



UNIVERSITY OF
CAMBRIDGE

Institute of Continuing Education

Undergraduate Diploma in Evolutionary Biology

2016-2017

Course code: 1617DCR305

COURSE SPECIFICATION

Welcome to the **Undergraduate Diploma in Evolutionary Biology**, a University of Cambridge award offered by the Institute of Continuing Education (ICE). The Diploma is taught and awarded at FHEQ level 5 (ie. second-year undergraduate level) and attracts 60 credits. The award is completed in one academic year and each unit (term) is equally weighted. For further information about academic credit please see our website <http://www.ice.cam.ac.uk/studying-with-us/information-for-students/faqs/3-credit-faqs>

The **Undergraduate Diploma in Evolutionary Biology** aims to introduce students to evolution at the grandest scale; major evolutionary transitions that gave rise to whole new lineages of organisms and events that have led to the extinction of other groups. It will investigate the driving forces behind key evolutionary changes and consequences at the molecular and the whole organism level. The course will begin by focussing on early events in evolution, the origin of life itself and the advent of multicellularity. It will go on to investigate the challenges and opportunities that multicelled life forms had to face and how these were met in different ways by the major kingdoms. The last part of the course will focus on three of the most important and diverse groups of organisms: the arthropods, the flowering plants and the vertebrates. It will explain what these groups can tell us about evolution and will explore key innovations that have allowed them to become so successful.

The course is supported by practical classes that allow students to appreciate the diversity of life first hand, gain experience in reconstructing evolutionary relationships, understand how fossil evidence can be interpreted to determine past evolutionary events, and explain how genetic regulation can give rise to complex organisms.

The **Undergraduate Diploma in Evolutionary Biology** is designed as a natural progression from the Undergraduate Certificates in Genetics and Evolutionary Biology, allowing students who have successfully completed one or both of these courses to develop their understanding of evolutionary and developmental biology still further.

The course offers three termly units and a syllabus and reading and resource list for each of these units is included in this specification.

The course aims to:

- Introduce students to major events in early evolution and the high-level diversity of life
- Demonstrate how evolutionary trees are constructed and their role in studying evolutionary change
- Introduce the key body forms of the major groups of multicellular life through consideration of the physical and historical constraints of their evolution
- Demonstrate how mass extinction events may have influenced the evolution of life on earth
- Demonstrate how the development of an organism is controlled genetically and how this can alter through evolutionary time
- Explain how extrinsic and intrinsic (including historical) factors can shape the evolutionary trajectories of major groups
- Explain and discuss the concepts of evolutionary success and long-term predictability of evolution

Teaching staff

Course Director/Tutor:

Dr Florin Mircea Iliescu studies variation in human populations and is deeply fascinated by the amazing human diversity. As a biologist interested in the history and variation of human populations, he works in the interdisciplinary space defined by the boundaries between genetics, evolution and anthropology. During his PhD at Cambridge University, which included six months of

fieldwork in Southern India, he studied the genetics of human pigmentation diversity among the Indian populations. He is now aiming to build on the results of his PhD research to further the understanding on the various evolutionary forces and their complex interplay that drive human phenotypic variation in India, and across the world.

Tutors:

Dr Peter Forster's research concerns the molecular population genetics of humans. Born in 1967, he studied chemistry at the universities of Kiel and Hamburg, specialised in genetics at the Heinrich-Pette-Institute of Virology and Immunology in Hamburg and received his PhD in Biology in 1997. After postdoctoral research at the Institute of Legal Medicine in Muenster until 1999, he was appointed Research Fellow at the McDonald Institute for Archaeological Research in Cambridge until 2006. In the same period, he became a Founding Member of the interdisciplinary Junge Akademie in Berlin. From 2006-2009 he was a university senior lecturer in forensics and life sciences. Peter Forster is currently Director of Research at the Institute for Forensic Genetics in Muenster (Germany), Vice-President of CSAR (based at Churchill College, Cambridge), and an editor of the International Journal of Legal Medicine (Springer, Heidelberg).

Dr Maya Ghoussaini completed a MSc degree in Gene Expression and Infectious diseases and PhD degree in Medical Genetics and Epidemiology at the Université de Lille II / Faculté de Médecine Henri Warembourg, France. During this period, she worked in the Pasteur Institute with Professor Philippe Froguel on the genetic susceptibility for childhood obesity and type 2 diabetes using multidisciplinary approaches that included molecular genetics and epidemiology, bio-statistics, and molecular and cellular biology. In 2007, she was appointed as a Research Associate at the Department of Oncology at the University of Cambridge, working with Professor Sir Bruce Ponder, Professor Douglas Easton and Dr. Alison Dunning. Since 2011 she has held a Postdoctoral Researcher position at St Johns College, Cambridge. Her current research focuses on the genetic susceptibility of common cancers through identification of regions of the human genome involved in breast cancer development and the disease causative variants within these regions (genetic mapping), and identifies how these genetic variants affect cancer susceptibility. She has also a particular interest in the Genetic Engineering field. Dr. Ghoussaini has a strong teaching interests and lectures on genetics as part of the MPhil course in Epidemiology and Public Health and has supervised undergraduate Part 1A students in the Natural Sciences Tripos (Mendelian Genetics, bacterial genetics, Physiology of Organisms).

Dr Tom Monie is a protein biochemist with a long-standing interest in infection and immunity. He studied for a PhD in Molecular Virology at the University of Cambridge, Department of Medicine. During this time he was investigating how viruses in the same family as HIV package all their genetic material into the new virus particle and was awarded the International Young Investigator Award. He then moved to Imperial College London to explore the field of structural biology and work on the role of host proteins in viral protein production. He returned to Cambridge to study how the innate immune response works with a particular focus on the recognition of danger and the relevance to disease of pattern recognition receptors in the cell cytoplasm. As part of this work he ran his own group whilst holding a prestigious Wellcome Trust Research Development Fellowship. His recent publications have covered topics including cat allergy - which was a global media story, Crohn's Disease, inherited autoinflammatory genetic diseases, species variations in immunity and inflammation. His first book on the innate immune system is due to be published in the New Year. Tom also has extensive experience in teaching in the University. This includes undergraduate supervisions, practical classes and lectures – he currently delivers the first year “Genes in Action” course for Biology of Cells. He also teaches Masters students and has a wide range of involvement with the provision of subject-specific and transferable skills training for graduate students. He is a Fellow and Tutor at Christ's College.

Dr Ellen Nisbet is a researcher based at the Department of Biochemistry in Cambridge where she studies the evolution of the malaria parasite, *Plasmodium falciparum*. The malaria parasite is a single celled eukaryotic pathogen, which contains a mitochondrion, as well as a remnant chloroplast, called an apicoplast. Although this is no longer able to carry out photosynthesis, it is still essential for the parasite's survival. Understanding the function of these organelles has important implications in the development of new anti-malarial drugs.

Dr Javier Ortega-Hernandez is a researcher based at the Department of Zoology in Cambridge. His main research interests include the palaeobiology and evolution of invertebrates, particularly arthropods, during the Cambrian Explosion some 530 million years ago. During his PhD he investigated aspects of the fundamental body organization of some of the oldest arthropod groups in the fossil record, such as trilobites. He is also interested in the phylogeny and diversity of various lower Palaeozoic arthropod groups.

Dr Douglas Palmer is a science writer and freelance journalist, based in Cambridge who specializes in the history of life, especially human evolution and Earth's environments. Over 20 of his books have been published over the last 14 years with *Fossil Detectives* and *Neanderthal* accompanying TV series. His latest published works are *Earth in 100 ground-breaking discoveries*, *Origins: human evolution revealed* and *Evolution: the story of life*. He is also a supervisor on the Natural Science Tripos for the University's Robinson College. Before this he was a senior lecturer and researcher in palaeontology at Trinity College, University of Dublin.

Dr Peter Sheldon is an Honorary Associate in the Department of Environment, Earth and Ecosystems at the Open University, where he was a Senior Lecturer in Earth Sciences until 2015. He has given 75 residential courses in geology, palaeontology and evolution for the University of Cambridge Institute of Continuing Education since 1979. From 2008 to 2011 he was External Examiner for Scientific Studies at Oxford University's Department for Continuing Education, where he has given over 40 day-schools since 1993. His teaching style combines fieldwork, hands-on study of real specimens of rocks, minerals and fossils, and interactive lectures. He chaired the Open University course on *Geology* and has contributed to many other OU courses, including *Fossils and the History of Life*, *Evolution*, *Earth's Physical Resources*, *Discovering Science*, *The Geological History of the British Isles* and *Earth Science*.

Dr Ed Turner is a conservation biologist who investigates management strategies that can be employed to conserve species diversity and healthy ecosystem functioning both in the UK and abroad. He carried out his PhD in Sabah, Malaysia, studying the impacts of rainforest loss and conversion to oil palm plantation on insect biodiversity. Since then he has worked with the Bedfordshire, Cambridgeshire and Northamptonshire Wildlife Trust, investigating butterfly diversity on chalk grassland reserves and with Imperial College, London running the Stability of Altered Forest Ecosystems Project in Sabah – one of the largest ecological experiments in the world. He is a Fellow at Clare College and Curator of Insects at the University Museum of Zoology, Cambridge.

Dr Matthew Wilkinson was a junior research fellow at Clare College and the Department of Zoology, Cambridge, specialising in pterodactyl flight. He then went to drama school, and now works as a freelance supervisor, lecturer and science writer between acting jobs. In 2005 he was runner up in the UK Famelab competition, and has since spoken at several science festivals and events, including the British Council's Darwin Now festival in China, the Royal Institution, and the 2016 Hay Festival. In 2009 he wrote and directed his first play, *This View of Life*, about the meaning of evolution. His first book *Restless Creatures: The Story of Life in Ten Movements* has just been published.

Guest Lecturers

Professor Jenny Clack FRS is Emeritus Professor of Vertebrate Palaeontology at the Department of Zoology in Cambridge. Her research investigates the origin, phylogeny and radiation of early tetrapods and their relatives, and the evolution of terrestriality.

Professor Howard Griffiths holds the Chair of Plant Ecology at the Department of Plant Sciences in Cambridge. His research interests include the molecular, physiological and environmental processes which regulate productivity and carbon-dioxide sequestration in plants.

Professor Chris Howe is Professor of Plant and Microbial Biochemistry at the Department of Biochemistry in Cambridge. The overall theme of his research is the biochemistry and molecular evolution of photosynthetic organisms.

Administrative staff

Academic Programme Manager: Dr Liz Morfoot, Institute of Continuing Education, University of Cambridge, Madingley Hall, Madingley, Cambridge CB23 8AQ, 01223 746226,
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Course fees

The fee for the course is £1,900 for the year and covers tuition, and tea, coffee and lunch at each of the day-schools. You can pay in one of two ways:

- in full on enrolment (by cheque payable to the University of Cambridge or by credit or debit card)
- in three instalments (credit/debit card only): the first on enrolment, the second on 1 November 2016 and the third on 1 February 2017.

Venue

Madingley Hall is an historic Tudor mansion on the outskirts of Cambridge with one of the finest gardens in the region.

The Hall is situated in the village of Madingley, three miles west of Cambridge with easy access from the M11 and the A14. Full directions are given on our website at
www.ice.cam.ac.uk/directions

The day-schools are held at Madingley Hall, which has a variety of teaching rooms ranging from the newly refurbished Courtyard Suite to rooms in the historic Hall. These sessions may be scheduled in different teaching rooms.

Parking

There is ample car parking reached via the roadway branching to the left at the top of the drive.

Contact details of ICE

Institute of Continuing Education
University of Cambridge
Madingley Hall
Madingley
Cambridge
CB23 8AQ
T: 01223 746222

www.ice.cam.ac.uk
ug-awards@ice.cam.ac.uk

Please also refer to the 'information for students' section on ICE's website <http://www.ice.cam.ac.uk/studying-with-us/information-for-students> and the forthcoming 2016/17 Student Handbook for award-bearing courses for further information and guidance relating to all aspects of the course including study skills, assignments, assessment and moderation. The Course Information and Help and Guidance section of the ICE VLE will also contain valuable information specific to your course.

Information correct as at 06/10/2016

Life, the first four billion years

Start date	8 October 2016	End date	10 December 2016
Day	Saturday	Time	10.00am – 5.00pm
Venue(s)	Madingley Hall, Madingley, Cambridge, CB23 8AQ		
Tutors	Maya Ghoussaini Florin Mircea Iliescu Ellen Nisbet Ed Turner Matthew Wilkinson	No of meetings	Five Saturday day-schools on 8 October, 22 October, 12 November, 3 December, 10 December 2016
Guest	Howard Griffiths		
Lecturers	Chris Howe Jason Head		

Aims

This unit will introduce the process of evolution on the grandest scale – the big transitions that gave rise to wholly new ways of life. We will cover the early events in the evolution of life, from its origin to the invention of multicellularity, to give students an understanding of how the cumulative process of natural selection opened doors to the existence of ever-more-elaborate kinds of organism. Practical work will introduce the key conceptual tools that enable us to reconstruct life's evolutionary tree and ancient history.

Content

This first unit will explore the early evolutionary transitions that gave rise to the first life-forms, the extraordinary cooperation that produced complex eukaryotic cells, and the events that led to the origin of multicellularity.

We will begin with the origin of life. Against all the odds, scientists are coming closer to understanding how and why this most important transition happened, using information about the conditions on the early Earth, the chemical behaviour of life's molecular building blocks and the nature of today's simplest life-forms to narrow down the range of possible scenarios. We will then investigate the diversity of the two great domains of prokaryotic life – the Archaea and Bacteria – to see how far evolution can go with such simple organisms. Special emphasis will be placed on the

diversification of metabolism, particularly the evolution of photosynthesis, the consequences of which changed the chemistry of the entire planet.

The terraforming carried out by the early prokaryotes – in particular the oxygenation of the oceans and atmosphere – made more complex cells possible. The origin of such eukaryotic cells was brought about by a partnership between representatives of the archaeal and bacterial domains, a partnership that, in conjunction with the invention of sexual reproduction, caused another explosion of diversity.

The unit will conclude with the origin of multicellularity, and will investigate how the genetic programs of single-celled organisms were tweaked to allow the diversification of cell-types – the hallmark of the many-celled – despite the fact that almost every cell in the body contains exactly the same genes.

Presentation of the unit

- The 5 day-schools will consist of a mixture of lectures illustrated by Powerpoint and practical sessions, which will give students experience of laboratory work.
- Discussion in class will facilitate an appreciation of the concepts under consideration.
- Students will be encouraged to access online journals and primary sources, where appropriate, to research their written assignments.

Provisional weekly lecture list

All sessions take place at Madingley Hall, Madingley, Cambridge unless otherwise stated.

MG = Maya Ghoussaini HG = Howard Griffiths CH = Chris Howe

FMI = Florin Mircea Iliescu EN = Ellen Nisbet ET = Ed Turner

MW = Matt Wilkinson JH = Jason Head

Day-school 1 10.00am – 5.00pm	8/10/16	This session will provide an introduction to the course and a brief overview of the diversity of life including its similarities and differences (FMI). We will discuss which factors unite life on earth, including the use of DNA as the universal hereditary material (MG). The day will also include study-skills sessions on essay writing, referencing and accessing scientific papers (MG).
Day-school 2 10.00am – 5.00pm	22/10/16	This session will explore early events in evolution, in particular, the origin of life itself and the transition from geochemistry to biochemistry (EN). A guest lecture will explore the origin of more complex cells and the eukaryotes (CH). Assignment 1.
Day-school 3 10.00am – 5.00pm	12/11/16	This session will explore some of the consequences of increasingly complex ways of life and cell-machinery, including the evolution of locomotion (MW) and photosynthesis (HG)
Day-school 4 10.00am – 5.00pm	03/12/16	This session will investigate the key evolutionary steps that allowed organisms to evolve from single to multiple-celled. This will include discussion of developmental patterning and communication between different cells in multicelled organisms (MW).

Day-school 5 10.00am – 5.00pm	10/12/16	This session will introduce methods that can be used to reconstruct the deep trees of life including a practical session on phylogenetic reconstruction (JH) . The day will also include a study skills session on writing up scientific practical classes (ET). Assignment 2.
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Outcomes

As a result of the unit, within the constraints of the time available, students should be able to:

- Demonstrate a knowledge and understanding of the major events in the early evolution of life on Earth;
- Reconstruct a simple phylogenetic tree given appropriate data and demonstrate an understanding of how such trees can be used to infer large-scale evolutionary change;
- Show a heightened ability to discuss scientific ideas, to write in a scientific way and to access and cite scientific publications

Student assignments

The course requires a commitment to reading and pre-class preparation, including some specific reading between class sessions.

There are a large number of references to various aspects of evolution and students are recommended to select those of particular personal interest from the reading list. Background reading will greatly increase appreciation of the course.

There are two practical assignments associated with the unit, weighted 50/50:

1. An essay discussing the origin of life and early events in evolution (1500-2000 words).
2. A practical write-up explaining the methodology used to reconstruct evolutionary trees (1500-2000 words).

Assignments word total (or equivalent): 3,000 - 4,000 words (or equivalent).

Closing date for the submission of assignments: **Monday 9 January 2017 by 12 (noon) UTC/GMT***

*Co-ordinated Universal Time / Greenwich Mean Time

Students are expected to submit their assignments online and feedback on assignments is delivered online.

Reading and resource list

Author	Title	Publisher and date
Barton, Nicholas et al.	Evolution	Cold Spring Harbor Laboratory Press 2007
Coyne, Jerry	Why Evolution is True	Oxford University Press 2009
Darwin, Charles	The Origin of Species Also available free through <i>Darwin Online</i> : www.darwin-online.org.uk/	Oxford World Classics Series 1859

Dawkins, Richard	The Selfish Gene 2 nd Edition	Oxford University Press 1989
Knoll, Andrew H	Life on a young planet	Princeton University Press 2003
Ridley, Mark	Evolution 3 rd Edition	Blackwell 2003
Tudge, Colin	The variety of life	Oxford University Press 2000
Wilkinson, Matthew	Restless Creatures: the story of life in ten movements	Basic Books 2016

Syllabus for second unit

Lent term 2017

Kingdom-building

Start date	21 January 2017	End date	18 March 2017
Day	Saturday	Time	10.00am – 5.00pm
Venue(s)	Madingley Hall, Madingley, Cambridge, CB23 8AQ The third session is held at the Sedgwick Museum and the Department of Zoology, Cambridge.		
Tutor(s)	Florin Mircea Iliescu Javier Ortega-Hernandez Douglas Palmer Peter Sheldon Ed Turner Matt Wilkinson	No of meetings	5 Saturday day-schools on 21 January, 11 February, 25 February (11 March 2017 and 18 March
Guest Lecturer	Jenny Clack		

Aims

This unit will show how the origin of multicellularity raised new physical and biological challenges, and will investigate how these challenges were met by the major kingdoms: plants, animals and fungi. The chief aim is to give students a deeper understanding of why these kingdoms are the way they are, in particular why their solutions to the problems of multicellular life are so different. Using real fossil specimens, we will also investigate how the fossil record records evolutionary change and the limitations of this process. The fieldtrip to the Sedgwick Museum will enable students to see some important fossil material, demonstrating key events in the diversification of multicellular life on earth.

Content

With the origin of multicellularity, life got big for the first time, and this unit will therefore begin with the many and various ways in which size affects an organism's biology. In so doing, it will introduce the simple physical tools that are vital to a full understanding of biological form and function – after all, organisms are physical objects like any other, and obey the same physical rules.

Becoming many-celled added a new dimension to evolution. Single-celled organisms are necessarily jacks-of-all-trades, but in their multicellular counterparts arose the ability to specify different fates for different cells by switching on and off subsets of the full genetic package. The evolution of such developmental programs is a major theme in the history of multicellular life, and this unit will explain how this can happen.

These introductory sessions will be followed by a more thorough exploration of the major kingdoms: what makes them distinct, the secrets of their success, and some major events in their evolutionary history, including the invasion of the land.

The unit will conclude with an investigation of the limitations of evolutionary possibility. As we will see, only a small subset of conceivable biological forms have been realised – why should this be so?

Presentation of the unit

- The 5 day-schools will consist of a mixture of lectures illustrated by Powerpoint and practical sessions.
- Discussion in class will facilitate an appreciation of the concepts under consideration.
- Students will be encouraged to access online journals and primary sources to write their assignments.

Provisional weekly lecture list

The first, second, fourth and fifth sessions take place at Madingley Hall, Madingley, Cambridge. The third session is held at the Sedgwick Museum and the Department of Zoology, Cambridge.

JC = Jenny Clack

FMI = Florin Mircea Iliescu

JO-H = Javier Ortega-Hernandez

DP = Douglas Palmer

PS = Peter Sheldon

ET = Ed Turner

MW = Matt Wilkinson

Day-school 1 10.00am – 5.00pm	21/01/17	The first session will provide an introduction to the second unit and written assignment feedback (FMI). We will go on to discuss the control of an animal's body plan and the origin of different tissues including nerves and muscles, using information from living organisms. This session will include a study skills session on popular science writing, associated with Assignment 1 (MW).
Day-school 2 10.00am – 5.00pm	11/02/17	This session will explore more about the control of the animal body plan, and the great diversification of animals seen in the Cambrian explosion as informed by exceptionally preserved fossils (JO-H).
Day-school 3 10.00am – 5.00pm	25/02/17	This session will investigate the invasion of land by animals with a visit to see some of the fossil material in the Sedgwick Museum (DP). A guest lecture will explore the evolution of terrestriality in our

Sedgwick Museum and the Department of Zoology		own group: the tetrapods (JC).
Day-school 4 10.00am – 5.00pm	11/03/17	This day-school will discuss fossil preservation processes, with hands-on study of fossil specimens. Other topics will be patterns of microevolution seen in the fossil record, natural biases that influence the evidence, and the relationship between evolution and environmental change (PS).
Day-school 5 10.00am – 5.00pm	18/03/17	This session will investigate the invasion of land by plants and fungi and the evolution of plant and fungal sex (Tutor TBC). We will finish with a discussion session, considering what factors affect the way an organism is capable of evolving and evolutionary constraint (FMI). Assignment 2

Outcomes

As a result of the unit, within the constraints of the time available, students should be able to:

- demonstrate a basic understanding of the processes and control of an organism's body plan and how these have changed through evolutionary time
- Demonstrate a knowledge of the constraints and evolutionary innovations that have allowed different taxa to colonise land
- Show a heightened ability to discuss scientific ideas, to write in a scientific way, and to access and cite scientific publications

Student assignments

The course requires a commitment to reading and pre-class preparation, including some specific reading between class sessions.

There are a large number of eminently readable introductions to various aspects of evolution and students are recommended to select those of particular personal interest from the reading list. Selected background reading will greatly increase appreciation of the course.

There are two practical assignments associated with the course, weighted 50/50:

1. A short popular science article discussing the origin of the nervous system (1,500 - 2000 words).
2. An essay discussing the colonisation of lands by plants (2,000-3000 words).

Assignments word total (or equivalent): 3500 - 5000 words (or equivalent).

*Closing date for the submission of assignments: Monday 10 April 2017 by 12 noon (BST)**

*British Summer Time

Students are expected to submit their assignments online and feedback on assignments is delivered online.

Reading and resource list

Author	Title	Publisher and date
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Barton, Nicholas et al.	Evolution	Cold Spring Harbor Laboratory Press 2007
Raven, Peter et al.	Biology of Plants 8th Edition	W.H. Freeman & Company 2012
Ridley, Mark	Evolution 3 rd Edition	Blackwell 2003
Tudge, Colin	The variety of life	Oxford University Press 2000
Wallace, Arthur	Evolution, a developmental approach	Wiley-Blackwell 2011

Syllabus for third unit
Easter term 2017

Success Stories

Start date	8 April 2017	End date	10 June 2017
Day	Saturday	Time	10.00am – 5.00pm
Venue(s)	Madingley Hall, Madingley, Cambridge, CB23 8AQ		
Tutors	Florin Mircea Iliescu Peter Forster Peter Sheldon Edgar Turner	No of meetings	5 Saturday day-schools on 8 April, 22 April, 6 May, 3 and 10 June 2017. Fieldtrip to the Oxford University Museum of Natural History on 29 April 2017.

Aims

The final unit will take a more in-depth look at the evolution of three particularly important and diverse groups of organisms – the arthropods, flowering plants and the vertebrates – to uncover the secrets of their evolutionary success. Students will learn about the concept of key innovations and will come to understand how and why the unique vertebrate solution to life's challenges gave rise to humanity. Practical work and the fieldtrip will complement the lectures by bringing students face-to-face with the organisms themselves.

Content

The unit will begin by discussing the tricky concepts of evolutionary success and key innovations and the role of chance in the evolution of life on earth. We will investigate the extraordinary diversity of the arthropods, especially the insects, which are more speciose than all other animal groups put together. We will attempt to find out what it is about the arthropod solution that lends itself to such morphological diversification, focusing particularly on the physical and physiological benefits of the jointed exoskeleton.

We will then move on to the flowering plants, another highly speciose group, to explore the causes of their explosive diversification. In so doing, we will not only look at processes intrinsic to the group itself, but will also examine how the evolutionary history of flowering plants is intertwined and dependent on that of animals, especially insects.

The rest of the unit concentrates on our own group, the vertebrates. Our use of hard tissues like bone means that we have an excellent fossil record, giving us a clear view of how evolution works in the long term. We will consider some of the major evolutionary transitions that have marked

vertebrate evolution, including the advent of humanity – one of the most interesting transitions of all.

Presentation of the unit

- The 5 day-schools will consist of a mixture of lectures illustrated by Powerpoint and practical sessions, which will give students experience of laboratory work.
- The fieldtrip to the Oxford University Museum of Natural History will allow students to appreciate some of the great diversity of life on Earth and to see and handle some of the amazing specimens housed in this collection.
- Discussion in class will facilitate an appreciation of the concepts under consideration.
- Students will be encouraged to access online journals and primary sources to research their assignments. Assignments will encourage students to carry out directed background research in subjects of their choice and to express opinions on contentious scientific matters. The voluntary presentations will give students an opportunity to develop their presentation skills in front of a friendly audience.

Provisional lecture list

All sessions take place at Madingley Hall, Madingley, Cambridge unless otherwise stated

PF = Peter Forster FMI = Florin Mircea Iliescu PS = Peter Sheldon ET = Ed Turner

Day-school 1 10.00am – 5.00pm	08/04/17	This day-school will start by discussing the fossil evidence for extinctions over the last 500 million years and the role of mass extinctions in the evolution of life Assignment 1 (PS). We will go on to discuss the role of chance in the history of life on earth and the role of Natural Selection versus Genetic Drift in evolution (FMI). There will be an opportunity to discuss choice of taxa for Assignment 2 .
Fieldtrip	29/04/17	Field trip to Oxford University Museum of Natural History. Tour around the museum to be led by Dr Darren Mann, Head of Life Collections (FMI).
Day-school 2 10.00am – 5.00pm	22/04/17	This session will explore the evolution of the enormous diversity of insects and key innovations that have underpinned this success. This includes a practical session in the Madingley Hall gardens to allow students to experience insect diversity first-hand (ET).
Day-school 3 10.00am – 5.00pm	06/05/17	This session will discuss the evolution of the extraordinary diversity of flowering plants (Tutor TBC).
Day-school 4 10.00am – 5.00pm	03/06/17	This session will examine the story of vertebrate evolution and the evolution of humans (FMI and PF).
Day-school 5 10.00am – 5.00pm	10/06/17	In the last session of the year, we will end with voluntary student presentations of research topics and a summing up of the course (FMI).

Outcomes

As a result of the unit, within the constraints of the time available, students should be able to:

- Critically assess the concepts of evolutionary success and long-term predictability of evolution
- Demonstrate a basic working knowledge of arthropod, flowering plant and vertebrate form and function and key factors that shaped the evolutionary trajectories of the arthropods, flowering plants and vertebrates.
- Demonstrate a good working knowledge of the evolution and characteristics of a specific taxa of the students' choice
- Demonstrate a basic understanding of the sequence of evolutionary transitions that led to the origin of humanity.
- Show a heightened ability to discuss scientific ideas, to write in a scientific way and to access and cite scientific publications

Student assignments

The course requires a commitment to reading and pre-class preparation, including some specific reading between class sessions.

There are a large number of eminently readable introductions to various aspects of evolution and students are recommended to select those of particular personal interest from the reading list. Selected background reading will greatly increase appreciation of the course.

There are two assignments associated with the unit, weighted 50/50:

1. Essay discussing the role of chance in the evolution of life on Earth (1,500-2000).
2. Report focussed on a taxa of the students choice (to be agreed in advance with the tutor), discussing their evolution and key traits (1,500 - 2000 words). Although not assessed, students are expected to present a 10 minute version of their report to the rest of the class as a powerpoint presentation on 03/06/17. Help will be available from the tutors in producing this.

Assignments word total (or equivalent): 3,000 - 4,000 words (or equivalent).

All students are expected to upload their assignments into the VLE and feedback on assignments is delivered online. Any assignments not suitable for uploading into the VLE will be clearly identified.

*Closing date for the submission of assignments: **Monday 3 July 2017 by 12 noon (BST)****

*British Summer Time

Students are expected to submit their assignments online and feedback on assignments is delivered online.

Reading and resource list

Author	Title	Publisher and date
Grimaldi, D & Engel, MS	Evolution of the Insects	Cambridge University Press 2004

Oppenheimer, S	Out of Eden, the peopling of the world	Constable 2003
Raven, Peter et al.	Biology of Plants 8th Edition	W.H. Freeman & Company 2012
Ridley, Matt	Genome: the Autobiography of a Species in 23 Chapters	Fourth Estate 2000
Wells, Spencer	The Journey of Man: A Genetic Odyssey	Penguin 2002

TIMETABLE

Michaelmas 2016

Life, the first four billion years

Day-school 1	8 October 2016
Day-school 2	22 October 2016
Day-school 3	12 November 2016
Day-school 4	3 December 2016
Day-school 5	10 December 2016

Lent 2017

Kingdom-building

Day-school 1	21 January 2017
Day-school 2	11 February 2017
Day-school 3 (<i>Sedgwick Museum & Zoology</i>)	25 February 2017
Day-school 5	11 March 2017
Day-school 5	18 March 2017

Easter 2017

Success stories

Day-school 1	8 April 2017
Day-school 2	22 April 2017
Fieldtrip to Oxford	29 April 2017
Day-school 3	6 May 2017
Day-school 4	3 June 2017
Day-school 5	10 June 2017

Whilst every effort is made to avoid changes to this programme, published details may be altered without notice at any time. The Institute reserves the right to withdraw or amend any part of this programme without prior notice.

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