UNIVERSITY OF CAMBRIDGE

Institute of Continuing Education

Undergraduate Diploma in Evolutionary Biology

2024-2025

Course code: 2425DCR200

COURSE GUIDE

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Contents

Welcome

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 (i.e. second-year undergraduate level) and attracts 60 credits. The award is completed in one academic year. For further information about academic credit please refer to the 'Academic credit and university-level study' section of the Student Handbook.

Important information for the 2022-2023 Academic Year

During the 2024-2025 Academic Year the **Undergraduate Diploma in Evolutionary Biology** is taught using remote methods. There will be no face-to-face teaching on the course. Teaching is via asynchronous, self-paced approaches facilitated by the course Virtual Learning Environment (VLE) along with scheduled synchronous delivery using remote learning platforms such as Zoom. You are encouraged to attend synchronous sessions to maximise your learning. However, as this may not always be possible we will record these sessions and place them in the Virtual Learning Environment.

Examples of asynchronous teaching approaches on the course include, but are not limited to: structured reading within the VLE and through external recommended sources; utilisation of podcasts or videos; engagement with virtual practical and laboratory resources; quizzes and activities in the VLE; pre-recorded lectures and seminars; online discussion forums; and your own self-directed learning. Synchronous teaching may include: delivery of lectures, seminars and their associated discussion; group-based activities; journal clubs; debates; discussions based around pre-reading; and practical demonstrations.

Synchronous teaching takes place during a time window as outlined in each provisional unit structure. Exactly when teaching occurs in this window varies from session to session and is confirmed, via the VLE, in advance of the teaching. This allows the teaching staff to maximise the effectiveness of the synchronous sessions for the material they are covering. For example, it might consist of 4 separate sessions each of 45 minutes in length; or a 30 minute seminar, followed by discussion, group work, group feedback and another seminar.

The majority of the course teaching, both in terms of material and content, occurs through asynchronous approaches via the VLE ahead of and between the synchronous sessions. This material appears progressively over the unit to help guide and structure your learning journey.

Course Overview

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 considers practical approaches to the study of evolutionary biology 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

Transferable skills for further study and employability

- The capacity for independent thought and judgement
- The development of independent learning, study and time management skills
- The deployment of skills in critical reasoning
- The development of competence in using IT to support one's work
- The ability to work with others, productively and equitably
- The qualities necessary for employment requiring the exercise of some personal responsibility and the demonstration of high levels of motivation and personal commitment through part-time study

Study hours

The award of academic credit is a means of quantifying and recognising learning and within the UK, one credit notionally represents 10 hours of learning[1]. Each of the units in this course attracts 20 credits, so students should expect to need to study for approximately 200 hours in total to complete each unit successfully. However, it is recognised that students study at different paces and use a variety of approaches, so this is a recommendation, rather than a hard-and-fast calculation.

[1] '**SEEC** Credit Level Descriptors for Higher Education

Teaching staff

A range of academic experts teach on the course. This means you will have access to and involvement with people who have extensive subject knowledge and who are, in many cases, actively involved in research in genetics and its related disciplines. Further details of the teaching staff are on the course website.

Academic Director:

Dr Emma English
Having completed her PhD in biochemistry Emma undertook her clinical scientist training at Addenbrooke's Hospital in Cambridge and holds HCPC registration. Emma is the Chair of an IFCC international education committee on diabetes biomarkers with a focus in LMICs. She is also a consultant to the WHO as well as other NGOs.

Emma has a broad experience of teaching and learning on a wide range of health programmes including, graduate entry medicine, biomedical science and dietetics. She has held the role of Director of Postgraduate Research as well as developed courses from concept through to accreditation.

Course Director:

Dr Florin Mircea Iliescu
Dr Mircea Iliescu studies the genetic evolution of human populations, with a focus on how human diversity has been shaped by adaptive forces in populations that have migrated and admixed at different timescales throughout evolution. He is a geneticist with a PhD in Human Evolutionary Genetics from the University of Cambridge and is currently working on understanding the evolution of traits such as skin colour and immune response in the Roma minority groups of Romania as well as in populations from across India.

Mircea greatly enjoys speaking to general audiences from across the world on the amazing world of genetics; he is a firm believer in a scientist's mission to both discover new wonders and enhance the understanding of science among people from all walks of life.

For a list of tutors who teach on the biological science programmes, please see the Biological and life sciences subject page on the Institute's website (https://www.ice.cam.ac.uk/courses/courses-subject/biological-sciences)

Administrative staff

Undergraduate Enquiries
e. undergraduate@ice.cam.ac.uk

Institute of Continuing Education

The Institute of Continuing Education's administrative headquarters are at Madingley Hall, an elegant country house built in the 16th century and set in gardens of about seven acres, designed in the 18th century by Capability Brown. Please visit www.ice.cam.ac.uk and www.madingleyhall.co.uk for further information.

Contact details of ICE

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Please also refer to the 'information for students' section on ICE's website www.ice.cam.ac.uk/studying-with-us/information-for-students and the 2024-25 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. Course Information and Help and Guidance section of the ICE VLE will also contain valuable information specific to your course.

Information correct as of 21/03/2024

Syllabus for first unit
Michaelmas term 2024

Life, the first four billion years

Start date	**11 October 2024**	**End date**	**8 January 2025**
Tutor(s)	**TBC**	**No of meetings**	**4**

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.

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.

Teaching Sessions/ Lectures list

Provisional unit structure

Topic	**Synchronous teaching date**	**Indicative content for synchronous and asynchronous delivery**
Early life	TBC	This topic will provide a brief overview of the diversity of life, including its similarities and differences. It will explore early events in evolution, in particular, the origin of life itself and consideration of the origin of more complex cells and the eukaryotes.

The evolution of complex life	TBC	An introduction to some of the consequences of increasingly complex ways of life and cell-machinery, including the evolution of locomotion and photosynthesis. Consideration of the key evolutionary steps that allowed organisms to evolve from single to multiple-celled. For example, discussion of developmental patterning and communication between different cells in multicelled organisms.
Phylogeny	TBC	This topic will introduce methods that can be used to reconstruct the deep trees of life including phylogenetic reconstruction.

Learning 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 assessment

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 assignments associated with the unit, each weighted at 50% of the overall unit mark:

Assignment 1: An essay discussing the origin of life and early events in evolution (1500-2000 words). The precise title is provided through the VLE at the start of the unit.

Assignment 2: Short answer and data handling questions on the material, including practical techniques, covered in the unit (equivalent to 1,500-2,000 words). The exact questions are provided through the VLE at the start of the unit.

Closing date for the submission of assignments
Wednesday 8 January 2025 by 12 noon GMT* (*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 *Darwin Online*: www.darwin-online.org.uk/	Oxford World Classics Series 1859
Dawkins, Richard	The Selfish Gene 2nd Edition	Oxford University Press 1989
Knoll, Andrew H	Life on a young planet	Princeton University Press 2003
Ridley, Mark	Evolution 3rd Edition	Blackwell 2003
Tudge, Colin	The variety of life	Oxford University Press 2000
John S. Torday and Virender K. Rehan	Evolution, the Logic of Biology	John Wiley & Sons 2017
Wilkinson, Matthew	Restless Creatures: the story of life in ten movements	Basic Books 2016

Syllabus for second unit
Lent term 2025

Kingdom Building

Start date	**6 January 2025**	**End date**	**26 March 2025**
Tutor(s)	**TBC**	**No of meetings**	**4**

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. We will investigate how the fossil record records evolutionary change, the limitations of this process and see how fossil material can demonstrate 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?

Teaching Sessions/ Lectures list

Topic	**Synchronous teaching date**	**Indicative content for synchronous and asynchronous delivery**
Body plans	TBC	The unit will start with consideration of the control of an animal’s body plan and the origin of different tissues including nerves and muscles, using information from living organisms. You will explore more about the control of the animal body plan, and the great

		diversification of animals seen in the Cambrian explosion.
The invasion of land	TBC	This topic will investigate the factors that affect the way an organism is capable of evolving and evolutionary constraint. It will explore the invasion of land by animals, plants and fungi as well as the evolution of plant and fungal sex.
The fossil record	TBC	This topic will discuss fossil preservation processes, patterns of microevolution seen in the fossil record, natural biases that influence the evidence, and the relationship between evolution and environmental change.

Learning 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 assessment

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 course, each weighted at 50% of the overall unit mark:

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

Closing date for the submission of assignments:
Wednesday 26 March 2025 by 12 noon (GMT)* (*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

Frederick B. Essig	Plant Life: a brief history	Oxford University Press 2015
Raven, Peter et al.	Biology of Plants 8th Edition	W.H. Freeman & Company 2012
Ridley, Mark	Evolution 3rd 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 2025

Success Stories

Start date	**31 March 2025**	**End date**	**13 June 2025**
Tutor(s)	**TBC**	**No of meetings**	**4**

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.

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.

Teaching Sessions/ Lectures list

Topic	**Synchronous teaching date**	**Indicative content for synchronous and asynchronous delivery**
Chance in evolution	TBC	This day-school will start by discussing the role of chance in the history of life on earth and the role of Natural Selection versus Genetic Drift in evolution. We will go on by discussing the fossil evidence for extinctions over the last 500 million years and the role of mass extinctions in the evolution of life.
Arthropods and Flowering Plants	TBC	This topic will explore the evolution of the enormous diversity of insects and key innovations that have underpinned this success. It will discuss the evolution of the extraordinary diversity of flowering plants.

Vertebrates	TBC	The final topic in the course will discuss the story of vertebrate evolution and provide a particular focus on the evolution of humans.

Learning 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 assessment

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, each weighted at 50% of the overall unit mark.:

1. Essay discussing the role of chance in the evolution of life on Earth (1,500-2,000 words).
2. Production of a report focussed on a taxa of the students choice (to be agreed in advance with the course director), discussing their evolution and key traits (1,500 – 2,000 words).

Closing date for the submission of assignments:
Friday 13 June 2025 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
Eugine E. Harris	Ancestors in our genome: The new science of human evolution	Oxford University Press 2014
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

FULL TIMETABLE

Michaelmas 2024	
Life, the first four billion years	
Synchronous session 1	26 October 2024
Synchronous session 2	9 November 2024
Synchronous session 3	23 November 2024
Synchronous session 4	7 December 2024
Lent 2025	
Kingdom Building	
Synchronous session 1	18 January 2025
Synchronous session 2	1 February 2025
Synchronous session 3	15 February 2025
Synchronous session 4	1 March 2025
Easter 2025	
Success Stories	
Synchronous session 1	12 April 2025
Synchronous session 2	26 April 2025
Synchronous session 3	10 May 2025
Synchronous session 4	24 May 2025

Whilst every effort is made to avoid changes to this course, changes to course-content and structure and timings may be made. Students will be consulted on any changes.