Trinity College Dublin
Coláiste na Tríonóide, Baile Átha Cliath
The University of Dublin

Science at Trinity

Faculty of Engineering, Mathematics and Science

TR063
Physical Sciences
Junior Fresh Programme 2018 - 2019

tcd.ie/science

This handbook applies to all students taking TR063: Physical Science. It provides a guide to what is expected of you on this programme, and the academic and personal support available to you. Please retain for future reference.

The information provided in this handbook is accurate at time of preparation. Any necessary revisions will be notified to students via email and the Science Programme Office website (http://www.tcd.ie/Science). Please note that, in the event of any conflict or inconsistency between the General Regulations published in the University Calendar and information contained in course handbooks, the provisions of the General Regulations will prevail.

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TR063: Physical Sciences

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TR063 : Physical Sciences introduction

Welcome to Physical Sciences – your entry to Physics, Physics and Astrophysics and Nanoscience.

There are all sorts of reasons why you might have chosen Physical Sciences as your preferred degree course. You might have chosen out of a love of physics, or perhaps because you have a facility with mathematics. Perhaps you are driven by curiosity about the world in which we live, and the pleasure of figuring out how it works. In the Physical Sciences course you will have the opportunity to follow all these interests and more. We will help you cultivate a never-ending curiosity about the universe, whether this is at the largest scales of astrophysics, the smallest scales of particle physics, or the intermediate scales in which we live, and where our modern and future technology operates.

It may be that you have entered the course with the specific idea of graduating with one of the degrees, either in **Physics**, or in **Physics and Astrophysics**, or in **Nanoscience**. Perhaps you are planning to pursue a career in research in one of these areas. In Physical Sciences we would certainly encourage these dreams, but we will also prepare you for your future role in society and for many other careers, in industry and beyond. In every career move that you may make in the future your Physical Sciences degree will be useful, because it will have helped you develop transferable skills and attributes that are in demand by employers. Among these are problem solving skills, the ability to deal with complex mathematical and physical problems, and the use of the scientific method. You will learn scientific thought processes and critical thinking skills, and you will develop the Trinity Graduate Attributes that are important not just in many careers, but in many other areas of society.

Regardless of your personal motivations we would like to reassure you that you have chosen well, and that you will have many opportunities in the Physical Sciences course to reach your goals and potential – and that we will help you do this. This of course is with the proviso that you engage fully from the outset with the course, the materials, the laboratories, your peers and the academic and other staff you encounter. In that sense you must be prepared to work independently. Your degree in the Physical Sciences course begins today!

The first two years of the Physical Sciences course cover the most essential topics necessary for each of the three possible degree routes in the final two years. In these “fresher” years you will study Physics and Mathematics and one other subject. The Physics course includes topics in astrophysics, statistics, mechanics, thermodynamics, electricity and magnetism, acoustics and optics, nuclear physics and quantum physics. The fresher Mathematics includes topics in calculus, linear algebra, differential equations, and Fourier analysis. As part of your Physics modules you will spend three hours per week in experimental or computational laboratories learning coding skills through Python.

In the Sophister years all students will continue to develop foundational topics in physics to an advanced level, through courses on quantum mechanics, electromagnetism and statistical mechanics. This is applied to atomic physics, condensed matter physics and particle physics. In addition to this common core, students taking **Physics** can choose from a range of specialist courses, covering areas such as magnetism, nanoscience, semiconductors, modern optics, superconductivity, & astrophysics. Students specialising in **Physics and Astrophysics** instead take courses on stellar and galactic structures, planetary and space science, the interstellar medium, and on cosmology. Students specialising in **Nanoscience** will study thin films and polymers, spectroscopy of nanostructures, and further modules in solid state chemistry, materials chemistry as well as condensed matter physics.

In addition, students in the Physical Sciences stream will use computers for numerical modelling via the Python programming language and how to use a range of physical instruments for making measurements in the laboratory. Students in the third year take a course in communication skills which helps them to hone their oral and written presentation skills and shows them how to prepare a curriculum vitae. Third year students can meet graduates of the School of Physics through the 'Wild Geese' GradLink programme where they receive guidance on building their careers.

All students in the fourth year undertake a nine week full time research project, which is carried out in a research laboratory in Trinity or in a research lab in another university or research institute. Students commonly travel to the US, UK, France, Germany and Australia for their final year projects. Students specialising in Physics and Astrophysics may travel to a telescope observatory.

Trinity Physical Science degrees are accredited by the Institute of Physics, the professional body for physicists in Ireland and the UK, as a basis for the professional status 'Chartered Physicist' (CPhys). Our graduates are always in high demand in Ireland, abroad and in modern high-tech industries, as well as in teaching. You may also find careers in academic institutions, government and industrial research organisations, production facilities or in the meteorological service. Diverse opportunities in electronics, telecommunications, biophysics, hospital and health physics, automation and computing are always available The Physical Sciences courses will give you the opportunity to acquire problem solving skills which will be highly valued by your future employer. It could also give you useful primary training for a legal, managerial or actuarial career, where a technical background is attractive.

Cormac McGuinness

Professor Cormac McGuinness
Director, TR063 Physical Sciences Course

TR063 Physical Sciences overview and module selection.

Professor Cormac McGuinness, the Course Director of the TR063: Physical Sciences Course, will address new entrants to the TR063 course in the Schrodinger Lecture Theatre of the Fitzgerald Building **at 12.00 am on Monday 3rd September 2018.** At this session students will obtain information on the course and will be advised on choice of approved modules. Following this, students will submit their approved module choices to the TR063 Course Director after consulting with Physics advisors in the Fitzgerald Library, also in the Fitzgerald building; or to the Science Course Office by 12.00 noon on Tuesday 4th September 2018. Additional introductory information sessions will occur on Thursday 6th September and/or Friday 7th September, their timing to be announced.

Students must take 40 core credit modules (20 per semester) as follows:

PYU11P10	Physics 1	1	10
PYU11P20	Physics 2	2	10
MAU11S01	Mathematics for Scientists 1	1	10
MAU11S02	Mathematics for Scientists 2	2	10

Students will choose approved modules to the value of 20 credits (10 per semester) from the following:

BYU11101	From Molecules to Cells	1	10
BYU11102	From Organisms to Ecosystems	2	10
CHU11101	General and Physical Chemistry	1	10
CHU11102	Introduction to Inorganic and Organic Chemistry	2	10
GSU11004	Spaceship Earth: An introduction to Earth System Science	1	10
GSU11005	Introduction to Geology: A beginner's Guide to Planet Earth	2	10

Moderatorships

In the Junior and Senior Fresh years TR063 students complete a course of study which will qualify them to compete for places in the following Moderatorships after the Senior Fresh year. The three available Moderatorship choices are:

- Physics
- Physics and Astrophysics
- Nanoscience

TR063: Physical Sciences Moderatorships

Moderatorship in Physics

In brief, a Moderatorship in **Physics** leads to a recognised Physics degree and encompasses the core physics subjects such as quantum mechanics, mechanics, thermodynamics, electromagnetism, oscillations and waves, condensed matter physics, atomic physics, relativity, nuclear structure, statistical physics, lasers and optics among others. The broad based Physics Moderatorship places an equal emphasis on diverse important subjects of nanoscience, magnetism, semiconductor device technology, photonics, nuclear and particle physics, superconductivity as well as aspects of astrophysics. It serves as the ideal launching point for a research or industrial career following any or all of these subject areas.

Moderatorship in Physics and Astrophysics

A Moderatorship in **Physics and Astrophysics** leads to a recognised Physics degree and encompasses the core physics subjects such as quantum mechanics, mechanics, thermodynamics, electromagnetism, oscillations and waves, condensed matter physics, atomic physics, relativity, nuclear structure, statistical physics, lasers and optics among others. The Physics and Astrophysics Moderatorship places astrophysics, stellar physics, stellar and galactic formation, cosmology and astronomical techniques first and foremost in this degree albeit at the expenses of subjects such as nanoscience, photonics, superconductivity and semiconductor device technology.

Moderatorship in Nanoscience

A Moderatorship in **Nanoscience** leads to a recognised Physics degree and encompasses the core physics subjects such as quantum mechanics, mechanics, thermodynamics, electromagnetism, oscillations and waves, condensed matter physics, atomic physics, relativity, nuclear structure, statistical physics, lasers and optics among others, as well as a recognisable core of physical, inorganic, organic and materials chemistry. The Nanoscience Moderatorship places the physics and chemistry of modern materials first and foremost which encompasses nanoscience, semiconductors and semiconductor device technology, photonics, materials chemistry, electrochemistry, polymers and photochemistry, all topics relevant to modern materials research, inclusive of energy materials, sensors and of microelectronics and any underpinning nanoscience.

Approved Module Choices in Junior and Senior Fresh Years

The following table is indicative of the core modules and available approved modules in both Junior Fresh and Senior Fresh year of the TR063: Physical Sciences degree.

Year 1: JUNIOR FRESH	
CORE MODULES – 40 credits 20/20	
Semester 1	**Semester 2**
PYU11P10 Physics 1	PYU11P20 Physics 2
MAU11S01 Mathematics	MAU11S02 Mathematics

Year 2: SENIOR FRESH			
CORE MODULES – 40 credits 20/20			
Semester 1		**Semester 2**	
PYU22P10 Physics 3		PYU22P20 Physics 4	
MAU22S01 Multi-variable calculus	MAU22S02 Vector Calculus	MAU22S03 Fourier analysis	HEPoS History, Ethics, Philosophy of Science

APPROVED MODULES – choose 20 credits 10/10	
CHU11101 General and Physical Chemistry	CHU11102 Introduction to Inorganic and Organic Chemistry
GSU11004 Spaceship Earth	GSU11005 Introduction to Geology
BYU11001 From Molecules to Cells	BYU11002 From Organisms to Ecosystems

APPROVED MODULES – choose 20 credits 10/10	
CHU22101 Chemistry	CHU22102 Chemistry
GSU22001 Physical Processes and Environment	GSU22003 Chemical Cycles in an Evolving Planet
BYU22001 From Molecules to Cells 2	BYU22002 From Organisms to Ecosystems 2

Note that there are limitations on approved module choices across the Junior and Senior Fresh years due to prerequisites in the Senior Fresh year that depend upon or require approved modules in the Junior Fresh year. The possible patterns of approved modules are shown in the diagram on the next page.

Moderatorships and Approved Module Choice Diagram

Moderatorships in **Physics** or in **Physics and Astrophysics** are available to all students regardless of the choice of approved modules in the Junior Fresh and Senior Fresh years

To qualify for the Moderatorship in **Nanoscience**, a student must take all available Chemistry approved modules in both semesters of the Junior and Senior Fresh years.

The following five patterns of Approved Modules are available to students across the Junior Fresh and Senior Fresh years. These are denoted A, B, C, D and E and correspond to the indicated patterns on the TR063 Physical Sciences Junior Fresh module choice form.

	Year 1: JUNIOR FRESH		**Year 2: SENIOR FRESH**	
	Semester 1	**Semester 2**	**Semester 1**	**Semester 2**
A	CHU11101 General and Physical Chemistry	CHU11102 Introduction to Inorganic and Organic Chemistry	CHU22101 Chemistry	CHU22102 Chemistry
B	CHU11101 General and Physical Chemistry	GSU11005 Introduction to Geology	GSU22001 Physical Processes and Environment	GSU22003 Chemical Cycles in an Evolving Planet
C	GSU11004 Spaceship Earth	GSU11005 Introduction to Geology	GSU22001 Physical Processes and Environment	GSU22003 Chemical Cycles in an Evolving Planet
D	BYU11001 From Molecules to Cells	BYU11002 From Organisms to Ecosystems	BYU22001 From Molecules to Cells 2	BYU22002 From Organisms to Ecosystems 2
E	BYU11001 From Molecules to Cells	GSU11005 Introduction to Geology	GSU22001 Physical Processes and Environment	GSU22003 Chemical Cycles in an Evolving Planet

Moderatorship

- Pattern A: **Nano-science**
- Patterns A, B, C, D and E: **Physics**; **Physics and Astro-physics**

Applications to choose a specific Moderatorship after the Senior Fresh year occur via a preferred Moderatorship choice form that will be available in Semester 2 of the Senior Fresh year. All qualified Physical Sciences students will be able to proceed to a Moderatorship.

Semester structure

TR063: PHYSICAL SCIENCES

CORE MODULES (mandatory) – 20 credits per semester

SEMESTER 1 – Michaelmas term 10 September 2018 – 30 November 2018	SEMESTER 2 – Hilary Term 21 January 2019-12 April 2019
PYU11P10: Physics 1	PYU11P20: Physics 2
MAU11S01: Mathematics 1	MAU11S02: Mathematics 2

APPROVED MODULES (optional): Students choose 10 credits from each semester

BYU11101: From Molecules to Cells	BYU11102: From Organisms to Ecosystems
CHU11101: General and Physical Chemistry	CHU11102: Introduction to Inorganic and Organic Chemistry
GSU11004: Spaceship Earth: An introduction to Earth System Science	GSU11005: Introduction to Geology: A Beginner's Guide to Planet Earth

Change of APPROVED modules

If, after a couple of weeks, you feel that you have perhaps made the wrong choice of approved module, **please seek advice immediately** from your Tutor, Course Director or the Science Course Office. It may be possible for you to change from one module to another within Science, subject to permission from the Associate Dean of Undergraduate Science Education. If you do decide to change modules, then do so **quickly** - it can be difficult to try to catch up with work in a new module if you have missed more than two or three weeks of lectures. You should call into the Science Course Office if you wish to change modules.

Faculty of Engineering Mathematics and Science

TR063: Physical Sciences

Junior Fresh module choice form – September 2018

Following the introductory session on Monday 3rd September 2018 at 12.00 noon in the Fitzgerald Building, students will be required to submit this module choice form to the Science Course Office by **12.00 noon** on **Tuesday 4th September 2018.**

BLOCK CAPITALS PLEASE

Name: ______________________ CAO No: ______________________

Date: ______________________ Student No: ______________________

SECOND LEVEL QUALIFICATIONS
Please enter below the grades obtained for subjects taken

SUBJECT	**Leaving Certificate**		**A Level**	**Other** (please indicate)
	H	O		
Physics				
Physics/Chemistry				
Chemistry				
Mathematics				
Applied Maths				
Biology				
Geography				
Geology				
Agricultural Sc.				
Other Science Subject (please indicate)				

PTO

CHOICE FORM: JUNIOR FRESH MODULES FOR 2018/19
(To be completed with help of Adviser)

Please circle appropriate Approved Module Choice

Module Code	Module Title	Semester	Credits					
Core modules – 20 credits per semester								
PYU11P10	Physics 1	1	10	MANDATORY				
PYU11F20	Physics 2	2	10					
MAU11S01	Mathematics 1	1	10					
MAU11S02	Mathematics 2	2	10					
Approved modules – 10 credits per semester				**A**	**B**	**C**	**D**	**E**
CHU11101	General and Physical Chemistry	1	10	✓	✓			
CHU11102	Introduction to Inorganic and Organic Chemistry	2	10	✓				
GSU11004	Spaceship Earth: An introduction to Earth System Science	1	10			✓		
GSU11005	Introduction to Geology: A beginner's Guide to Planet Earth	2	10		✓	✓		✓
BYU11101	From Molecules to Cells	1	10				✓	✓
BYU11102	From Organisms to Ecosystems	2	10				✓	
Total Credits: 30 per semester (20 core and 10 approved)		**Circle Choice:**		**A**	**B**	**C**	**D**	**E**

Signature: ______________________

Date: ______________________

Adviser: ______________________

TR063 Physical Sciences Core Modules

PYU11P10: Physics 1

Semester 1, 10 credits

The most fundamental foundational aspects of any physics education concern the motion of objects due to forces and how to mathematically describe these motions. Collective motions in response to forces lead to propagating physical waves, where similar mathematics can then describe electromagnetic waves or light. The first semester of your Physical Sciences education has an in-depth study of motion, forces, oscillation and light as the key physical concepts upon which to build. Of equal importance to the mathematical description of how the world we live in behaves, as described by a physical law, is an ability to make a measurement to verify or otherwise test the action of a physical law. Hence the physics laboratory plays a key role in the Physical Sciences education where the techniques of physical measurements are introduced together with the fundamentals of the experimental method and the manner in which the results of any experiment can be analysed.

Structure and contact hours

Lectures (4-5 hrs per week); practical laboratory (3hrs per week); online assignments (1 per week) and small group tutorials (1 hr every second week)

Lecture Topics

Introduction to Physics - 1 lectures (M. Möbius)
The Physics of Motion - 22 lectures (M Ferreira)
Waves and Optics I - 20 lectures (L Bradley)
Statistics - 10 lectures (M. Möbius).

Learning outcomes

On successful completion of this module students should be able to:

- Express in mathematical language the motion of a body under the action of forces.
- Describe wave motion and relate it to basic phenomena in light and sound.
- Understand sources of errors in measurements and calculate their propagation.
- Prepare a brief report, which includes an error analysis, of a simple physical experiment.

Syllabus

Introduction to Physics: 1 lecture

An introduction to the School of Physics and the JF Physics course.

The Physics of Motion: 22 lectures

Kinematics: velocity, acceleration, representation of motion through graphs, projectile motion, circular motion; Statics: forces, torque, equilibrium; Dynamics: Force-motion relations, Newton's laws, work, energy, linear and angular momenta, impulse, collisions, conservation laws

Waves and Optics I: 20 lectures

Resonance, harmonic oscillators, SHM, frequency. Waves: standing, travelling, wavelength, wave velocity. Sound: music, vibrations of a string and of a column of air, harmonics, Doppler Effect. Light: Rayleigh scattering, refraction, reflection, dispersion, index of refraction, polarization, polarized reflection, Malus' law, birefringence, total internal reflection, colour vision, gas discharges, lasers. Optics: refracting optics, lenses, real images, focus, focal length, f-numbers, lens equation, cameras, reflecting optics, curved mirrors, telescopes. Interference: superposition of waves, beating, 2 beam interference, anti-reflection coating. Diffraction: Huygen's principle, diffraction by a slit and grating, X-ray diffraction

Statistics: 10 lectures

Systematic and random errors. Discrete and continuous distributions such as binomial, Poisson, Gaussian and Lorentzian. Moments of a distribution. Histograms and probability densities. Estimation of mean and standard deviation in a measurement. Error propagation and transformation of variables in probability distributions. Linear regression analysis, method of least squares, goodness of fit (Chi squared) and plotting techniques. Introduction to programming basics in Python

Methods of Teaching and Student Learning:

A mixture of lectures, small group tutorials, hands-on laboratory practicals and weekly on-line assignments based on both numerical and conceptual questions from the textbook are used in the delivery of this module. The lecture course follows the material in the textbook very closely with reading assignments clearly indicated to students as the lecture course progresses.

The practical sessions are structured to provide an introduction to the process of measurement, estimations of uncertainty (error) and propagation of errors as applied to physics experiments as well as introducing students to programming and data analysis through Python based computational physics experiments. Each experiment has its own specific learning outcomes and is structured to further clarify concepts met in the textbook and lectures thus reinforcing learning.
Weekly homework assignments, typically alternating between topics, are submitted by students through an online system and corrected, with some limited feedback to the student available through the online system post deadline. The lecturer has oversight of the scores and responses to each assignment and can address these in subsequent lectures and tutorials.

Small group tutorials – in groups of 6-8 – meet with assigned academics every second week to introduce and practice the concepts of physics problem solving and the use of mathematics in physics and to develop physics insight in the students. These small group tutorials try to emphasise peer learning within the tutorial format and these problem solving activities provides an additional opportunity for the assigned academic to assess understanding and gauge the knowledge level of the students.

Finally, a number of lecturers use class based polling of student responses to questions using the available “clicker” technologies.

Methods of Assessment and Weighting

Examination – Written examination paper 60%; Laboratory Practical work 30%; online tutorial homework assignments 10%.

Reading List:

- University Physics - extended version with Modern Physics, by Hugh D. Young and Roger A. Freedman, Addison-Wesley, 2016, 14th end.
  Students do NOT buy this book - further information at first lecture of term.
  https://www.pearson.com/us/higher-education/program/Young-University-Physics-with-Modern-Physics-Plus-Mastering-Physics-with-e-Text-Access-Card-Package-14th-Edition/PGM76533.html

Online Assignments:

Online assignments are submitted through the Mastering Physics system where electronic access is associated with the required/provided text book.
https://www.masteringphysics.com/site/login.html

Online Resources:

Software used in the practical laboratory – Logger Pro; as well as examples of Python code for analysis of data in the practical laboratory are available through the School of Physics website:
https://www.tcd.ie/Physics/study/current/undergraduate/Software-and-online-resources/

Module Website:

Visit http://www.tcd.ie/Physics/study/current/undergraduate for links to all Physics modules and to Blackboard for each module.

PYU11P20: Physics 2

Semester 2, 10 credits

The motion and response of electrons due to electric and magnetic forces as well as the energies of electrons in atoms, molecules or metals determine almost all our interactions with our surroundings. The technological era is predicated on the motion of free electrons in electrical circuits, the coupling of motion to electric current and vice versa via magnetic interactions. The behaviour of electrons in atoms, molecules, metals and semiconductors is described by quantum theory which also describes electrons participating in the interaction of light and matter. An introduction to the quantum physics and quantum mechanics of light and electrons in atoms are the next foundational aspects of any physics education and are the heart of the second semester of your Physical Sciences education. Finally, our understanding and ability to observe the universe around us is through the interaction of light and matter, with the structure of the universe governed by the interaction of matter with matter. Gravitational and rotational dynamics determine the structure of the solar system and of the universe, and our knowledge of the universe is through the light we observe across all energy ranges. This is the last of the topics introduced in this first year of your education in the Physical Sciences. The physics laboratory continues in its key role in the Physical Sciences education with further training in experimental methods, analysis techniques and refining of your ability to describe the outcomes of an experiment.

Structure and contact hours:

Lectures (4-5 hrs per week); practical laboratory (3hrs per week); online assignments (1 per week) and small group tutorials (1 hr every second week)

Lecture Topics:

- Electricity and Magnetism - 20 lectures (J. Groh)
- Quantum Physics - 18 lectures (J. Pethica)
- Gravitation and Astrophysics - 12 lectures (A Vidotto)

Learning Outcomes:

On successful completion of this module students should be able to:

- Solve steady state time-varying electric current and electric potential problems
- Solve electrostatic problems using Gaussian Surfaces
- Describe how physics of matter and radiation is underpinned by quantum physics
- Develop the ideas of Newton's Law of Gravitation, with emphasis on it being an inverse square law
- Describe observational insights into the structure and evolution of the Universe

Syllabus:

Electricity and Magnetism I: 20 lectures

Electrostatics: electric charge, Coulomb's law, electric field, electric dipoles, Gauss's law, electric potential energy, voltage, electric polarization, capacitance, dielectrics, Electric current, resistance, Ohm's law, electromotive force, power in electric circuits, Kirchoff's laws, RC circuits. Magnetism, magnetic field lines and flux; Lorentz force on moving charge; Energy of and torque on a current loop in a magnetic field; Biot-Savart Law illustrated by magnetic fields of a straight wire and circular loop; forces between current-carrying straight wires; Ampere's Law in integral form.

Quantum Physics: 18 lectures

Origins of quantum physics. Photoelectric effect. Compton Effect. De Broglie's Postulate. The Uncertainty Principle. Black body radiation and specific heat. Atomic spectra. Bohr model of the atom. Correspondence Principle. Steady-state Schrödinger equation. Particle in a 1-D box. Finite potential well. Simple harmonic oscillator. Particle at potential step. Tunnelling through a barrier. Angular momentum and spin. Quantum theory of Hydrogen atom. The periodic table. Formation of chemical bonds. Quantum information.

Gravitation and Astrophysics: 12 lectures

Motion of the planets: early models of the solar system, Newton's law of gravitation, gravitational potential energy, motion of satellites, Kepler's laws and the motion of planets (derivation of the orbit equation, conservation of angular momentum, properties of the ellipse), apparent weight and the earth's rotation, escape velocity. Our solar system - the planets: physical properties, composition, terrestrial planets, gas giants. Extrasolar planets: detection methods. Observing the universe: refracting telescopes, reflecting telescopes, space telescopes, radio observations. The Sun: physical properties, solar interior, solar surface and atmosphere. Stars: constellations, magnitudes, distances, size of stars, the Hertzprung-Russell Diagram, introduction to stellar evolution. Galaxies: the Milky Way, other galaxies, dark matter. Origin and evolution of the universe: the expansion of the universe, age of the universe, big bang models, cosmic microwave background.

Methods of Assessment and Weighting:

Examination – Written examination paper 60%; Laboratory Practical work 30%; online tutorial homework assignments 10%.

Reading List:

- University Physics - extended version with Modern Physics, by Hugh D. Young and Roger A. Freedman, Addison-Wesley, 2016, 14th end.
  Students do NOT buy this book - further information at first lecture of term.
  https://www.pearson.com/us/higher-education/program/Young-University-Physics-with-Modern-Physics-Plus-Mastering-Physics-with-e-Text-Access-Card-Package-14th-Edition/PGM76533.html

Online Assignments:

Online assignments are submitted through the Mastering Physics system where electronic access is associated with the required/provided text book.
https://www.masteringphysics.com/site/login.html

Online Resources:

Software used in the practical laboratory – Logger Pro; as well as examples of Python code for analysis of data in the practical laboratory are available through the School of Physics website:
https://www.tcd.ie/Physics/study/current/undergraduate/Software-and-online-resources/

Module Website:

Visit http://www.tcd.ie/Physics/study/current/undergraduate for links to all Physics modules and to Blackboard for each module.

PYU11P10 and PYU11P20: Physics 1 and Physics 2 Laboratory Practicals - CORE

Summary of Laboratory Practicals

Across Physics 1 and Physics 2 modules students complete 2 computational physics experiments (using Python) and 16 out of 20 available bench experiments for a total of 18 experiments performed by the student in the academic year. Many of the laboratory experiments are available on the bench in both semesters and thus the progress of students through the experiments differs from student to student with the exception of the computational physics experiments which all students complete. Students are required to record all data and information related to experiments in a hardback practical laboratory notebook which is assessed.

Laboratory Practicals

Introduction to Python
Python lab 1: Monte Carlo Approximation
Python lab 2: The Trajectory of a Projectile with Friction
Experiment 1: The Pendulum
Experiment 2: Energy Conservation
Experiment 3: Thin Lenses
Experiment 4: Density and the Principle of Archimedes
Experiment 5: Surface Tension
Experiment 6: Electrical Resistance
Experiment 7: DC Circuits
Experiment 8: Charging/Discharging a Capacitor
Experiment 9: Collisions and Momentum Transfer
Experiment 10: The Resonance Tube
Experiment 11: Leslie's Cube
Experiment 12: Faraday's Law
Experiment 13: Aperture and Depth of Field
Experiment 14: Interference and Diffraction
Experiment 15: The Geiger Counter
Experiment 16: Centripetal Acceleration
Experiment 17: The Photoelectric Effect
Experiment 18: The Bandgap of Germanium
Experiment 19: The Spectrometer
Experiment 20: AC circuits

Online Resources:

Software used in the practical laboratory – Logger Pro; as well as examples of Python code for analysis of data in the practical laboratory are available through the School of Physics website:
https://www.tcd.ie/Physics/study/current/undergraduate/Software-and-online-resources/

Assessment of the laboratory

Half of a student's experiments are assessed through an at-the-bench laboratory notebook assessment – the rest of the students experiments are assessed through written reports of the experiment. In all experiments both the laboratory notebook and the submitted experimental reports must include and require a complete data analysis, error estimation and statistical analysis and description and concise report of the outcomes of the experiment, and any inferences or conclusions that can be drawn from the outcome. A similar assessment requirement applies to the python based computational physics experiments, with the addition of assessment of the code used by the student.

Junior Fresh Physics Coordinator

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MAU11S01: Mathematics for Scientists 1

Semester 1, 10 credits

Contact hours:

11 weeks, 6 lectures + 2 tutorials per week
This is the first semester module of a two semester sequence. It leads on to module MAU11S02 in the second semester.

Module Personnel

Prof. Kirk Soodhalter and Prof. Anthony Brown

Learning outcomes:

On successful completion of this module students will be able to

- Manipulate vectors to perform algebraic operations on them such as dot products and orthogonal projections and apply vector concepts to manipulate lines and planes in space R3 or in Rn with n≥4.
- Use Gaussian elimination techniques to solve systems of linear equations, find inverses of matrices and solve problems which can be reduced to such systems of linear equations.
- Manipulate matrices algebraically and use concepts related to matrices such as inevitability, symmetry, triangularity, nilpotence.
- Manipulate numbers in different bases and explain the usefulness of the ideas in computing.
- Use computer algebra and spreadsheets for elementary applications.
- Explain basic ideas relating to functions of a single variable and their graphs such as limits, continuity, inevitability, even/odd, differentiability and solve basic problems involving these concepts.
- Give basic properties and compute with a range of rational and standard transcendental functions, for instance to find derivatives, antiderivatives, critical points and to identify key features of their graphs.
- Use a range of basic techniques of integration to find definite and indefinite integrals.
- Apply techniques from calculus to a variety of applied problems.

Module content:

The content is divided in two sections, one for each lecturer.
Calculus with applications for Scientists
The lecturer for this part will be Prof. Anthony Brown. The main textbook will be [Anton] and the syllabus will be approximately 7 Chapters of [Anton] (numbered differently depending on the version and edition)
Chapter headings are

- Before Calculus (9th Ed) {was `Functions' in the 8th edition};
- Limits and Continuity;
- The Derivative;
- The Derivative in Graphing and Applications;
- Integration;
- Exponential, Logarithmic and Inverse Trigonometric Functions;

Discrete Mathematics for Scientists
The lecturer for this part will be Prof. Kirk Soodhalter.
The order of the topics listed is not necessarily chronological. Some of the topics listed below linear algebra will be interspersed with linear algebra.

- **Linear algebra**
  The syllabus for this part will be approximately chapters 1, 3 and parts of 10 from [AntonRorres].
    - Vectors, geometric, norm, vector addition, dot product
    - Systems of linear equations and Gauss-Jordan elimination;
    - Matrices, inverses, diagonal, triangular, symmetric, trace;
    - Selected application in different branches of science.
- **Computer algebra.**
  An introduction to the application of computers to mathematical calculation. Exercises could include ideas from calculus (graphing, Newton's method, numerical integration viatrapezoidal rule and Simpsons rule) and linear algebra. We will make use of the computational software Mathematica which is used in many scientific applications.
- **Spreadsheets.** A brief overview of what spreadsheets do. Assignments based on Google docs.
- **Numbers.** An introduction to numbers and number systems e.g. binary, octal and hexadecimal numbers and algorithms for converting between them.

Recommended reading list:

[Anton]
Combined edition: Calculus: late transcendentals: Howard Anton, Irl Bivens, Stephen Davis 10th edition (2013) (Hamilton Library 515 P23*9)
Or
Single variable edition.

[AntonRorres]
Howard Anton & Chris Rorres, Elementary Linear Algebra with supplementary applications. International Student Version (10th edition). Publisher Wiley, c2011. [Hamilton 512.5 L32*9;-5, S-LEN 512.5 L32*9; 6-15]

Assessment details:

This module will be examined in a 3 hour **examination** in Trinity term. Assignments and tutorial work will count for 20% of the marks. There will be final examination in April/May counting for the remaining 80%. For supplementals, if required, the supplemental exam will count for 100%.

Module Coordinators for MAU1S001

Professor Kirk Soodhalter	E-mail: ksoodha@maths.tcd.ie ph. 01/896 8515
Professor Anthony Brown	E-mail: anthony.brown@ucd.ie
General enquires:	E-mail: mathdep@maths.tcd.ie

MAU11S02: Mathematics for Scientists 2
Semester 2, 10 credits

Contact hours:
11 weeks, 6 lectures + 2 tutorials per week

Module personnel
Prof. Miriam Logan and Prof Colm O'Dunlaing

Learning outcomes:

On successful completion of this module students will be able to:

- Apply definite integrals to various geometric problems.
- Apply various methods of integration.
- Use the concept of differential equations and methods of their solution.
- Use the concept of infinite series and their convergence; Taylor series.
- Use the concepts of parametric curves and polar coordinates.
- Define and calculate determinants by cofactor expansion and through upper triangular form.
- Use Cramer's Rule to solve linear equations.
- Use the Adjoint Matrix to invert matrices.
- Construct bases for row space, column space, and nullspace of a matrix.
- Construct orthonormal bases in three dimensions.
- Calculate the matrices of various linear maps.
- Compute linear and quadratic curves matching data through least squared error criterion.
- Calculate eigenvalues and eigenvectors for 2x2 matrices, with applications to differential equations.
- Derive probability distributions in simple cases.
- Apply the Binomial Distribution.
- Compute the conditional probability $P(A_i \mid D)$ given $P(D|A_i)$.
- Apply the Poisson distribution to traffic-light queuing problems.
- Apply continuous distributions, Normal, chi-squared, Student's t-distribution.
- Obtain confidence intervals for mean and standard deviation.
- Apply the Central Limit Theorem to approximate the binomial distribution for large n.
- Perform basic hypothesis testing.

Module content:

The content is divided in two sections, one for each lecturer.

Calculus with applications for Scientists

The lecturer for this part will be Prof Miriam Logan

- Application of definite integrals in geometry (area between curves, volume of a solid, length of a plane curve, area of a surface of revolution).
- Methods of integration (integration by parts, trigonometric substitutions, numerical integration, improper integrals).
- Differential equations (separable DE, first order linear DE, Euler method).
- Infinite series (convergence of sequences, sums of infinite series, convergence tests, absolute convergence, Taylor series).
- Parametric curves and polar coordinates.

Discrete Mathematics for Scientists

The lecturer for this part will be Prof Colm O Dunlaing

Module Content:

Linear Algebra

- This reference for this part of the course will be (AntonRorres). The syllabus will be approximately chapters 2, 5, section 4.2 and a selection of application topics from chapter 11 of (AntonRorres).
- Determinants, Evaluation by Row Operations and Laplace Expansion, Properties, Vector Cross Products, Eigenvalues and Eigenvectors;
- Introduction to Vector Spaces and Linear Transformations. Least Squares Fit via Linear Algebra;
- Differential Equations, System of First Order Linear Equations;
- Selected Application in Different Branches of Science;

Probability

- Basic Concepts of Probability; Sample Means; Expectation and Standard Deviation for Discrete Random Variables; Continuous Random Variables; Examples of Common Probability Distributions (binomial, Poisson, normal) (sections 24.1 - 24.3, 24.5 - 24.8 of (Kreyszig).

Recommended reading lists:

(Stewart)
Single Variable Calculus 7th ed. Early Transcendentals by James Stewart.

(Anton)

- Combined edition:
- Calculus: late transcendentals: Howard Anton, Irl Bivens, Stephen Davis 10th edition (2013) (Hamilton Library 515P23*9)

Or

- Single variable edition.

(AntonRorres)

- Howard Anton & Chris Rorres, Elementary Linear Algebra with supplementary applications. International Student Version (10th edition). Publisher Wiley, c2011. (Hamilton 512.5L32*9; - 5, S-LEN 512.5 L32*9;6-15):

Recommended References:
(Kreyszig)

- Erwin Kreyszig, Advanced Engineering
- Erwin Kreyszig, Advanced Engineering Mathematics (10th edition), (Erwin Kreyszig in collaboration with Herbert Kreyszig, Edward J. Normination), Wiley 2011 (Hamilton 510.24 L21*9)

(Thomas) Thomas' Calculus, Author Weir, Maurice D. Edition 11th Ed/based on the original work by George B. Thomas, Jr., as revised by Maurice D. Weir, Joel Hass, Frank R. Giordano, Publisher Boston, Mass., London: Pearson/Addison Wesley, c2005. (Hamilton 515.1 K82*10;*)

Module Prerequisite:
MAU1S001 Mathematics for Scientists 1 (First Semester)

Assessment details:
This module will be examined in a 3 hour **examination** in Trinity term. **Continuous assessment** in the form of weekly tutorial work will contribute 20% to the final grade at the annual examinations, with the examination counting for the remaining 80%. For supplementals if required, the supplemental exam will count for 100%.

Module Coordinators for MAU1S002

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Professor Colm O'Dunlaing	Ph: 01 896 1948 E-mail: odunlain@maths.tcd.ie
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TR063: Physical Sciences – APPROVED MODULES

BYU11101: From Molecules to Cells

Semester 1, 10 credits

Module learning aim:

This module aims to provide an introduction to molecular and cellular biology, and will therefore include key topics in Cell Biology, Biochemistry, Genetics, and Microbiology. A description of the possible origin of life, from the abiotic world to single-celled and multicellular organisms will be given, and the ultrastucture of the prokaryotic and eukaryotic cells will be covered in detail. The properties and functions of the major classes of biochemicals found in living systems (carbohydrates, lipids, proteins and nucleic acids) will be described, the structure and function of membranes and organelles, and the chemical basis of metabolism and energy transfer in the cell. Students will then be introduced to basic concepts in Genetics, how the information contained in DNA (genes) is expressed, replicated and inherited. Finally, the sheer diversity of life forms, from viruses to prokaryotic and eukaryotic microorganisms, to more complex plant and animal life forms will be described. Students will also study cell and virus structure, cell growth and viral replication, agents of infectious diseases, and host immunity.

Learning outcomes:

On successful completion of the module, students will be able to:

1. Provide an account of the cellular basis of life: from its origins in the abiotic world, to the evolution of unicellular and multicellular organisms.
2. Describe the diversity of life forms: including viruses, Prokaryotes (bacteria), Archaea, and Eukaryotes (unicellular organisms, animals and plants).
3. Provide an account of the chemical basis of life and the biochemistry on which living systems depend: the properties and functions of the major classes of biomolecules, the structure and function of membranes and organelles, and the chemical basis of metabolism and energy transfer.
4. Describe how the information contained in DNA (genes) directs the construction and growth of an organism, and how this information is replicated and transmitted from one generation to the next (inheritance; genetics).
5. Employ a range of laboratory techniques, demonstrating the development of practical scientific skills, knowledge of experimental design and the interpretation of results.
6. Apply the scientific method as a fundamental approach to experiment-based investigations, critical analysis of data, and problem solving.

Module content:

Lectures	Topic and Content
Lecture 1	**Module: Introduction, objectives and overview.** **Module Coordinator** (Professor Tony Kavanagh)

SECTION 1 **Origin of Life - Cellular basis of life - Diversity of Life Forms** (11 lectures)

Lecture 2 & 3: Origin of Life (Professor Luke O'Neill)
- What is Life? How did it arise?
- The Origin of Life from a chemical and cellular perspective. The abiotic world.
- The prebiotic world. Miller-Urey experiment. The first cell.
- Photosynthesis and oxygen – mass extinction. Origin of first eukaryotic cell.
- Multicellular life. Cell specialization.

Lecture 4 – 6: Cellular basis of life (Professor Fred Sheedy)
- Cell structure – Prokaryotes, Archaea, Eukaryotes - Animal and Plant
- Organelles & their prokaryotic origin – Mitochondria, Chloroplasts
- Mitosis and Meiosis – Cell division – Regulation of cell division (introduction)

Lecture 7 – 12: Diversity of Microbial Life (Professor Alastair Fleming)
- The Tree of Life (Professor Alastair Fleming)

Lecture 8-**Bacteria** (Professor Alastair Fleming)
- Cell structure, morphology, function and habitat.

Lecture 9- **Fungi & Protists** (Professor Alastair Fleming)
- Fungal cell structure, morphology, function and habitat.
- Protist cell structure, morphology, habitat and life-cycles: extreme cell diversity.

Lecture 10- **The Archaea** (Professor Alastair Fleming)
- A third way of life; features of both prokaryotes and eukaryotes: cell structure, morphology and function. Extremophiles.

Lecture 11-**Viruses** (Professor Alastair Fleming)
- Alive? Structure, function and habitat.

Lecture 12 – **Relationship between life forms**: (Professor Alastair Fleming)
- The good, the bad and the ugly. Concepts of Symbiosis and Parasites. Plant and animal diseases.

Lecture 13 **Summary of key concepts: Q&A Profs. LO'N, FS, AF**

ONLINE ASSESSMENT OF SECTION 1 via MCQ

SECTION 2 **Chemistry of Life** (11 lectures)

Lecture 14: Introduction to biochemistry:
Structural principles for small molecules (Professor Luke O'Neill)
- Elements and chemical groups commonly found in Nature
- Bonds, bond energies, bond lengths in Nature.
- Asymmetry: right and left-handed molecules etc.
- Typical forces between molecules and chemical groups in nature
- Four basic classes of Biomolecules: Amino acids, Nucleotides, Carbohydrates & Lipids

Lecture 15: Nucleotides, Amino acids and peptides (Professor Luke O'Neill)
- Classes of nucleic acids (DNA, RNA), Chromatin and chromosome structure, Properties of amino acids: chemical features and physical properties of the R-groups.
- The peptide unit and peptide bond
- Introduction to polypeptides & concept of folding

Lecture 16: Proteins and protein structure (Professor Luke O'Neill)
- Concept that shape dictates function
- Hierarchical organization of protein structure: concept of primary, secondary, tertiary and quaternary structure.
- Introduction to forces that stabilize protein structure

Lecture 17: Protein function (Professor Luke O'Neill)
- Major functional classes of protein
- Introduction to bioinformatics: Proteins and evolution; relationships between proteins: similarity and identity.

Lecture 18, 19: Enzymes: the catalysts of life (Professor Vincent Kelly)
- Enzyme structure & function
- Enzyme reaction mechanism (co-factors and vitamins)
- Enzyme kinetics
- Regulation of enzyme activity

Lecture 20: Lipids and membranes (Professor Vincent Kelly)
- Lipid structures: fatty acids, phospholipids etc.
- Membranes: chemical and physical properties
- Membrane proteins
- Transport across membranes
- Concept of compartmentation and membrane traffic

Lecture 21, 22: Metabolism & major metabolic pathways (Professor Vincent Kelly)
- The starting point: introduction to carbohydrates and fatty acids
- Organization, energetic principles, key steps and links between the main metabolic pathways.
- Glycolysis, TCA cycle, beta oxidation
- Outline of the reversing catabolic pathways: gluconeogenesis and fatty acids synthesis.

Lecture 23: Mitochondria & Respiration (Professor Vincent Kelly)
- Mitochondria, redox reactions and energy transduction
- Electron transport and the electron transport chain
- Oxidative phosphorylation
- Coupling of oxidation to phosphorylation: chemiosmotic view of energy transduction (in brief).

Lecture 24: Chloroplasts and Photosynthesis (Professor Vincent Kelly)
- Chloroplasts: architecture and function
- Overview of the light and dark reactions of photosynthesis

Lecture 25 **Summary of key concepts: Q&A Profs. LO'N, VK**

ONLINE ASSESSMENT OF SECTION 2 via MCQ

SECTION 3 Biological Information: Genetics, Heredity and DNA (11 lectures)

Lecture 26: Introduction to Genetics (Professor Jane Farrar)
- Introduction to the course content: An outline of some core concepts from classical genetics to the present will be presented. A whistle stop tour of key discoveries in the history of genetics.

Lecture 27: Mendelian Genetics: (Professor Jane Farrar)
- Mendel's laws: the 1st law of segregation and the 2nd law of independent assortment using monohybrid and dihybrid crosses; concepts relating to genetic analysis and the use of model systems will be described. Inheritance patterns for single gene disorders will be presented - pedigree analysis.

Lecture 28 and 29: Linkage and recombination (Professor Jane Farrar)

- Meiosis and the role of 'crossing over' in gene mapping (meiosis covered in detail elsewhere). A brief recap regarding Mendelian genetics – for example, highlighting that genetic linkage breaks Mendel's 2nd law of independent assortment (refer back to L27).
- Outline of key concepts underlying the generation of genetic maps. Reference will be made to some classical work by Sturtevant and Morgan.

Lecture 30: Identification of DNA as hereditary material (Professor Jane Farrar)
- Key experiments establishing DNA as the genetic material; bacterial transformation and its significance (Griffith / Avery, McLeod & McCarthy / Hershey-Chase); the concept of horizontal gene transfer (mechanisms transformation, conjugation, transduction). Differences in vertical and horizontal gene transfer.

Lecture 31: Quantitative Genetics (Professor Jane Farrar)
- An overview of some concepts relating to discrete variation versus continuous variation. Experiments demonstrating that quantitative traits are inherited.
- Examples of some quantitative traits in humans. Concepts regarding the use of GWAS to elucidate the genetics architecture of complex traits using an example of one or more disorders.

Lecture 32: DNA, Structure and Function (Professor Tony Kavanagh)
- The double helix - discovery of the structure of DNA – DNA composition - DNA replication semi-conservative replication, replication forks, leading and lagging strand synthesis, DNA polymerases.
- DNA replication in prokaryotes and eukaryotes.

Lecture 33 - 35: Information flow in the cell - The Central Dogma (Professor Tony Kavanagh)**.**
- Transcription, RNA Polymerases in prokaryotes and eukaryotes.
- Promoters, repressors, terminators – the *lac* operon; transcription factors, enhancers.
- Decoding the information in mRNA
- Translation (Protein synthesis).
- Ribosomes in prokaryotes and eukaryotes, tRNAs and aminoacyl tRNA synthetases, the genetic code; translation;
- Introduction to the regulation of gene expression – positive and negative regulation

Lecture 36: DNA –Mutation and its consequences (Professor Tony Kavanagh)
- Mechanisms by which mutations are generated.
- The different types of mutation (missense, nonsense, frameshift mutations) and their molecular consequences in relation to gene expression and protein function. Mutations causing inherited diseases and cancer.
- DNA repair – mechanisms of DNA repair; repair deficiency and disease.

Lecture 37 **Summary of key concepts: Q&A Profs. GJF, TK**

ONLINE ASSESSMENT OF SECTION 3 via MCQ

Lecture 38 **Module: overview and objectives.**
Module Coordinator (Professor Tony Kavanagh)

Recommended reading lists:

(1) Campbell Biology, 11th Edition By Lisa A. Urry, Michael L. Cain, Steven A. Wasserman, Peter V. Minorsky, Jane B. Reece (Published by Pearson (2018))

Contact Hours/Methods of Teaching and Student learning.

65 hours consisting of a mixture of lectures, tutorials and hands-on laboratory practicals. The practical sessions are formatted in order to further clarify concepts thus reinforcing learning. A tutorial problem solving activities provides an additional opportunity for the lecturer to assess understanding and gauge the knowledge level of the students.

Method of assessment

Continuous assessment 50%

- Laboratory practical assessment: 35%
- Online Assessment via multiple choice questions (MCQ) 15%: there will be three MCQ online assessments, each worth 5%

Written Examination 50%

One written examination paper of 1.5 hour duration. –
There will be three sections on the examination paper:

- Section 1 will have 2 questions on Section 1 of the module (Origin of Life) you are required to answer 1 question from this section
- Section 2 will have 2 questions on Section 2 of the module (Chemistry of Life) you are required to answer 1 question from this section
- Section 3 will have 2 questions on Section 3 of the module (Biological Information) you are required to answer 1 question from this section
- All questions carry equal marks

Module coordinator - BYU11101 From Molecules to Cells

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Executive Officer

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BYU11102: From Organisms to Ecosystems
Semester 2, 10 credits

Module learning aim

The Organisms to Ecosystems module aims to introduce students to the biology of individuals, species, populations and ecosystems, and explore how humans interact with other living organisms. It will cover the developmental biology of organisms, their physiology, brain function and the evolutionary and ecological responses of organisms to their environment. Topics incorporate the diversity of life and its biological development, interactions between organisms and their environment, the biological context of climate change, human impacts on the environment, future food sustainability, urban ecology, ecosystem services and the value and conservation of biodiversity. Topics are arranged in three sections: 1) Multicellularity and Development, Physiology, Behaviour and Neuroscience, 2) Evolution: Adaptation, Populations and Biodiversity, and 3) Ecology and Environment.
A mixture of lectures, tutorials and hands-on laboratory practicals are used in the delivery of this module. There will be one - ecology practical - on a field site outside of campus. Essay writing skills are developed through tutorial sessions.

Learning outcomes

On successful completion of this course, the student will be able to:

1. Outline the major steps involved in how complex animal and plants are formed and be able to relate the morphological changes that occur to the molecular and cellular changes that underlie and drive embryo and organ development
2. Describe the concept of homeostasis at the cell, organ and organism level; give examples of the functional interrelationships that exist between cells, organs and systems; provide an account of how organisms can sense change in the environment
3. Describe the basic principles by which the brain functions and outline key experimental steps and informative clinical cases that have elucidated our current understanding of brain function.
4. Recognise the diversity of life on earth and describe how it evolved over geological time scales
5. Describe the ecological relationships between individuals, populations, communities and ecosystems, and between organisms and their environment
6. Recognise how humans can positively and negatively influence other living organisms and their environment and understand the value of other living organisms for humans
7. Demonstrate practical, numerical and analytical skills
8. Collate, synthesise, organise and present information in written reports

Module content:

Lectures	Topic and Content
Lecture 1	**Lecture 1 Module: Introduction, objectives and overview.** Module Coordinator Professor Trevor Hodkinson
SECTION 1A	**Multicellularity and Development** (Professor Rebecca Rolfe) (5 Lectures) **Lecture 2 - Introduction to development** - core concepts / model organisms / analysis of development (morphology, genetic, biochemical) **Lecture 3 - Embryogenesis and morphogenesis** - germ layers **Lecture 4 - Intercellular communication, determination, potency, axis formation** - anterior-posterior, dorsal-ventral. **Lecture 5 Pattern formation** - morphogens, gradients and thresholds. **Lecture 6 Differential gene expression** - temporal and spatial, master regulators
SECTION 1B	**Physiology and Neuroscience** (Professor Áine Kelly and Professor Tomas Ryan) (6 Lectures) **Lecture 7 - Form and Function** (Professor Áine Kelly) - Functional characteristics of living things - Specialisation of cells/tissues/organs to fulfill specific functions **Lecture 8 – Homeostasis** (Professor Áine Kelly) - The concept of the internal environment. Composition, temperature, pH etc. of body fluids. Maintenance of homeostasis by cooperation of different physiological systems. Feedback and feed-forward **Lecture 9 - Physiological regulation of function** (Professor Áine Kelly) - Fundamentals of nervous and endocrine control of function and comparison of speed and modes of action**.** How an individual organism senses and responds to changes in the external and internal environments. - **Behaviour and Neuroscience** (Professor Tomas Ryan) **Lecture 10 - Pre-neuroscience history of mind/brain ideas** - Cartesian dualism and materialist and non-materialist explanations of mind. The brain as the substrate of mind. The effects of head trauma on behaviour and memory, anatomy of the human/mammalian brain, functions in behaviour and in homeostasis, overview of human brain regions and attribution of various regions to broad functions (evidence from lesions, imaging). **Lecture 11 - Fundamentals of nervous system structure and function** - Reticular vs. neuron theory, nervous system as electrically active, Helmholtz and excitable neurons, action potentials & synaptic transmission. **Lecture 12 - Introduction to the biology of memory storage** - Challenges of integrating neurobiology and brain function at multiple levels. Reductionism and correlation vs. causation. The biology of memory storage.
Lecture 13	**Summary of key concepts: Q&A Profs. Rolfe, Kelly and Ryan**
	ONLINE ASSESSMENT ON SECTIONS 1A and 1B via MCQ
SECTION 2	**Evolution: adaptation, populations, biodiversity** (Professor Trevor Hodkinson) (11 Lectures) **Lecture 14 - Short history of life** - timeline, major groups, diversity.

Lecture 15 - Selection/modern synthesis
- adaptation

Lecture 16 - Species
- Definitions, taxonomy, diversity, species rich groups

Lecture 17 - Speciation
- allopatric, sympatric, adaptation, radiations, key innovations

Lecture 18 – Extinction
- fossils, global change (climate, atmosphere, tectonic)

Lecture 19 - Phylogeny, homology, convergence, reversals, methods
Lecture 20 - Genetic basis of selection (Professor Aoife McLysaght)
Lecture 21 - Genetic basis of evolution
- Molecular variation, neutral theory, drift

Lecture 22 - Genetic basis of evolution
- Molecular evolution of population genetic variation

Lecture 23 - Genetic basis of evolution
- Population genetic variations

Lecture 24 - Human evolution

Lecture 25 **Lecture 25 - Summary of key concepts: Q&A Profs. Hodkinson & McLysaght**

ONLINE ASSESSMENT ON SECTION 2 via MCQ

SECTION 3 **Ecology and Environment** (Professor Jennifer McElwain & Professor Yvonne Buckley) (11 Lectures)

Global ecology (Professor Jennifer McElwain)
Lecture 26 - Global ecology and climate change
- Future climate change – global challenges – projections
- Pest diseases, human physiology, how to predict
- Need to understand fundamentals of ecology to address these global challenges

Lecture 27 - Biomes, niches
- Introduction to biomes, what shapes biome distribution? climate change
- concepts – climate niches / fundamental versus realized niche
- challenge of predicting future ecological responses to climate change

Populations to communities: challenges & solutions (Professor Yvonne Buckley)
Lecture 28 - Commonness, rarity and population processes (Professor Yvonne Buckley)
- Extinction or persistence are processes that operate at the population level.
- Introduction to concepts of abundance and rarity, competition, dispersal, demography and its application to conservation (incl. endemism and invasions)

Lecture 29 - Conservation
- applications of population biology at the species level, including prioritizing species for conservation management, assessing threat and red listing

Lecture 30 - Trophic cascades and rewilding
- What is a community**,** energy flow, applications of community ecology to conservation and rewilding challenges. Consumption, facilitation & predation

Lecture 31 - Constructing ecosystems and conservation
- In the Anthropocene humans have constructed new ecosystems, what are they, where do we find them and what are their values? Contrast with “natural” ecosystems

Lecture 32 - Urban ecology
- How have organisms adapted to living in urban environments? How can we better design our cities and buildings to gain more value from nature and support

biodiversity?

Lecture 33 - Ecosystem services and natural capital

- Nature provides many valuable ecosystem services supported by natural capital
- Introduction to the concepts and controversies surrounding the ecosystem services and natural capital concepts

Food and feedbacks (Professor Jennifer McElwain)

Lecture 34 - Food: environmental impacts and ecological process

- Food security- ecological concepts- productivity- energy flows through ecological systems/basic concepts of biogeochemical cycles.

Lecture 35 - Future food and a changing planet

- Food security
- Ecological concepts, human population increase, projections for future productivity.

Lecture 36 - Biosphere feedbacks on climate system

- Introduction to biological feedbacks on the climate system: at global level
- Carbon sequestration/ transpiration/ water budget, within biomes
- Fire feedbacks/rain seeding. Nature based solutions to climate mitigation and adaptation
- Green and blue solutions – cities etc., 'The Martian' closed systems

Lecture 37 **Lecture 37 - Summary of key concepts: Q&A Profs. Buckley & McElwain**

ONLINE ASSESSMENT ON SECTION 3 via MCQ

Lecture 38

Lecture 38 - Module: Overview and integration of all concepts

Module Coordinator -Trevor Hodkinson

Recommended reading lists:

(1) Campbell Biology, 11th Edition By Lisa A. Urry, Michael L. Cain, Steven A. Wasserman, Peter V. Minorsky, Jane B. Reece (Published by Pearson (2018))

Contact Hours/Methods of Teaching and Student learning.

65 hours consisting of a mixture of lectures, tutorials and hands-on laboratory practicals. The practical sessions are formatted in order to further clarify concepts thus reinforcing learning. A tutorial problem solving activities provides an additional opportunity for the lecturer to assess understanding and gauge the knowledge level of the students.

Method of assessment

Continuous assessment 50%

- Laboratory practical assessment: 35%
- Online Assessment via multiple choice questions (MCQ) 15%: there will be three MCQ online assessments, each worth 5%

Written Examination 50%

One written examination paper of 1.5 hour duration

There will be three sections on the examination paper:

- Section 1 will have 2 questions on Sections 1A and 1B of the module (Multicellularity and Development; **and** Physiology and Neuroscience) you are required to answer 1 question from this section
- Section 2 will have 2 questions on Section 2 of the module (Evolution: adaptation, populations, biodiversity) you are required to answer 1 question from this section

- Section 3 will have 2 questions on Section 3 of the module (Ecology and Environment) you are required to answer 1 question from this section
- All questions carry equal marks

Contacts:

Module coordinator - BYU11102 From Organisms to Ecosystems

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Executive Officer
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CHU11101: General and Physical Chemistry
Semester 1, 10 credits

Rationale and Aims:

To provide a general introduction to chemistry and physical chemistry and equips the student with the knowledge to understand the basic concepts in chemistry, understanding of the building principles of matter, chemical bonding and molecular structure, an introduction to thermodynamics, electrochemistry, acid/base reactions and to the chemistry of liquids, solids and solutions.

Learning outcomes

- Explain, using appropriate terminology and physical units, basic concepts in chemistry, including precipitation and redox reactions.
- Analyse bonding and molecular structure
- Apply the ideal gas law to calculations of gas properties
- Describe the principles underpinning the kinetic theory of gases
- Analyse and identify the main types of intermolecular forces
- Identify and explain the principal features of the phase diagrams of pure compounds, including pressure dependence of melting and boiling points, triple point and critical point, and variation of vapour pressure with temperature.
- Calculate chemical equilibria and illustrate the key concepts, including variation of components with concentration, temperature and pressure
- Discuss simple acid/base chemistry and apply to solution equilibria
- Illustrate the basic concepts of an electrochemical cell, including half-cell reactions, cell potential and reaction free energy and be able to determine these properties as well as concentration dependence
- Describe the main classes of the solid-state structure; cubic- and hexagonal close packing; body-centred and face-centred cubic structures: NaCl and CsCl. Octahedral and tetrahedral holes, coordination numbers, the Born-Haber cycle, lattice energy
- Identify, describe and analyse the factors affecting solubility.
- Define and explain colligative properties, including Raoult's Law and the calculation of molecular weights
- Understand and apply the concepts underlying the First and Second Laws of Thermodynamics to numerical problems

Assessment details:

This module will be examined via a combination of in-course assessments (25% of the final mark) and a 3 h paper at the end of semester 1 (75% of the final mark).

CHU11102: Introduction to Inorganic and Organic Chemistry

Semester 2, 10 credits

Rationale and Aims:

The first part of this module introduces the student to the structure, bonding and reactivity of simple functional groups in organic chemistry. The emphasis is on understanding reaction mechanisms, in terms of the inherent reactivity and polarisation of the two reaction components, which allows the mechanism to be understood, and also facilitates the student to spot patterns and similarities between different reaction mechanisms, which makes learning easier. The second part of this module covers inorganic chemistry, with emphasis on understanding and explaining the similarities and differences that arise in the properties of elements in the periodic table.

Learning outcomes

- Identify and explain bonding, hybridisation and mechanisms.
- Describe and explain the chemistry of functional groups (alkanes, alkenes and alkynes, aromatics, alkylhalides, alcohol, aldehydes, ketones and amines) and their applications.
- Analyse and discriminate between mechanisms in terms of the inherent reactivity/polarisation etc. of the two reaction components.
- Identify and classify chiral centres in organic molecules.
- Describe the chemical and physical properties of elements as a function of their position in the periodic table.
- Determine and explain the origin of the trends within groups and across periods of the properties of elements in the periodic table.
- Describe the typical structures of some common compounds of the main group elements.
- Classify elements as metallic/metalloid/non-metallic and contrast their characteristic properties.
- Explain the practical and industrial uses of key elements and compounds, and relate these to their properties.

Module Prerequisite:

CHU11101 General and Physical Chemistry (First Semester)

Assessment details:

This module will be examined via a combination of in-course assessments (25% of the final mark) and a 3 h paper at the end of semester 2 (75% of the final mark).

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GSU11004: Spaceship Earth: An introduction to Earth System Science
Semester 1, 10 credits

More than 7 billion people now inhabit the Earth and no corner of the planet is unaffected by human activity. The rise of our species has been fuelled by our ability to access planetary storehouses of energy and employ this to manipulate the environments around us. The global-scale of human impacts has led some to suggest we are entering a new era of Earth history - the Anthropocene. Dealing with the effects of environmental and climate change is one of the most significant challenge that our species faces in the 21st century.

This module provides a foundation for understanding global environmental issues by considering the Earth as an interconnected system in which matter and energy are exchanged between the Geosphere, Biosphere, Atmosphere, Hydrosphere and the Anthroposphere. It considers the life-support systems of 'spaceship Earth' and aims to provide a theoretical basis for evaluating the role of humans as agents of climate and environmental change.

Module learning aims

To provide foundation-level knowledge of:

- Fundamental concepts of Earth systems science and the theoretical basis of the 'systems approach' in Geography and Geoscience
- Character and scope of Earth's principal sub-systems: Geosphere, Hydrosphere, Atmosphere, Biosphere and Anthroposphere
- Composition / structure of the solid Earth (Geosphere) and the principal processes / drivers responsible for its formation and evolution
- Composition / structure of atmosphere and ocean, the physical processes / drivers of their circulation, and the nature of coupling between them
- Weather and climate at a global scale including climate change past, present and future
- Biogeochemical cycling and the role of interconnected biotic and abiotic systems in the maintenance of life on Earth
- Ecological and historical biogeography including fundamentals of ecology, evolution and extinction
- Nature and scope of human impacts on the Earth system including the 'Anthropocene' concept

To develop the following skills & graduate attributes:

- Digital skills to manipulate and analyse geographical data, including use of Google Earth and Excel
- Self-motivated and reflective approach to independent learning, including completion of assigned reading, activities and formative assessment
- Make connections between a student's core subject areas and the field of geography & geoscience

Module Learning Outcomes

On successful completion of this module students will be able to:

- Outline the fundamental concepts of Earth Systems Science with reference to its major subsystems: Geosphere, Biosphere, Atmosphere, Hydrosphere and Anthroposphere
- Illustrate how material and energy are cycled through the Earth system
- Describe the links between biotic and abiotic systems and their role in maintaining a habitable planet
- Apply an Earth Systems approach to describe the phenomena of environmental and climate change
- Discriminate between 'weather' and 'climate' and situate concerns about current climate change in a longer-term (geological) context
- Identify how human activities modify Earth System function
- Make links between Earth Systems Science and topics covered in their chosen field of study

Module content

Week	**Topic and Description**
Week 1	**Introduction to Earth System Science: What is Earth System Science?**
Lecture 1: (3 webcast presentations; 1 classroom lecture)	**Prof Robin Edwards** - The scientific method; scientific reductionism - The systems approach; isolated, open, closed systems; models, fluxes, reservoirs - Major subsystems: Geosphere, hydrosphere, atmosphere, biosphere, anthroposphere. - Characteristics of natural systems. Feedback processes. - Chaos theory, complex systems, emergent properties. - Module outline & scope. - Learning outcomes. Assessment methods. Timetable & curriculum.
Lecture 2	**Spaceship Earth: Life support on planet Earth – Prof Carlos Rocha** - systems, energy and matter; biogeochemistry – quantitative study of life and chemistry - species and environment - Box models; the hydrological cycle, fluxes & rates - homeostasis
Student Activity 1	**Daisyworld modelling exercise: Practical model application – Prof Carlos Rocha** - albedo, feedback
Assigned Reading	Blue Planet: Chapters 1 and 2 Holden: Chapter 1
Week 2	**Our habitable planet**
Lecture 3	**Third Rock from the Sun: Introducing the Geosphere – Prof Robin Edwards** - Matter & the finite nature of resources - composition of the Earth, principal chemical elements, minerals, rocks and rock types - Earth structure; rock cycle; the tectonic cycle - plate tectonics as a unifying theory
Lecture 4	**Making Earth Habitable: The Atmosphere & Climate Control. Atmosphere – source and composition – Prof Robin Edwards** - insolation and the global heat budget - the greenhouse effect links between atmosphere and geosphere; the

	goldilocks zone; evidence for a long-term thermostat – feedback cycles, Venus & the runaway greenhouse, Snowball earth; tipping points, recent global warming, atmospheric CO2 in context
Student Activity 2	**Plate tectonics in Google Earth: familiarisation with Google Earth – Prof Robin Edwards** - Plate boundaries, types, location and associate geomorphic/ geological features
Assigned Reading	Blue Planet: Chapters 3, 5, 7, 11
Week 3	**Understanding and modelling cycles**
Lecture 5	**Into the Hydrosphere The hydrological cycle – Prof Carlos Rocha** - sources, sinks, reservoirs and fluxes, residence time (ocean)
Lecture 6	**The air that we breathe Thermoregulation, equations for life, oxygen and photosynthesis – Prof Carlos Rocha** - carbon cycling; life as a rechargeable battery; carbon storage and atmospheric oxygen; biological carbon pump
Student Activity 3	**Hydrological Cycle Box Model - Prof Carlos Rocha**
Assigned Reading	Blue Planet: Chapters 8
Week 4	**Ocean circulation - Professor Robin Edwards**
Lecture 7	**A brief introduction to Planet Ocean:** Ocean heat budget, sea surface temperature; atmosphere – ocean interaction; wind-driven ocean circulation; geostrophy, ocean gyres, westward intensification; garbage patches; ENSO, upwelling and marine fisheries
Lecture 8	**Into the Abyss: The oceanic interior**: Ocean stratification, temperature, salinity, density; water masses; convective overturning; thermohaline circulation; atmosphere – ocean interaction 2 – gas exchange, oxygen and life, CO2 and marine sequestration
Assigned reading	Blue Planet – Chapter 10 Holden: Chapter 3 Pinet: Chapters 6, 7, 8
Student Activity 4	**Argo floats in Google Earth: Professor Robin Edwards** - surface ocean circulation patterns - exploring current systems and gyres - marine technology
Week 5	**Weather – The atmosphere in motion**
Lecture 9	**Introduction to the Atmosphere: Professor Gayle McGlynn** - weather vs climate - climate forcing - atmospheric composition and structure - movement of heat and moisture - adiabatic lapse rates, clouds - driving atmospheric circulation
Lecture 10	**Global Atmospheric Circulation: Professor Gayle McGlynn** - 3 cell model - low, middle and high latitude circulation - jet streams; monsoons - ENSO; cyclones and hurricanes
Assigned reading	Blue Planet – Chapter 12 Holden: Chapters 6, 8, 9
Student Activity 5	**Exploring Hurricanes – Professor Gayle McGlynn**

Week 6	**The Earth's Climate System – Professor Pete Coxon**
Lectures 11 and 12	- temperature anomalies - extreme weather events - NAO; weather vs climate - change in natural systems - global temperature: instrumental and proxy data - Milankovitch and astronomical theory of climate - CLIMAP; Biostratigraphy; oxygen isotopes; ocean and ice core records - glacial – interglacial transition; abrupt climate change - Greenhouse gases and future change
Assigned Reading	Blue Planet – Chapter 13 Holden Chapters 4, 5
Student Activity 6	**Reconstructing past climate: Professors Pete Coxon and Robin Edwards** Excel-based exercise using oxygen isotope data to explore glacial-interglacial climate cycles
Week 8	**Geomorphology: Shaping the Earth's surface**
Lecture 13	**Shaping the Surface: Professor Robin Edwards** - Controls on landscape development - timescale of change - inheritance - physical processes: erosion, transport and deposition - sediment type, description and classification - particle size and grain size distributions - Hjulström diagram; settling lag; depositional environments – coastal illustration - bedforms and morphodynamics – an introduction
Lecture 14	**Coastal Geomorphology: Professor Mary Bourke** - coasts – definition & significance - coastal morphodynamics, feedbacks, timescales - geomorphic systems approach; tides & waves, inc. storms and tsunamis - sedimentary systems - depositional coasts & landforms; erosion & rocky coasts
Assigned reading	Holden – Chapters 16, 22
Student Activity 7	**Coastal Geomorphology: Professor Mary Bourke** Google Earth to measure: 1) dynamic coastal change in a coastal barrier island system; 2) identify coastal landforms in satellite images
Week 9	**Making a Living on Earth**
Lecture 15	**Structuring the Biosphere – Energy: Professor Carlos Rocha** - insolation as the power source - energy distribution and climate regions; ecosystem components – biotic & abiotic - Illustration: aquatic/marine biomes - energy exchange in ecosystems - photosynthesis - pyramids and trophic levels - hydrothermal vents and autotrophic chains;

Lecture 16 **Structuring the Biosphere – Biogeochemistry - Carlos Rocha**

- nutrient cycles and life
- fundamental concepts in biogeochemistry
- carbon cycle
- nitrogen cycle
- phosphorus cycle
- human impacts on biogeochemical cycles

Week 10 **Biogeography**

Lecture 17 **Introduction – Explaining the Patterns of Life: - Professor Robin Edwards**

- Biomes & Ecozones
- Biogeography – history and ecology
- fundamental units of life – individual, population, species
- habitat; ecological optima/tolerance; carrying capacity and population growth (human); planetary boundaries
- species interactions; niche – partitioning space; generalist vs specialist
- biodiversity – definition and threats; resilience

Lecture 18 **Biogeographic Change - Evolution & Extinction: Professor Robin Edwards**

- Biogeographic engines – plate tectonics & evolution. Zoogeographic maps, disjunct populations, isolation & endemism
- illustration – Australia. Fundamentals of evolution – competition, variation, reproduction, inheritance; response to environmental change – move, adapt, die
- vicariance & connectivity; ecological succession; r- and k- selected species
- range expansion/contraction/fragmentation, refugia
- speciation and evolutionary geography; extinction (including the 6th extinction)

Assigned Reading Blue Planet: Chapters 14,16
Holden; Chapters 10, 11

Student Activity 9 **Planetary Boundaries exercise – Professor Robin Edwards**

Week 11 **Terraforming Spaceship Earth - Professor Mary Bourke**

Lecture 19 **The Anthropocene**

- rise and spread of humans; technology and agriculture
- humans as geomorphic agents
- population growth, energy consumption
- human impact on the geosphere, hydrosphere, atmosphere & biosphere
- The Anthropocene – a new geological epoch?

Lecture 20 **Resource types and uses: Professor Mary Bourke**

- natural resources – historical overview of uses
- renewable/non-renewable; the resource cycle
- Illustration – forests; mineral resources, mining, hydrocarbon industry
- renewable energy

Student Activity 10 **Google Earth Engine: Professor Mary Bourke**
Monitoring of earth system change using remote sensing platforms

Assigned Reading Blue Planet; Chapters 17, 18, 19
Holden: Chapters 25, 26

Week 12	**The end of the beginning**
Lecture 21	**The future of climate: Professor Gayle McGlynn** - earth's climate system; carbon cycle and climate - human activities and atmospheric change - measuring human impact on climate; the IPCC - scientific consensus on climate change; how to predict the future – approaches and limitations - Climate modelling and projection; climate as a policy issue; A +2°C future?
Lecture 22	**Summary & Synthesis - Professor Robin Edwards**
Student Activity 11	**Modelling future climate**
Assigned Reading	Blue Planet; Chapter 19 Holden: Chapter 7 IPCC AR 5

Contact hours: 22 hours

Recommended Reading List:
Holden, J. (2018) An Introduction to Physical Geography and the Environment. 4th Edition. Pearson: Harlow, UK. 876 pages. Skinner, B.J., Murck, B. (2011) The Blue Planet: An Introduction to Earth System Science. 3rd Edition. J. Wiley & Sons: Hoboken, USA. 656 pages.

Assessment Details: 100% continuous assessment via in-course tests and assignments.

Module Website: Blackboard

GSU11005: Introduction to Geology: A beginners Guide to Planet Earth
Semester 2, 10 credits

From the vastness of space, to the microscopic crystal structure of minerals; from events which take billions of years, like galaxy formation, to volcanic eruptions which may last only minutes or seconds. Geology, or Earth Science, is the all-encompassing study of Planet Earth. Geology sets out to investigate the origin and development of the planet, the natural principles that govern it, the processes that act in it, on it, and around it, and finally the life that has evolved with it. Many sciences are conducted in the laboratory, but to a geologist, the Earth itself is the laboratory.

The module is organised into two main themes. Firstly, we will look at **'Earth In Space'**. We live on a dynamic and ever-changing planet, where the surface is constantly being destroyed and renewed. This theme looks at the origin of the Earth, what it's made of and the processes at work, inside and out, which drive this change. The second theme, **'Earth In Time'**, then focuses on the evolution of the planet over time, and the life that has evolved with it. Earth has been around for just over 4,500 000 000 years, and remarkably, we have evidence that life has existed for at least 3,800 000 000 of those years. There are times in Earth's history when geological events have changed the course of biological evolution. And, perhaps more intriguingly, there are times when life has changed the way the planet operates. So, this theme of Earth and Life evolving together through geological time is illustrated by looking at eight key episodes in Earth's history, without which, we simply wouldn't be here.

Module learning aims

To provide foundation-level knowledge of:

- Fundamental concepts and principal methods employed in the science of geology
- Planetary origins and evolution of planet Earth
- Rock types, composition, classification and transformation
- Structure of planet Earth and plate tectonic theory
- The distribution and causes of geohazards (volcanoes, earthquakes, tsunamis)
- Fossil evidence of the origins and evolution of life on Earth
- Geological evidence of past environments and climatic conditions
- Economic geology and the nature of geological resources

To develop the following skills & graduate attributes

- Written and digital / analytical skills
- Critical thinking
- Make connections between a student's core subject areas and the science of Geology

Module learning outcomes

On successful completion of this module students will be able to:

- Outline the origin and evolution of planet Earth
- Describe and illustrate the dynamic nature of planet Earth with reference to specific geological processes
- Describe the origins of life on Earth and list the major evolutionary episodes evident in the fossil record
- Explain the links between the evolution of life and environmental conditions on planet Earth
- Outline the geological history of the island of Ireland
- Make basic geological observations, measurements and interpretations in the field and laboratory

Module content

Week	Topic and Description
Week 1	**The Earth In Space (1)**
Lecture 1	**Introduction #1: A Dynamic Planet: The Great Neptunist** - Plutonist Controversy - The Rock Cycle - A Brief Introduction to your Home Planet
Lecture 2	**Introduction #2: Rocks & Time: Rock Classification** - Minerals & Crystals - Geological Time - Catastrophism or Uniformitarianism?
Lecture 3	**The Small Matter of Our Universe: Origins** - What's in Space? - Star Birth - The Stellar Engine: The Proton-Proton Chain Reaction - Death Star
Week 2	**The Earth In Space (2)**
Lecture 4	**Birth of the Solar System: Early Formation of the Solar System** - Planetary Accretion - Emergence of the Solar System - A Rough Guide to Our Solar System - Meet the Neighbours: The Terrestrial Planets - Ice Worlds - And What About Earth?
Lecture 5	**At the Earth's Core: What's in the Inner Core?** - The Great Melting Pot - The Outer Core: How do we Know its Liquid? - Where Does Earth's Magnetic Field Come From?
Lecture 6	**Mantle, Moho and Melt: Mr. Mohorovičić** – Ophiolites - Mafic Igneous Rocks - Down Below the Moho - Asthenosphere and Lithosphere - Heat Loss From the Core: Driving the Lithospheric Plates - Mantle Plumes and 'Hot Spots'
Week 3	**The Earth In Space (3)**
Lecture 7	**Forming a Crust: Two Types of Crust** - Continents and Ocean Basins - Exposing the Crust to the Atmosphere: Earth Surface Processes - How and When Did Continental Crust and Plates Evolve? - Continental Drift - Types of Plate Boundary
Lecture 8	**A Filling on the Crust: Sedimentary Basins** - Clastic Sediments - Energy of Transport - Depositional Environments – Burial and Lithification - Chemical Precipitates - Carbonates (Inorganic and Organic) - Evaporites

Lecture 9 **Causing a Rift: Origins of the Plate Tectonic Theory**

- Magnetism in Basalt - Sea-Floor Spreading - Continental Rifting - What Happens if Continental Rifting Goes 'All the Way'? - Ireland's Own Continental Rift

Week 4 **The Earth In Space (4)**

Lecture 10 **Earth Story: Ring of Fire (DVD)**

Lecture 11 **Subduction! Subduction Zones I: Oceanic**

- Oceanic Collision
- Subduction Zones II: Oceanic
- Continental Collision
- Melting and Intrusion at Subduction Zones
- Melting and Extrusion at Subduction Zones
- Metamorphism at Subduction Zones

Lecture 12 **Collision Course! How Do Continent**

- Continent Collisions Happen?
- Features of Continent
- Continent Collisions
- Deformation in Rocks: Stress and Strain
- Squashing and Heating During Collision: Metamorphism
- Isostasy During Collision
- Conservative Plate Boundaries

Week 5 **The Earth In Space (5)**

Lecture 13 **Earth Story: Journey to the Centre of the Earth (DVD)**

Lecture 14 **Volcanoes: Viscosity and Explosivity**

- What Do Volcanoes Produce?
- Different Types of Volcano
- What Are the Plate Tectonic Settings for Different Types of Volcano?

Lecture 15 **Volcanoes: Hazards and History: Basaltic Shield Volcano Hazards**

- Andesitic Stratovolcano Hazards
- Rhyolitic Lava Dome Hazards
- Secondary Volcanic Hazards

Week 6

Lecture 16 **Earthquakes and Tsunamis: The Birth of Seismology**

- What Causes an Earthquake?
- Earthquake Hazards
- Neotectonics: Tectonics Happening Right Now
- Earthquake Generated Tsunamis
- Tsunamiites: Preserving Tsunamis in the Rock Record
- Alternative Ways to Generate Tsunamis

Lecture 17 **How to be a Fossil: What is a Fossil?**

- What Happens When Organisms Die?
- How Can We Preserve Signs of Life in Rocks?
- What is a Species?
- How Do Species Evolve?
- Zoological vs Fossil Species
- What Do Fossils Tell Us?

Lecture 18 **Life and Death on Ancient Earth: An Introduction to the Main Invertebrate Fossil Phyla**

- Taphonomic Processes and Preservational Bias
- Functional Morphology
- Examples of Adaptation to Specific Palaeo-environments

Week 7	**Study Week – No lectures**	
Week 8	**The Earth in Time – Key Episodes in Earth's History 1-2**	
Lecture 19	**Continents Adrift: Telling the Time Accurately: Biostratigraphy**	
	- Telling the Time Accurately: Radiometric Age Dating - Palaeo-Latitudes and Palaeo-Wander - Palaeo-Environments	
Lecture 20	**Episode 1: Slimeworld Natural Selection and Genetic Mutation**	
	- The Origin of Life - Advent of Photosynthesis - Consequences of Photosynthesis - What Was Happening in Ireland During the Early – Mid Precambrian?	
Lecture 21	**Episode 2: Snowball Earth and Slugworld Slimeworld Gradually Changes 'Snowball Earth' - Steps Towards a 'Snowball Earth'**	
	- Back From the Brink - So What Was Happening in Ireland During the Late Precambrian? - After the Snowball: The 'Cambrian Explosion' (~600 – 520 Ma) - The Burgess Shale	
Week 9	**Key Episodes in Earth's History 3-5**	
Lecture 22	**Episode 3: How Green is the Valley? What Were the First Vertebrates?**	
	- Evolution of Jaws - What About Life on Land? - What Was Ireland Doing in the Early Paleozoic?	
Lecture 23	**Episode 4: Tetrapods and Tropics How Did we Get the First Vertebrates on Land?**	
	- How Do You Get a Fish Out of Water? - Tetrapods: The First Land Vertebrates - Amphibians to Reptiles - Ireland's Lazy Wander Through the Tropics	
Lecture 24	**Episode 5: A Farewell to Familiar Families Mass Extinction Events: The 'Big Five' (or Six!)**	
	- How Can We Cause a Mass Extinction? - Volcanism: Flood Basalts - Volcanism: Super-eruptions - Sea Level Change: Glaciations - Sea Level Change: Sea-Floor Spreading Rate - Extra-terrestrial - So What Caused the 'Big Five'?	
Week 10	**Key Episodes in Earth's History 6-8**	
Lecture 25	**Episode 6: Reptiles Rule! Pangaea: The Reptiles Take Over**	
	- Origin of the First Mammal-like Reptiles - The Mesozoic Era - Reptile World Domination - Mammals Await Their Chance - The Mesozoic in Ireland	
Lecture 26	**Episode 7: It Came from Outta Space! 'Terrible Lizards'**	
	- Dinosaurs Rule! - Ornithiscians – Saurischians - Upsetting the Evolutionary Apple-Cart - The Smoking Gun… So Why Might Chicxulub Have Caused a Mass Extinction?	
Lecture 27	**Episode 8: Greenhouse – Icehouse What is Characteristic of the Cenozoic**?	
	- How Can Palaeo-Temperatures be Recorded? - The Magic of Planktonic and Benthic Foraminifera - Cenozoic Radiation - How and Why Did Humans Evolve? - Ireland in the Cenozoic	

Week 11	**Economic Geology**
Lecture 28	**Economic Geology 1 - What is Economic Geology? Facts & Misconceptions: What is Economic Geology?** - What are Mineral Deposits? - Where are Mineral Deposits Found? - Do We Really Need Mines Anymore? - Mining History?
Lecture 29	**Economic Geology 2 - What are Resources? Mining & Exploration 1: Fossil Fuel Resources:** - Peat - Coal - Oil & Gas - Types of Non-Fuel Mineral Resources - Focus on Metallic Minerals - What Constitutes Ore? - What is the Minerals Cycle? - Ore Minerals and Metal Extraction
Lecture 30	**Economic Geology 1 - What are Resources? Mining & Exploration 2: Where are Mineral Deposits Found?** - Metal Sources - Modern Seafloor Zn-Pb Deposits - Seafloor Sulphide Deposits - Hydrothermal Deposits - Deposit Types
Week 12	**Module Summary**
Lecture 31	**Earth Story: The Big Freeze (DVD)**
Lecture 32	**Module Close-Out Summary of Module Learning Outcomes**: - Key Concepts That You Should Now Know About - Coping With the Theory Exam: Exam Structure and Content - Worked Examples and Past Papers

Recommended Reading List:

Nicholas, C. J., 2018. A Beginner's Guide to Planet Earth: Introductory Lectures in Geology. C.J. Nicholas (ISBN 978-1-911180-33-3)

Assessment details: 50% examination; 50% continuous assessment via in-course tests and assignments.

Module website: https://www.tcd.ie/Geology/undergraduate/modules/year1/

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Graduate Attributes

The Trinity Graduate Attributes represent the qualities, skills and behaviours that you will have the opportunity to develop as a Trinity student over your entire university experience, in other words, not only in the classroom, but also through engagement in co- and extra-curricular activities (such as summer work placements, internships, or volunteering).

The four Trinity Graduate Attributes are:

- To Think Independently
- To Act Responsibly
- To Develop Continuously
- To Communicate Effectively

Why are the Graduate Attributes important?

The Trinity Graduate Attributes will enhance your personal, professional and intellectual development. They will also help to prepare you for lifelong learning and for the challenges of living and working in an increasingly complex and changing world.

The Graduate Attributes will enhance your employability. Whilst your degree remains fundamental, also being able to demonstrate these Graduate Attributes will help you to differentiate yourself as they encapsulate the kinds of transversal skills and abilities, which employers are looking for.

How will I develop these Graduate Attributes?

Many of the Graduate Attributes are 'slow learned', in other words, you will develop them over the four or five years of your programme of study.

They are embedded in the curriculum and in assessments, for example, through undertaking independent research for your final year project, giving presentations and engaging in group work.

You will also develop them through the co-curricular and extra-curricular activities. If you help to run a club or society you will be improving your leadership skills, or if you play a sport you are building your communication and team-work skills.

Dates to Note:

Freshers Orientation Week: 3rd September 2018 – 7th September 2018

TR063 Introductory Lecture

Schrodinger Lecture Theatre, Fitzgerald Building at 12.00 am on Monday 3rd September 2018

Student to Student (S2S):

Following the general orientation presentation, students will meet their S2S (Student to Student) mentor groups who will assist with integration into College life and will address any queries that students may have.

TR063 Physical Sciences Introduction: 3rd September 2018 12:00noon.

Schrodinger Lecture Theatre, Fitzgerald Building.

TR063 Module Registration: 3rd September 2018 12:30pm.

Fitzgerald Library, Fitzgerald Building.

Deadline for submission of module choice form to the Science Course Office before **12.00 noon** on **Tuesday 4th September 2018**.

Further events in Orientation week related to Physics modules and approved modules will take place on Thursday 6th and Friday 7th September 2018 as will be advised at the TR063 Introductory Lecture.

Academic Year Structure 2018/19

Key Dates:

Freshers/Orientation Week:	Monday 3 September to Friday 7 September 2018
Study/Review Week:	Monday 22 October to Friday 26 October 2018
Revision Week Semester 1:	Monday 3 December to Friday 7 December 2018
Study/Review Week:	Monday 4 March to Friday 8 March 2019
Revision Week Semester 2:	Monday 15 April to Friday 19 April 2019
Trinity week:	Monday 29 April to Friday 3 May 2019

Formal Assessment weeks

Semester 1 examinations	Saturday 8 December to Friday 14 December 2018
Semester 2 examinations	Tuesday 23 to Saturday 27 April 2019 (and Tuesday 30 April and Thursday 2 May 2019 if required)

Closing Dates for Course Transfer

If you decide to transfer out of your course altogether, you must submit an application for **transfer of course** to the Academic Registry, following discussion with your tutor. Decisions are based on **a)** the availability of places, and **b)** the entry qualifications of the transfer applicant. It may not be possible to permit transfers to subjects which already have a full complement of students. Further details are available on the following link:

http://www.tcd.ie/study/apply/making-an-application/undergraduate/index.php

Students may not register or attend a course until their application to transfer has been formally approved by the Senior Lecturer

Progression and Awards

Information on progression and awards can be found via the following webpage:
https://www.tcd.ie/TEP/assets/Docs/factsheet_students_progression_awards.pdf

Attendance

All students should enter into residence in or near Dublin and must begin attendance at the College not later than the first day of teaching term, and may not go out of residence before the last day of teaching term, unless they have previously obtained permission from the Senior Lecturer through their tutor.

Students must attend College during the teaching term. They must take part fully in the academic work of their class throughout the period of their course. Lecture timetables are published through my.tcd.ie and on school or department notice-boards before the beginning of Michaelmas teaching term. The onus lies on students to inform themselves of the dates, times and venues of their lectures and other forms of teaching by consulting these timetables.

The requirements for attendance at lectures and tutorials vary between the different faculties, schools and departments. Attendance is compulsory for Junior Fresh in all subjects. The school, department or course office, whichever is relevant, publishes its requirements for attendance at lectures and tutorials on notice-boards, and/or in handbooks and elsewhere, as appropriate.

Absence from College – Medical and Absence Certificates

MEDICAL CERTIFICATES

Where a student misses an assigned laboratory practical class through illness, they should **(a)** submit a Medical Certificate to the Science Course office **on the day of their return to College** and **(b)** inform the laboratory practical supervisor of their absence at the next session.

- Science **Medical Certificate** Form (**use with med cert from doctor**) – Available from Science Course Office

For periods of illness of **three days or less** (but **no more than seven days in any year**) a student may 'self-certify' their illness on the forms supplied, again to the Science Course Office on the day of their return to College.

- Science Medical **Self Certification** Form (**use for 3 days med not covered by doctor**) – Available from the Science Course Office

OTHER ABSENCES

Students who require to be absent from a laboratory practical classes (with or without an associated assessment) for any other reason, such as a sporting or social event, should inform the appropriate module coordinator **well in advance of the event** (preferably a week beforehand).

- Science Absence from College Form, Sport or Other – Available from the Science Course Office

Where possible they will be assigned to an alternative laboratory practical session, but if that is not possible, and the justification for the absence is considered legitimate, they may be treated in the same manner as students submitting medical certificates (i.e. assigned an alternative assessment for one missed or awarded a pro-rata/pass mark). This is decided by the individual Disciplines concerned (i.e. Biology, Chemistry, Physics etc.) not the Science Course Office.

Excuses for absence, presented after the event, **will not be entertained. Students who anticipate that their sporting commitments may necessitate more than the occasional absence from College** (e.g. Sport Scholars, etc.) **should discuss their situation with their tutor and the Associate Dean of Undergraduate Science Education (ADUSE).**

Non-satisfactory attendance and course work

All students must fulfil the requirements of the school or department, as appropriate, with regard to attendance and course work. Where specific requirements are not stated, students may be deemed non-satisfactory if they miss more than a third of their course of study or fail to submit a third of the required course work in any term. Further information on non-satisfactory attendance and course work may be found via the following webpage:

https://www.tcd.ie/undergraduate-studies/academic-progress/attendance-course-work.php

Plagiarism- 2018/19

It is important to emphasise that all students, i.e., undergraduate, postgraduate, new entrants and existing students, will be required to complete the online tutorial 'Ready, Steady, Write'. Students must ensure that the cover sheets they complete when submitting assessed work, contain the following declaration:

I have read and I understand the plagiarism provisions in the General Regulations of the University Calendar for the current year, found at: http://www.tcd.ie/calendar

I have also completed the Online Tutorial on avoiding plagiarism 'Ready, Steady, Write', located at http://tcd-ie.libguides.com/plagiarism/ready-steady-write

Students should read the items listed below to ensure that they understand plagiarism.

1. The weblink to the Library Repository, http://tcd-ie.libguides.com/plagiarism
2. The 2018-19 Calendar entry on plagiarism; Plagiarism
3. Guidelines on the appropriate methodology for the kind of work that students will be expected to undertake. Providing discipline specific examples of good academic practice for referencing is very helpful for students. We would like to draw your attention to the 2018-19 Calendar entry on plagiarism which states that "all Schools and departments must include in their handbooks or other literature given to students, guidelines on the appropriate methodology for the kind of work that students will be expected to undertake";
4. A statement informing all students that they must complete the online tutorial on avoiding plagiarism 'Ready, Steady, Write', located at http://tcd-ie.libguides.com/plagiarism/ready-steady-write
5. The template of the coversheet/s which students must complete and attach to work submitted in hard or soft copy or via Blackboard. NB. The coversheet must include the declaration noted above.

[1] UG: Calendar Part II, General Regulations, Academic Progress, Paragraphs 82 and following; PG Calendar Part III, General Regulations, Paragraphs 1.32 and following.

Trinity Tutorial Service

The Tutorial Service is unique, confidential and available to all undergraduate students offering student support in all aspects of College life. The Tutorial Service is supported and co-ordinated by the Senior Tutor's Office which is located on the ground floor in House 27.

Opening Hours

The Senior Tutors Office is open Monday - Friday from 9am - 5.30pm. Closed for lunch from 1-2pm.

Appointments

If you require specific advice or would like a confidential meeting with the Senior Tutor, you can make an appointment by telephoning +353 1 896 2551 or by emailing stosec@tcd.ie

What is a Tutor?

A Tutor is a member of the academic staff who is appointed to look after the general welfare and development of the students in his/her care. Whilst the Tutor may be one of your lecturers, this is not always the case as the role of the College Tutor is quite separate from the teaching role.

When should I go to see my Tutor?

Whenever you are worried or concerned about any aspect of College life or your personal life, in particular if it is affecting your academic work. Everything you say to your Tutor is in strict confidence. Unless you give him/her permission to do so, s/he will not give any information to anybody else, whether inside College or outside (to your parents/family for example). Your Tutor can only help you if s/he knows you are facing difficulties, so if you are worried about anything go and see your Tutor before things get out of hand.

Further information on the Senior Tutors Office and College Tutors may be found via the following webpage: **Senior Tutor's Office - https://www.tcd.ie/seniortutor/students/undergraduate/**

Disability Services

The Disability Service aims to provide appropriate advice, support and information to help students and staff with disabilities. The Disability Service has in place a range of supports to ensure that students with disabilities have full access to the same facilities for study and recreation as their peers. Most students registering with the Disability Service request access to a range of supports that help the student reach their full potential while studying. Most students' needs are accommodated through these supports. The student decides what level of support they require.

Further information on the support available may be found via the following link: https://www.tcd.ie/disability/services/

For contact information or to make an appointment please contact the Disability Services – contact details are available via the following webpage:

https://www.tcd.ie/disability/contact/

Student Counselling

The Student Counselling Service is here to help you to manage any difficulties you are experiencing so you can enjoy and fully participate in your time here at College.

If you wish to make an appointment with the Student Counselling Service, please consider one of the options below. If you have any other queries you can call into reception on the 3rd floor of 7-9 South Leinster Street or contact us on:

- Phone: (01) 8961407
- Email: student-counselling@tcd.ie

For further information visit the following webpage:
https://www.tcd.ie/Student_Counselling/

Useful College Websites:

Orientation – Student Life
https://www.tcd.ie/students/orientation/

In the first few weeks at College, you will hear an array of abbreviations, titles and place names. So visit the jargon buster page: https://www.tcd.ie/students/jargon-buster/

Student life offers information on Supports and Services, Clubs and Societies, Student Unions etc., https://www.tcd.ie/students/

For information on Registration, Fees, Grants, ID Cards etc. visit the Academic Registry (AR) in the Watts Building or the visit the AR website: https://www.tcd.ie/academicregistry/

TR063: Physical Sciences

Contacts:

Physical Sciences Course Director

Professor Cormac McGuinness
Ph: 01 896 3547
E-mail: Cormac.McGuinness@tcd.ie

Junior Fresh Physics Coordinator

Professor Matthias Moebius
Ph: 01 896 1055
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School of Physics Senior Executive Officer

Ms Una Dowling
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SCIENCE COURSE OFFICE

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NOTE: All of the information contained in this booklet is accurate at time of publication. However, the Science Course Office reserves the right to modify information, dates and times as necessary. Students will be notified of any changes via e-mail and the Science webpage.

Trinity College Dublin
Coláiste na Tríonóide, Baile Átha Cliath
The University of Dublin

Science Course Office

Faculty of Engineering, Mathematics and Science Trinity College Dublin 2, Ireland.

Oifig na gCúrsaí Éolaíochta Dámh na hinne-altóireachta, na Matamaitce agus na hÉolaíochta Ollscoil Átha Clíath, Coláiste na Tríonóide Baile Átha Cliath 2. Éire.

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