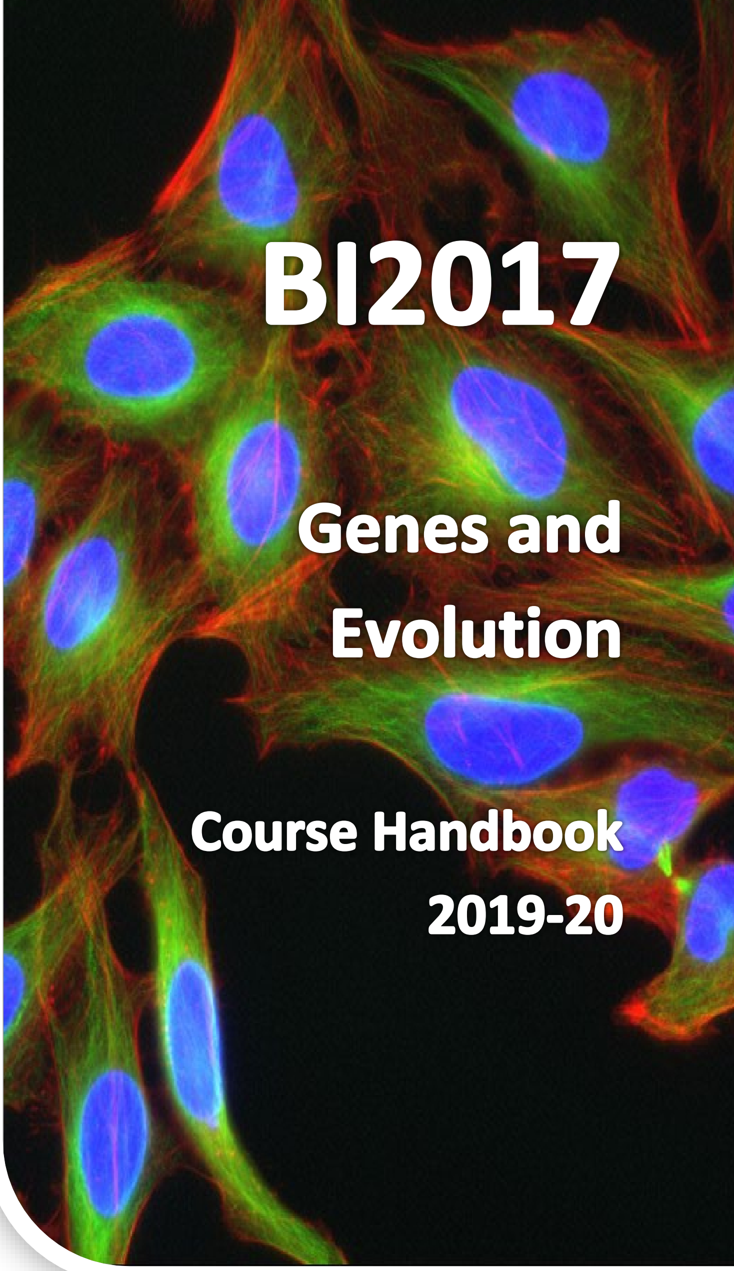
School Of Medicine, Medical Sciences & Nutrition



BI2017

Genes and Evolution

Course Handbook
2019-20

UNIVERSITY OF ABERDEEN

Contents

Cover image:
Confocal micrograph of fluorescently labelled HeLa cells.
Nuclei are labelled in blue, tubulin in green and actin fibres in red.

Courtesy of:
Kevin Mackenzie
Microscopy and Histology Core Facility
Institute of Medical Sciences
University of Aberdeen
http://www.abdn.ac.uk/ims/microscopy-histology

Course Summary

Genes and Evolution is a level 2 biology course, relevant to all students in biological sciences. Genetics and evolution are the two major unifying themes in biology –they were discovered by biologists that everyone has heard of, including Darwin, Mendel, Crick and Watson – and they are so inextricably linked that we have taken the decision to bring them together in a single course.

A large part of the information that specifies the form and development of an organism is encoded in the DNA sequence of its genes. This information is translated into the proteins that build and maintain the organism. These principles apply to all forms of life, from viruses all the way to humans. But the DNA sequence is not identical in all members of a species – diversity is generated by the two processes (mutation, recombination) that we introduced in the first year courses. It is this diversity that evolution acts upon. According to the principle of natural selection (first described by Charles Darwin and Alfred Russell Wallace), some organisms in a population are better adapted to survive, because of the particular combination of alleles they have, and therefore more likely to breed and pass on their alleles to the next generation. In this way, a species gradually changes (evolves) over time. Ultimately, some members of a species may become so different that they give rise to a new species.

By looking at organisms and their genes, we can see the evidence of these changes, and we will consider many examples in the course. We can also look at evolution from a mathematical viewpoint – it can be described as changes in the relative frequencies of different alleles of a species' various genes, over a period of time. This study is called population genetics and we shall be introducing you to it in the course. Population genetics has many interesting applications, for example in understanding why some apparently harmful genetic diseases are common in some parts of the world.

There are 32 lectures (3 per week over the 11 weeks of the course), 6 practical sessions (one of which is computer-based) and 2 online assignments. Assessment is by a combination of written examination and coursework (see later in the manual for full details).

We (the teaching staff) have enjoyed putting together this course. We hope you are going to enjoy actually doing it!

Course Aims & Learning Outcomes

When you have successfully completed the course, you will have gained a solid understanding of the following. Some of the key terms are in bold type:

- The rules of **genetic inheritance**, including segregation and linkage
- The role of **genetic mutation** in generating diversity, and the molecular basis and effects of mutation
- An understanding of the general lines of evidence that illustrate the process of **evolution**, and the forces that shape it
- Deducing the evolutionary relationships between organisms and their genes, and describing them as **phylogenies** (“trees”)
- **Population genetics** – the study of changes in allele frequencies in a population
- The processes leading to **evolution** within a **species**, and the formation of new species and new major groups of organisms
- An appreciation of how scientists first discovered the basics of **genetics** and **evolution**, and how they are being studied today
- The basis of further study in any area of biology in future years of your University career

In addition, by participating in the course, you will have improved your general (generic) skills in several areas. These are as shown below, together with the components of the course that are particularly relevant:

- **Numeracy** – practical’s (calculations involved in analysis of results), problem-solving questions from past exam papers, lectures on quantitative topics such as population genetics
- **Information technology** – use of specialist software for phylogeny analysis (2nd practical) and general software such as word-processing and spreadsheets in written work and calculation
- **Literacy** – writing practical reports and lecture notes, practise for essay questions in examination
- **Teamwork** – working with other students in practical’s
- **Observation and analysis** – practical’s, absorbing and understanding lecture material
- **Communication** – with other students and staff, especially in interactive classes such as practical’s, and in communicating generally with staff during the course on matters that concern you

Course Teaching Staff

Course Co-ordinators:

Dr Arimantas Lionikas (**a.lionikas@abdn.ac.uk**) and Mrs Cath Dennis **(c.dennis@abdn.ac.uk)**

Other Staff:

Dr Adam Price (**a.price@abdn.ac.uk**)
Dr Petra Louis (**p.louis@abdn.ac.uk**)
Dr Jonathan Pettitt **(j.pettitt@abdn.ac.uk)**
Dr Cathy Jones **(c.s.jones@abdn.ac.uk)**
Dr Paul Haggarty **(p.haggarty@abdn.ac.uk)**
Dr Bruno Lopes **(bruno.lopes@abdn.ac.uk)**

Assessments & Examinations

This course is assessed by a combination of course work (50%) and a multiple choice question (MCQ) type of examination (50%). The course work comprises 3 practical's and 2 online tests.

Course work: Practicals. Assessment of each practical consists of a Prep-MCQ test (carries 4% of the final mark) and a practical report (carries 10% of the final mark). The Prep-MCQ test assesses knowledge of material covered in the booklet of the upcoming practical and MUST be completed prior to attending the practical session (submission deadline set to 11:00 am on the day of the relevant practical; an exception is the Phylogenies practical, where the Prep-MCQ test should be submitted on Week 11 of the course). The practical report MUST be written and submitted through Turnitin by the deadline indicated in the table below (in general, within a week after the second part of the practical).

Course work: Online tests. The online tests (each carries 4% of the final mark) include short answer questions on course material covered from the start or since the previous online test. There is a time limit for the test of 1 hour (unless other provisions apply). The test will be made available on the course website during the weeks shown in the table below. It MUST be taken on a University computer and completed within that week (for deadlines see table below).

Examination. The exam consists of 60-80 MCQs all of which must be answered. A portion of questions will be of a problem solving type, therefore **do NOT forget to bring your calculator to the exam!**

To achieve an overall pass for the course you MUST obtain an overall grade of D3 or better for the course. For students who do not achieve this, there will be a resit examination (usually in July) in the same format as the first examination.

Submitting course work:

Practical reports should be submitted through Turnitin. The deadlines for reports and online tests are indicated in the table below. IMPORTANT: components of assessment not received by the deadline will **not** be marked but awarded a zero.

Work to hand in	Week	Deadline
Linkage Practical report	12	Oct 15 (Tue), 23.59
1st Online Assessment	12	Oct 18, (Fri), 23:59
Phylogenies Practical report	14	Oct 29, (Tue), 23.59
2nd Online Assessment	16	Nov 15 (Fri), 23:59
Mutations Practical report	18	Nov 26 (Tue), 23.59

We aim to return marked reports within 2 weeks.

Class Representatives

We value students' opinions in regard to enhancing the quality of teaching and its delivery; therefore, in conjunction with the Students' Association we support the Class Representative system.

In the School of Medicine, Medical Sciences & Nutrition we operate a system of course representatives, who are elected from within each course. Any student registered within a course that wishes to represent a given group of students can stand for election as a class representative. You will be informed when the elections for class representative will take place.

What will it involve?

You will communicate with your fellow students on the course and then represent their views and any concerns at the Staff Student Liaison Committee meeting. As a representative, you will also be able to contribute to the agenda. You will then feedback to the students after this meeting with any actions that are being taken.

Training

Training for class representatives will be run by the Students Association. Training will take place within each half-session. For more information about the Class representative system visit **www.ausa.org.uk** or email the VP Education & Employability **vped@abdn.ac.uk**. Class representatives are also eligible to undertake the STAR (Students Taking Active Roles) Award with further information about this co-curricular award being available at: **www.abdn.ac.uk/careers**.

Problems with Coursework

If students have difficulties with any part of the course that they cannot cope with, alone they should notify one of the course coordinators immediately. If the problem relates to the subject matter general, advice would be to contact the member of staff who is teaching that part of the course. Students with registered disabilities should contact Mrs Jenna Reynolds (**medsci@abdn.ac.uk**) in the Medical Sciences Office (based in the Polwarth Building, Foresterhill), or Mrs Sheila Jones **(s.jones@abdn.ac.uk)** in the Old Aberdeen office associated with the teaching laboratories, to ensure that the appropriate facilities have been made available. Otherwise, you are strongly encouraged to contact any of the following as you see appropriate:

- Course student representatives
- Course co-ordinator
- Convenor of the Medical Sciences Staff/Student Liaison Committee (Prof Gordon McEwan)
- Personal Tutor
- Medical Sciences Disabilities Co-ordinator (Dr Derryck Shewan)

Course Reading List

The course text book is "Life – the science of Biology" (10th or 11th editions) by Sadava, Hillis, Heller and Hacker and published by W.H.Freeman. Earlier editions of the book are also useful but are obviously not so up to date with new ideas in genetics. Some earlier editions have different authors including Purves.

You are strongly recommended to buy your own copy of this book. Although the library does have a limited number of copies, it is much better to have your own so you can refer to it at any time. You may find that older editions are more cost-effective, just remember to check the newer version if you are researching a new idea.

Text book Website:

The publishers of the textbook have a website where you do various tutorials and revision exercises connected with the material in the textbook. Its address is: **www.thelifewire.com**

Lecture Synopsis

The lecture course is divided into sections which correspond to those in the course text, 'Life' (Sadava, Hillis, Heller & Hacker, 11th Edition 2017). Older editions of this text will be perfectly usable for the course but be aware that occasionally chapters or even sections may have been moved.

You will notice that the chapters covered are not fully consecutive. This course focusses on evolutionary genetics rather than molecular genetics.

INTRODUCTION AND THE HISTORY OF GENETICS

Mrs Cath Dennis, Dr Ari Lionikas

The first three lectures will introduce you to the structure and content of the course and look back at the volatile history of the subject. The 'Ancient Mutations' session will showcase recent research into genes and evolution, where surprises are still common.

Note: these three lectures have no direct link to a textbook chapter. References will be provided in class for further reading.

Adaptation and natural selection – the Darwinian paradigm: Prior to the 17th and 18th centuries concepts of biodiversity were primarily driven by religious dogma and the orthodox belief that organisms were fixed in form. The voyage of Charles Darwin on HMS Beagle led him to devise the process of organic evolution, an idea already considered by contemporaries like Lamarck and Wallace. Darwin produced 5 interrelated theories that together constitute the Darwinian paradigm: evolution as such; common descent; multiplication of species; gradualism; and natural selection.

Natural selection meets mutation and inheritance – the neo-Darwinian paradigm: When Darwin put forward the theory of natural selection, he lacked a satisfactory theory for inheritance. As a result, the importance of natural selection was widely doubted until it was shown in the 1920s and 1930s how natural selection could operate with Mendelian inheritance. The synthesis of Darwin's and Mendel's theories is variously called the "modern synthesis" or "Neo-Darwinism", and is now all pervasive in biology, unifying genetics, systematics, palaeontology, comparative morphology and embryology.

GENES & HEREDITY ('Life' Part 4)

<u>Inheritance, genes & chromosomes (Chapter 12): Dr Ari Lionikas</u>

These 3 lectures revise the basics of genetics and extend your knowledge of the topics of linkage and genetic mapping. The topics covered are:

Revision of Mendel's laws of inheritance; Mendel's 2nd law explained in terms of probability; application to human pedigrees; alleles and dominance; gene interactions (epistasis); multiple genes influencing single traits; gene-environment interactions; linkage (an exception to Mendel's 2nd law); recombination frequencies; genetic maps; sex determination and sex linkage; co-dominance; non-nuclear inheritance.

<u>Gene mutation (& molecular medicine) (Chapter 15): Dr Petra Louis</u>

Mutation is one of the mechanisms for increasing genetic diversity, by creating new alleles. Much of the pioneering work was done on micro-organisms. These 2 lectures cover the following topics, including not only mutation but also the way in which mutations can be corrected (DNA repair).

Mutations and mutants, genotypes and phenotypes; bacteria and mutations; why we use mutants; selection and detection of mutants; types of mutation (nucleotide substitutions, frameshifts, deletions and insertions, rearrangements); mutation rate and its measurement; mutagenesis (the creation of mutants: spontaneous; chemical; radiation-induced); DNA repair mechanisms (mismatch repair, apurinic gap repair, photoreactivation repair, excision repair, postreplication repair); reverse and suppressor mutations.

Your third practical will recreate the famous Luria Delbruck fluctuation test, which gave evidence for the spontaneous mutation hypothesis.

Regulation of gene expression (Chapter 16): Dr Paul Haggarty

We will start with a BBC Horizon film, which shows the story of the very recent discovery of the epigenome: 'The Ghost in Your Genes'. This is followed by two lectures, which will explain current understanding of epigenetic control.

The human genome contains information, which is not fully described by the DNA sequence alone. This so-called "epigenetic" information fundamentally affects the way in which the genetic code is interpreted. The sequence information in the human genome determines the function of expressed proteins whilst the epigenetic information determines how, when and where the genetic data is used. This process of epigenetic control is now recognised as a fundamental regulator of the metabolic response of all cells in the body. This lecture will introduce the topic of epigenetics and how it regulates the genome and determines cell identity.

Epigenetics, Human Health, and Evolution Epigenetic marking of the genome is influenced by nutrition and lifestyle and epigenetic change has been implicated in cancer, cardiovascular disease, cognition, reproduction function, diabetes, obesity and ageing. A particular type of epigenetic mark is inherited from the parents and this raises the possibility that "epigenetic risk" accumulated by one generation may be passed on to the next. Epigenetics may also influence the process of human evolution and has led some to reconsider the concept of Lamarckian as opposed to Darwinian evolution. This lecture will consider the role of epigenetics in human reproduction, and the consequences for human health and evolution.

GENOMES ('Life' Part 5)

Genomes (Chapter 17): Dr Petra Louis, Dr Adam Price, Mrs Cath Dennis

Mechanisms of bacterial diversity: gene acquisition, mutation and gene loss: Bacteria serve as an example for illustrating the generation of diversity by various mechanisms that involve gaining or losing large amounts of DNA. They include gene acquisition (transfer of DNA by transformation, plasmids and phage, transposable elements) which can lead to the spread of antibiotic resistances between species; mutation (drug resistance and selection); and gene loss (leprosy, endosymbionts).

Plant genomes: major differences between plants and animals – the breeding schemes, the genomes size, the number of genes.

Comparative genome structure and synteny: It has recently become apparent that the organisation of genomes is conserved between related species, even though the DNA is rearranged. This is called synteny. The study of synteny reveals processes in evolution and has important consequences for medicine and agriculture.

Genes, development & evolution (Chapter 19): Dr Jonathan Pettit

The Hox genes (1): Development of animal bodies

The homeobox (hox) genes were first discovered as giving rise to strange looking, “homeotic” mutants in flies, where legs grow in the place of antennae, or there are extra pairs of wings. This lecture covers how the homeobox gene cluster works to specify axial patterning in flies – how Homeobox proteins pattern the fly body, leading to the development of a complex organism from a fertilised egg.

The Hox genes (2): Relationship of phenotype and genotype

Hox proteins are "master switches" that turn sets of genes on or off. When a Hox protein is expressed in a cell, the expression state of many other genes will be different from a cell in which the Hox protein is not expressed. All animals examined so far have Hox genes, suggesting that all use the same basic mechanism to direct their development. This lecture will describe the mechanism by which Hox proteins function and how they specify appropriate cell fates.

The Hox genes (3): Evolution of animal bodies

This lecture gives an overview of the role of Homeobox patterning in the evolution of arthropods, and vertebrate axial patterning. Specific examples include the butterfly P. coenia, fruitfly Drosophila and other arthropods such as Artemia, millipedes, etc. As a vertebrate example we will consider how the snake lost its legs.

THE PROCESSES AND PATTERNS OF EVOLUTION (‘Life’ Part 6)

Processes of evolution (Chapter 20): Mrs Cath Dennis

The evidence for evolution and natural selection: a number of lines of evidence indicate that species have evolved from a common form through the process of natural selection, rather than being created separately and fixed in form. This evidence can be seen spatially, with observed changes in extant species, or temporally, from the fossil record and extinct species.

Population genetics: allele frequencies in populations are described by a simple equation, the Hardy-Weinberg equilibrium. Forces that act on allele frequencies in populations include migration, selection, drift and mutation. We will consider the effects of random and non-random mating, and heterozygous advantage – why some harmful alleles are more common than they should be. The concept of haplotypes and their use in determining the genetic relationship of individuals within and between populations.

Speciation (Chapter 22): Dr Petra Louis, Mrs Cath Dennis, Prof Frithjof Kuepper

Molecular clocks and phylogenies: the fact that mutations accumulate through time leads to the appreciation that the divergence between the corresponding homologous sequences of two individuals can be used to determine evolutionary genetic relatedness. The rate of sequence mutation appears to have a constant rate in some sequences, a phenomenon known as a molecular clock. The time of sequence diversion can be calculated, and this allows estimation of the timing of major evolutionary events.

Species concept in bacteria: it is difficult to define what we mean by a species in organisms such as bacteria that can breed without sex. This lecture considers phenotypic and genotypic definitions of species, using the bacteria Mycobacterium and Neisseria as examples. We also consider clonality, population diversity and selection.

Adaptation to the physical and biological environment: sex is almost universal in animals and its role in adaptation to evolutionary pressure from parasites and pathogens. Evidence supporting the various models explaining the maintenance of sex in spite of its cost will be considered and illustrated with case examples.

Mechanisms of speciation in animals: the role of breeding systems and their consequences for speciation will be illustrated with examples from a variety of groups.

Evolution of genes & genomes (Chapter 23): Dr Ari Lionikas, Dr Adam Price

Evolution and protein structure: mutations can be either neutral (having no effect on the organism's fitness) or they may alter fitness, either to increase or decrease it. Mutations that affect fitness usually do so by altering the structure or expression of a protein. Various examples of how this happens will be considered, and it will also be shown how the amino-acid sequence of a protein contains clues to its evolutionary history. The concepts of gene and protein families are introduced, as is the idea of homology between DNA and protein sequences (meaning that 2 sequences are similar because they have a common evolutionary origin). Plant genetics lectures will highlight the major differences between plant and animal genetics defences. A co-evolution between plants and their diseases will be discussed providing an excellent example of convergent evolution.

History of life on Earth (Chapter 24): Mrs Cath Dennis

We're currently in a mass-extinction that has a biological basis (us!). Have these types of extinction happened before and if so, what were their causes and effects?

BIOETHICS

Mrs Cath Dennis

Note: this session has no direct link to a textbook chapter. References will be provided in class for further reading.

Where 'science' considers causes, effects and influences, 'ethics' considers questions of right and wrong, should or should not. It is important for every bioscientist to have a grasp of ethical thinking. This session will introduce the concept of bioethics and provide space for a discussion around a relevant bioethical topic.

Practical/Lab/Tutorial Work

See accompanying manuals on MyAberdeen.

University Policies

Students are asked to make themselves familiar with the information on key institutional policies which been made available within MyAberdeen (**https://abdn.blackboard.com/bbcswebdav/institution/Policies**). These policies are relevant to all students and will be useful to you throughout your studies. They contain important information and address issues such as what to do if you are absent, how to raise an appeal or a complaint and indicate how seriously the University takes your feedback.

These institutional policies should be read in conjunction with this programme and/or course handbook, in which School and College specific policies are detailed. Further information can be found on the **University[1]s Infohub webpage** or by visiting the Infohub.

The information included in the institutional area for 2019/20 includes the following:

- Absence
- Appeals & Complaints
- Student Discipline
- Class Certificates
- MyAberdeen
- Originality Checking
- Feedback
- Communication
- Graduate Attributes
- The Co-Curriculum

Medical Sciences Common Grading Scale

Grade	Grade Point	Category	Honours Class	Description
A1	22	Excellent	First	• Outstanding ability and critical thought • Evidence of extensive reading • Superior understanding • The best performance that can be expected from a student at this level
A2	21			
A3	20			
A4	19			
A5	18			
B1	17	Very Good	Upper Second	• Able to argue logically and organise answers well • Shows a thorough grasp of concepts • Good use of examples to illustrate points and justify arguments • Evidence of reading and wide appreciation of subject
B2	16			
B3	15			
C1	14	Good	Lower Second	• Repetition of lecture notes without evidence of further appreciation of subject • Lacking illustrative examples and originality • Basic level of understanding
C2	13			
C3	12			
D1	11	Pass	Third	• Limited ability to argue logically and organise answers • Failure to develop or illustrate points • The minimum level of performance required for a student to be awarded a pass
D2	10			
D3	9			
E1	8	Fail	Fail	• Weak presentation • Tendency to irrelevance • Some attempt at an answer but seriously lacking in content and/or ability to organise thoughts
E2	7			
E3	6			
F1	5	Clear Fail	Not used for Honours	• Contains major errors or misconceptions • Poor presentation
F2	4			
F3	3			
G1	2	Clear Fail/ Abysmal	-	• Token or no submission
G2	1			
G3	0			

Course Timetable BI2017: 2019-2020

Date	Time	Place	Subject	Session	Staff
Week 7					
Mon 9 Sep	14:00-15:00	ZG18	L1 Course introduction	Lecture	AL
	15:00-18:00	ZB13/14/11	Practical group 1: Phylogenies 1	Practical	CD
Tue 10 Sep	15:00-18:00	ZB13/14/11	Practical group 2: Phylogenies 1	Practical	CD
Wed 11 Sep					
Thu 12 Sep	12:00-13:00	MT1	L2 A brief history of genes and evolution	Lecture	CD
Fri 13 Sep	15:00-16:00	MT4	L3 Ancient mutations	Lecture	AL
Week 8					
Mon 16 Sep	14:00-15:00	ZG18	L4 Genes and Inheritance 1	Lecture	AL
Tue 17 Sep					
Wed 18 Sep					
Thu 19 Sep	12:00-13:00	MT1	L5 Genes and Inheritance 2	Lecture	AL
Fri 20 Sep	15:00-16:00	MT4	L6 Genes and Inheritance 3	Lecture	AL
Week 9					
Mon 23 Sep	14:00-15:00	ZG18	L7 Horizon: The Ghost in Your Genes	Lecture	CD
	15:00-18:00	ZB13/14/11	Practical group 1: Linkage 1	Practical	AL
Tue 24 Sep	15:00-18:00	ZB13/14/11	Practical group 2: Linkage 1	Practical	AL
Wed 25 Sep					
Thu 26 Sep	12:00-13:00	MT1	L8 Epigenetics 1	Lecture	PH
Fri 27 Sep	15:00-16:00	MT4	L9 Hox genes 1	Lecture	JP
Week 10					
Mon 30 Sep	14:00-15:00	ZG18	L10 Epigenetics 2	Lecture	PH
Tue 1 Oct					
Wed 2 Oct					
Thu 3 Oct	12:00-13:00	MT1	L11 Hox genes 2	Lecture	JP
Fri 4 Oct	15:00-16:00	MT4	L12 Hox genes 3	Lecture	JP
Week 11					
Mon 7 Oct	14:00-15:00	ZG18	L13 Population genetics 1	Lecture	CD
	15:00-18:00	S81/F86	Practical group 1: Linkage 2	Practical	AL
Tue 8 Oct	15:00-18:00	S81/F95	Practical group 2: Linkage 2	Practical	AL
Wed 9 Oct					
Thu 10 Oct	12:00-13:00	MT1	L14 Population genetics 2	Lecture	CD
Fri 11 Oct	15:00-16:00	MT4	L15 Population genetics 3	Lecture	CD
Week 12					
Online Test 1 released, to be submitted by the end of Friday					
Mon 14 Oct	14:00-15:00	ZG18	L16 Kin selection Evidence for evolution	Lecture	CJ
Tue 15 Oct					
Wed 16 Oct					
Thu 17 Oct	12:00-13:00	MT1	L17 Molecular clock	Lecture	FK
Fri 18 Oct	15:00-16:00	MT4	L18 Evolution and protein structure	Lecture	AL
Week 13					
Mon 21 Oct	14:00-15:00	ZG18	L19 Phylogenies	Lecture	FK
	15:00-18:00	F86/F95/S81/S84	Practical group 1: Phylogenies 2	Practical	CD
Tue 22 Oct	15:00-18:00	MR117/MR106	Practical group 2: Phylogenies 2	Practical	CD
Wed 23 Oct					

Thu 24 Oct	12:00-13:00	MT1	L20 Plant genomes	Lecture	AP
Fri 25 Oct	15:00-16:00	MT4	L21 Animal genomes	Lecture	CD
Week 14					
Mon 28 Oct	14:00-15:00	ZG18	L22 Bacterial diversity	Lecture	PL
Tue 29 Oct					
Wed 30 Oct					
Thu 31 Oct	12:00-13:00	MT1	L23 Mutation 1	Lecture	PL
Fri 1 Nov	15:00-16:00	MT4	L24 Mutations 2	Lecture	PL
Week 15					
Mon 4 Nov	14:00-15:00	ZG18	L25 Bioethics	Lecture	CD
	15:00-18:00	ZB13/14/11	Practical group 1: Mutations 1	Practical	BL
Tue 5 Nov	15:00-18:00	ZB13/14/11	Practical group 2: Mutations 1	Practical	BL
Wed 6 Nov					
Thu 7 Nov	12:00-13:00	MT1	L26 Plants and the evolutionary arms race	Lecture	AP
Fri 8 Nov	15:00-16:00	MT4	L27 Plant case study	Lecture	AP
Week 16					
Online Test 2 released, to be submitted by the end of Friday					
Mon 11 Nov	14:00-15:00	ZG18	L28 Reproduction and Speciation 1	Lecture	CD
Tue 12 Nov					
Wed 13 Nov					
Thu 14 Nov	12:00-13:00	MT1	Spare slot	Lecture	
Fri 15 Nov	15:00-16:00	MT4	L29 Reproduction and Speciation 2	Lecture	CD
Week 17					
Mon 18 Nov	14:00-15:00	ZG18	L30 Species concepts in bacteria	Lecture	PL
	15:00-18:00	ZB13/14/11	Practical: Mutations 2	Practical	BL
Tue 19 Nov	15:00-18:00	ZB13/14/11	Practical: Mutations 2	Practical	BL
Wed 20 Nov					
Thu 21 Nov	12:00-13:00	MT4	L31 Evidence for evolution	Lecture	CD
Fri 22 Nov	15:00-16:00	MT4	L33 Macroevolution	Lecture	CD

Staff
AP: Adam Price
CJ: Catherine Jones
JP: Jonathan Pettitt
PL: Petra Louis
AL: Arimantas Lionikas (Course Co-ordinator)
CD: Cath Dennis (Course Co-ordinator)
PH: Paul Haggarty
BL: Bruno Lopes

Venues
Lectures are on Mondays at 2 pm in Zoology Lecture Theatre (ZG18), Thursdays at noon in Meston 1 (MT1) Lecture Theatre, and Fridays at 3 pm in Meston 4 (MT4) Lecture Theatre.

Practical lab sessions are in the Zoology Labs (weeks 7, 9, 15, and 17) or computer classes (weeks 11 and 13). For each practical the class is divided into 2 halves, with one half doing the practical on Monday afternoons at 3-6 and the other half on Tuesday afternoon at 3-6. Note that for computer based practical sessions Monday and Tuesday groups will be further divided into two 1.5-hour slots.