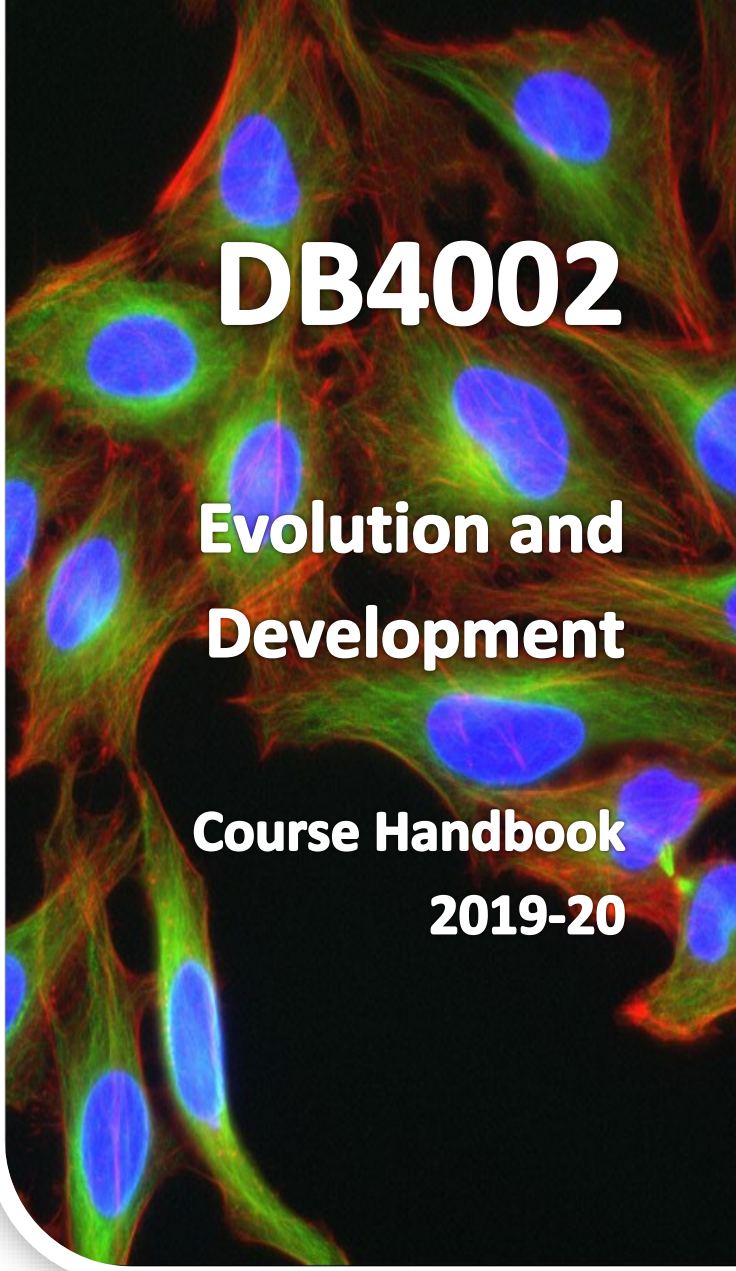
School Of Medicine, Medical Sciences & Nutrition



DB4002

Evolution and Development

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

"Nothing in biology makes sense, except in the light of evolution". Theodosius Dobzhansky.

All living organisms are the products of the selective pressures that shaped the form and function of their ancestors. Evolutionary biology traces the changes that have occurred to give rise to the diversity of modern organisms. Developmental biology provides information about how tissues, organs and ultimately organisms arise from the single, fertilised egg. We can now understand how changes at the genetic level can lead to changes in cell fate and morphogenesis that allow existing structures to change and adopt new configurations. This course will show how combining the two approaches of evolutionary and developmental biology allows an understanding of the mechanisms by which organisms evolve, which cannot be achieved by either discipline alone.

Course Coordinator: Dr Neil Vargesson (Ext: 7374) **n.vargesson@abdn.ac.uk**

Course Aims & Learning Outcomes

1. Know the major groups of animals and their interrelationships.

2. Understand how the interrelationships between extant animal phyla are determined.

3. Know the major developmental events associated with the evolution of different body plans.

4. Have an appreciation of the likely mechanisms by which specific organs and structures have evolved.

Course Teaching Staff

Course Co-ordinator(s):

Dr Neil Vargesson (NV), (Course Co-ordinator)

Other Staff:

Prof Stefan Hoppler (SH),

Dr Alasdair MacKenzie (AMK)

Dr Jonathan Pettitt (JP),

Prof Martin Collinson (JMC)

Assessments & Examinations

Students are expected to attend all lectures, laboratory classes, and tutorials, and to complete all class exercises by stated deadlines. The minimum performance acceptable is attendance at 75% of the lectures, seminars, practical classes, and presentation of all set course work, written and oral.

Assessment is derived from course work (30%) and a written examination (70%). The continuous assessment (CA) component is a problem-based assignment.

Written Examination: 70% of the total assessment is based on one 1.5 hour written paper. The student has to answer two questions of equal weighting selected from a list of four.

Common grading scale (CGS) grade: The overall performance of the student is expressed as a grade awarded on the common spine marking scale.

The degree examination is held in December, with the re-sit examination in July.

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?

It will involve speaking to your fellow students about the course you represent. This can include any comments that they may have. You will attend a Staff-Student Liaison Committee and you should represent the views and concerns of the students within this 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 the course coordinator 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 (Professor Gordon McEwan)
- Medical Sciences Disabilities Co-ordinator (Dr Derryck Shewan)

All staff are based at Foresterhill and we strongly encourage the use of email or telephone the Medical Sciences Office. You may have a wasted journey travelling to Foresterhill only to find staff unavailable.

If a course has been completed and students are no longer on campus (i.e. work from second semester during the summer vacation), coursework will be kept until the end of Fresher's Week, during the new academic year. After that point, unclaimed student work will be securely destroyed.

Course Reading List

Essential Developmental Biology by JMW Slack (Blackwells, 2nd Edition, 2006) will be the main textbook used for the course.

Additionally, Principles of Development by Lewis Wolpert *et al*. (Oxford University Press, 3rd Edition, 2007) and Developmental Biology by Scott F. Gilbert (Sinaur Associates Inc. 8th Edition, 2006) will be useful textbooks' for some aspects of the course.

Lecture Synopsis

Lecture 1: The concept of homology and the hierarchy of biological systems – Dr Jonathan Pettitt (JP)

How do we know when biological systems in different organisms share a common ancestor? And why should we care? This lecture will introduce, and revisit important concepts involved in evolutionary biology as it relates to developmental processes. The lecture will also cover the implications of gene, cell, tissue and organ-level views of biological systems, and the problems that can arise when they are inappropriately used.

Lecture 2: How We Know What We Think We Know About Animal Evolution – Dr Jonathan Pettitt (JP)

The relationship between humans and each member of the animal kingdom has been the subject of intense research since Darwin and his contemporaries formulated the concept that all life arises from a series of common ancestors. The lecture will discuss our current understanding of the evolutionary relationship between different animal groups (phyla) and why this is important for our understanding of human biology.

Lecture 3: Meet the ancestors 1: The evolution of multicellularity – Dr Jonathan Pettitt (JP)

The lecture will consider current evidence and hypotheses as to how the first animals evolved. Using recent evidence from a variety of genome projects it will illustrate how the diverse range of animal developmental strategies is based upon a common molecular toolkit that likely predated the evolution of the first animals.

Lecture 4: Geoffroy's Lobster, Urbilateria and the evolution of bilaterality – Professor Stefan Hoppler (SH)

The recent molecular insight into the mechanisms of embryonic development has revealed the originally proposed body plans for different groups of animals in Zoology lectures reflected in reality in the conserved phylotypic stage; but this molecular insight has quite unexpectedly also revealed a much deeper and remarkable conservation which we share with all animals in fundamental organisation, which is called the zootype. This lecture will explore the molecular hallmarks of the zootype, from the Hox cluster and possibly related clusters (which patterns the anteroposterior axis in different germ layers) to the conservation of dorso-ventral patterning (but with a twist as originally proposed in Geoffroy's Lobster). We will go in search for our Urbilaterian ancestor and discover that the fundamental molecular zootype organisation is conserved even in animals in which asymmetry is not morphologically evident.

Lecture 5: Meet the ancestors 2: Chordates and the evolution of vertebrates – Professor Stefan Hoppler (SH)

A number of developmental model systems are used because of their position at the base of the vertebrate evolutionary tree. These have been used to shed light on the developmental innovations critical to vertebrate development, such as the notochord, and the formation of somites.

Lecture 6: Genomic dark matter and its role in shaping the embryo – Dr Alasdair MacKenzie (AMK)

In addition to the requirement for normally functioning proteins it is critical that these proteins be expressed at the right times in the right places and at the correct amounts. Understanding the systems that ensure normal gene expression lags many years behind our understanding of protein function. However, thanks to the sequencing of multiple vertebrate genomes and the new science of "Comparative Genomics" the regulatory sequences that

control gene expression during development are now being identified. This lecture will describe that instead of consisting of "Junk" DNA the non-coding vertebrate genome, often described as "genomic dark matter", contains a wealth of regulatory information that is required to shape the embryo and possibly provide the plasticity required to drive evolution.

Lecture 7: The evolution of eyes 1 – Professor Martin Collinson (JMC)

Ernst Mayr in 1961 stated that 'It requires little persuasion to be convinced that the lens eye of a vertebrate and the compound eye of an insect are independent evolutionary events.' But both invertebrates and vertebrates use rhodopsin as a primary photosensory pigment, and in the last 15 years it has become apparent that at the genetic and cell biology level that there are many similarities between the development of eyes across diverse animal taxa. This lecture will explore the concept of deep homology as it applies to genes involved in eye development, and assess the evidence that the eyes of invertebrates and vertebrates are in fact homologous structures derived from a common ancestor that had an eye.

Lecture 8: The evolution of eyes 2 – Professor Martin Collinson (JMC)

Among vertebrates there is an extraordinary range of extant eye morphologies, demonstrating eye developmental pathways are under strong evolutionary selection. This lecture will track some of the developmental specialisations that have been shown to underlie vertebrate eye evolution. The genetics of eye development and degeneration in Mexican cavefish will be used as an example of an animal that has traded in its eyes in exchange for better taste and smell. We will look at the specialisations of eyes in mammals that live underground – mole-rats and true moles – examine the genetic mutations that underlie their eye phenotypes and ask whether they are just 'mammalian cavefish'.

Lecture 9: The Evolution of Limb development – Dr Neil Vargesson (NV)

Limbs are complicated appendages; yet show an incredible range of diversity between species in the Animal Kingdom. This lecture will describe how the human limb has evolved into the structures we know and love, using examples from the animal kingdom and in an historical context.

Lecture 10: If You Want to Get Ahead, Get a Head: the evolution of the vertebrate head – Professor Stefan Hoppler (SH)

Vertebrate evolution is characterised by formation of ever more sophisticated heads, to develop ever more sophisticated sense organs and jaws to find, catch and process our food. The prime example in evolution of modifying existing structures for new functions is the evolution from cranial neural crest-derived support structures for gill arches in jawless vertebrates first into integral components of jaws and then further into bones in the mammalian middle ear, which allow us to sense sound waves in the air in our terrestrial habitat.

Lecture 11: The Human Evolution and Development– Professor Martin Collinson (JMC)

There are a number of features that distinguish us from our closest-living relatives, the great apes. Recent work has shown that it is possible to identify genes that may have been responsible for the increases in brain size and language acquisition.

Practical/Lab/Tutorial Work

Phylogeny Tutorial, Report and Presentation

As part of the course there will be a tutorial on how to interpret phylogenetic trees. The tutorial will provide you with the skills needed to complete a problem solving exercise which will contribute 30% of your final mark. Guidance on this exercise will be provided online and during the tutorial session.

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'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 DB4002: 2019-2020

Date	Time	Place	Subject	Session	Staff
Week 7					
Mon 9 Sep					
Tue 10 Sep					
Wed 11 Sep	09:00-10:00	1:039/040	Lecture 1: The concept of homology and the hierarchy of biological systems	Lecture	JP
	11:00-12:00	1:039/040	Lecture 2: How We Know What We Think We Know About Animal Evolution	Lecture	JP
Thu 12 Sep					
Fri 13 Sep					
Week 8					
Mon 16 Sep	09:00-10:00	1M:001	Phylogeny Tutorial	Lecture	JP
Tue 17 Sep	09:00-10:00				
Wed 18 Sep	11:00-12:00	1M:003	Lecture 4: Meet the ancestors 1: the evolution of multicellularity	Lecture	JP
Thu 19 Sep	14:00-16:00	1:032/033	Lecture 5: Geoffroy's Lobster, Urbilateria and the evolution of bilaterality	Tutorial	SH
Fri 20 Sep					
Week 9					
Mon 23 Sep					
Tue 24 Sep	09:00-10:00	1M:001	Lecture 5: Meet the ancestors 2: Chordates and the evolution of vertebrates	Lecture	SH
Wed 25 Sep	11:00-12:00	1M:003	Lecture 6: Genomic dark matter and its role in shaping the embryo	Lecture	AMK
Thu 26 Sep					
Fri 27 Sep					
Week 10					
Mon 30 Sep	09:00-10:00	1M:001	Lecture 7: The evolution of eyes 1	Lecture	JMC
Tue 1 Oct					
Wed 2 Oct	11:00-12:00	1M:003	Lecture 8: The evolution of eyes 2	Lecture	JMC
Thu 3 Oct					
Fri 4 Oct					
Week 11					
Mon 7 Oct	09:00-10:00	1M:001	Lecture 9: The evolution of limb development	Lecture	NV
Tue 8 Oct					
Wed 9 Oct	11:00-12:00	1M:003	Lecture 10: If you want to get ahead get a head: the evolution of the vertebrate head	Lecture	SH
Thu 10 Oct					
Fri 11 Oct	09:00-11:00	1:039/040	Lecture 11: Human Evolution and Development	Lecture	JMC

Staff

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Prof Stefan Hoppler (SH)
Dr Alasdair Mackenzie (AMK)
Prof Martin Collinson (JMC)
Dr Neil Vargesson (NV) (Course Co-ordinator)