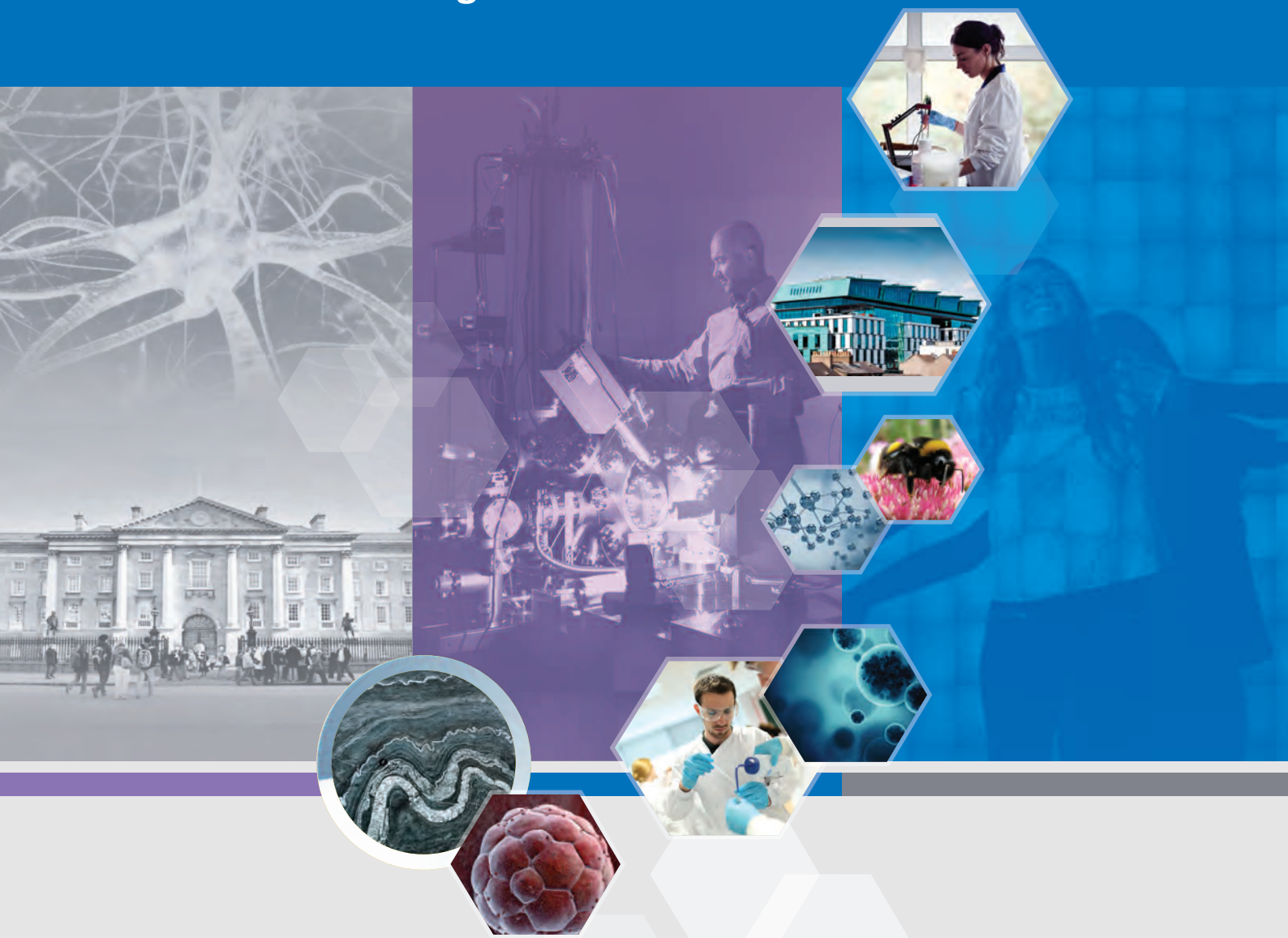
Trinity College Dublin
Coláiste na Tríonóide, Baile Átha Cliath
The University of Dublin

Science at Trinity

Faculty of Science, Technology, Engineering and Mathematics (STEM)

TR062: Geography and Geoscience
Junior Freshman Programme 2023 - 2024



tcd.ie/science

This handbook applies to all students taking TR062: Geography and Geoscience. 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
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Contents

Welcome to Science at Trinity

TR062: Geography and Geoscience introduction

Welcome to Geography and Geoscience at Trinity. Geography and Geoscience is the study of our planet and the people that live on it. This multi- disciplinary programme is designed by leading research scientists in response to critical challenges facing the Earth system and humanity in the 21st century. It integrates knowledge from the physical, chemical, biological and social sciences to develop novel insights into Earth system function and human- environment interactions.
Our four-year programme, culminating in the degrees of Geography or Geoscience, combines classroom lectures, seminars, laboratory-based practical classes, and outdoor field work, to develop the theoretical understanding and technical expertise needed to address applied, real-world problems such as natural resource management and sea level rise.

In years 1 and 2 you will acquire a broad grounding in geography and geoscience with an emphasis on physical geography, geology and human-environment interactions. You will learn about topical issues such as climate change, natural hazards (e.g. volcanoes, earthquakes, landslides), energy, sustainability and natural resources. These foundation years cover a diverse range of material including: the origins and development of our planet; earth structure and composition; circulation in the atmosphere and oceans; the evolution of life on Earth; Earth surface processes and environments (e.g. glaciers, rivers and deserts). In addition to learning about the physical, chemical and biological processes responsible for creating and shaping the Earth, you will also consider the unique role that humans play in the Earth system, including our impacts on the land, air and water, and the grand challenges linked to environmental governance, policy and management.

In years 3 and 4, you will deepen your knowledge in specialist areas, while further developing a portfolio of practical and technical skills. The flexible programme structure provides for module choice while retaining coherent curriculum design, thereby ensuring you will be well prepared for entry to the constantly changing job market. Specialist options span the breadth of Geography and Geoscience, allowing you to tailor the course to suit your interests. In this way, you may focus on topics traditionally associated with geography (e.g. geomorphology, globalisation, sustainability) or geology (e.g. volcanology, palaeontology, natural resources), or you may choose to retain a broader, multi-disciplinary perspective that spans the critical interface between science and society.

An important part of your final year of study is the independent research project in which you will undertake an in-depth investigation of a specific topic. This project acts as a catalyst for you to reflect on your learning from the programme as a whole and to demonstrate your ability to think independently, communicate effectively, develop continuously and act responsibly as you transition to the world of work or to postgraduate studies.

My colleagues and I look forward to working with you and hope you will find your time at Trinity enjoyable, challenging and rewarding in equal measure.

Dr Micha Ruhl
Director, TR062 Geography and Geoscience

TR062 Geography and Geoscience overview and module selection

Module choices will be made online. Please read the following information on pages 2 and 3 and then go to the https://forms.office.com/e/uR8p1ZPanA 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.

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

GSU11001	Spaceship Earth: An introduction to Earth System Science	1	10
GSU11002	Introduction to Geology: A Beginner's Guide to Planet Earth	2	10
GSU11003	The Anthropocene: Constructing the Human Planet	2	10
MAU11001	Mathematics, Statistics & Computation	1	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	Organisms to Ecosystems	2	10
CHU11101	General and Physical Chemistry	1	10
CHU11102	Introduction to Inorganic and Organic Chemistry	2	10
GGU11006	Human Geography: Exploring the Interconnected World	1	10
PYU11F20	Foundation Physics for Life and Earth Scientists 2	2	10

Moderatorships

In the Junior and Senior Freshman years TR062 students complete a course of study which will qualify students to compete for places in the following Moderatorships after the Senior Freshman year:

- Geography
- Geoscience

Semester structure

TR062: GEOGRAPHY AND GEOSCIENCE

CORE MODULES (mandatory) – 20 credits per semester

SEMESTER 1 – Michaelmas term **25th September to 01st December 2023**	**SEMESTER 2 – Hilary Term** **22nd January to 12th April 2024**
GSU11001: Spaceship Earth: An introduction to Earth System Science	GSU11002: Introduction to Geology: A Beginner's Guide to Planet Earth
MAU11001: Mathematics, Statistics and Computation	GSU11003: The Anthropocene: Constructing the Human Planet

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
GGU11006: Human Geography – Exploring the Interconnected World	PYU11F20: Foundation Physics

Change of Approved Modules

If, after a couple of weeks, a student feels that they have perhaps made the wrong choice of approved module, they should seek **advice immediately** from a Tutor, Course Director or the Science Course Office. It may be possible to change from one module to another within your course, subject to permission from the Associate Dean of Undergraduate Science Education. Once a decision has been made to change modules, it should be done **quickly** - it can be difficult to try to catch up with work in a new module when more than two or three weeks of lectures have been missed. Change of module forms are available from the Science Course Office.

TR062: GEOGRAPHY AND GEOSCIENCE – CORE MODULES

GSU11001: 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.

TR062: Geography and Geoscience Course Director

Professor Micha Ruhl E-mail: Micha.Ruhl@tcd.ie

Geology Executive Officer

Ms Sarah Guerin E-mail: TR062Admin@tcd.ie

Geography Executive Officer

Ms Helen O'Halloran E-mail: geography@tcd.ie

GSU11002: 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.

GSU11003: The Anthropocene: Constructing the Human Planet

Semester 2, 10 credits

Contact hours: Lectures and seminars = 23 hrs
Module coordinator: Dr Rory Rowan (rowanro@tcd.ie)

Learning outcomes:
On successful completion of this module you will be able to:

- Understand and explain the scientific and cultural significance of the Anthropocene;
- Critically engage with key debates over the Anthropocene that span the natural sciences, social sciences, arts and humanities;
- Identify the major ethical and political questions facing humanity in a time of ecological uncertainty and environmental degradation;
- Connect the Anthropocene with current events and everyday life, particularly as relates to urban sustainability.

Learning Aims:

- Develop core reading skills and capacity to synthesize and build arguments through involvement in small-class seminars;
- Develop core writing skills through academic and creative writing assignments.

Module content:
The "Anthropocene" is a term that has become widely used since Nobel Prize Laureate Paul Crutzen and Eugene Stoermer began popularizing it in 2000. They argued that humans had so dramatically transformed the planet that it was time to pronounce a new geological epoch: the Anthropocene—or, "the human age."

Whether the Anthropocene is officially accepted as the designation of a new geological epoch or not, the term has sparked debates and discussions across the natural sciences, social sciences, arts and humanities. The multi-disciplinary interest in the Anthropocene demonstrates that the term is more than simply a geological or physical phenomenon; it has complex social, cultural, political, and economic dimensions.

From plastic-filled oceans to species extinction, there is little doubt that human activities are making their mark on the planet. The challenge is to develop more critical, trans-disciplinary understandings of how this situation has arisen and how we might learn to live better on a damaged planet. This module sets out to meet this challenge by engaging ideas and perspectives from the natural sciences, social sciences, arts and humanities, students will learn to describe and understand environmental change from multiple perspectives.

Recommended Reading List:

- Ellis, E. (2018) The Anthropocene: A Very Short Introduction. Oxford: Oxford University Press.
- Lewis, S., & Maslin, M. (2018) The Human Planet: How We Created the Anthropocene. London: Penguin Books.

Assessment:
100% continuous assessment.

MAU11001: Mathematics, Statistics and Computation

Semester 1, 10 credits

Module learning aim:
The students should be enabled to use maths and statistics as tools to solve problems in their scientific discipline, like finding maxima or minima of functions, solving (matrix) difference equations and performing a basic statistical analysis of a data set, aided by the computer language R. When using R and predefined R-functions, students should be in the position to understand the underlying principles., for example how confidence intervals are obtained from integrals of probability density functions. The relevant sciences will help these aims by emphasising the role of mathematical and statistical methods in the context of their respective disciplines.

Module learning outcomes:
On successful completion of this module, students will be able to:

- Use graphs of functions in the context of derivatives and integrals.
- Compute derivatives and equations of tangent lines for graphs of standard functions including rational, trigonometric, exponential and logarithmic functions.
- Compute definite and indefinite integrals using substitution and integration by parts.
- Solve maximisation/minimisation problems using the first derivative test and other applied problems based on population dynamics and radioactive decay.
- Algebraically manipulate matrices by addition and multiplication and use Leslie matrices to determine population growth.
- Solve systems of linear equations using Gauss-Jordan elimination.
- Calculate the determinant of a square matrix and use Gauss-Jordan elimination to determine a matrix inverse.
- Find the eigenvalues and the eigenvectors of a given square matrix.
- Learn the basic ideas of descriptive statistics, types of variables and measures of central tendency and spread.
- Recognise common discrete and continuous distributions and how these naturally arise in life science examples.
- Extract information from a data set and make inference about a population using ideas of sampling distributions, confidence intervals and hypothesis testing.
- Carry out basic tasks using the statistical software R such as importing, exporting and manipulating data, analysing and graphing data, loading and installing package extensions, as well as using help files and online resources to either solve error queries or achieve more niche capabilities.

Module content

- **Calculus part:** functions and graphs, limits, continuity, definition of derivative, rules of differentiation, graphical interpretation of derivatives, optimisation problems, growth and decay applications, semilog and log-log plots, techniques of integration, differential equations and initial value problems.
- **Discrete part:** limits of sequences, difference equations, discrete time models, vectors and matrices, inverse matrices, determinants, systems of difference equations, systems of linear equations, eigenvalues and eigenvectors, Leslie matrices, matrix models.
- **Statistics part:** numerical and graphical descriptions of data, relationships and linear regression, samples and inference, conditional probability and Bayes' rule, discrete and continuous random variables, sampling distribution, confidence intervals, hypothesis testing.

Recommended reading lists:

- Biocalculus: Calculus, probability and statistics for the life sciences by Stewart and Day.
- Getting started with R: An introduction for biologists by Beckerman, Childs and Petchey.

Methods of Teaching and Student Learning

11 weeks of teaching with 5 lectures, 2 tutorials and 1 computer practical per week 1 or 2 lecturers from the school of mathematics

Methods of Assessment

- This module is examined in a 2-hour examination at the end of Semester 2.
- The mathematics part of the module contributes 70% towards the overall mark (with 50% based on the exam and 20% based on the tutorials).
- The statistics part of the module contributes 30% towards the overall mark (based on a group assignment during the last weeks of the semester with groups of 1-3 students working together on a data analysis project).
- Re-assessment, if needed, consists of 100% exam.

Module Coordinator:

Professor Anthony Brown (Mathematics)	E-mail: anthony.brown@ucd.ie
Prof John McDonagh (Stadistics)	E-mail: mcdonaj5@tcd.ie
General enquiries:	E-mail: mathdep@maths.tcd.ie Phone: 01 896 1949

TR062: Geography and Geoscience – Open Modules

BYU11101: From Molecules to Cells I

Semester 1, 10 credits
Module Coordinator: Kevin Mitchell (Email: kevin.mitchell@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 ultrastructure 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 practical's will be supplemented with information sessions, tutorials and activities that provide guidance in the use of library resources, laboratory health and safety, writing techniques, help with avoiding plagiarism and examination techniques. Sixty-five hours contact time.

Module Content

Lecture Topic	Lecturer	Practical
Introduction and overview	Kevin Mitchell	
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	
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	Kevin Mitchell	
30. Information Flow - The Central Dogma	Kevin Mitchell	
31. Information Flow - The Central Dogma	Kevin Mitchell	
32. Information Flow - The Central Dogma	Kevin Mitchell	
33. Mutation & the Consequences	Kevin Mitchell	

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**: chloroplast, 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 examination: 50% of module mark**

(B) **Coursework: 50% of module mark.** Coursework includes compulsory attendance at laboratory sessions, assignments associated with practical's, in-course essay and MCQ tests of lecture material.

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: Kevin Mitchell	kevin.mitchell@tcd.ie
Biology Course Coordinator: Dr Glynis Robinson	robinsog@tcd.ie Phone: 01 8962895
Laboratory Manager: Audrey Carroll	aucarrol@tcd.ie Phone: 01 8961049
Executive Officer: Lang Hu	btcadmin@tcd.ie Phone: 01 8961117

BYU11102: Organisms to Ecosystems I

Semester 2, 10 credits

Module Coordinator: Trevor Hodkinson (hodkinst@tcd.ie)

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. Recognize 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. Recognize 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, synthesize, organize and present information in written reports

Contact Hours/Methods of Teaching and Learning

Lectures and practical's will be supported by online resources provided in Blackboard.
Essay writing skills will be developed. 65 hours contact time.

Module Content

Lecture Topic	Lecturer	Practical
Introduction and overview	Trevor Hodkinson	
Section 1 Multicellularity and Development, Physiology, Behaviour and Neuroscience		
1. Multicellularity and Development	Paula Murphy	
2. Introduction to Development	Paula Murphy	Development and Floral Morphology
3. Embryogenesis and Morphogenesis	Paula Murphy	
4. Intercellular Communication,	Paula Murphy	
5. Pattern Formation	Paula Murphy	Physiology
6. Differential Gene Expression	Paula Murphy	
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	Jay Piggott	
24. Species - Conservation	Jay Piggott	Biodiversity & Ecosystems Services
25. Trophic Cascades and Rewilding	Jay Piggott	
26. Constructing Ecosystems and Conservation	Jay Piggott	
27. Urban ecology	Jay Piggott	
28. Ecosystem Services and Natural Capital	Jay Piggott	Biological Environmental Systems
29. Global Ecology and Climate Change	Richard Nair	
30. Biomes, Niches	Richard Nair	
31. Biomes and Global Productivity	Richard Nair	
32. Biomes and Biogeochemical Cycles	Richard Nair	
33. Desiccation Resistance and Space Travel	Richard Nair	

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; specialisation of cells/tissues/organs to fulfil 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: Assessment Details:
(A) **End of semester examination: 50% of module mark**
(B) **Coursework: 50% of module mark.** Coursework includes compulsory attendance at laboratory sessions, assignments associated with practical's, in-course essay and MCQ tests of lecture material.

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

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CHU11101: General and Physical Chemistry

Semester 1, 10 credits

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

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 (30% of the final mark) and a 3 h examination (70% of the final mark).

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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).

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GGU11006: Human Geography – Exploring the Interconnected World

Semester 1, 10 credits

Learning Outcomes:

- Describe the evolution of the discipline with respect to the philosophical bases which have contributed to its development, the range and changing character of methodological approaches and the foci of geographical enquiry.
- Demonstrate a knowledge of contemporary approaches to the study of human geography.
- Display an ability to use an approach to "thinking geographically" to analyse current events.
- To develop an ability to identify and engage critically with relevant debates within human geography through an in-depth analysis of relevant literature.
- Identify how urbanisation occurs, why urbanisation is a global phenomenon and recognise the forces underlying the growth of urban settlements.
- Describe the impact of urbanisation on different parts of the world.
- Apply approaches in urban geography to analyse key urban problems and challenges.

Module Outline:
This module will provide students with an introduction to key topics, concepts, and approaches in human geography. The overarching theme of the module is exploring the interconnected world, which will entail two interrelated components: exploring how globalisation has produced interdependencies between different parts of the world and understanding how geographers have both shaped the world and our understandings of it. The module will include a mixture of lecture and tutorial classes. The lectures will provide students with an insight into what it means to "think geographically" about contemporary and historical world challenges. It will focus, in particular, on how understanding the development of the discipline of Geography, its philosophical bases and methodological practices can illuminate crucial contemporary challenges such as migration and urbanisation. The tutorials will expand on these topics by providing students with the basis for key geographical, methodological, and analytical skills.

Recommended Reading List:

Section 1

- Boyle, M. Human Geography**:** A concise Introduction (Wiley-Blackwell, Chichester, 2015).
- Daniels, P., Bradshaw, M., Shaw, D. & Sidaway, J.: An Introduction to Human Geography. (Pearson, Harlow, 2008)
- Johnson, R., & Sideway, J.D. Geography and Geographers: Anglo American Geography since 1945 (seventh edition) (Routledge, London, 2015
- Knox, P.L. & Marston, S.A.: Human Geography – places and regions in global context. (Pearson, Upper Saddle River, NJ, 2007)
- Massey, D. & Allen, J. (eds.): Geography Matters (Cambridge Univ. Press, 1984)
- Sparke, M. Introducing globalization: Ties, tensions, and uneven integration. (John Wiley & Sons, 2012)

Section 2

- Clark, D.: Urban World, Global City (Routledge, 1996)
- Edwards, C., & Imrie, R. The short guide to urban policy. (Policy Press, Bristol, 2015).
- Jonas, A. E., McCann, E., & Thomas, M. Urban geography: a critical introduction. John Wiley & Sons, Chichester, 2015).
- Knox, P.L.: Urbanization: an Introduction to Urban Geography (Prentice Hall, 1994)

Section 3

- Dicken, P.: Global Shift (Sage, London, 2003 & subsequent editions)
- Held, D. (ed.): A Globalizing World? Culture, Economics, Politics. (Routledge, London, 2004)
- Johnston, R.J., Taylor, P. & Watts, M.: Geographies of Global Change. (Blackwell, Oxford, 2002)
- Knox, P., Agnew, J.: The Geography of the World Economy, (Arnold, London, 1998)
- Lee, R. & Wills, J.: Geographies of Economies. (Arnold, London, 1997)
- Perrons, D.: Globalization and Social Change. (Routledge, London. 2004)
- Potter, R., Binns, T., Elliott, J. and Smith, D.: Geographies of Development (Addison Wesley Longman, Harlow. 1999)
- Sokol, M., Economic Geographies of Globalisation: A short Introduction, Cheltenham (Edward Elgar. 2011)

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

Module Director
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PYU11F20: Foundation Physics for Life and Earth Sciences

Semester 2, 10 credits

Foundation Physics for the Life and Earth Sciences is a foundation module (10 credits) in physics. It is available as an approved 10 credit module for TR060 and TR062 students, all of whom are taking Maths, Stats, & Computation (10 credits); as well as for TR061 students (if not taking Physics 1 or Physics 2) who take both Mathematics 1 (10 credits) and Mathematics 2 (10 credits). It is available in both semesters for TR060 students, (but cannot be taken twice); it is only available in semester 2 for TR061 and TR062 students.

Module Content: This foundation module comprises lectures, practical work and tutorials, providing an introduction to: physics of motion, biomechanics, physics of hearing and seeing, electricity, magnetism and bioelectricity, radioactivity, nuclear physics and related medical applications, heat, pressure, as well as fluids and their biological, geological and medical applications.

Module Learning Outcomes:
On successful completion of this module, students should be able to:

- Demonstrate the application of Classical Physics within the biomedical and earth sciences
- Connect the study of wave phenomena and electromagnetism with ultrasound diagnostics and vision
- Relate basic knowledge of atomic and nuclear physics to radiation diagnostics and therapy, and to geological applications
- Prepare a brief report, including error analysis, on a simple physical experiment
- Through homework: (i) identify the appropriate concepts, principles, and relations that apply to the problem; (ii) provide a reasonable and appropriate explanation of why they apply; and (iii) solve physics problems at a foundation level.

Module Structure:
Contact Hours: 42 lectures/tutorials, three-hour practical laboratories, online homework.
Module Personnel: Lecturers: Prof. Lewys Jones; Prof. Martin Hegner; Prof. Matthias Möbius

Summary of Laboratory Practicals: In the Foundation Physics for Earth and Life Sciences students complete a minimum of three of the available bench experiments in the semester. The emphasis in the laboratory practical is on learning to make physical measurements, record keeping in laboratory notebooks and estimating uncertainties in measurements, while using these estimates in analysing data in order to make a quantitative measurement of a physics property. Differing students will attempt a differing set of experiments from those available. There may also be differing availability of experiments on the bench in both semesters. Students are required to record all data and information related to experiments in a hardback practical laboratory notebook which is assessed.

Laboratory Practicals: Experiments are selected from among but are not limited to: Pendulum, Thin Lenses, Density and the Principle of Archimedes, Surface Tension, Electrical Resistance, Collisions and Momentum Transfer, Resonance Tube, Leslie's Cube, Geiger Counter, and Photoelectric Effect among others.

Assessment of practical experiments: All student's physics experiments are assessed through both online and submission of written experimental reports and through an at-the-bench laboratory notebook assessment. These reports and notebooks must include and require a documented complete data analysis, description and concise report of the outcomes of the experiment, and any inferences or conclusions that can be drawn from the outcome.

Reading List:

There is required reading and textbook for this course is an online e-Book, "Physics: Principles with Applications" by Giancoli from Pearson publishers. The e-Book includes access to the online homework platform used for assessment, and purchasing this bundle is a requirement for enrolling on this course. The School of Physics has negotiated a group-discount for this book and details of how to obtain this discount will be shared with students after enrolment.

Online Assignments:

Online assignments are submitted through the online homework platform associated with the "Physics: Principles with Applications" by Giancoli. The electronic access is associated with the required text book and details of how to register once you have purchased the e-Book will be shared after enrolment.

Methods of Teaching and Student Learning:

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

The practical sessions are structured to provide a firm introduction to the process of physical measurements, as well as an introduction to estimations of uncertainty (error) and propagation of errors as applied to physics experiments. Each experiment has its own specific learning outcomes and is structured in order 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.
Finally, a number of lecturers use class-based polling of student responses to questions using the available "clicker" technologies.

Methods of Assessment:

Assessment is by a combination of examination and continuous assessment and will include multiple choice tests (MCQs) examination paper; laboratory practical work; and online tutorial homework assignments.
Module website: See links at: http://www.tcd.ie/Physics/study/current/undergraduate/

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Dates to Note:

Freshman Orientation: 18th September to 22nd September 2023

Semester one term dates: 11th September to 16th December 2023

Study Week Semester 1: 23rd to 27th October 2023

Semester one examinations: 11th to 15th December 2023

Semester two-term dates: 22nd January 2024 to 12th April 2024

Study week semester 2: 4th to 8th March 2024

Semester two examinations: 29th April to 3rd May 2024

Teaching Term Dates 2023-2024					
Michaelmas Term Monday 11th Sept 2023 - Friday 01st Dec 2023			**Hilary Term Monday 22nd January 2024 - Friday 12th April 2024**		
Teaching wk. 1	Week 03	11 Sept – 15 Sept	Teaching wk. 1	Week 22	22 Jan - 26 Jan
Teaching wk. 2	Week 04	18 Sept - 22 Sept	Teaching wk. 2	Week 23	29 Jan – 02 Feb
Teaching wk. 3	Week 05	*25 Sept - 29 Sept	Teaching wk. 3	Week 24	*05 Feb - 09 Feb
Teaching wk. 4	Week 06	02 Oct - 06 Oct	Teaching wk. 4	Week 25	12 Feb - 16 Feb
Teaching wk. 5	Week 07	09 Oct - 13 Oct	Teaching wk. 5	Week 26	19 Feb - 23 Feb
Teaching wk. 6	Week 08	16 Oct – 20 Oct	Teaching wk. 6	Week 27	26 Feb – 01 Mar
Study week	**Week 09**	**23 Oct - 27 Oct**	**Study week**	**Week 28**	**04 Mar - 08 Mar**
Teaching wk. 8	Week 10	* 30 Oct - 03 Nov	Teaching wk. 8	Week 29	*11 Mar - 15 Mar
Teaching wk. 9	Week 11	06 Nov - 10 Nov	Teaching wk. 9	Week 30	18 Mar - 22 Mar
Teaching wk. 10	Week 12	13 Nov - 17 Nov	Teaching wk. 10	Week 31	25 Mar - *29 Mar
Teaching wk. 11	Week 13	20 Nov - 24 Nov	Teaching wk. 11	Week 32	* 01 Apr - 05 Apr
Teaching wk. 12	Week 14	27 Nov – 01 Dec	Teaching wk. 12	Week 33	*08 Apr - 12 Apr

***25th September, Junior Freshman Teaching begins.**

Bank Holidays 2023-24 – College closed

30th October 2023 – October bank holiday
5th February 2024 - St Bridget's Day
18th March 2024 – St Patrick's Day
29th March 2024 – Good Friday
1st April 2024 – Easter Monday

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:
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/TR062/junior-freshman/junior-fresh.phpDublin (tcd.ie)

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/TR062/junior-freshman/junior-fresh.php

- 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/TR062/junior-freshman/junior-fresh.php
-
- **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/TR062/junior-freshman/junior-fresh.php

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:

Full regulations on non-submission of coursework can be found via the following:
https://www.tcd.ie/teaching-learning/academic-policies/assets/assess-nonsub-absence-sep2020.pdf

Further details of procedures for reporting a student as non-satisfactory are given on the College website at https://www.tcd.ie/academicregistry/student-cases/

Academic Integrity

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 https://libguides.tcd.ie/academic-integrity

- Academic Integrity homepage (formerly Avoiding Plagiarism): https://libguides.tcd.ie/academic-integrity

- Ready Steady Write tutorial: : https://libguides.tcd.ie/academic-integrity/ready-steady-write
- Coversheet declaration: https://libguides.tcd.ie/academic-integrity/declaration
- Levels and consequences: https://libguides.tcd.ie/academic-integrity/levels-and-consequences

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 visit the AR website: https://www.tcd.ie/academicregistry/

Contact Details

Course Director TR062 Geography and Geoscience

Professor Micha Ruhl
E-mail: micha.ruhl@tcd.ie
Phone: 01 165

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

Ms. Helen O'Halloran
Geography Department
E-mail: geog@tcd.ie
Ph: 01 896 1576

Science Course Office

Professor Fraser Mitchell
Associate Dean of Undergraduate Science Education
E-mail: Fraser.Mitchell@tcd.ie
Ph: 01 896 2025

Ms. Ann Marie Brady
Science Course Office Manager
E-mail: ennisa@tcd.ie
Ph: 01 896 2829

Ms. Helen Sherwin Murray
Administrative Officer
E-mail: sherwinh@tcd.ie
Ph: 01 896 2799

Ms. Andressa dos Santos Melo
Executive Officer
E-mail: dossanta@tcd.ie
Ph: 01 896 1970

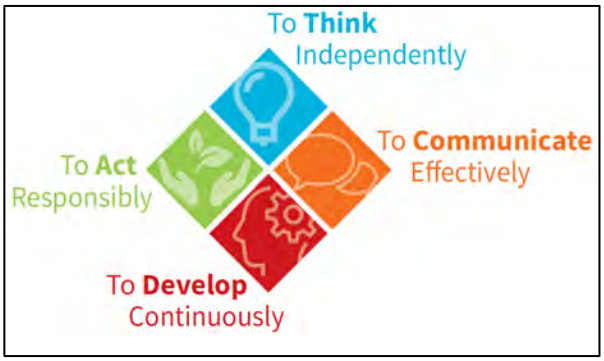
Ms. Inelda Shinko Rama
Executive Officer
E-mail: ishinkor@tcd.ie
Ph: 01 896 2022

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

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 Link here for more information: https://www.tcd.ie/teaching-learning/academic-policies/assets/assess-nonsub-absence-sep2020.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-and-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: TR062-foundation-scholarship-information-22-23.pdf (tcd.ie)

Appendix 1: General Information	
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 Student Evaluation and Feedback: https://www.tcd.ie/teaching-learning/quality/quality-assurance/evaluation.php Academic Integrity: https://libguides.tcd.ie/academic-integrity National Framework for Qualifications: https://www.qqi.ie/what-we-do/the-qualifications-system/national-framework-of-qualifications
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/student-representation/ducac/ https://www.tcd.ie/Sport/student-sport/

Appendix 1: General Information	
Information on TCDSU, Including student representative structures	TCDSU https://www.tcdsu.org/
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 Science, Technology, Engineering and Mathematics, Trinity College Dublin 2, Ireland.

Oifig na gCúrsaí Éolaíochta Dámh na hEolaíochta, na teichneolaíocht, na hInnealtóireachta agus na Matamaitce (STEM), 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