UNIVERSITY OF CAMBRIDGE

Institute of Continuing Education

Undergraduate Diploma in Evolutionary Biology

2020-2021

Course code: 2021DCR200

COURSE GUIDE

University of Cambridge Institute of Continuing Education, Madingley Hall, Cambridge, CB23 8AQ
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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. The award is completed in one academic year. For further information about academic credit please see our website: http://www.ice.cam.ac.uk/studying-with-us/information-for-students/qualifications-that-we-offer.

Important information for the 2020-2021 Academic Year

During the 2020-2021 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
- The ability to reference sources of information to support one's reasoning
- The ability to understand how to approach a research question in evolutionary biology

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 'Academic credit in higher education in England – an introduction'. The Quality Assurance Agency for Higher Education, 2009

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.

The overall Academic Director is Dr Tom Monie, a protein biochemist and Deputy Director of Academic Centres at the Institute of Continuing Education. Tom is a firm believer that learning should be fun, that learner participation is central to this process, and that successful teaching requires responsiveness to the needs of the learners.

The Course Director is Dr Florin Mircea Iliescu who studies variation in human populations and is deeply fascinated by the amazing nature of 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.

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. (http://www.ice.cam.ac.uk/courses/courses-subject/biological-and-life-sciences)

Administrative staff

Arts and Sciences Enquiries
e. artscience@ice.cam.ac.uk t. 01223 746418 / 746236

The 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.

The course itself is taught entirely remotely during the 2020-21 Academic Year.

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 2020/21 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 Virtual Learning Environment (VLE) will also contain valuable information specific to your course.

Information correct as at 19/08/2020

Syllabus for first unit
Michaelmas term 2020

Life, the first four billion years

Start date	16 October 2020	**End date**	16 December 2020
Synchronous Sessions	Saturday 31 October 2020 Saturday 14 November 2020 Saturday 28 November 2020 Saturday 12 December 2020		
Delivery	Remote: Zoom-based synchronous and online VLE-based asynchronous teaching	**No of synchronous 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.

Provisional unit structure

Topic	Synchronous teaching date	Indicative content for synchronous and asynchronous delivery
Early life	31/10/2020 10:00-16:00	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	14/11/2020 10:00-16:00 & 28/11/2020 10:00-16:00	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	12/12/2020 10:00-16:00	This topic will introduce methods that can be used to reconstruct the deep trees of life including phylogenetic reconstruction.

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 assignments associated with the unit, weighted 50/50:

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 6th January 2021 by 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 2021

Kingdom Building

Start date	9 January 2021	**End date**	31 March 2021
Synchronous Sessions	Saturday 9 January 2021 Saturday 23 January 2021 Saturday 6 February 2021 Saturday 20 February 2021		
Delivery	Remote: Zoom-based synchronous and online VLE-based asynchronous teaching	**No of synchronous 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?

Provisional unit structure

Topic	Synchronous teaching date	Indicative content for synchronous and asynchronous delivery
Body plans	09/01/21 10:00-16:00	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	23/01/21 10:00-16:00 & 06/02/21 10:00-16:00	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	20/02/2021 10:00-16:00	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.

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 assignments associated with the course, weighted 50/50:

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 31st March 2021 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
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 2021

Success Stories

Start date	17 April 2021	**End date**	04 June 2020
Synchronous Sessions	Saturday 17 April 2021; Saturday 01 May 2021; Saturday 15 May 2021; Saturday 29 May 2021		
Delivery	Remote: Zoom-based synchronous and online VLE-based asynchronous teaching	**No of synchronous 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.

Provisional unit structure

Topic	Synchronous teaching date	Indicative content for synchronous and asynchronous delivery
Chance in evolution	17/04/2020 10:00-16:00	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	01/05/2021 10:00-16:00	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	15/05/2021 10:00-16:00 & 29/05/2021 10:00-16:00	The final topic in the course will discuss the story of vertebrate evolution and provide a particular focus on the evolution of humans.

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 (1,500-2,000 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 4th June 2021 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

TIMETABLE

Michaelmas 2020
Life, the first four billion years

Synchronous session 1	31st October 2020
Synchronous session 2	14th November 2020
Synchronous session 3	28th November 2020
Synchronous session 4	12th December 2020

Lent 2021
Kingdom-building

Synchronous session 1	9th January 2021
Synchronous session 2	23rd January 2021
Synchronous session 3	6th February 2021
Synchronous session 4	20th February 2021

Easter 2021
Success stories

Synchronous session 1	17th April 2021
Synchronous session 2	1st May 2021
Synchronous session 3	15th May 2021
Synchronous session 4	29th May 2021

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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