recommendations), which will be extended and applied to conservation using a wide range of examples of conservation research and management. Lectures will be interspersed with several 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

1 **Introduction to Conservation:** Effect of man on the environment and biodiversity. Millenium ecosystem assessment. What is conservation biology?
2,3 **Biological Diversity:** What is biodiversity? How is biodiversity quantified? Geographical distribution of biodiversity, biodiversity of different ecosystems.
4,5 **Biodiversity Value:** Ecosystem services, resource management. **Case study 1**.
6 **Non-environmentally related conservation problems:** invasive species, hybridisation, disease (in endangered species and zoonoses in humans).
7,8 **Problems of small populations:** loss of genetic diversity and adaptive potential, inbreeding depression, captive breeding, reintroduction.
9 **Case Study 2:** Grey wolves in Europe.
10,11 **Problems of fragmented populations:** population structure and gene flow, habitat corridors, translocations.
12 **Case Study 3:** Orang-utans in Borneo.
13 **What should we conserve?** Populations? Species? Ecosystems?
14-15 **Ecosystem management 1:** managing protected and unprotected areas, potential importance of agricultural landscapes.
16 **Restoration Ecology and Bioremediation**
17-18 **Conservation and sustainability:** what does the future hold?

Assessment - Final examination (2 hour combined short answer and essay style paper) - 75% of marks. Coursework: essay based on a Case Study - 20% of marks; online seminar based on a Case Study – 5% of marks.

Feedback – individual feedback will be provided on a preliminary half-page outline of the coursework essay as well as on the final coursework essay itself.

Employability Skills

Oral communication - Students are encouraged to take part in discussion of the material covered during seminars
Written communication - Students required to submit a coursework essay based on a case study
Group/Team working - Students are encouraged to take part in group discussions during seminars

Innovation/Creativity - Students have the opportunity to be creative in terms of their approach to the coursework essay
Research - Research required for the coursework essay
Analytical skills - Students are encouraged to think analytically about the material covered in seminars

Prerequisites

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

Recommended Reading

Introduction to Conservation Genetics (Frankham, Ballou & Briscoe)
Essentials of Conservation Biology (Primack);

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

An informal, seminar approach (rather than lectures) forms the basis of this unit. Each session is a discussion of research papers that are made available to students a week before the lectures together with a brief description of intended learning aims. During the seminars there is an opportunity to ask questions, discuss material and consider the implication of the work. 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. Links will be provided on the course website on blackboard to reviews and commentaries that are relevant to the topics discussed to provide sufficient background. 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. During the session, students receive oral feedback on their understanding on the research area covered and how the papers relate to the learning aims. Individual feedback will be given on the course work submitted.

Employability Skills

Oral communication - All lectures based upon question and answer sessions so students have the opportunity to ask question in each lecture
Written communication – Coursework is in the form of a written analysis of a relevant paper. As part of their assessment students have to summarise the article in a way that is suitable for a broad audience.
Innovation/Creativity - Students have the opportunity to be creative in terms of their analysis or the manuscripts covered and in consideration of future directions for the research.
Research - The unit is research paper based and students are required to critically examine and discuss key scientific papers which have been set in the previous week. Specifically to analyse the strengths, weaknesses and limitations of the work and how it might develop in the future with additional research.
Analytical skills - Students are required to analyse scientific literature and be able to discuss the key points.

Assessment
Course work will constitute 30% of the mark that will be based upon a presentation (10%) and a piece of written work (20%). The written work will be assessed based upon a analysis of a paper that is related to one of the topics covered in the course. Students will be expected to summarise the article and aim to explain to a broad audience, the relevant background, the main finding and the wider significance (500-1000 words). The presentation will be based upon summarising the papers covered in a particular week by the students.

The remaining 70% 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. Topics selected for the final exam will be vetted by staff and individual feedback given on their suitability.

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

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

GREEN BIOTECHNOLOGY BIOL31501

Unit Coordinator(s): Dr Jon Pittman **Semester 1**
(jon.pittman@manchester.ac.uk) **Credits 10**

Aims
Green Biotechnology is a rapidly expanding field within modern biotechnology and involves the exploitation of plants and algae 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 compared to traditional industrial agriculture or chemical industry methods. 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.

Employability Skills

Oral communication - Students each give a group oral presentation of a research paper in five student-led seminar sessions.
Written communication - Coursework report and two exam essays.

Group/Team working - The oral presentation is given as a group (of 5-8 students) so students have to work in a group to decide how and what they are going to present.
Project management - Students have to decide between themselves how to manage the student-led seminar they are presenting.
Leadership - Although not explicitly required, it is likely that some students will take the lead in organising the direction of the student-led seminar.
Innovation/Creativity - The coursework report requires the students to generate a hypothetical research grant application therefore innovation is needed in the research ideas they identify.
Research - In generating the coursework report
Analytical skills - Student-led seminar presentation and coursework report requires critical analysis of research paper data and experimental results. Critical analysis of the literature and lecture taught material is also expected in the exam essays.
Problem solving - Possible opportunity to develop problem solving skills depending on the topic of the coursework report and the exam questions which may require a degree of problem solving.

Assessment
Two hour essay-based examination (70%), participation in discussion group and student-led presentation (5%), coursework assignment: a 3-page report based on a research paper (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 **Semester 1**
(thomas.nuhse@manchester.ac.uk) **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

Students will be able to

- Define the different types of biotic interactions and describe the molecular, developmental and ecological processes associated with them
- Understand how biotic interactions shape ecosystem structures and steer evolutionary processes
- Explain the relevance of biotic interactions for infectious disease management and traditional/ 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 in the fifth week will recapitulate the material 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. The content of the second essay is also presented in the workshop; online discussion within each team presenting the same paper is encouraged and moderated by the lecturer(s).

Feedback

Formative feedback for the two “F1000” reviews and on request for workshop preparation (Lecturers are available for discussion online). Lecture topics are recapitulated and discussed during workshops. Mock/ past exam available

Employability Skills

Oral communication - Research articles that are the basis of written essays will be discussed in workshops (3 out of 18 sessions are workshops). Small groups of students present and lead a mini- journal club style discussion of each paper in the workshops.
Written communication - Students will write short summaries of high-impact research paper, loosely based on the “Faculty of 1000” style (F1000). The writing style should be accessible for a non-specialist audience and summarize background, novel findings and wider relevance/impact.

Group/Team working - Small groups of students will jointly present “their” research paper in the workshop . This requires some form of collaboration, either online only or by meeting up in person.
Leadership - The coordination of group presentations requires initiative and leadership to aim for top marks.
Research - In the sense of engaging with primary literature, analysing and discussing scientific approaches to biological problems.

Assessment
2 “Faculty of 1000”-style research paper review (5% and15%), Participation in workshops (5%), 2 hour examination (75%), comprising 2 essays (choice of 4 topics).

Prerequisites

BIOL21211 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 Catherine Walton

BIOETHICS: CONTEMPORARY ISSUES IN SCIENCE BIOL31522 & BIOMEDICINE

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 publics 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 principal.

Intended learning outcomes

The students will be able to:

Describe different ethical principle with which different people may approach the same scientific issues.

Describe a range of contemporary ethical issues in science.

Describe a range of contemporary ethical issues in biomedicine

Describe how an understanding of current bioethical issues can be applied to novel bioethical issues of the future.

Develop organisation and presentation skills to prepare and defend a debate topic argument.

Develop organisation and presentation skills to research and prepare an assessed essay.

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.

Employability Skills

Oral communication - Students encouraged to ask and answer questions during lectures. Group oral presentations.
Written communication - Essay and short answer question.
Group/Team working - Group oral debate in teams of 7-10 students.

Project management - Group oral presentation for debate is a project undertaken over a period of weeks by a small group of students.
Leadership - Group oral presentation will need people to demonstrate leadership to ensure that it is completed in an efficient and timely manner.
Innovation/Creativity - Group oral presentation is viewed by all participants in the unit and should be interesting. Essay is written on a topic of student's choice and allows for both innovation and creativity.
Research - Group oral debate and essay require independent research of topic areas.
Analytical skills - Group oral debate and essay require analysis of available information related to topic areas.
Problem solving - Understanding information in relation to lecture topics, debate area and essay require an ability to assimilate information and problem solve in the context of the question being asked.

Assessment: Group oral presentations on specific topics (15%), essay of not more than 5 pages (excluding references) on topic of students 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 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 these environmental issues.

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

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 *e*Portfolio and on media story analysis, formative feedback in class during seminars via discussions and/or verbal feedback on presentations.

Employability Skills

Written communication - Essay on 'research behind the media'.
Innovation/Creativity - Make livebinder eportfolio online.
Research - Research topics in literature for essay and livebinder.
Other - Online web skills.

Assessment

Personal Livebinder *eP*ortfolio (10%), written analysis of the research on an aspect of biological impact of climate change '*The research behind the story*' (20%- 3 pages) and 2 hr written exam at the end of the semester (70%-2 essays from 6 titles).

Prerequisites

- BIOL21211 Ecology and Ecosystems (Recommended)

Recommended Reading

Mainly case studies and research literature used, in addition to:

- Climate Change Biology. Newman *et* a/2011 -for background reading

Teaching Staff

Dr Amanda Bamford, Dr Roland Ennos, Dr Robert Gilman, Dr Richard Preziosi, Dr Keith White.

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 urban 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; air pollutants from transport; impact of ozone and nitrogen dioxide plants and ecosystems.

Feedback

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

Employability Skills

Oral communication - Students asked questions during lectures
Written communication - Individual e-poster, literature review assignment and revision multiple choice answers plus essay/short note questions during examination
Project management - Organise and produce e-poster and literature review to specified deadline

Innovation/Creativity – e-Learning poster designed to be appealing to a general audience.
Research - Required for e-poster and literature review
Analytical skills - e-poster and literature review requires analysis of primary and secondary (reviews) sources and critically evaluate experimental and field data
Problem solving - e-learning questions include those that require problem solving

Assessment
Two hour written examination (60%), max 5 page assignment: case study of pollution incident (30%), individual poster (10%).

Prerequisites
BIOL21211 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 Caroline Bowsher, Dr Roland Ennos, 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
In this unit, students from a wide range of backgrounds explore how reproduction is controlled, influenced by medical and pharmacological intervention and affected by disease.

Intended learning outcomes
Upon completion of this unit, students will have gained an overall understanding of human reproduction, its associated technologies and reproductive disorders. They will be able to describe:

- The mechanisms of action of peptide and steroid hormones;
- Gamete production in male and female, fertilisation, the pre-implantation embryo, implantation, placental function and parturition;
- How imaging techniques can reveal embryonic and fetal growth;
- How genetics has been exploited in mouse and human to probe aspects of reproductive physiology.

They will be able to integrate this knowledge into outputs that draw on a range of course topics and show an awareness of current advances.

Lecture content

- Hypothalamic-pituitary-gonadal axis.
- Steroids and their receptors.
- Spermatogenesis, testicular stem cells and fertility in the male.
- Ovarian and uterine function in the menstrual cycle.
- Fertilisation and pre-implantation development.
- Implantation, placental development and fetal imaging
- Vascular adaptations in pregnancy.
- The major diseases of pregnancy: miscarriage, pre-eclampsia and fetal growth restriction.
- Mechanism of parturition.
- Developmental programming: how events in fetal life affect health in the adult.

Feedback
Feedback is provided via interactive Blackboard packages and posts. On-line evaluations (5%) support in-session study of key terminology and concepts and generate mid-course feedback. There is a post-exam clinic.

Employability Skills

Oral communication - Student-led session on required reading from primary literature.
Written communication - Groups produce 1 page summaries of oral presentations.
Group/Team working - Students work in groups to prepare a presentation and written summary.
Leadership - Students are expected to take initiative to organise their groups effectively and decide on who is presenting and who is preparing written summaries.
Innovation/Creativity - In the context of presentation skills.
Research - Background reading to consolidate lecture information into a coherent understanding of complex topics.
Analytical skills - 1. Data from different parts of the course has to be integrated into exam essays. 2. The online quizzes require analysis of histological images.
Problem solving - Online quizzes.

Assessment
2 hour written examination (95%); on-line evaluation (5%)

Prerequisites
No compulsory units

Recommended Reading
Compulsory, recommended, background and further reading are provided.

Other sources:

Johnson M (2007) *Essential Reproduction (6th edition) Blackwell Science*.

Jones RE (2006) *Human Reproductive Biology (3rd edition) Academic Press*

(revision and refresher) Heffner LJ and Schust DJ *(2010) The Reproductive System at a Glance (3rd Edn).Wiley-Blackwell.*

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 **Semester 1**
(d.ward@manchester.ac.uk) **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 Ca^{2+} homeostasis. PTH, vitamin D_3 & calcitonin: production, receptors & roles. Clinical abnormalities of Ca^{2+} metabolism: Hyper- and Hypo- parathyroidism, Osteoporosis, Rickets, and mutations of PTH & Ca^{2+}-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

FEEDBACK SURGERY - Marked scripts available for inspection at a 2-hour drop-in surgery to be held in February.

Blackboard Discussion Board - checked regularly by Unit Coordinator

2 interactive Blackboard packages – including how to diagnose & treat a virtual patient.

Employability Skills

Oral communication - Two interactive sessions, one with a patient and one with a clinician discussing cases.
Written communication - Essay writing in the unit summative assessment. Use of Blackboard in the formative assessment. Use of on-line e-Learning tools.
Group/Team working - Peer assessment of submitted essay plans

Research - Students directed towards Henry Stewart Talk podcasts and Endotext.org for additional self-directed learning
Problem solving - Diagnosis of the clinical case in the lecture. Virtual diagnosis in an on-line case

Assessment

2-hour written examination (90%), comprising 2 essays from a choice of 5.
Blackboard on-line quiz (5%); Essay plans (2) from a past paper (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, 6th 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 be able to:

- describe the ionic basis of the resting membrane and action potentials in the heart and the steps involved in coupling electrical activity to the development of active force.
- describe the intracellular mechanisms by which it may be possible to alter the contractile state of the heart and the changes in ion channel function that occur in various heart diseases.
- describe neural, endothelial and pharmacological mediation of excitation-contraction coupling in vascular smooth muscle.
- describe the risk factors for hypertension and the mechanisms underlying the development of primary and secondary hypertension.
- describe the causes and consequences of stroke and current limitations in stroke therapy.
- describe the cellular mechanisms involved in atherosclerosis and current treatment therapies.

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: Regulation of blood vessel tone; Specialised circulations – inc. skeletal muscle, coronary, cerebral & pulmonary; Atherosclerosis – pathology & clinical approaches to treatment
Hypertension: Epidemiology and risk factors for hypertension; Secondary hypertension – renal and adrenal mechanisms; Primary hypertension – vascular and renal mechanisms.
Stroke: Cerebrovascular disease: role of inflammation; treatment & future perspectives

e-Learning Activity
Online, summative self-assessment tests (x3) designed to test both factual recall and deeper understanding of more complex concepts.

Feedback
Individual feedback will be provided through online self-assessment tests to help students identify strengths and weaknesses in their understanding.

Employability Skills

Written communication - Written essays in the exam require students to demonstrate their knowledge of a topic by structuring answers in a clear and logical manner.
Research - Students will be recommended review and primary research papers to read for particular lectures and should read appropriate textbooks for background material.
Analytical skills - Online assessments designed to test understanding of complex concepts and may require students to think analytically about a topic.

Assessment
Three online assessments (5%), 2 hour examination (95%)

Prerequisites

EITHER BIOL21141 Cell Membrane Structure and Function **(Compulsory)**
OR
BIOL21321 Membrane Excitability: Ion Channels & Transporters in Action **(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)

Teaching Staff

Prof Stuart Allan, Dr Nick Ashton, Dr Cathy Holt, Prof Alison Gurney, Prof Andrew Trafford

ADVANCED ION TRANSPORT BIOL31591

Unit Coordinator(s): Dr Liz Fitzgerald **Semester 1**
(elizabeth.m.fitzgerald@manchester.ac.uk) **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 specific physiological examples.

Intended Learning Outcomes

On completion of the course it is expected students will

understand how ion channels and transporters are assembled into unique complexes to enable control of discrete cellular functions.

have developed transferable skills in evaluating published material and, information gathering.

Lecture Content

Transporters and aquaporins The structures, functions and regulation of acid-base transporters, solute transporters and aquaporins inphysiological systems. The co-operative interactions of channels and transporters in epithelial ion transport.

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

Voltage-gated ion channels The basic structures of membrane potential sensitive channels exemplified by review of voltage-gated Ca^{2+}, Na^+ and K^+ channels. Their roles in controlling neuronal, cardiovascular and endocrine cell function.

Ligand-gated ion channels Review of the families of ligand-gated channels, their physiological roles and pharmacological regulation.

Ion channel integration and cell function How channels work together to regulate cell function e.g. excitation-contraction coupling in muscle.

Feedback

Online problem solving and questions related to lecture material (5% of final mark).
Discussion Board (Unit Blackboard site).

Employability Skills

Written communication - Essay questions in exam
Research - Students are encouraged to read additional materials and on completion of this course should have developed information gathering skills.
Analytical skills - On completion of this course students should be able to critically evaluate published material
Problem solving - Online problem solving and questions relating to lecture material

Assessment

2 hour Examination (95%), completion of online feedback (5%)

Prerequisites

Any ONE of the RSM units i.e. BIOL 20922, BIOL 20932 **or** BIOL 20942 **(Compulsory)**
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 AND 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
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 (5% of total marks)
Submission of detailed essay plan (5% of total marks)
2 hour exam: 4 Short Answer Questions (45% total marks)
1 essay (out of 4) (45% total marks)

Feedback

Feedback from answers to assessed online short answer questions will be provided. Students will also receive feedback on assessed essay plans via Blackboard. An online discussion forum will be available.

Employability Skills

Oral communication - Students invited to answer and ask questions in lectures. Revision/feedback session in final lecture slot.
Written communication - Submission of detailed essay plan. Essay and short answer questions in exam.
Research - Researching background information for essay plan; background reading in support of lecture material.
Analytical skills - Analysis of research papers in background reading. Online questions.
Problem solving - Online short answer questions.

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

Professor lan Kimber, Professor Richard Walmsley, Dr Jen Cave!, Dr Rebecca Dearman, Dr Andrew Gilmore. Dr Katherine Hinchliffe, Dr Owen Jones,

NEUROINFLAMMATION IN HEALTH & DISEASE BIOL31612

Unit Coordinator(s): Dr Catherine Lawrence Semester 2
(catherine.lawrence@manchester.ac.uk) 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 that 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 on the pathogenesis of, and inflammatory responses to acute and chronic nervous system disorders.

Intended learning outcomes

Students will be able to:

- Describe 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 of, and inflammatory response to acute and chronic central and peripheral nervous system disorders.
- Describe the principle and clinical application of brain imaging techniques
- Demonstrate knowledge in the 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 and subarachnoid haemorrhage . The mechanisms of neurovascular unit dysfunction, neuronal

plasticity, glial scar, neurogenesis and angiogenesis will be addressed. Finally, these lectures will provide knowledge on the use of 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 (no more than 2 pages, 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 online material on several topics (enquiry-based learning), and will answer MCQs through Blackboard. A feedback session for each e-learning case will provide answers and give more information each topic, 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.

Employability Skills

Written communication - As part of an e-learning exercise students have to write a brief summary of a scientific seminar they have to view.
Research - The lectures the students are given contain some current research that in some cases is the lecturers own research.
Problem solving - Students have to solve some problems based on some e-learning exercises

Assessment
2 hour examination including 4 short answer questions (out of 6) and 1 essay (out of 5) (85%); MCQs on e-learning topics (5%) (deadlines to be announced); Essay on online seminar (no more than 2 pages) (10%, marked based on performance) (deadline to be announced)

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 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 BIOL31622

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

Semester 2
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 recognise the pivotal role of ion channels and transporters in cellular activity and understand 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 (95%); online assessments (5%)

Feedback - Verbal feedback during lectures; Discussion Board; online assessments.

Employability Skills

Oral communication - Students are encouraged to answer questions during lectures.
Written communication - On-line questions.
Research - This is a final year unit and the lecture content is provided by research-active academics with emphasis on current research. Students are encouraged to read around the subject and, in addition to their own literature-based research, are directed to additional scientific papers to enhance their knowledge.
Analytical skills - On-line questions will require analysis.
Problem solving - On-line questions will require problem-solving.
Other - After each lecture students are encouraged to undertake additional reading and both self-discipline and time management are important skills which good students will develop in doing this.

Prerequisites

Any ONE of the RSM units i.e. BIOL 20922 Neuroscience RSM, BIOL 20932 Pharmacology RSM or BIOL 20942 Physiology RSM **(Compulsory)**
BIOL31591 Advanced Ion Transport **(Compulsory)**

BIOL10832 Excitable Cells (Strongly Recommended)

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 (2011) *Rang & Dale's Pharmacology (7th 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

IMAGING IN BIOMEDICAL RESEARCH BIOL31631

Unit Coordinator(s): Dr Ingo Schiessl **Semester 1**
(i.schiessl@manchester.ac.uk) **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. We will provide formative feedback on a 1000 word hand written essay that is written in weeks 4 and 5 on an early topic in the course. 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 is available.

Employability Skills

Oral communication - Research papers are discussed during the lecture and students are encouraged to verbally summarise the content of each paper. Time set aside at the end of each lecture for student questions and feedback.
Written communication - Students submit a 1000 word coursework essay and formative feedback is provided
Research - The course utilises review and research papers
Analytical skills - Students should be able to analyse the imaging techniques covered in terms of the advantages and disadvantages of each. E-learning questions on the research papers discussed.
Problem solving - Students should be able to discuss which of the imaging methods covered in the course is suitable to address a given research problem

eLearning activity
An e-learning module (10% of mark) 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 (90%) - essay questions, e-learning module (10%), essay (formative)

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 and Dr Ingo Schiessl

ADVANCED DEVELOPMENTAL BIOLOGY BIOL31642

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

Semester 2
Credits 10

Aims

To understand how multiple developmental mechanisms regulate the stepwise and reproducible formation of specific body parts, such as the limb, the head and internal organs, how these mechanism are re-used during regeneration, and how they are relevant to understand disease..

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, how they are being repeatedly employed to contribute to distinct developmental processes and how they can provide important explanations for human disease.

Lecture content

This lecture series hightlights 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

Writing of an essay outline on which detailed feedback is given (5% of course mark)

3 multiple choice/answer e-assessments after lecture 6, 12 and 18, as an incentive to re-visit lecture notes during the course and providing detailed feedback on course contents (5% to the final course mark)

Employability Skills

Written communication - Principles of essay writing
Innovation/Creativity - Modern trends in Biology and their various uses and applications; creative thinking about biological problems in ways different from any current text books
Research - Understanding of research strategies and the appreciation of molecular and cellular mechanisms at the level of tissues and organisms, immediately relevant for disease
Analytical skills - Recognise commonalities and differences of molecular and cellular mechanism within the context of whole tissues or organisms
Problem solving - Multiple choice test aiming to dissect problems mentioned in the lecture from a different angle. Essay writing about biological problems.
Other - understanding the close relationships between developmental biology and human embryology or regenerative medicine

Assessment
2 hr essay-based written examination (90%), 3 multiple-choice/answer e-assessments (5%), a written outline of an essay answering a representative exam question (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
Andreas Prokop, Adam Hurlstone, Kimberly Mace, Karel Dorey, Shane Herbert

ADVANCES IN ANATOMICAL SCIENCES BIOL31651

Unit Coordinator(s): Dr Ingrid Gouldsborough (niggy.gouldsborough@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.
to be arranged
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.

Employability Skills

Oral communication - Two interactive revision lectures are held in which students are encouraged to discuss anatomical topics with the whole group.
Written communication - As part on the online assessment students will write an essay which will be marked and feedback given.
Group/Team working - In the interactive lectures students will work in small, self arranged groups. They are also encouraged to work in groups in the practical dissecting room session. Students with a scientific background (BSC students) are encouraged to share their scientific knowledge with those students with a more clinical background (intercalating medics). This process is reversed when the subject matter has more of a clinical basis.
Research - Many of the lectures focus on current research in a particular anatomical field. The students will therefore gain a greater insight into the theory of research.

Assessment
eLearning assessments (10%)
2 hour summative exam: (90%)
Section A - cardiorespiratory theme, answer 1 essay question from a choice of 2
Section B - skull theme, answer 1 essay question from a choice of 2
Section C - gastrointestinal theme, answer 1 essay question from a choice of 2

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 Gouldsborough, Dr Chris Klingenberg, Dr Sarah Herrick, Dr Kathryn Hentges, Dr John McLaughlin

NEUROPHARMACOLOGY OF HUMAN HEALTH BIOL31671

Unit Coordinator(s): Professor Richard Baines Semester 1
(Richard.Baines@manchester.ac.uk) 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 (especially on the motor system). The role of dopamine in reward (including drugs of abuse) will also be covered.

Glutamate - Lectures will cover the glutamate synapse and the ionotropic and metabotropic receptors that mediate/regulate glutamatergic neurotransmission. There will be coverage of the diverse biophysical properties of the ionotropic receptors, plus the diverse pharmacology of both ionotropic and metabotropic receptors. Emphasis will be placed on the role that this transmitter system plays in mediating the pathophysiology of excitoxicity, and how glutamate receptors are being targeted of as potential therapy in a variety of CNS disorders including stroke, epilepsy and schizophrenia.

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 including use and applicability of animal models.

GABA, anxiety and epilepsy - The synthesis and activity of GABA including 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.

Brain regulation of 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 will be provided. These may include a summary of lecture material and/or key reference material. Each lecture block will have an associated element of self-directed activity to allow for formative assessment of learning and feedback on understanding (this activity will collectively be worth 10% of the final mark).

Employability Skills

Oral communication - Students are encouraged to ask questions during and after lectures
Written communication - Formative and summative exam answers (SAQ and essay)
Research - Expectation that the student will undertake additional reading to understand and extend knowledge provided in lectures
Analytical skills - Multiple sources of information often provide conflicting views. The student needs to balance what they read to reach an appropriate conclusion.

Assessment
2 hour examination (90%) consisting of:
Section A (1 hour) - answer 1 essay question from a choice of 3
Section B (1 hour) - answer 1 essay question from a choice of 3
Self-directed activity (10%) (*see Feedback section)*

Prerequisites

BIOL21312 Drugs & the Brain **(Compulsory)**

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*.
E.R. Kandel, J.H Schwartz, T.M. Jessell. *Principles of Neural Science*

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

Teaching Staff
Professor Richard Baines, Professor Simon Luckman, Professor David Sattelle, Dr David Bechtold, Dr Owen Jones, Dr Jon Turner

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 (95%) - choose 2 from 6 essay titles. 5% elearning core multiple choice mid-semester test

Feedback
References to specific studies relevant to each lecture, announcements via Blackboard 9, post-exam guidance. A compulsory eLearning core multiple choice mid-semester test worth 5% will provide students with insight into how well they have understood course content. Further feedback will be provided at an end of course question and answer review session.

Employability Skills

Oral communication - Students are encouraged to answer questions during lectures.
Written communication - Essay questions in examination.
Research - Students are directed to read primary literature in topics raised during the lectures and to independently search for new findings in those topics.
Analytical skills - Students are encouraged to analyse the validity of conclusions of experiments presented during the lectures.

Prerequisites

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

Recommended Reading

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

Teaching Staff

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

LEARNING, MEMORY & COGNITION BIOL31692

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

Semester 2
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. A session will be held following the release of final unit marks to enable students to see their commented scripts and ask for feedback from the attending teaching staff.

Employability Skills

Written communication - Written examination in which students must choose two essay titles to answer
Analytical skills - MCQ eLearning exam
Problem solving - MCQ eLearning exam

eLearning
We are developing 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 (95%); MCQ eLearning exams in weeks 6 and 12 of the course (2.5% each; total 5%).

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, Prof Hugh Piggins and Dr Jon Turner

DEVELOPMENTAL NEUROBIOLOGY BIOL31732

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

Semester 2
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 mechanisms that shape 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; and, Cerebrospinal Fluid and Human Disorders.

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

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.

Employability Skills - This unit will provide a core foundation for students seeking to pursue a career in neuroscience, since understanding how the brain develops is essential background when it comes to working out potential ways to fix a broken brain. More generally, research on brain development has been instrumental in identifying novel mechanisms that have since been shown to have wider application in biological systems and beyond. The material in this unit will therefore enhance the deductive reasoning and problem-solving capabilities of those taking the course, both of which could be applied in any future working environment.

Written communication - Optional: Students are encouraged to attempt a past essay question from the unit to receive direct formative feedback. This is purely optional and is in place from the end of the unit (S1; week 6) until the end of the semester.
Analytical skills - Students are encouraged to ask questions throughout the lecture series. In addition, several lectures pose direct questions to get the students thinking about how material covered in different lectures is linked.
Other - A progress test is available on blackboard during week 4 to give the students formative feedback during the course. This test also contributes towards the final degree mark for the unit. An additional formative test becomes available, from week 7 through to exam day, so that students can regularly test themselves and gauge their knowledge acquisition.

Prerequisites

BIOL10521 Genes, Evolution and Development (Recommended)
BIOL21172 Principles of 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 Jaleel Miyan, Dr Jon Turner

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 retinobastomas and breast cancers.

Molecular basis

Tumour suppressor proteins including p53 and RB and relationship to cell cycle
Epigenetic and gene regulation changes in cancer
Introduction to MAP kinase signal transduction pathways
Nuclear targets of MAP kinase signal transduction pathways. e.g. c-Fos and c-Jun.
Relationship between oncogenes and signal transduction pathways.
Pathway crosstalk 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 (95%); Short essay question (in course assessment; 5%)

Feedback
Feedback will also be provided on the in course assessment, and via an interactive e-learning exercise.

Employability Skills

Written communication - Short essay writing (1000 word) as part of in course assessment. Also 2 essays in final exam.
Research - As with all units, students need to evaluate the literature critically, and assess which research gives a useful advance, and which does not.
Analytical skills - Assessing primary research papers is important here and is a skill that should be developed.
Problem solving - There is an online learning resource which asks students to work through a case scenario, which leads to a cure for cancer. They then uncover what the molecular features are.

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): Prof 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 endogenous or transplanted 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 1-2 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.It 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 and Embryonic stem cells will be introduced as examples.

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: 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 form ES cells and their problems; methods to bi- pass 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. 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). Reference to established HSC (L9-10) and prototype MSC (L 8) therapies.

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

Employability Skills
Written communication - Students have the opportunity to receive feedback on an optional essay. Written essays in exam require students to be able to structure a well written response in order to demonstrate their subject knowledge.
Research - Students are encouraged to read around the lecture material and analyse current literature including reviews and primary research papers.
Analytical skills - Analysis of relevant literature and integration of lecture materials.

Assessment
2 hour examination (95%), eLearning coursework (5%)

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.

Employability Skills

Oral communication - Students will do one journal club presentation. 7-10 students per presentation, with one presentation in each of 4 lecture slots.

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 (7th edition), 2012, 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, plus two guest lecturers

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 filiariasis 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
Individual formative feedback will be given on coursework that will contribute to the overall assessment. There will also be feedback in the form of an extensive question and answer session at the end of the course.

Employability Skills
Written communication - Feedback on sample exam question

Assessment
2 hour written examination (95%)
One piece of written work. Summary (500 word) of a recent high impact research paper on parasites chosen from the literature (published in Nature or Science) by the student (5%).

Prerequisites

BIOL21242 Immunology (Recommended)
BIOL21252 Parasitology (Strongly 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 Werner Muller **Semester 2**
(Werner.muller@manchester.ac.uk) **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. Iimmune 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 (95%) – Essay based, 2 out of 5 questions
Online essay and peer marking task (5%)

Prerequisites
BIOL21242 Immunology (Recommended)
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 Sheena Cruickshank, Dr Declan de Freitas, , Dr Werner Muller, Dr Mark Travis

CHEMISTRY OF BIOLOGICAL PROCESSES BIOL31812

Unit Coordinator(s): Professor David Leys
(david.leys@manchester.ac.uk)

Semester 2
Credits 10

Aims

To illustrate that complex biochemical processes are underpinned by chemical logic, and to understand that constraints are imposed by chemistry on these processes (and their manipulation through biotechnology/synthetic biology). Topics include: the chemical basis of enzyme catalysis and enzyme engineering, understanding/manipulating metabolic pathways from a chemical perspective, chemical logic underpinning important processes such as cell signalling, N_2 and CO_2 fixation. Understanding the challenges encountered in attempts to adapt biochemistry to replace traditional chemistry (i.e. biotechnology), replacing the use of non-renewable reagents (oil, plastics) with biological alternatives (biofuels, bioplastics).

Intended Learning Outcomes

When succesfully completing this course, students should:

have active knowledge of chemistry concepts that apply to biological processes

understand and demonstrate how biochemical processes have arisen from a chemical perspective (coupling to ATP to “drive” reactions, regio- and stereo-specific reaction through enzyme catalysis, use of metals for 1-electron reactions etc)

be able to understand how various structures/cofactors come together and form a biological process such as respiration/photosynthesis/cell signalling and clarify the role of these components in these processes.

be able to explain the challenges encountered in biotechnological applications aimed at replacing/expanding on traditional chemical processes.

Lecture Content

2 lectures reviewing chemistry concepts and key classes of biomolecules

5 lectures on enzyme catalysis and engineering, covering advanced enzymology to laboratory protein evolution

6 lectures illustrating chemistry underpinning complex biological processes: cell signalling, N2/CO2 fixation, aerobic respiration.

4 lectures on biotechnology: covering biofuels and development of new antibiotics.

1 lectures on synthetic biology: covering biomimetic chemistry: novel nucleic acids/photosynthesis mimicry

Assessment

2 hour examination (80%) and eLearning assessments (20%)

Feedback

Feedback will be online, with general responses for the MCQ and personalised feedback for the open questions.

Employability Skills

A clear understanding of chemistry underpinning biology (in terms of reaction mechanism, small molecule binding, limitations and scope of biochemistry) is a key skill for those seeking a career in biotechnology/drug design areas.

Prerequisites

BIOL21162 Chemistry of Biomolecules **(Compulsory)**

Recommended Reading

- Voet & Voet, *Biochemistry,* 4[1]h edition, 2011, Wiley
- Review and primary articles in the field (from journals such as Nature Chemical Biology; Current Opinion in Chemical Biology). A detailed list of these will be giving in the first lecture.

Teaching Staff

David Leys, Nigel Scrutton, Andrew Munro, Erika Takano

MADNESS & SOCIETY IN THE MODERN AGE, 1780-2000 HSTM30832/HSTM40332

Unit Coordinator(s): Prof. Michael Worboys (michael.worboys@manchester.ac.uk)

Semester 2

Credits 10/20

Aims

To explore a selection of topics in the social, cultural, intellectual, and institutional history of psychiatry in Britain from 1800 to the present. Students will become familiar with the main ideas, figures, and events in the history of views about the nature and management of madness, and the changing social meanings and context of mental illness. And they will develop an understanding of the history of psychological medicine as a case study in the interaction of science, society, and culture.

Intended Learning Outcomes - Students will be able:

to show an appreciation of historical approaches to medicine
to demonstrate a knowledge of the chronology of changes in the understanding and management of mental illness since 1800
to have a critical appreciation of the debates surrounding the reasons for particular policies and treatments for mental illness
to take part in informed discussions on these topics and issues
to reflect critically on the changing role of psychiatry and the cultural meanings of madness

Lecture Content

Introduction and 'The Age of Unreason'
Reforming the Mad Trade
The Great Confinement
Theories of Insanity: Phrenology to Degeneration
Insanity, Crime and Responsibility
The Madwoman and her doctors
Sigmund Freud and the 'birth' of psychoanalysis
Shell Shock, Psychiatry and War
Treating Madness: 'A Therapeutic Revolution'?
The Closure of Mental Hospitals
From Anti-Psychotic to Life Style Drugs

Assessment

10 credit unit (HSTM30832) - Essay (30%) and 2 hour examination (70%)
20 credit unit (HSTM40332) - Short essay (15%); 2 hour examination (35%); long essay (50%)

Feedback - students may ask questions at any time during lectures and seminars. Teaching staff can usually answer specific queries by email or during office hours, and will provide contact details in the course handbook or at lectures. All submitted coursework will be returned with annotations and an assessment sheet explaining the mark awarded. In addition, students on the 20-credit version receive comments through individual supervision meetings.

Employability Skills - **General Statement** - Verbal communication skills are developed in seminars and writing skills in assignments; preparing for seminars and essays uses qualitative research skills and answering questions; initiative is developed through the learning demands of the course; the course requires organisation skills to meet deadlines and to coordinate the different learning resources used; seminars require working as part of group, adapting to different demands and negotiating with other students.
Oral communication - Students take part in informed discussions of the topics covered.

Written communication - Students receive feedback on a coursework essay. 20 credit students also produce a long essay/project.
Group/team working - Students take part in group discussions and debates relating to the issues and topics covered.
Project management - 20-credit students are required to submit a written project.
Innovation/Creativity - Students have the opportunity to be innovative in terms of how they address their essay topic.
Research - Research required for essays and projects. Students learn to search, access and interpret online resources.
Analytical skills - Students encouraged to reflect critically on the topics covered.

Prerequisites - None.

Recommended Reading

Shorter, E *A History of Psychiatry: From the Era of the Asylum to the Age of Prozac* 1998 John Wiley & Sons – suggested purchase
Faulks, S *Human Traces* 2006 Vintage (Novel)
Scull, A. *The Most Solitary of Afflictions: Madness and Society in Britain 1700-1900* 2005 Yale University Press
Porter, R. *Madness: A Brief History* 2003 Oxford University press
Barker P *Regeneration: A Novel* 1992 Penguin (Novel)

Teaching Staff - Professor Michael Worboys

THE NUCLEAR AGE: HIROSHIMA TO NUCLEAR TERRORISM HSTM31212/HSTM31712

Unit Coordinator(s): Dr Jeff Hughes (jeff.hughes@manchester.ac.uk)

Semester 2
Credits 10/20

Aims
To provide an introduction to the history and politics of nuclear weapons and nuclear power, and to the culture of the nuclear age. To explore the interactions of science, technology, politics, gender and cultural production in the nuclear world. To examine and assess the impact of the nuclear age on human affairs.

20-credit unit only – Additionally to give students the opportunity of exploring in detail some aspect of the nuclear age through an individual research project.

Intended Learning Outcomes
Students will understand the origins of nuclear weapons and have an appreciation of the debates surrounding their use in 1945; appreciate the diverse reasons for the proliferation and control of nuclear weapons and the relationships between science, politics and state formations in the Cold War and after; be able to analyse the cultural phenomena associated with nuclear weapons, including film, literature, television and the media; be aware of the effect of nuclear weapons on military strategy both in general terms and in specific instances, e.g. the Cuban Missile Crisis. Students taking the 20-credit unit will also extend and develop their research and writing skills through an individual research project.

Lecture Content

Hiroshima, Nagasaki and the end of the Second World War. The origins of atomic weapons, reasons for their use, and controversy over their role in ending the War.

Nuclear proliferation and nuclear culture, 1945-1955.

The Hydrogen Bomb and Massive Retaliation, 1950-1965. The origins of the hydrogen bomb and its effects on nuclear offensive and defensive strategy.

The Cuban Missile Crisis, 1962. Origins, development and outcome of the Crisis, and its impact on international relations and nuclear culture.

'Civil Defence' and *The War Game*. Organisation and critiques of civil defence in the nuclear age. CND and anti-nuclear protest.

Nuclear test bans and nuclear intelligence, 1963-1996. Relationships between international nuclear treaties.

The growth of nuclear energy and the nuclear industry in Britain.

Nuclear weapons and nuclear power accidents. Case study: Windscale.

Nuclear smuggling and nuclear terrorism. Current threats of nuclear terrorism.

Assessment
10 credit unit (HSTM31212) - 2000-word essay (50%) and coursework (50%).
20 credit unit (HSTM31712) - 2000-word essay (25%); coursework (25%); individually supervised 3000-word research project (50%).

Feedback
Students may ask questions at any time during classes. Specific queries can be dealt with by email or during office hours; the lecturer will provide contact details in the course handbook. All submitted coursework will be returned with annotations and an assessment sheet explaining the mark awarded. Group meetings will provide direction and feedback on project work.

Employability Skills
Oral communication - Students are encouraged to participate in classroom discussions of set readings and issues of current topical concern.

Written communication - Coursework assignments and formative feedback are designed to develop students' writing skills. Beginning with a small review task, students progress to a focused piece of individual research, then complete a larger essay requiring more sustained attention to issues of structure and organisation in writing. Students taking the course for 20 credits further develop their research and writing skills in a substantial additional individual research project.
Group/Team working - Students may have the opportunity to be involved in peer review of the smaller individual research projects as the basis for a web-publication project. This is delivered in a workshop setting in which students are encouraged to discuss and offer constructive feedback on each other's work.
Project management - Students taking the course for 20 credits complete a 3,000-3,500 word individual research project requiring integration of primary and secondary sources. The project runs over the entire course of the semester, and requires students to develop time-management and related project management skills.
Innovation/Creativity - The individual research projects and larger 20-credit projects require the use of primary sources. Students are required to locate relevant primary and secondary sources, and to use them to write a contained piece of original historical work.
Research - As above
Analytical skills - The entire unit is predicated on the development of students' analytical skills in being able to find and assess evidence and to represent those judgments in coherent focused pieces of writing. The course has direct topical relevance in, for example, analysis of the national security state and notions of governmentality.

Prerequisites - None, though other HSTM courses an advantage

Recommended Reading

Gerald de Groot, *The Bomb: A Life.* Pimlico, 2005.
J.M. Siracuse, *Nuclear Weapons. A Very Short Introduction*. Oxford University Press, 2008.
John Hersey, *Hiroshima* (many editions and publishers)

Teaching Staff – Dr Jeff Hughes

FROM BAKER STREET TO CSI: THE HISTORY OF FORENSIC MEDICINE HSTM32011/HSTM32511

Unit Coordinator(s): Dr Elizabeth Toon (elizabeth.toon@manchester.ac.uk)

Semester 1
Credits 10/20

Aims
To investigate the growing literature on the legal application of medical and scientific expertise; to contextualize contemporary understandings of and interest in forensics and its popular representations; to consider the history of forensics as a practical example of the dynamics of public understanding of science.

20 credit unit only - to explore in detail some aspect of these themes through an individually supervised research project.

Intended Learning Outcomes
By the end of this Unit, a student will have an appreciation of the basic features of historical developments in 19th and 20th century forensic medicine and science; the social, institutional and technical foundations for rise of specific forensic techniques; the conditions governing the application of forensic techniques in specific historical cases; the sources of debate in the medical, scientific, legal and public domains concerning the credibility of forensic evidence; the historical impact of popular representations of forensics.

Students taking the 20 credit unit will also be able to find and research a topic of their own choosing; to find and assess critically primary and secondary sources; to write, with full scholarly apparatus, a report on their individual research project.

Lecture Content
1. From Baker Street to CSI: An introduction and overview
2. History of Forensics and Crime
3. Technologies of Identity
4. “Born Criminals” in late 19th-c Criminology & Crime Fiction
5. Determining Sanity
6. Poison and the Victorians
7. Tales from the Dead
8. Traces from the Living
9. Witnessing Truth
10. DNA Fingerprints, Proof and Persuasion
11. Watching the detectives: from Baker Street to CSI

Assessment
10 credit unit (HSTM32011): 1500 word essay (50%); two hour final exam (50%)
20 credit unit (HSTM32511): 1500 word essay (25%); two hour final exam (25%); final project (50%)

Feedback
Students may ask questions at any time during lectures and seminars. Teaching staff can usually answer specific queries by email or during office hours, and will provide contact details in the course handbook or at lectures. All submitted coursework will be returned with annotations and an assessment sheet explaining the mark awarded.

Employability skills

Oral communication - students encouraged to pose and answer questions in lectures, and discuss readings and course themes in workshop session
Written communication - Short essay and essay exam for all students, longer essay for 20-credit students

Group/team working - Collaboration on short in-class projects during workshop sessions
Project management - For 20-credit students, choosing topic, researching, and writing long essay
Research - 20-credit students do independent research for their long essays
Analytical skills - Class discussion and all written work, including exams, requires analyzing critiquing scholarly works as well as primary sources

Prerequisites - None

Teaching Staff- Dr Elizabeth Toon

HISTORY OF CLIMATE CHANGE HSTM33201/HSTM33501

Unit Coordinator(s): Dr Simone Turchetti **Semester 1**
(simone.turchetti@manchester.ac.uk) **Credits 10/20**

Aims
Climate change is the most divisive and debated issue of the 21st century. And both believers and sceptics have mobilized an impressive amount of scientific data to tell us about the future of our planet. Yet, few have considered what originated such an interest in the past. When it is that global warming has come to be perceived as a major threat for humanity? And why is it that the climate change discourse has occupied such a prominent position in the political arena?

In order to understand it, we have to look at the historical trajectories of climate science that have typified the last century. By looking at the history of earth and environmental studies and the theories associated with climatic changes (greenhouse effect, weather forecasting, ozone studies, ice modelling), this course introduces arts, humanities and sciences students to the ways in which scientific ideas on climate were first conceived. Using a variety of resources including scientists' writings, newspapers and films, it also provides an understanding of the historical, social and political context in which these studies developed. And it seeks to explain how they have intersected major transitions in culture and international relations; up to the contemporary debate on global warming.
An inconvenient truth? A suitable way to find out about it!

Intended Learning Outcomes
To have an appreciation of the complexity of the issues related to modern climate change in the broad context of its historical development; to understand a range of ways of thinking about the issue and contemporary economy, politics and society; be able to reflect critically on opposing and alternative views and probe underneath daily rhetoric to grasp the driving forces of climate change.

Lecture Content
1. Let's play back. The "Hockey Stick" controversy.
2. Tyndall, Arrhenius and the "greenhouse effect".
3. A help from the outside(r): George Guy Callendar
4. Sudden climatic changes: exception, rule or possibility?
5. A Cold War gift: computers and numerical weather forecasting.
6. *Reading Week*
7. Monitoring ice. Glaciology and climate change.
8. Ash-disrupted. Volcanoes and climate change
9. Carbon dioxide from Revelle to IPCC
10. The Ozone layer and its enemies
11. The truly inconvenient truth, i.e. the politics of climate change
12. What does it all mean for me?

Seminar Content - Seminars consolidate lecture material through a set weekly reading. Students are required to answer a short series of questions based on the set text on a intranet discussion board. These questions form the basis of the seminar discussion. In two occasions there will be film screenings to complement seminar activities.

Feedback
Students may ask questions at any time during lectures and seminars. Teaching staff can usually answer specific queries by email or during office hours, and will provide contact details in the course handbook or at lectures. All submitted coursework will be returned with annotations and an assessment sheet explaining the mark awarded.

Employability Skills

Oral communication - Seminars
Written communication - Preparation of coursework via blackboard, essays and exam papers.
Group/Team working - Seminar activities to be carried out in groups. Blackboard activities entailing group work in terms of exchanges between students.
Project management - Students take turns in reporting findings by groups.
Leadership - Participation is not about 'spoon-feeding' but active learning through collective work which allows students to establish leadership in analysis of the areas covered.
Innovation/Creativity - Blackboard activities entailing original ways to retrieve information.
Research - Blackboard, essay writing and seminar activities entailing original research using a variety of sources.
Analytical skills - Especially in terms of content analysis.

Assessment
10 credit unit (HSTM33201) - 1500 word essay (45%); 2 hour examination (45%); coursework (via intranet discussion board) (10%).

20 credit unit (HSTM33501) - 1500 word essay (25%), 2 hour examination (25%) and 3500 word project (40%); coursework (via intranet discussion board) (10%).

Prerequisites - None.

Recommended Reading

Spencer Weart, *The Discovery of Global Warming*, 2003, Harvard
Fleming, J R *Historical Perspectives on Climate Change,* 1998, Oxford

Teaching Staff - Dr Simone Turchetti, Dr Leucha Veneer

KEY ISSUES IN CONTEMPORARY MEDICINE: HSTM36202/HSTM36702 WHAT CAN HISTORY TEACH US?

Unit Coordinators: Dr Carsten Timmermann **Semester 2**
(carsten.timmermann@manchester.ac.uk) **Credits 10/20**

Aims

To introduce students to the recent history of health and medicine by focusing on issues that are presently controversial or likely to illuminate future developments; to develop the skills needed to make informed judgements on the basis of historical evidence. To this end students will learn how to reconstruct past developments, using historical sources and appreciating the historical contexts. We will cover a range of issues, from demographic and epidemiological questions to forms of diagnosis and treatment and the politics and organisation of medical services.

Intended Learning Outcomes

By the end of this course, students will:

have gained insights into the histories of some of the key issues in contemporary medicine
be able to mobilise historical evidence for policy debates
know how to find, and assess critically, primary and secondary sources

20 credit unit only:

have undertaken an individual research project and produced, with full scholarly apparatus, a report based on this research

Lecture Content

Introduction to the Contemporary History of Medicine
The Case of Cancers: Incidence, prevention and treatment
Smoking and the New Public Health
Inequality and health
Medicalisation
Doctors and other health professionals
Patients and Activism
Death and Dying
Mental illness and care in the Community
Where Did the NHS Come From?
Where is the NHS Going?

Assessment

10 credit unit (HSTM36202) - 1500 word essay (50%) and a 2 hour examination (50%).
20 credit unit (HSTM36702) - 1500 word essay (25%), a 2 hour examination (25%), and a 3500 word project (50%)

Feedback - Students may ask questions at any time during lectures and seminars. Teaching staff can usually answer specific queries by email or during office hours, and will provide contact details in the course handbook or at lectures. All submitted coursework will be returned with annotations and an assessment sheet explaining the mark awarded.

Employability Skills

Oral communication - The course is taught through interactive lectures and weekly seminars. Required readings are discussed in each session. Course content is drawn on to understand recent news item in their broader historical contexts.
Written communication - All students submit a 1500 word essay. In addition, 20 credit students also write a 3500 word project. Lecturers offer to discuss essay and project outlines with students in individual meetings, and feedback is given for all submitted pieces

of coursework in in the form of annotations and an assessment sheet explaining the mark awarded.
Project management - All students pursue independent research for their 1500-word essays. Students on the 20-credit unit complete a more substantial individual research project and produce a full report based on this research.
Innovation/Creativity - Innovative approaches to essay and project research are encouraged.
Research - Essays and projects require independent research.
Analytical skills - Students are required to find and critically assess relevant primary and secondary sources.
Problem solving - Problem solving skills are required when it comes to extracting relevant information from a broad range of sources.

Prerequisites - None.

Recommended Reading

Klein, R *The New Politics of the NHS (5th edition)* 2006 Radcliffe Publishing Ltd
Cooter, R & Pickstone, J (ed.) *Companion to Medicine in the 20th century* 2002 Routledge
Harrison, S & McDonald, R, *The Politics of Healthcare in Britain* 2008 Sage Publications

Teaching Staff - Dr Valerie Harrington, Dr Stephanie Snow, Dr Carsten Timmerman