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 Freshman Programme 2021 - 2022

tcd.ie/science

This handbook applies to all students taking TR063 Physical Sciences. 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 Course 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.

Produced by: **The Science Course Office**
Trinity College Dublin 2
Tel: **+353 1 896 1970**
Web Address: **http://www.tcd.ie/Science/**

Contents

Welcome to Physical Sciences

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 topics, energy and quantum optics and information. Students specialising in **Physics and Astrophysics** instead take courses on stellar and galactic structures, planetary and space science, the interstellar medium, astrophysical instrumentation and on cosmology. Students specialising in **Nanoscience** will study courses at the boundaries of physics and chemistry in as is described by nanoscience, as well as advanced modules in solid state chemistry, materials chemistry, condensed matter physics and further options.

In addition, students in the Physical Sciences stream will use computers for numerical modelling via the Python programming language and learn 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 capstone 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, high tech 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, appraise complex data, apply critical thinking and use creativity, all of 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.

Professor Cormac McGuinness
Director, TR063 Physical Sciences Course

TR063 Physical Sciences overview and module selection.

Module choices will be made online. Prior to selecting modules, you should read this booklet, in particular pages 3-7 and then go to the TRO63 Module Choice Form to select your modules. If you feel that you need assistance with your choices, please contact us at jfsco@tcd.ie and we will be happy to help.

Please note that choices you make at the start of your Junior Freshman year determine your choices in the second semester of Junior Freshman year and throughout the Senior Freshman year.

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 Open 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: Introduction to Earth System Science	1	10
GSU11005	Geology: A Beginner's Guide to Planet Earth	2	10

Note again that only certain patterns of choice of Open Modules are possible, and that the choice of Open modules in the Junior Freshman year then determines the Open Modules that must be taken in the Senior Freshman year. This is fully explained in the following pages.

Physical Sciences Moderatorships

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

- Physics
- Physics and Astrophysics
- Nanoscience

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.

Open Module Choices in Junior and Senior Freshman Years

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

Year 1: JUNIOR FRESHMAN	
CORE MODULES – 40 credits 20/20	
Semester 1	**Semester 2**
PYU11P10 Physics 1	PYU11P20 Physics 2
MAU11S01 Mathematics for Scientists 1	MAU11S02 Mathematics for Scientists 2
OPEN MODULES – choose 20 credits 10/10	
CHU11101 General and Physical Chemistry	CHU11102 Introduction to Inorganic and Organic Chemistry
GSU11004 Spaceship Earth: Introduction to Earth System Science	GSU11005 Geology: A Beginner's Guide to Planet Earth
BYU11101 From Molecules to Cells	BYU11102 Organisms to Ecosystems

Year 2: SENIOR FRESHMAN			
CORE MODULES – 40 credits 20/20			
Semester 1		**Semester 2**	
PYU22P10 Physics 3		PYU22P20 Physics 4	
MAU22S01 Multi-variable calculus	MAU22S03 Fourier Analysis	MAU22S04 Vector Calculus	PIU22292 History, Philosophy and Ethics of Science
OPEN MODULES – choose 20 credits 10/10			
CHU22201 Chemistry 1		CHU22202 Chemistry 2	
GSU22201 From Atoms to Rocks: Introduction to Geochemistry		GSU22006 Physical Geography: Dynamic Earth	
GSU22205 Sedimentary Processes & Environments in a Changing World			
BYU22201 From Molecules to Cells 2		BYU22202 From Cells to Organisms	

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

Moderatorships and Open Module Choice Diagram

Moderatorships in **Physics** or in **Physics and Astrophysics** are available to all students regardless of the choice of Open modules in the Junior Freshman and Senior Freshman years
To qualify for the Moderatorship in **Nanoscience**, a student must take all available Chemistry Open modules in both semesters of the Junior and Senior Freshman years.
The following five patterns of Open Modules are available to students across the Junior Freshman and Senior Freshman years. These are denoted A, B, C, D and E and correspond to the indicated patterns on the TR063 Physical Sciences Junior Freshman module choice form.

	Year 1: JUNIOR FRESHMAN		Year 2: SENIOR FRESHMAN		Moderatorship
	Semester 1	**Semester 2**	**Semester 1**	**Semester 2**	
A	CHU11101 General and Physical Chemistry	CHU11102 Introduction to Inorganic and Organic Chemistry	CHU22201 Chemistry 1	CHU22202 Chemistry 2	**Nanoscience**
	Semester 1	**Semester 2**	**Semester 1**	**Semester 2**	
B	CHU11101 General and Physical Chemistry	GSU11005 Geology: A Beginner's Guide to Planet Earth…	GSU22201 From Atoms to Rocks: An introduction to Geochemistry .. / GSU22205 Sedimentary Processes & Environments in a Changing World	GSU22006 Physical Geography: Dynamic Earth	**Physics**
	Semester 1	**Semester 2**	**Semester 1**	**Semester 2**	
C	GSU11004 Spaceship Earth: Introduction to Earth System Sciences…	GSU11005 Geology: A Beginner's Guide to Planet Earth	GSU22201 From Atoms to Rocks: An introduction to Geochemistry .. / GSU22205 Sedimentary Processes & Environments in a Changing World	GSU22006 Physical Geography: Dynamic Earth	
	Semester 1	**Semester 2**	**Semester 1**	**Semester 2**	
D	BYU11101 From Molecules to Cells	BYU11102 Organisms to Ecosystems	BYU22201 From Molecules to Cells 2	BYU22202 From Cells to Organisms	**Physics & AstroPhysics**
	Semester 1	**Semester 2**	**Semester 1**	**Semester 2**	
E	BYU11101 From Molecules to Cells	GSU11005 Geology: A Beginner's Guide to Planet Earth	GSU22201 From Atoms to Rocks: An introduction to Geochemistry .. / GSU22205 Sedimentary Processes & Environments in a Changing World	GSU22006 Physical Geography: Dynamic Earth	

Applications to choose a specific Moderatorship after the Senior Freshman year occur via a preferred Moderatorship choice form that will be available in Semester 2 of the Senior Freshman year. **Note especially that there are quotas and hence competition for in-demand Moderatorships.** Allocation of places in Moderatorships is based on student ranking of final weighted average marks across all Senior Freshman modules for those who successfully complete the Senior Freshman 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 27th September 2021 – 17th December 2021	SEMESTER 2 – Hilary Term 24th January 2022-15th April 2022
PYU11P10: Physics 1	PYU11P20: Physics 2
MAU11S01: Mathematics 1	MAU11S02: Mathematics 2

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

BYU11101: From Molecules to Cells	BYU11102: 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: Geology: A Beginner's Guide to Planet Earth

Change of selected Open Modules

If, after a couple of weeks, you feel that you have perhaps made the wrong choice of Open 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.

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), large tutorial classes (1 per week after 3rd or 4th week of semester) and elective small group tutorials (1 hr every second week).

Lecture Topics

Introduction to Physics - 1 lectures (O. Hess)
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, large group tutorials, hands-on laboratory practicals and weekly on-line assignments based on both numerical and conceptual questions from the textbook, as well as online video resources and elective small group tutorials 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.

Large tutorial groups of the order of 20-30 students meet to discuss with lecturers the solutions to specific assigned physics problems, discussing the approaches, methods, mathematics and physics of the correct solutions. Video resources comprising short videos on physical intuition, thinking, problem solving or physics approaches as well as some relevant mathematical techniques will be made available online will supplement lecture material and will include some additional short physics topics from your textbooks to illustrate techniques. In additions, students are invited to elect to attend small group tutorials – in groups of 6-8 – which would 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 or poll response technologies in live in-person or live-online lectures.

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, 2020, 15th 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-Pearson-e-Text-Access-Card-Package-15th-Edition/PGM2485469.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), large tutorial classes (1 per week after 3rd week of semester) and elective small group tutorials (1 hr every second week).

Lecture Topics:

- Electricity and Magnetism - 20 lectures (A. Lunghi)
- Quantum Physics - 18 lectures (P. Eastham)
- Gravitation and Astrophysics - 12 lectures (A. Physicist)

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, and the motion of planets and satellites
- Describe the main properties of planets, exoplanets, the Sun and stars

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
Basic Astrophysical concepts: scale of the universe, our movement through space, celestial sphere and constellations. Motion of the planets: Newton's law of gravitation, gravitational potential energy, motion of satellites, Kepler's laws and the motion of planets, apparent weight and the earth's rotation, escape velocity. Our solar system - the planets: physical properties, composition, terrestrial planets, gas giants. Exoplanets and life in the Universe: planet formation, exoplanets detection and statistics, life in the universe. Stars: the electromagnetic spectrum, physical properties of the Sun and stars, Blackbody radiation, Wien's law, Stefan-Boltzmann law, introduction to the Hertzsprung-Russell Diagram. Binary stars: Doppler effect in astronomy, stellar masses, mass-luminosity-radius relationship. Telescopes: light-collecting power, angular resolution, telescope designs, types of observations.

Method 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, 2020, 15th 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-Pearson-e-Text-Access-Card-Package-15th-Edition/PGM2485469.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. A proportion of these experiments may be virtual experiments performed or data analysed at home in the academic year 2021/2022, either singly or with virtual partners, possibly augmented by at-home experimental measurements. Some assessments may then also take place in a virtual interview, instead of at-bench interviews.

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 student's 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. As a proportion of these experiments may be virtual experiments performed at home, some assessments may then also take place in a virtual interview, instead of at-bench interviews.

Junior Freshman Physics Coordinator

Professor Ortwin Hess

E-mail: Ortwin.Hess@tcd.ie

Ph: 01 896

Administrative Officer

Ms. Una Dowling

Ph: 01 896 1675

E-mail: dowlingu@tcd.ie

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 MAU11S01

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

Dr. Miriam Logan and Dr. 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 | 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 Dr.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.

Further linear algebra and statistics for scientists

The lecturer for this part will be Dr. Colm O Dunlaing

Module Content:

Learning outcomes

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

- Calculate determinants and apply them to inverting matrices; calculate best-fit linear and quadratic curves; calculate eigenvalues and eigenvectors for 2x2 matrices, and apply them to systems of differential equations.
- Calculate bases for certain vector spaces, and calculate matrices for certain linear maps.l
- Compute simple probability distributions and be familiar with others, including tbe Binomial distribution, the Normal distribution, and the t-distribution
- Work with sample means and sample variance, and calculate confidence intervals.
- Apply hypothesis testing.

Linear Algebra

- Determinants, Evaluation by Row Operations and Laplace Expansion, Properties, Vector Cross Products, Eigenvalues and Eigenvectors;
- Bases and dimension; row space, column space, and nullspace of a matrix.
- Least squares fit via Linear Algebra.
- Eigenvalues and eigenvectors; systems of first-order differential equations.

Probability

- Outcomes and basic distributions. Events and conditional probability.
- Expectation; sample mean, sample standard deviation.
- Some important distributions (uniform, binomial, normal, Student's t-distribution. Central limit theorem and normal approximation to the Binomial distribution.
- Confidence intervals.
- Hypothesis testing.

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 MAU11S02

Dr. Miriam Logan	E-mail: loganmi@tcd.ie
Dr. Colm O 'Dunlaing	Ph: 01 896 1948 E-mail: odunlain@maths.tcd.ie
General enquires:	E-mail: mathdep@maths.tcd.ie

TR063: Physical Sciences – OPEN MODULES

BYU11101: From Molecules to Cells I

Semester 1, 10 credits

Module Coordinator: Tony Kavanagh tkvanagh@tcd.ie

Module Learning Aims

This module aims to introduce students to molecular and cellular biology, including 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 is given, and the ultrastucture of the prokaryotic and eukaryotic cells is covered in detail. The properties and functions of the major classes of biochemicals found in living systems (carbohydrates, lipids, proteins and nucleic acids) are described, the structure and function of membranes and organelles, and the chemical basis of metabolism and energy transfer in the cell. Students are 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 is described. Students 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:

Provide an account of the cellular basis of life: from its origins in the abiotic world, to the evolution of unicellular and multicellular organisms.

Describe the diversity of life forms: including viruses, prokaryotes (bacteria), archaea, and eukaryotes (unicellular organisms, animals and plants).

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.

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).

Employ a range of laboratory techniques, demonstrating the development of practical scientific skills, knowledge of experimental design and the interpretation of results.

Apply the scientific method as a fundamental approach to experiment-based investigations, critical analysis of data, and problem solving.

Contact Hours/Methods of Teaching and Learning
Lectures and practicals will be supplemented with information sessions, tutorials and activities that provide guidance in the use of library resources, laboratory health and safety, help with avoiding plagiarism and examination techniques. Sixty-five hours contact time.

Module Content

Lecture Topic	**Lecturer**	**Practicals**
Introduction and overview	Glynis Robinson	
Section 1 Origin of Life - Cellular basis of life - Diversity of Life Forms		
1. Origins of Life	Luke O'Neill	The Diversity of Life Forms
2. Origins of Life	Luke O'Neill	
3. Cellular Basis of Life	Fred Sheedy	Liquid Handling
4. Cellular Basis of Life	Fred Sheedy	
5. Cellular Basis of Life	Fred Sheedy	Bacterial Growth & Survival
6. The Tree of Life	Alastair Fleming	
7. Bacteria	Alastair Fleming	
8. The Archaea	Alastair Fleming	
9. Fungi & Protists	Alastair Fleming	
10. Viruses	Kim Roberts	
11. Relationship Between Life Forms	Alastair Fleming	
Section 2 The Chemistry of Life		
12. Introduction to Biochemistry	Luke O'Neill	
13. Nucelotides, Amino Acids & Peptides	Luke O'Neill	Enzyme Purification (Chromatography)
14. Protein Structure	Ken Mok	
15. Protein Function	Ken Mok	Enzyme *Characterisation* (Electrophoresis)
16. Enzymes	Vincent Kelly	
17. Enzymes	Vincent Kelly	Enzyme *Characterisation* (Kinetics)
18. Lipids & Membranes	Vincent Kelly	
19. Metabolism	Vincent Kelly	
20. Metabolism	Vincent Kelly	
21. Mitochondria & Respiration	Vincent Kelly	
22. Chloroplasts & Photosynthesis	Vincent Kelly	
Section 3 Biological Information – Genetics, Heredity & DNA		
23. Introduction to Genetics	Jane Farrar	Mendelian Genetics
24. Mendelian Genetics	Jane Farrar	
25. Linkage & recombination 1	Jane Farrar	
26. Linkage & Recombination 2	Jane Farrar	
27. Identification of DNA as Hereditary Material	Jane Farrar	

28. Quantitative Genetics	Jane Farrar	
29. DNA - Structure & Function	Tony Kavanagh	
30. Information Flow - The Central Dogma	Tony Kavanagh	
31. Information Flow - The Central Dogma	Tony Kavanagh	
32. Information Flow - The Central Dogma	Tony Kavanagh	
33. Mutation & the Consequences	Tony Kavanagh	

Lecture Content:

- **Origin of Life:** 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.
- **Cellular basis of life:** Cell structure – prokaryotes, archaea, eukaryotes - animal and plant
  organelles & their prokaryotic origin – mitochondria, chloroplasts, mitosis and meiosis – cell division – regulation of cell division.
- **Diversity of Microbial Life:** the tree of life; bacteria, archaea, fungi & protists, cell structure, morphology, function and habitat; extremophiles; viruses
- **Relationship between life forms**: the good, the bad and the ugly; concepts of symbiosis and parasites; plant and animal diseases.
- **Structural principles for small molecules:** elements and chemical groups in life, bonds, bond energies, bond lengths; forces between biological molecules and chemical groups; asymmetry; four classes of biomolecules: amino acids, nucleotides, carbohydrates & lipids
- **Nucleotides, Amino acids and peptides**: 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
- **Proteins and protein structure:** the 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.
- **Protein function**: functional classes of protein; introduction to bioinformatics; proteins and evolution; relationships between proteins; similarity and identity.
- **Enzymes:** structure & function; reaction mechanisms; co-factors and vitamins; kinetics; regulation of enzyme activity
- **Lipids and membranes:** lipid structures, fatty acids, phospholipids; membranes, chemical and physical properties, membrane proteins; transport across membranes; concept of compartmentation and membrane traffic.
- **Metabolism & major metabolic pathways:** 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.
- **Mitochondria & Respiration:** 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).

- **Chloroplasts and Photosynthesis: c**hloroplast, architecture and function, overview of the light and dark reactions of photosynthesis.
- **Introduction to Genetics:** an outline of some core concepts from classical genetics to the present; a whistle stop tour of key discoveries in the history of genetics.
- **Mendelian Genetics**: 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; inheritance patterns for single gene disorders - pedigree analysis.
- **Linkage and recombination:** Meiosis and the role of 'crossing over' in gene mapping ; a brief recap regarding Mendelian genetics – for example, highlighting that genetic linkage breaks Mendel's 2nd law of independent assortment; outline of key concepts underlying the generation of genetic maps; classical work by Sturtevant / Morgan.
- **Identification of DNA as hereditary material;** 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.
- **Quantitative Genetics:** an overview of concepts relating to discrete variation versus continuous variation; experiments demonstrating that quantitative traits are inherited, examples of 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.
- **DNA, Structure and Function:** 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.
- **Information flow in the cell - The Central Dogma:** transcription, RNA polymerases in prokaryotes and eukaryotes; promoters, repressors, terminators – the *lac* operon; transcription factors, enhancers; decoding the information in mRNA, translation; ribosomes in prokaryotes and eukaryotes, tRNAs and aminoacyl tRNA synthetases, the genetic code; introduction to the regulation of gene expression – positive and negative regulation
- **DNA –Mutation and its consequences:** mechanisms by which mutations are generated - including errors in DNA replication; the action of chemical and physical mutagens; errors in chromosome construction and distribution; an outline of 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.

Recommended Text Book

Campbell Biology, 11th Edition By Lisa A. Urry, Michael L. Cain, Steven A. Wasserman, Peter V. Minorsky, Jane B. Reece (Published by Pearson (2019)

Assessment Details:
(A) **End of semester written examination: 50% of module mark**
Two questions from each of the three sections of the lecture course. Students must answer one question from each section.
(B) **Three in-term MCQ tests: one on each section of the lecture course, each worth 5% of module mark**
(C) **Practical write-ups/assessments: 35% of module mark. Attendance at practicals and submission of the associated exercises is compulsory.**

Students must obtain an overall module mark of 40% to pass the module.
A student who fails to attend more than one-third (1/3) of the practical sessions cannot pass the module without completion of a supplementary practical session, or an alternative exercise in the event that a practical is not possible.

Contacts:

Module Coordinator: Tony Kavanagh tkvanagh@tcd.ie

Biology Course Coordinator: Glynis Robinson, robinsog@tcd.ie**,** Phone: 01 8962895

Laboratory Manager: Siobhan McBennett, smcbnntt@tcd.ie, Phone: 01 8961049

Executive Officer: Helen Sherwin-Murray btcadmin@tcd.ie, Phone: 01 8961117

BYU11102: Organisms to Ecosystems I

Semester 2, 10 credits

Module learning aims

Organisms to Ecosystems I aims to introduce students to the biology of individuals, species, populations and ecosystems, and explore how humans interact with other living organisms. It covers 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.

Learning outcomes

On successful completion of this module, 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

Contact Hours/Methods of Teaching and Learning

Lectures and practicals will be supported by discussion sessions and tutorials. Sixty-five hours contact time.

Module Content

Lecture Topic	Lecturer	Practicals
Introduction and overview	Trevor Hodkinson	
Section 1 Multicellularity and Development, Physiology, Behaviour and Neuroscience		
1. Multicellularity and Development	Rebecca Rolfe	
2. Introduction to Development	Rebecca Rolfe	Development and Floral Morphology
3. Embryogenesis and Morphogenesis	Rebecca Rolfe	
4. Intercellular Communication,	Rebecca Rolfe	
5. Pattern Formation	Rebecca Rolfe	Physiology
6. Differential Gene Expression	Rebecca Rolfe	
7. Form and Function	Áine Kelly	
8. Homeostasis	Áine Kelly	
9. Physiological Regulation	Áine Kelly	
10. Pre-neuroscience History of Ideas of Mind & Brain	Tomas Ryan	
11. Fundamentals of Nervous System Structure and Function	Tomas Ryan	
12. Introduction to the Biology of Memory Storage	Tomas Ryan	
Section 2 Evolution: Adaptation, Populations and Biodiversity		
13. History of life	Trevor Hodkinson	First Life
14. Selection/modern synthesis	Trevor Hodkinson	
15. Species	Trevor Hodkinson	Diversity of Life
16. Speciation	Trevor Hodkinson	
17. Extinction	Trevor Hodkinson	Evolution
18. Phylogeny	Trevor Hodkinson	
19. Genetic Basis of Selection	Aoife McLysaght	Species Diversity Evolution & Modularity
20. Genetic Basis of Evolution 1	Aoife McLysaght	
21. Genetic basis of Evolution 2	Aoife McLysaght	
22. Human Evolution	Aoife McLysaght	
Section 3 Ecology and Environment		
23. Species	Yvonne Buckley	
24. Species - Conservation	Yvonne Buckley	Biodiversity & Ecosystems Services
25. Trophic Cascades and Rewilding	Yvonne Buckley	
26. Constructing Ecosystems and Conservation	Yvonne Buckley	
27. Urban ecology	Yvonne Buckley	
28. Ecosystem Services and Natural Capital	Yvonne Buckley	Biological Environmental Systems
29. Global Ecology and Climate Change	Jennifer McElwain	
30. Biomes, Niches	Jennifer McElwain	
31. Biomes and Global Productivity	Jennifer McElwain	
32. Biomes and Biogeochemical Cycles	Jennifer McElwain	
33. Desiccation Resistance and Space Travel	Jennifer McElwain	

Lecture Content:

- **Introduction to development:** core concepts, model organisms, analysis of development; morphology, genetic, biochemical.
- **Embryogenesis and morphogenesis:** germ layers
- **Intercellular communication:** determination, potency, axis formation – anterior-posterior, dorsal-ventral.
- **Pattern formation**: morphogens, gradients and thresholds.
- **Differential gene expression**: temporal and spatial, master regulators.
- **Form and Function**: functional characteristics of living things; secialisation of cells/tissues/organs to fulfill specific functions.
- **Homeostasis**: 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.
- **Physiological Regulation of Function**: 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.
- **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).
- **Fundamentals of nervous system structure and function**: reticular vs. neuron theory, nervous system as electrically active, Helmholtz and excitable neurons, action potentials & synaptic transmission.
- **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.
- **Short history of life**: timeline, major groups, diversity.
- **Selection/modern synthesis**: adaptation
- **Species**: definitions, taxonomy, diversity, species rich groups.
- **Speciation**: allopatric, sympatric, adaptation, radiations, key innovations.
- **Extinction**: fossils, global change (climate, atmosphere, tectonic).
- **Phylogeny:** homology, convergence, reversals, methods.
- **Genetic basis of selection**
- **Genetic basis of evolution**: molecular variation, neutral theory, drift; molecular evolution of population genetic variation.
- **Human evolution**
- **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.
- **Biomes, niches:** introduction to biomes, what shapes biome distribution? climate change, climate niches / fundamental versus realized niche; challenge of predicting future ecological responses to climate change
- **Commonness, rarity and population processes: e**xtinction 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 (endemism and invasions).

- **Conservation:** applications of population biology at the species level, including prioritizing species for conservation management, assessing threat and red listing.
- **Trophic cascades and rewilding:** what is a community**,** energy flow, applications of community ecology to conservation and rewilding challenges; consumption, facilitation & predation.
- **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.
- **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?
- **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: environmental impacts and ecological process**: food security- ecological concepts- productivity- energy flows through ecological systems/basic concepts of biogeochemical cycles.
- **Future food and a changing planet**: food security; ecological concepts, human population increase, projections for future productivity.
- **Biosphere feedbacks on climate system**: introduction to biological feedbacks on the climate system; 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 system.

Recommended Textbook

Campbell Biology, 11th Edition By Lisa A. Urry, Michael L. Cain, Steven A. Wasserman, Peter V. Minorsky, Jane B. Reece (Published by Pearson (2019)

Assessment Details:

(A) **End of semester written examination: 50% of module mark**
Two questions from each of the three sections of the lecture course. Students must answer one question from each section.
(B) **Three in-term MCQ tests: one on each section of the lecture course, each worth 5% of module mark**
(C) **Practical write-ups/assessments: 35% of module mark. Attendance at practicals and submission of the associated exercises is compulsory.**

Students must obtain an overall module mark of 40% to pass the module.
A student who fails to attend more than one-third (1/3) of the practical sessions cannot pass the module without completion of a supplementary practical session, or an alternative exercise in the event that a practical is not possible.

Contacts

Module Coordinator: Professor Trevor Hodkinson, email: hodkinst@tcd.ie
Biology Course Coordinator: Glynis Robinson, **robinsog@tcd.ie,** Phone: 01 8962895
Laboratory Manager: Siobhan McBennett, smcbnntt@tcd.ie, Phone: 01 8961049
Executive Officer: Helen Sherwin-Murray btcadmin@tcd.ie, Phone: 01 8961117

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.

Content Layout

Teaching Week	Topic
1-4 (15 L)	Introduction to General Chemistry • Motivation for studying chemistry; physical states of chemical matter; classification of matter, physical and chemical properties of pure substances and mixtures; extensive and intensive properties; chemical analysis. • Measurements and units; the international system of units; derived units, the reliability of measurements and calculations; significant figures in simple calculations. • Structure and building principles of atoms; element symbols; masses and the mole; introduction to the periodic table; brief introduction to the structure of the electron shell; ionisation energy and electron affinity. • Law of conservation of mass; law of definite composition; bonding in chemical substances; ionic bonding; covalent bonding; weak bonding; molecules and solid state structures; electronegativity; the periodic table. • Chemical nomenclature of inorganic compounds; stoichiometry; mole, molarity and concentration; interpreting stoichiometric coefficients; sample calculations. • Chemical reactions; symbolizing reactions; balancing equations; limiting reagents and yields; role of water in chemical reactions; important classes of chemical reactions; precipitation reactions; examples of precipitation reactions in chemistry net ionic equations. • Introduction to acid and base reactions; acid-base titration, • Introduction to oxidation and reduction reactions; oxidation number and electron transfer; oxidizing and reducing agents; half-reactions. •

	The Electronic Theory of Chemistry **1. Periodic Classification** • Atoms, Molecules, and Ions. • Atomic structure and the Periodic Table. • The spectrum of atomic hydrogen. • Wave properties of particles. • The structures of many-electron atoms. Orbital energies. • The building-up principle. • A survey of periodic properties. • Periodicity of physical properties. **2. Structure and Bonding** • Lewis structures of polyatomic molecules. • Bond parameters. • Charge distribution in compounds. • Assessing the charge distribution. • Polarization. Ionic and atomic radii. • Ionization energy and Electron Affinity. • Electronegativity. • Dipole moments; Polar and non-polar molecules. • The Chemical Bond. Ionic bonds. • The formation of ionic bonds. • Variable valence. • Covalent bonds. • The electron-pair bond. Lewis acids and bases. • The Shapes of Molecules. • Valence Shell Electron Repulsion theory. • The arrangement of electron pairs. • Polar molecules. • The orbital model of bonding. • Hybridization. • Molecular orbitals. • Bonding in Period 2 diatomic molecules. • A perspective on chemical bonding.
5-12 (24 L)	**Introduction to Physical Chemistry** • The ideal gas law • Kinetic molecular theory of ideal gases • Differences between real and ideal gases • The First Law of Thermodynamics • Internal Energy, Enthalpy and Calorimetry • Cp and Cv, expansion/compression of gases. Adiabatics. • The Second Law of Thermodynamics: entropy • The Carnot cycle • Gibbs' Free Energy • Chemical Equilibrium • Boltzmann's Factor • Acids-Bases and Titrations • Electrochemistry: Nernst equation, electrochemical potential, galvanic cells, electrolysis

	• Phases of state • Intermolecular forces – origin, distance-dependence and effect on properties • Structure and packing of solid structures and their properties • Properties of liquids – viscosity, surface tension, vapour pressure • Water – the universal solvent • Phase transitions and phase diagrams • Thermodynamics and phase transitions • Solutions: liquids in liquids, gases in liquids, solids in liquids • Thermodynamics of solvation • Colligative properties

Reading list/ Indicative Resources

- Chemistry & Chemical Reactivity Hardcover by Paul Treichel, John Kotz, John Townsend, David Treichel; Publisher: Brooks Cole; 9 ed.
- Atkins, P.W. & de Paula, J. (2011) Physical Chemistry for the Life Sciences , 2nd Edition, W H Freeman & Co

Methods of Teaching and Student Learning

A mixture of lectures, tutorials and hands-on laboratory practicals are used in the delivery of this module. The practical sessions are formatted in order to further clarify concepts thus reinforcing learning. A weekly hour of tutorial problem solving activities provides an additional opportunity for the lecturer to assess understanding and gauge the knowledge level of the students.
All lecture notes and problem sheets and a selection of self-assessment quizzes are available for students on Blackboard.

Learning outcomes

On completion of this module the student should be able to:

- Explain, using appropriate terminology and physical units, basic concepts in chemistry, including precipitation and redox reactions.
- Analyse bonding and atomic 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. 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 (40% of the final mark) and a 3 h examination (60% of the final mark).

Course Director:
Professor Yurii Gunko — E-mail: igounko@tcd.ie
Phone:01 896 3543

Coordinator Freshman Teaching
Dr Noelle Scully — E-mail: jfchem@tcd.ie
Phone: 01 896 1972

Senior Executive Officer
Ms AnneMarie Farrell — E-mail: farrea25@tcd.ie
Phone: 01 896 1726

CHU11102: Introduction to Inorganic and Organic Chemistry

Semester 2, 10 credits

Content Layout

Teaching Week	Topic
1-8 (28 L)	Introduction to Organic Chemistry • Alkanes, isomers, homologous series, IUPAC nomenclature, physical properties and molecular size, the tetrahedral carbon atom, shapes of organic molecules, alicyclic rings, concept of bond strain, conformations of ethane and of the cyclohexane ring, chair and boat forms and their relative stabilities, axial and equatorial bonds. • Alkenes, nomenclature, the double bond as an electron rich centre mechanism of electrophilic addition of hydrogen halides, water, and halogens to the double bond, Markownikoff rule, shape of the double bond, geometric isomerism, cis-trans isomers and *E-Z* nomenclature, catalytic hydrogenation, oxidative cleavage of double bonds including ozonolysis. • Alkyne reactions treated briefly as a simple extension of alkene reactions, acidity of alkynes and nucleophilic character of the alkyne anion. • Introduction to aromaticity: benzene structure. Resonance forms and Kekulé structures. Nomenclature. Orbital picture -Consequences of structure. Stability. Quantification of resonance stabilisation energy. Electrophilic addition reactivity. Electrophilic aromatic substitution. Mechanism. Reaction types. Bromination. Nitration. Sulfonation. The Friedel-Crafts reaction. Friedel-Crafts. • Alkyl halides, idea of leaving group, introduction to the use of curly arrows in representing mechanism, idea of nucleophiles and electrophiles, nucleophilic substitutions, SN1 and SN2 mechanisms, carbocations, dehydrohalogenation, elimination mechanisms E1 and E2 emphasising common intermediate for SN1 and E1, direction of elimination, Saytzeff rule, organo lithium and Grignard reagents as carbon nucleophiles. • Alcohols, hydrogen bonds, differences between primary secondary and tertiary, amphoteric nature of the OH group, alkoxides, mechanism of dehydration, oxidation. • Amines as bases and as nucleophiles. • Aldehydes and ketones, nucleophilic attack on the carbonyl carbon, cyanohydrins, oximes, hydrazones, Grignard products, acetals and the mechanism of their formation, oxidation and reduction of the carbonyl group, keto-enol tautomerism, the enolate anion, resonance, haloform reaction, aldol condensation. • Carboxylic acids, acid strength, carboxylate anions, esters, acid halides, acid anhydrides, amides, emphasis on electrophilic nature of the carbonyl group, mechanism of esterification and hydrolysis.

9-12 (14 L)	**Chemistry of the Elements** • Hydrogen and the s-Block Elements. Some important hydrogen compounds. Group I: the alkali metals. Group II: the alkaline earth metals. Some important Group II compounds. • The p-Block Elements; Group III: boron and aluminium. Group III oxides. Other important Group III compounds. Group IV: carbon and silicon. Group IV oxides. Other important Group IV compounds. Group V: nitrogen and phosphorus. Hydrogen and halogen compounds of Group V elements. Group V oxides and oxoacids. Group VI: oxygen and sulfur. Some important compounds of sulfur. Group VII: the halogens. Halides. Halogen oxides and oxoacids. Group VIII: the noble gases. Compounds of the noble gases. • The d-Block Elements. Important properties of d-block elements and their compounds. Trends in physical properties. Reactions of d-block complexes.

Reading list/ Indicative Resources

- Fundamentals of Organic Chemistry, by John E. McMurry and Eric E. Simanek
- Chemistry & Chemical Reactivity Hardcover by Paul Treichel, John Kotz, John Townsend, David Treichel; Publisher: Brooks Cole; 9 ed.
- Organic Chemistry, by Jonathan Clayden and Nick Greeves; Publisher: OUP Oxford; 2 ed.

Methods of Teaching and Student Learning

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

Learning outcomes

On completion of this module the student should be able to:

- 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 examination paper (75% of the final mark).

Course Director:
Professor Yurii Gunko — E-mail: igounko@tcd.ie
Phone:01 896 3543

Coordinator Freshman Teaching
Dr Noelle Scully — E-mail: jfchem@tcd.ie
Phone: 01 896 1972

Senior Executive Officer
Ms AnneMarie Farrell — E-mail: farrea25@tcd.ie
Phone: 01 896 1726

GSU11004: Spaceship Earth: An Introduction to Earth System Science

Semester 1 – 10 credits

Contact hours: Lectures = 22 hrs; Tutorials (5 x 1 hrs)
Module coordinator: Professor Robin Edwards (robin.edwards@tcd.ie)

Learning Outcomes
On successful completion of this module you 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
- Apply core concepts in geography and geoscience to real-world examples

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
- Discuss contemporary issues in geography and geoscience in a small group context
- Conceptual framework that will underpin subsequent specialism in Geography & Geoscience.

Module Outlines

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.

Recommended reading lists

- Holden, J. (2017) An Introduction to Physical Geography and the Environment. 4th Edition. Pearson: Harlow, UK.
- 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:

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

Course Director TR062 Geography and Geosciences

Professor Robin Edwards — E-mail: Robin.Edwards@tcd.ie, Phone: 01 896 1713

Executive Officers:

Ms Helen O'Halloran, Geography Department — E-mail: geog@tcd.ie, Ph: 01 0896 1576

Ms Sarah Guerin, Geology Department — E-mail: TR062Admin@tcd.ie, Ph: 01 896 1074

GSU11005: Introduction to Geology: A Beginner's Guide to Planet Earth

Semester 2, 10 credits

Contact hours: Lectures = 26 hrs; Practicals = 18 hrs: Fieldtrips TBC
Module coordinator: Professor Christopher Nicholas (nicholyj@tcd.ie)

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

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
- Field and laboratory techniques that will be employed in Geography & Geoscience

To develop the following skills & graduate attributes:

- Written and digital / analytical skills
- Critical thinking
- Effective work as part of a team
- Conceptual framework that will underpin subsequent specialism in Geography & Geoscience

Module content:
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.

Recommended Reading List:

- Nicholas, C. J., 2017. A Beginner's Guide to Planet Earth: Introductory Lectures in Geology. C.J. Nicholas (ISBN 978-1-911180-33-3)

Assessment:
50% Theory Exam; 50% in-course assessment.

Course Director TR062 Geography and Geosciences

Professor Robin Edwards	E-mail: Robin.Edwards@tcd.ie
	Phone: 01 896 1713

Executive Officers:

Ms Helen O'Halloran	E-mail: geog@tcd.ie
Geography Department	Ph: 01 0896 1576
Ms Sarah Guerin	E-mail: TR062Admin@tcd.ie
Geology Department	Ph: 01 896 1074

Dates to Note:

Freshman Orientation: 20th to 24th September 2021

Semester one term dates: 27th September to 17th December 2021

Study Week Semester 1: 25th to 29th October 2021

Semester one examinations: 10th to 14th January 2022

Semester two term dates: 24th January 2022 to 15th April 2022

Study week semester 2: 7th to 11th March 2022

Semester two examinations: 2nd to 6th May 2022

Teaching Term Dates 2021-2022					
Michaelmas Term Monday 27 September 2021 - Friday 17 December 2021			**Hilary Term Monday 24 January 2022 - Friday 15 April 2022**		
Teaching wk. 1	Week 03	13 Sept – 17 Sept	Teaching wk. 1	Week 22	24 Jan - 28 Jan
Teaching wk. 2	Week 04	22 Sept - 24 Sept	Teaching wk. 2	Week 23	31 Jan – 04 Feb
Teaching wk. 3	Week 05	27 Sept - 01 Oct	Teaching wk. 3	Week 24	07 Feb - 11 Feb
Teaching wk. 4	Week 06	04 Sept - 07 Oct	Teaching wk. 4	Week 25	14 Feb - 18 Feb
Teaching wk. 5	Week 07	11 Oct - 15 Oct	Teaching wk. 5	Week 26	21 Feb - 25 Feb
Teaching wk. 6	Week 08	18 Oct - 22Oct	Teaching wk. 6	Week 27	28 Feb – 04 Mar
Study week	**Week 09**	*** 25 Oct - 29 Oct**	**Study week**	**Week 28**	**07 Mar - 11 Mar**
Teaching wk. 8	Week 10	01 Nov - 05 Nov	Teaching wk. 8	Week 29	*14 Mar - 18 Mar
Teaching wk. 9	Week 11	08 Nov - 12 Nov	Teaching wk. 9	Week 30	21 Mar - 25 Mar
Teaching wk. 10	Week 12	15 Nov - 19 Nov	Teaching wk. 10	Week 31	28 Mar - 01 Apr
Teaching wk. 11	Week 13	22 Nov - 26 Nov	Teaching wk. 11	Week 32	04 Mar - 08 Apr
Teaching wk. 12	Week 14	29 Nov – 03 Dec	Teaching wk. 12	Week 33	*11 Apr - 15 Apr
Teaching wk. 13	Week 15	06 Dec – 10 Dec			
Teaching wk. 14	Week 16	13 Dec – 17 Dec			

* Monday 25th October 2021 Bank Holiday - College closed
* Thursday 17th March 2022 St Patricks Day - College closed
* Friday 15th April 2022 – College closed

College registration

The Academic Registry issue an **'Invite to Register'** email to all new entrant and continuing students eligible to register for the forthcoming academic year. This communication is issued via the my.tcd.ie portal and your institutional (TCD issued) email address.

On receipt of the emailed invitation, you should log in to the my.tcd.ie to complete the registration steps.

All information regarding College registration is available at the following links:
https://www.tcd.ie/academicregistry/registration/how-to-register/
http://www.tcd.ie/academicregistry/registration/

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/teaching-learning/academic-affairs/ug-prog-award-regs/index.php

Information in relation to all undergraduate Regulations can be found via the following:
https://www.tcd.ie/teaching-learning/academic-affairs/ug-regulations/

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 Freshman 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

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.
Please note: a student may self-certify for no more than 1/3 of laboratory sessions in a module and no more than 1/3 of course work in a module.

- Science **Medical Certificate** Form (**use with med cert from doctor**) – Forms to be submitted via the Science website: https://www.tcd.ie/Science/TR060/junior-freshman/

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, – Forms to be submitted via the Science website: https://www.tcd.ie/Science/TR060/junior-freshman/

- Science Medical **Self Certification** Form (**use for 3 days med not covered by doctor**) – Forms to be submitted via the Science website: https://www.tcd.ie/Science/TR060/junior-freshman/

Please note: a student may self-certify for no more than 1/3 of laboratory sessions in a module and no more than 1/3 of course work in a module.

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 – – Forms to be submitted via the Science website: https://www.tcd.ie/Science/TR060/junior-freshman/

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 accepted.
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

Academic Culture - Plagiarism

Plagiarism is using someone else's ideas, charts, concepts or words in your assignments and using them as if they were your own, and without giving credit to the actual author. Plagiarism is considered a serious offence in Trinity and carries penalties depending on the severity of the plagiarism.

To ensure that you have a clear understanding of what plagiarism is, how Trinity deals with cases of plagiarism, and how to avoid it, you will find a repository of information at http://tcd-ie.libguides.co /plagiarism

We ask you to take the following steps:

I. Visit the online resources to inform yourself about how Trinity deals with plagiarism and how you can avoid it at http://tcd-ie.libguides.com/plagiarism. You should also familiarize yourself with the 2018-19 Calendar entry on plagiarism located on this website and the sanctions which are applied;
II. Complete the 'Ready, Steady, Write' online tutorial on plagiarism at http://tcd-ie.libguides.com/plagiarism/ready-steady-write. Completing the tutorial is compulsory for all students.
III. Familiarise yourself with the declaration that you will be asked to sign when submitting course work at http://tcd-ie.libguides.com/plagiarism/declaration;
IV. Contact your College Tutor, your Course Director, or your Lecturer if you are unsure about any aspect of plagiarism.

Correct referencing is essential when crediting your sources and avoiding plagiarism. Your course handbook will tell you what style of referencing you should use in your assignments so be sure to check that out before you start any assignments. You will waste a lot of time if you have to redo your references.

Resources
Referencite, University of Auckland, New Zealand has some good interactive resources to help you understand plagiarism and how to avoid it: http://www.cite.auckland.ac.nz/index.php?p=home

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.

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/

Contacts: TR063: Physical Sciences

Physical Sciences Course Director

Professor Cormac McGuinness

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

Junior Freshman Physics Coordinator

Professor Ortwin Hess

Ph: 01 896
E-mail: Ortwin.Hess@tcd.ie

School of Physics Executive Officer

Ms. Una Dowling

Ph: 01 896 1675
E-mail: dowlingu@tcd.ie

Science Course Office

Professor Áine Kelly
Associate Dean of Undergraduate Science Education

Ph: 01 896 2025
E-mail: aduse@tcd.ie

Ann Marie Brady
Science Course Office Manager

Ph: 01 896 2829
E-mail: ennisa@tcd.ie

Ms Agnes Gogan
Senior Executive Officer

Ph: 01 896 2022
Email: gogana@tcd.ie

Ms. Mary Pat O'Sullivan
Executive Officer

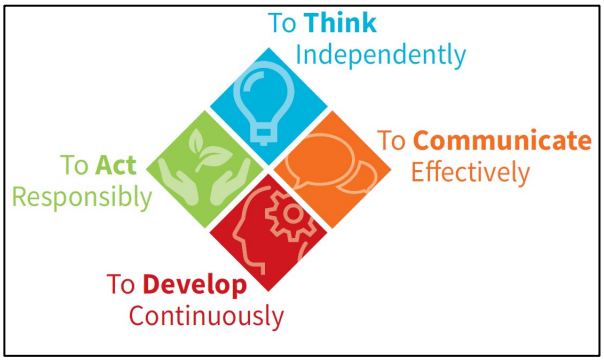
E-mail: mpsullvn@tcd.ie
Ph: 01 8961970

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.

Appendix 1

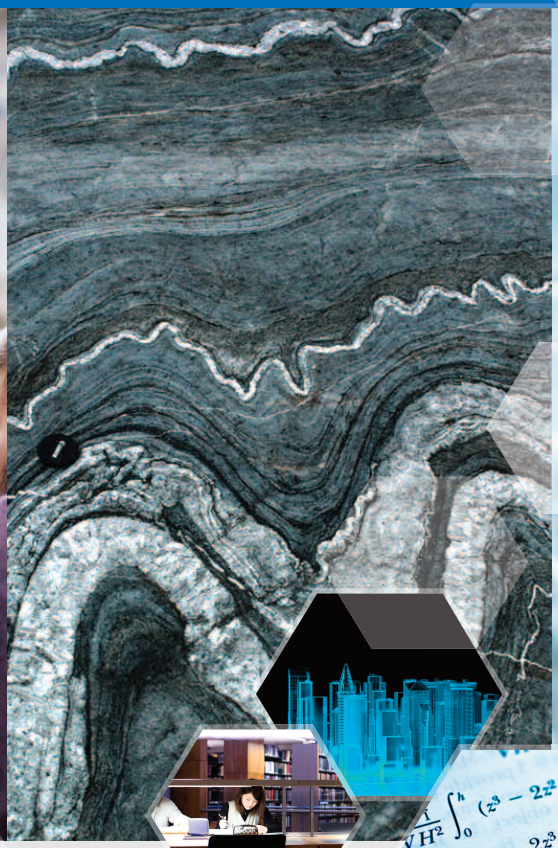
Appendix 1: General Information	
ITEM	REFERENCE/Source
General Regulations	Calendar, Part II - General Regulations and Information, Section II, Item 12: https://www.tcd.ie/calendar/undergraduate-studies/general-regulations-and-information.pdf Calendar, Part III, General Regulations, Section 1.20 https://www.tcd.ie/calendar/graduate-studies-higher-degrees/complete-part-III.pdf Attendance Requirements: Calendar, Part II, General Regulations and Information, Section II, Items 17-23 Calendar, Part III, General Regulations and Information, Sections 1.23; 2.11; and 3.2 Absence from Examinations Calendar, Part II, General Regulations and Information, Section II, Item 35 Calendar, Part III, Section 3.5 Calendar – General Regulations: https://www.tcd.ie/calendar/undergraduate-studies/general-regulations-and-information.pdf Plagiarism Policy and information: https://www.tcd.ie/teaching-learning/UG_regulations/Plagiarism.php https://libguides.tcd.ie/friendly.php?s=plagiarism
General Information	Timetable are available via my.tcd.ie portal: https://my.tcd.ie/urd/sits.urd/run/siw_lgn Blackboard: https://tcd.blackboard.com/webapps/login/ Academic Registry: https://www.tcd.ie/academicregistry/ Data Protection: https://www.tcd.ie/info_compliance/data-protection/student-data/ Dignity & Respect Policy https://www.tcd.ie/equality/policy/dignity-respect-policy/
Foundation Scholarship	Foundation and Non Foundation Scholarship: Calendar, Part II www.tcd.ie/calendar/undergraduate-studies/foundation-and-non-foundation-scholarships.pdf Science Foundation Scholarship information sheet:

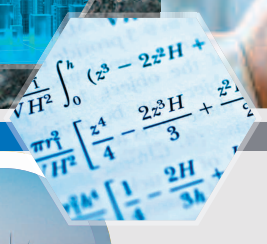
Appendix 1: General Information	
	https://www.tcd.ie/Science/assets/documents/PDF/Foundation-Scholarship-Information%202018-19.pdf
Teaching and Learning	Academic Policies: https://www.tcd.ie/teaching-learning/academic-policies/ Student Learning and Development: https://www.tcd.ie/Student_Counselling/student-learning/ Student Complaints Procedure: https://www.tcd.ie/about/policies/160722_Student%20Complaints%20Procedure_PUB.pdf Dignity & Respect Policy https://www.tcd.ie/equality/policy/dignity-respect-policy/ Student Evaluation and Feedback: https://www.tcd.ie/teaching-learning/quality/quality-assurance/evaluation.php Avoiding Plagiarism: https://libguides.tcd.ie/friendly.php?s=plagiarism/about National Framework for Qualifications: http://www.nfq-qqi.com/index.html
Student support	Student Support Services: https://www.tcd.ie/students/supports-services/ Student Services Booklet: www.tcd.ie/students/assets/pdf/Student%20Services%20Booklet%20(web%20version).pdf Senior Tutor & Tutorial Service www.tcd.ie/students/assets/pdf/Student%20Services%20Booklet%20(web%20version).pdf Graduate Studies https://www.tcd.ie/graduatestudies/ Mature Student Office https://www.tcd.ie/maturestudents/
Co-curricular activities	Central Societies Committee: https://www.tcd.ie/calendar/general-information/students-unions-societies-and-clubs.pdf DUCAC: https://www.tcd.ie/Sport/student-sport/ducac/?nodeId=94&title=Sports_Clubs

Appendix 1: General Information	
Information on TCDSU and GSU, Including student representative structures	TCDSU https://www.tcdsu.org/ TCDSU Student Representation Overview https://www.tcdsu.org/aboutus TCD GSU https://www.tcdgsu.ie/ GSU - Student Representation Overview https://www.tcdgsu.ie/becomearep/
Emergency Procedure	In the event of an emergency, **dial Security Services on extension 1999** Security Services provide a 24-hour service to the college community, 365 days a year. They are the liaison to the Fire, Garda and Ambulance services and all staff and students are advised to always telephone extension 1999 (+353 1 896 1999) in case of an emergency. Should you require any emergency or rescue services on campus, you must contact Security Services. This includes chemical spills, personal injury or first aid assistance. It is recommended that all students save at least one emergency contact in their phone under ICE (In Case of Emergency).

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.

PH: +353 1 896 1970
E-mail: science@tcd.ie
Web: www.tcd.ie/Science

tcd.ie/science