UNIVERSITY OF CAMBRIDGE

Institute of Continuing Education

Undergraduate Diploma in Genetics

2021-2022

Course code: 2122DCR105

COURSE GUIDE

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Welcome to the **Undergraduate Diploma in Genetics,** 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 see our website:
http://www.ice.cam.ac.uk/studying-with-us/information-for-students/qualifications-that-we-offer.

Important information for the 2021-2022 Academic Year

During the 2021-2022 Academic Year the **Undergraduate Diploma in Genetics** 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 Certificate in Genetics** focuses on DNA at the core of life - how DNA works and how it informs the structures and functions of living things. The course will provide a detailed overview of the fundamental processes involved in the transfer and interpretation of genetic information, including its application in both research and industrial settings. The course will also introduce the use of, the importance of, and some of the caveats with, model organisms. It will finish with an exploration of the wonderful world of plant and microbial genetics.

Genetics is at the forefront of biological science. The course aims to discuss the successes of the Human Genome Project, the ease with which genomes can be sequenced, and the continual development in gene editing technology. These advances make this an extremely exciting time to be learning about the importance of genetics. Each unit contains one or two specific assignments related to the unit content. These allow you to demonstrate how you have met the course learning outcomes. In addition to summative assignments you will have opportunity to produce work for formative feedback from the teaching team and your fellow learners.

The course is three discrete units. A broad overview of each unit, the dates of synchronous teaching delivery and a course reading and resource list for each of these units is included in this course guide. Throughout the year additional readings and resources are put on the course VLE.

The course aims to:

1. develop a detailed understanding of the cellular and molecular mechanisms that facilitate the transfer of information held within DNA into functional molecules
2. introduce the importance of recombinant DNA technology by exploring key historical advances alongside modern day approaches.
3. introduce students to the essential biological and genetic experimental system, the model organism
4. explore, where relevant, the importance and relevance of bacterial and viral experimental systems.
5. deepen student understanding of genetics through the study of plant and microbial systems with a particular focus on how genetic methods control physiological, metabolic, developmental and cell signalling processes.
6. will provide students with a critical awareness of the important role plant and microbial systems have in genetic engineering and how these systems are integral to scientific and societal advancement
7. provide particular consideration to the practical applications of plant and microbial systems along with discussion of how these applications impact on an ethical and a practical level within society.

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 Course Director is Dr Kyren Lazarus, a cancer biologist and pharmaceutical professional. Kyren believes that equal engagement between students and lecturers, and that this engagement leads to a enjoyable experience.

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 2021-22 Academic Year.

Contact details of ICE

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Please refer to the 'information for students' section on ICE's website www.ice.cam.ac.uk/studying-with-us/information-for-students and the 2021/22 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 16.08.2021

Syllabus for first unit

Michaelmas term 2021

The regulation and control of gene expression

Start date	16 October 2021	**End date**	04 December 2021
Synchronous Sessions	Saturday 16 October 2021 Saturday 30 October 2021 Saturday 13 November 2021 Saturday 27 November 2021		
Delivery	Remote: Zoom-based synchronous and online VLE-based asynchronous teaching	**No of synchronous meetings**	4

Summary

This unit aims to develop a detailed understanding of the cellular and molecular mechanisms that facilitate the transfer of information held within DNA into functional molecules. Students will explore and investigate the mechanisms by which these processes are regulated, consider why regulation is important and assess what can happen when regulation goes wrong. The unit will also introduce the importance of recombinant DNA technology by exploring key historical advances alongside modern day approaches.

Content

Proteins, the products of gene expression, dictate cellular phenotype and function. The regulation of gene expression is a critical element in the normal functioning of the cell. Disruption of this process can lead to significant changes in the behaviour and function of a cell and may lead to the development of disease. It is consequently essential to understand how genetic information is expressed and regulated in a controlled manner.

Using examples from both prokaryotic and eukaryotic systems this unit will provide detailed coverage of the biological mechanisms that control gene expression. This will include, but is not limited to: transcriptional and pre-transcriptional regulation, protein translation, epigenetic regulation and small non-coding RNAs. The unit will also address some of the biological impacts - at the level of the individual cell, tissue and organism - of the failure of proper regulation of gene expression.

The importance of understanding how gene expression can be controlled and manipulated has been at the forefront of advances in molecular biology and in the pharmaceutical industry. The unit will use case studies and online practical sessions to explore the historical context and application of recombinant DNA technology and how it continues to drive the advancement of biological and genetic knowledge.

Provisional unit structure

Topic	**Synchronous teaching date**	**Indicative content for synchronous and asynchronous delivery**
Manipulation of DNA	16/10/2021 10:30-15:30 & 30/10/2021 10:30-15:30	These two teaching sessions will cover the theory and practice of recombinant DNA technology and its application in the advancement of biological knowledge. Case studies and online practical sessions will demonstrate the fundamental experimental principles and their application.
The flow of genetic information	13/11/2021 10:30-15:30 & 27/11/2021 10:30-15:30	Using examples from prokaryotic and eukaryotic systems these two sessions will consider the wide range of mechanisms regulating and controlling gene expression and what happens when these mechanisms go wrong.

All times are GMT (*Greenwich Mean Time), except 2310/2021 (BST, *British Summer Time)

Learning outcomes

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

- Explain how the principles of genetics underlie much of the basis of molecular biology
- Explain the principles of gene expression and how it is controlled through the use of detailed examples
- Identify, analyse and communicate the principles and concepts underlying our understanding of genetics and any competing perspectives
- Collect and synthesis relevant information from a range of authoritative sources to inform solutions for unfamiliar genetics based problems
- Use openly available computational tools and databases to extract and analyse genetic information
- Extract, analyse, evaluate and communicate genetic information

Student assessment

The unit requires a commitment to reading and pre-class preparation, including some specific reading between class sessions, along with ongoing engagement with the VLE.

There are two assessment pieces for this unit and each contributes 50% of the credit for this unit.

Assessment 1: Using three specific examples analyse how gene expression is regulated and why this is important.

- This work must be presented as an essay of 2,000 words that contains appropriate figures and referencing.
- Examples may originate from material covered in the course, or may come from your own research.
- The precise title is provided through the VLE at the start of the unit.

Assessment 2: Complete a series of short answer questions and problems relating to the theory and application of DNA technology. This will include some data handling questions connected to the teaching delivered in the unit.

- The exact questions are provided through the VLE at the start of the unit.

Questions about the assignments should be directed to the course director.

All students are expected to upload their assignments into the VLE and these are analysed using the text comparison software Turnitin.

Closing date for the submission of assignments:
Wednesday 5th January 2022 before noon (GMT)

Syllabus for second unit

Lent term 2022

Model Organisms

Start date	08 January 2022	**End date**	26 February 2022
Synchronous Sessions	Saturday 08 January 2022 Saturday 22 January 2022 Saturday 05 February 2022 Saturday 19 February 2022		
Delivery	Remote: Zoom-based synchronous and online VLE-based asynchronous teaching	**No of synchronous meetings**	4

Aims

This unit will introduce students to the essential biological and genetic experimental system, the model organism. Students will be able to explore the historical importance and modern day relevance of key model organisms including *Drosophila melanogaster, Caenorhabditis elegans, Mus musculus*, and *Arabidopsis thalania*. The unit will also explore, where relevant, the importance and relevance of bacterial and viral experimental systems.

Content

Genetics, possibly more than any other branch of biology, has made extensive use of model organisms to enhance our functional and molecular understanding of biological systems. Since the early days of Gregor Mendel's observations around the inheritance patterns displayed by the pea plant geneticists have sought to observe and manipulate the genetic makeup of a range of organisms to better understand how they, and more complex organisms, such as humans, work.

Within this unit and using five core experimental systems, students will consider the importance of model organisms to the development of understanding and progress in the area of genetics. Topics of study will include: the historical context; landmark experiments; the relevance of the model system to the wider genetic landscape; caveats specific to each model organism; and the applicability of the model system to genetics in the future.

Provisional unit structure

Topic	Synchronous teaching date	Indicative content for synchronous and asynchronous delivery
Mus musculus	8/01/2022 10:30-15:30	The mouse (Mus musculus) as a model organism.
Drosophila melanogaster	22/01/2022 10:30-15:30	The fruit fly (Drosophila melanogaster) as a model organism.
Arabidopsis thaliana	05/02/2022 10:30-15:30	Plants as model organisms – the use and utility of Arabidopsis thaliana.
Caenorhabditis elegans and Saccharomyces cerevisiae	19/02/2022 10:30-15:30	Worms and yeasts – using Caenorhabditis elegans and Saccharomyces cerevisiae as model organisms.

All times are GMT (*Greenwich Mean Time), except 2310/2021 (BST, *British Summer Time)

Learning outcomes

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

- Explain how the principles of genetics underlie much of the basis of molecular biology
- Understand why model organisms are used and the relative advantages, disadvantages and applications of different model systems
- Identify, analyse and communicate the principles and concepts underlying our understanding of genetics and any competing perspectives
- Identify patterns and relationships in data through undertaking research of the existing literature
- Collect and synthesis relevant information from a range of authoritative sources to inform solutions for unfamiliar genetics based problems
- Evaluate the results of experimental data in the context of appropriate genetic models and theories
- Use openly available computational tools and databases to extract and analyse genetic information
- Devise and evaluate appropriate experimental approaches to investigate relevant areas of genetics
- Extract, analyse, evaluate and communicate genetic information

Student assessment

The unit requires a commitment to reading and pre-class preparation, including some specific reading between class sessions, along with ongoing engagement with the VLE.

There are two assessment pieces for this unit and each contributes 50% of the credit for this unit.

Assessment 1: Perform a critical analysis of a relevant research paper (1,750 – 2,000 words).

- A selection of relevant research papers that utilise model organisms to advance the understanding of genetics along with a suggested framework to structure the assignment will be provided.
- Students are expected to consider how the paper fits within the published literature, whether its methodology and analysis is sound, whether the data supports the conclusions drawn, and what additional experiments would seem appropriate to consider.

Assessment 2: Complete four problem-based learning exercises focused on experimental studies using model organisms (equivalent to 1,750 – 2,000 words).

- Guidance on how to address these sorts of questions, and the opportunity to complete practice questions for formative feedback will be provided through the teaching and the VLE.

Questions about the assignments should be directed to the course director.

All students are expected to upload their assignments into the VLE and these are analyzed using the text comparison software Turnitin.

Closing date for the submission of assignments:
Wednesday 23rd March 2022 by noon (BST*) (*British Summer Time)

Syllabus for third unit

Easter term 2022

Plant and Microbial Genetics

Start date	28 March 2022	**End date**	21 May 2022
Synchronous Sessions	Saturday 02 April 2022 Sunday 24 April 2022 Sunday 8 May 2022 Saturday 14 May 2022		
Delivery	Remote: Zoom-based synchronous and online VLE-based asynchronous teaching	**No of synchronous meetings**	4

Aims

This unit will deepen student understanding of genetics through the study of plant and microbial systems with a particular focus on how genetic methods control physiological, metabolic, developmental and cell signalling processes. Students will be able to demonstrate the importance and benefit of comparative genomics. The unit will provide students with a critical awareness of the important role plant and microbial systems have in genetic engineering and how these systems are integral to scientific and societal advancement.

Content

The previous two Units have introduced multiple examples of the importance of understanding how non-mammalian genetics work. In this Unit we will build on this knowledge by providing an in depth understanding of the core concepts of plant and microbial genetics.

The key characteristics of microbial and plant genetics will be considered both in terms of their uniqueness, as well as their similarity, to mammalian systems. This will enable an exploration of the importance of these systems in their own right and their relevance to the improved understanding of other branches of genetics.

Particular consideration will be given to the practical applications of plant and microbial systems along with discussion of how these applications impact on an ethical and a practical level within society.

Provisional unit structure

Topic	Synchronous teaching date	Indicative content for synchronous and asynchronous delivery
Microbial genetics	02/04/2022 10:30-15:30	An introduction to microbial genetics; the differences between prokaryotic and eukaryotic genetics; the applications and uses of microbial genetics in understanding complex systems.
Plant genetics	24/04/2022 10:30-15:30	An introduction to plant genetics; similarities, differences, and applicability to mammalian genetics; the application of plant genetics to understanding cellular functionality.
Practical applications	8/05/2022 10:30-15:30	This session will consider some of the practical applications and experimental underpinnings of plant and microbial systems.
Case studies	14/05/2022 10:30-15:30	Using a range of plant and microbial case studies students will be introduced to key issues, technologies, and applications with relevance to, or impacts upon, society. These may include approaches such as genetic modification of crops and the application of CRISPR-based cloning technologies.

Learning outcomes

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

- Explain how the principles of genetics underlie much of the basis of molecular biology, including through the context of plant and microbial genetics
- Describe how comparative genetics has contributed to understanding core cellular functions
- Identify, analyse and communicate the principles and concepts underlying our understanding of genetics and any competing perspectives
- To identify patterns and relationships in data through undertaking research of the existing literature
- Collect and synthesis relevant information from a range of authoritative sources

Student assessment

The unit requires a commitment to reading and pre-class preparation, including some specific reading between class sessions, along with ongoing engagement with the VLE.

There is one assessment piece for this unit.

The study of plant and microbial genetics has been essential to our understanding of mammalian biology. Using specific examples discuss the validity of this statement.

- This work must be presented as an essay of 3,500 – 4,000 words that contains appropriate figures and referencing.

- Examples may originate from material covered in the course, or may come from your own research.

Questions about the assignments should be directed to the course director.

All students are expected to upload their assignments into the VLE and these are analyzed using the text comparison software Turnitin.

Closing date for the submission of assignments:
Friday 10th June 2022 by noon BST* (British Summer Time)

Recommended Readings

Engagement with a wide range of reading material and additional resources will enhance and improve your understanding of the subjects you are studying and help you have a more comprehensive and satisfactory learning experience.

Many genetics and molecular biology texts exist and the majority of these provide excellent introductions to the topics taught in the course. The texts and resources listed below are an indication of the sorts of reading material that will benefit your learning. They are a mix of textbooks popular science books. Where possible the textbooks are available electronically through the University library and can be accessed using your Raven credentials.

Throughout the course you are given specific readings as part of the teaching. Information about, and links to, these appear in the VLE as necessary.

For some texts older editions still contain the relevant information and students are welcome to discuss this, and other reading options, with the Tutors or Course Director. Background reading will greatly increase appreciation of the course.

AUTHOR	**TITLE**	**PUBLISHER**
Arney, Kat	Herding Hemingway's Cats: Understanding how our genes work	Bloomsbury Publishing, 2016
Bonini NM and Berger SL	The sustained impact of model organisms-in genetics and epigenetics	Genetics 205: 1–4. (2017)
Cobb, Matthew	Life's Great Secret: The Race to Crack the Genetic Code	Profile Books, 2015
Fletcher, Hugh *et al.,*	BIOS Instant Notes in Genetics	CRC Press LLC, 2012
Gupta, PK	Molecular Biology and Genetic Engineering	Global Media, 2007
Hanage WP	Not so simple after all: Bacteria, their population genetics, and recombination.	Cold Spring Harb Perspect Biol. 2016;8(7) pii:a018069
Hartl DL	Essential Genetics and Genomics	Jones & Bartlett Learning, 2020
Krebs, J *et al.,*	Lewin's Genes XII	Jones & Bartlett, 2018
Kohler REE	Lords of the Fly: Drosophila Genetics and the Experimental Life	University of Chicago Press, (1994)
Lehner B	Genotype to phenotype: lessons from model organisms for human genetics.	Nat. Rev. Genet. 14: 168–178. (2013)
Leyser O and Day S	Mechanisms of Plant Development	Blackwell Science, Oxford (2003)

Miglani, Gurbachan S.	Essentials of Molecular Genetics	Alpha Science International, 2015
Mukherjee, Siddhartha	The Gene: An Intimate History	Vintage, 2017
Reich, David	Who we are and how we got here	OUP, 2018
Ridley, Matt	Francis Crick: Discoverer of the Genetic Code	Harper Perennial, 2006
Rutherford, Adam	A brief history of everyone who ever lived	Orion Publishing, 2016
Sapolsky, Robert	Behave: The Biology of Humans at Our Best and Worst	Vintage, 2018
Sulston, John	The Common Thread	Joseph Henry Press Books, 2002
Tobias, ES *et al.,*	Essential Medical Genetics (6th Edition)	Wiley Blackwell, 2011
Venter, Craig	A Life Decoded	Penguin Press Science, 2008

TIMETABLE FOR SYNCHRONOUS TEACHING

Michaelmas 2021: **The regulation and control of gene expression**	
Saturday 16th October 2021	Between 10:30 and 15:30 GMT
Saturday 30th November 2021	Between 10:30 and 15:30 GMT
Saturday 13th November 2021	Between 10:30 and 15:30 GMT
Saturday 27th November 2021	Between 10:30 and 15:30 GMT
Lent 2022: **Model Organisms**	
Saturday 8th January 2022	Between 10:30 and 15:30 GMT
Saturday 22nd January 2022	Between 10:30 and 15:30 GMT
Saturday 5th February 2022	Between 10:30 and 15:30 GMT
Saturday 19th February 2022	Between 10:30 and 15:30 GMT
Easter 2022: **Plant and Microbial Genetics**	
Saturday 2nd April 2022	Between 10:30 and 15:30 BST
Sunday 24th April 2022	Between 10:30 and 15:30 BST
Sunday 8th May 2022	Between 10:30 and 15:30 BST
Saturday 14th May 2022	Between 10:30 and 15:30 BST

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.