



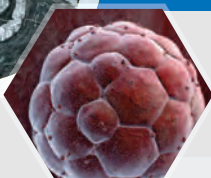
Trinity College Dublin
Coláiste na Tríonóide, Baile Átha Cliath
The University of Dublin

Science at Trinity

**Faculty of Science, Technology, Engineering and
Mathematics**

TR061: Chemical Sciences

Junior Freshman Programme 2023 - 2024



This handbook applies to all students taking TR061: Chemical 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
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TR061: Chemical Sciences introduction

Welcome to your first year in the TR061 Chemical Sciences degree programme! The Chemical Sciences play a central role among the sciences. Chemistry is the study of matter, that is, the composition, structure and properties of substances and the changes they undergo. Life on Earth owes its origin to a series of these chemical changes. An understanding of molecular structures and properties and how to tailor those through chemical changes is critical in many scientific fields and underpins important technologies we rely on every day.

Chemistry is a dynamic discipline that interfaces constantly with other disciplines. Chemists enjoy analysing, synthesising, and designing new compounds and materials to solve modern societal, medical and environmental challenges. Chemists also engage in the creative process of developing new models and theories to explain the workings of our natural world. As part of your degree, you will learn core foundational principles of the chemical sciences but will also be introduced to new areas of chemistry at the frontiers with biology, physics, medicine and computer sciences. Importantly, we will help you acquire proficiency in technical methodologies while supporting the development of effective professional communication skills that are essential for your future career, whether you aspire to becoming a practicing chemist in industry or academia, or to working in business, consultancy or social enterprises.

Formal Chemistry teaching in TCD commenced in August 1711 as part of the new School of Medicine and is now delivered by the staff in the School of Chemistry. The TR061 Chemical Sciences is a new and highly flexible 4-year degree programme that allows you to tailor the focus of your degree through selection of module combinations over the course of your entire undergraduate education. Entry into TR061 gives you the option to choose amongst five Moderatorships as exit routes, namely:

- Chemistry;
- Chemistry with Biosciences;
- Chemistry with Molecular Modelling;
- Medicinal Chemistry;
- Nanoscience.

Junior Freshman module choices recommended and/or required for completing each of the above Moderatorships are discussed in this handbook.

Staff, Research and Facilities in the School of Chemistry

The School of Chemistry currently has 24 academic staff and 10 technical staff. The School has an active research programme, with approximately 100 postgraduate students and postdoctoral researchers. They study a range of subjects such as organic, inorganic, organometallic, physical, theoretical, medicinal, analytical, material, polymer, environmental, and supramolecular chemistry. Research income is earned from national, international and commercial sources and the School has held grants in all relevant research programmes funded by the EU. The College also fosters an interdisciplinary approach to research, with members of the School having strong links with colleagues in the physical, technological and biological sciences both within College, nationally and internationally.

The main chemistry building includes two lecture theatres and four research laboratories. A suite of teaching laboratories (the Cocker laboratories) provides facilities for the teaching of preparative inorganic and organic chemistry. The Sami Nasr Institute for Advanced Materials (SNIAM) provides

ca. 1500 m² of accommodation for the School of Chemistry. This includes a Physical Chemistry teaching laboratory and six research laboratories to house ca. 40 researchers. Computational Chemistry research is housed in the Lloyd Institute on a multidisciplinary computational-science floor comprising researchers from Mathematics, Physics, Chemistry and High-Performance Computing. In addition, chemists play an important role in interdisciplinary research taking place in TCD's research institutes: (i) the Nanoscience Institute – The Centre for Research on Adaptive Nanostructures and Nanodevices (CRANN), and (ii) the Trinity Biomedical Sciences Institute (TBSI).

As part of your degree, you will gain exposure to open ended research thanks to the support of academic staff who work at the cutting-edge of science and through access to state-of-the-art instrumentation. The school is well equipped for its research activities, having Agilent 800 and 400 MHz, and Bruker 600 and 400 MHz high-field multi-nuclear NMR, FTIR, dispersive IR and UV-visible spectrometers, high performance liquid (HPLC) and gas (GC) chromatography equipment, a Rigaku Saturn 724 Diffractometer and Bruker SMART APEX single crystal and Siemens D500 powder diffractometers, Micromass LCTM (TOF) mass spectrometer, thermogravimetric analysis and differential scanning calorimetry, dynamic light scattering, several spectrofluorimeters for steady-state and time-resolved fluorescence measurements, circular and linear dichroism, and a large range of wave generators and potentiostats for cyclic voltammetry.

TR061 Chemical Sciences overview session and module selection

All Chemical Sciences students **must** attend their introductory session **on Monday 18th September 2023 in the Chemistry Large Lecture Theatre from 11.00 to 12.00 hrs** where they will receive important course information and also guidance on choosing the correct modules for the pathway they wish to follow. Students will also meet many of the Academic members of staff who will be delivering lectures and running labs during the year.

In the Junior and Senior Freshman years TR061 students complete a course of study that will qualify them for a place in one the following Moderatorships after their Senior Freshman year:

- Chemistry (C)
- Chemistry with Bioscience; (CB)
- Chemistry with Molecular Modelling (CMM)
- Medicinal Chemistry (MC)
- Nanoscience (N)

The curriculum in the five Moderatorships is tailored to offer a general Chemistry degree (C), a degree focusing on the chemicals and chemical reactions involved in biological processes (CB), a degree with an emphasis on computational methods in chemistry, (CMM), a degree focusing on the synthesis and applications of small drugs for medicinal purposes (MC) and a degree with emphasis on the chemistry and physics of advanced materials and nanomaterials (N). We recommend discussing with the academic staff available during orientation week which of these Moderatorships is best aligned with your current interests. Importantly, students should ensure that module choices over JF and SF years fulfil the requisites to apply for a place in the preferred Moderatorship(s).

The pattern choices available prepare the student through a different balance in the content of their foundation courses. The credits dedicated to each discipline depending on module pattern choice are outlined below:

| | Pattern JF.1 | Pattern JF.2 |
|------------------|-----------------------------------------------|------------------------------------|
| Core credits | 20 ECTS Chemistry 20 ECTS Maths | 20 ECTS Chemistry 20 ECTS Maths |
| Approved credits | 10 ECTS Biology 10 ECTS Foundation Physics | 20 ECTS Physics |

The Table below summarises which JF module patterns fulfil requisites to apply for each of the five Moderatorships.

| Chemistry (C) | Chemistry with Biosciences (CB) | Chemistry with Molecular Modelling (CMM) | Medicinal Chemistry (MC) | Nanoscience (N) |
|------------------------------------|----------------------------------------|-------------------------------------------------|---------------------------------|------------------------|
| Pattern JF.1 OR Pattern JF.2 | Pattern JF.1 | Pattern JF.1 OR Pattern JF.2 | Pattern JF.1 | Pattern JF.2 |

Studies in your SF year of TR061 will also allow for a choice of open modules, however it is important to note that open SF modules will require the student to have completed the corresponding pre-requisites:

- the **BYU11101** module is a pre-requisite to **Biology** modules in SF year
- the **PYU11P10/P20** modules are pre-requisites to **Physics** modules in SF year

In their Junior Freshman year all students must take the 4 core modules for a total of 40 ECTS (20 ECTS per semester) as follows:

| Code | Module Title | Semester | ECTS |
|-----------------|-------------------------------------------------|----------|------|
| CHU11101 | General and Physical Chemistry | 1 | 10 |
| CHU11102 | Introduction to Inorganic and Organic Chemistry | 2 | 10 |
| MAU11S01 | Mathematics for Scientists 1 | 1 | 10 |
| MAU11S02 | Mathematics for Scientists 2 | 2 | 10 |

Students will choose 2 additional modules among those approved for the TR061 programme, for a total of 20 ECTS (10 ECTS per semester). The following two module patterns are available to all students in TR061:

| Code | Module Title | Semester | ECTS |
|-------------------------------------------------------------------------------|----------------------------------------------------|----------|------|
| Pattern JF.1 (fulfils requisites for Moderatorships in C, CB, CMM, MC) | | | |
| BYU11101 | From Molecules to Cells | 1 | 10 |
| PYU11F20 | Foundation Physics for Life and Earth Scientists 2 | 2 | 10 |
| Pattern JF.2 (fulfils requisites for Moderatorships in C, CMM, N) | | | |
| PYU11P10 | Physics 1 | 1 | 10 |
| PYU11P20 | Physics 2 | 2 | 10 |

Semester Structure

TR061: CHEMICAL SCIENCES

CORE MODULES (mandatory) – 20 credits per semester

| SEMESTER 1 – Michaelmas term (25 th September – 01 st December 2023) | SEMESTER 2 – Hilary Term (22 nd January – 12 th April 2024) |
|-----------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| CHU11101: General and Physical Chemistry | CHU11102: Introduction to Inorganic and Organic Chemistry |
| MAU11S01: Mathematics for Scientists 1 | MAU11S02: Mathematics for Scientists 2 |

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

| | |
|-----------------------------------|------------------------------------------------------------|
| BYU11101: From Molecules to Cells | PYU11F20: Foundation Physics for Life and Earth Scientists |
| OR | |
| PYU11P10: Physics 1 | PYU11P20: Physics 2 |

Module Choice Form

- Module choices will be made online. **Please note that choices you make in Junior Freshman year may influence your choices in the Senior Freshman year.**
- Please read this booklet carefully, paying particular attention to the information on pages 4, 5 and 6 and then go to: <https://forms.office.com/e/HWXVDw6Egq> to select your modules. If you feel that you need assistance with your choices, please contact us at jfsc@tcd.ie and we will be happy to help. Please note that the online module choice forms will **not** open until after the introductory session on Monday the 18th September. Forms must be submitted by 12.00 noon on Tuesday the 19th September 2023.
- Please note that if you do not submit your open module choices you will not have a full timetable nor will you receive up-to-date module information via Blackboard.

Change of open modules

If, after a couple of weeks, a student feels that they have perhaps made the wrong choice of open 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.

TR061 Chemical Sciences - Core Modules

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) | <p>Introduction to General Chemistry</p> <ul style="list-style-type: none">• 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. |

| | |
|-------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| | <p>The Electronic Theory of Chemistry</p> <p>1. Periodic Classification</p> <ul style="list-style-type: none"> • 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. <p>2. Structure and Bonding</p> <ul style="list-style-type: none"> • 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) | <p>Introduction to Physical Chemistry</p> <ul style="list-style-type: none"> • 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 |

| | |
|--|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| | <ul style="list-style-type: none"> • 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) | <p>Introduction to Organic Chemistry</p> <ul style="list-style-type: none">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 <i>E-Z</i> 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 <ul style="list-style-type: none"> 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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MAU11S01: Mathematics for Scientists 1

Semester 1, 10 credits

Contact hours:

11 weeks of teaching with 6 lectures and 2 tutorials per week

Learning outcomes:

On successful completion of this module students will be able to

- Explain basic ideas relating to functions of a single variable and their graphs such as limits, continuity, invertibility and differentiability.
- State basic properties and compute limits, derivatives and integrals for a wide range of functions including rational and transcendental functions.
- Use derivatives to find the minimum and maximum values of a function of one real variable.
- Use various techniques of integration to compute definite and indefinite integrals.
- Apply techniques from calculus to a variety of applied problems.
- Manipulate vectors to perform algebraic operations such as dot products and orthogonal projections and apply vector concepts to manipulate lines and planes in \mathbb{R}^n .
- Use Gaussian elimination techniques to solve systems of linear equations, find inverses of matrices, and solve problems that can be reduced to systems of linear equations.
- Manipulate matrices algebraically and use concepts related to matrices such as invertibility, symmetry, triangularity, nilpotence.
- Manipulate numbers in different number systems.
- Use computer algebra and spreadsheets for elementary applications.

Module content:

- **Calculus part:** functions, limits and continuity, derivatives, graphs of functions, optimisation problems, integration, exponential functions, logarithmic functions, inverse trigonometric functions.
- **Discrete part:** vectors, dot product, system of linear equations, Gauss-Jordan elimination, inverse matrix, diagonal and triangular matrices, symmetric matrices, number systems, spreadsheets.

Recommended reading list:

- *Calculus: Late transcendentals* by Anton, Bivens, and Davis.
- *Elementary linear algebra* by Anton and Rorres.

Assessment details:

- This module is examined in a 3-hour examination at the end of Semester 1.
- Continuous assessment contributes 20% towards the overall mark.
- Re-assessment, if needed, consists of 100% exam.

Module Coordinator

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MAU11S02: Mathematics for Scientists 2

Semester 2, 10 credits

Contact hours:

11 weeks, 6 lectures + 2 tutorials per week

Learning outcomes:

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

- Use standard techniques to compute definite integrals.
- Use integrals to compute volumes, areas and lengths.
- Evaluate improper integrals.
- Formulate and solve first-order differential equations.
- Determine whether a given sequence converges or not.
- Test a given series for convergence.
- Approximate a given function by polynomials using Taylor and Maclaurin series.
- Compute determinants using either cofactor expansion or upper triangular forms.
- Use Cramer's rule to solve linear equations.
- Use the adjoint matrix to invert matrices.
- Construct bases for the 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 using the least squared error criterion.
- Calculate eigenvalues and eigenvectors for 2×2 matrices, with applications to differential equations.
- Derive probability distributions in some simple cases.
- Solve problems involving the binomial distribution.
- Calculate percentage points for continuous distributions such as the normal, chi-squared, and student's t-distribution.
- Compute confidence intervals for the mean and standard deviation.

Module content:

- Applications of integrals: area between curves, volume of a solid, length of a plane curve, area of a surface of revolution.
- Techniques of integration: integration by parts, trigonometric substitutions, numerical integration, improper integrals.
- Differential equations: separable, first-order linear, Euler method.
- Infinite series: convergence of sequences, sums of infinite series, tests for convergence, absolute convergence, Taylor series.
- Parametric curves and polar coordinates.
- Determinants, Cramer's rule, adjoint matrix formula for inverse.
- Row space, column space and nullspace of a matrix.
- Orthonormal bases in three dimensions.
- Least squared error linear and quadratic estimates.
- Eigenvalues and eigenvectors for 2×2 matrices, systems of linear differential equations.
- Probability distributions: binomial, chi-squared, normal, Poisson, uniform.
- Central limit theorem.
- Hypothesis testing, confidence intervals for the mean and standard deviation.

Recommended reading lists:

- *Calculus: Late transcendentals* by Anton, Bivens and Davis.
- *Elementary linear algebra* by Anton and Rorres.

Module Prerequisite:

MAU1S001 Mathematics for Scientists 1 (First Semester)

Assessment details:

- This module is examined in a 3-hour examination at the end of Semester 2.
- Continuous assessment contributes 20% towards the overall mark.
- Re-assessment, if needed, consists of 100% exam.

Module Coordinators for MAU11S02

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TR061 Chemical Sciences - 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 | Practicals |
|------------------------------------------------------------------------------------|------------------|--------------------------------------|
| 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. Nucleotides, 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 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:

- End of semester examination: 50% of module mark**
- 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
Biology Course Coordinator: Glynis Robinson

Laboratory Manager: Audrey Carroll

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PYU11F10: Foundation Physics for Life and Earth Sciences

Semester 1 or 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 (but cannot be taken twice); it is only available in semester 2 for TR061 or 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 Practicals: In the Foundation Physics for Earth and Life Sciences students complete a minimum of three practical experiments, including from those experiments available at the bench in the laboratory during the semester. The emphasis in these practicals whether at home or in the laboratory is on learning to make physical measurements, record keeping in scientific laboratory notebooks, estimating uncertainties in measurements, while using these estimates in analysing data in order to make a quantitative measurement of a physical property. Differing students will attempt a differing set of experiments selected from those available. There may also be a differing availability of laboratory experiments on the bench in both semesters. Students are required to record all data and information related to their experiments in a hardback practical laboratory notebook which is assessed. At-home physics practical experiments may be assigned and evaluated together with the laboratory based practicals.

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 practicals, 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 to further clarify concepts met in the textbook and lectures to reinforce 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 and at-home assessed practical work; and online tutorial homework assignments.

Module website: See links at: <http://www.tcd.ie/Physics/study/current/undergraduate/>

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Junior Freshman Physics Coordinator:

Prof. Matthias Möbius

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General Enquiries:

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Senior Executive Officer:

Ms Una Dowling

E-mail: dowlingu@tcd.ie

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 – 20-22 lectures (M. Ferreira)

Waves and Optics I – 18-20 lectures (L. Bradley)

Statistics – 6-10 lectures and labs (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: 20-22 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: 18-20 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: 6-10 lectures and labs

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 may be invited 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%.

Note: There is a minimum mark requirement of 30% separately in the Examination component and the Laboratory component, in order for a Pass or Qualified Pass mark in the module to be granted. Other components making up fewer marks are not included in this requirement.

Reading List:

- University Physics - extended version with Modern Physics, by Hugh D. Young and Roger A. Freedman, Addison-Wesley, 2020, 15th ed.

Students do NOT buy this book - further information at first lecture of term.

Students purchase a Mastering Physics subscription with e-text (and optionally physical textbook) via Pearson Learner Store here: [Mastering Physics with Pearson eText for University Physics with Modern Physics, Global Edition](#). **Wait until instructed to purchase.**

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.

Junior Freshman Physics Coordinator

Professor Evan Keane

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Administrative Officer

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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 (E. Keane)

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%.

Note: There is a minimum mark requirement of 30% separately in the Examination component and the Laboratory component, in order for a Pass or Qualified Pass mark in the module to be granted. Other components making up fewer marks are not included in this requirement.

Reading List

- University Physics - extended version with Modern Physics, by Hugh D. Young and Roger A. Freedman, Addison-Wesley, 2020, 15th ed.

Students do NOT buy this book - further information at first lecture of term.

Students purchase a Mastering Physics subscription with e-text (and optionally physical textbook) via Pearson Learner Store here: [Mastering Physics with Pearson eText for University Physics with Modern Physics, Global Edition](#). Wait until instructed to purchase.

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 Practical - CORE

Summary of Laboratory Practical

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 2020/2021 but 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 Practical:

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.

Physics Undergraduate Laboratory Coordinator

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Junior Freshman Physics Coordinator

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Administrative Officer

Ms. Una Dowling

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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 11 st Sept 2023 - Friday 01 st Dec 2023 | | | Hilary Term Monday 22 nd January 2024 - Friday 12 nd 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 issues 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/student-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

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

Medical Certificates

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

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/TR061/junior-freshman/junior-fresh.php>

- 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/TR061/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/TR061/junior-freshman/junior-fresh.php>

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/TR061/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>

Non-attendance regulations

<https://www.tcd.ie/calendar/undergraduate-studies/general-regulations-and-information.pdf>

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/

Student Learning Development

Student Learning Development (SLD) supports Trinity students reach their academic potential. SLD offer a range of services including individual appointments, workshops and skills events. These services are designed to develop your skills in areas such as academic writing, self and time management, exam & assessment skills for PG & UG students.

For further information visit the following webpage: <https://student-learning.tcd.ie/>

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/>

TR061: Chemical Sciences

Contact details:

Course Director TR061: Chemical Sciences

Professor Valeria Nicolosi

E-mail: nicolov@tcd.ie

Phone: 01 896 4408

Coordinator Freshman Teaching

Dr Noelle Scully

E-mail: jfchem@tcd.ie

Ph: 01 896 1972

Administrative Officer

Ms. Anne Marie Farrell

E-mail: farrea25@tcd.ie

Ph: 01 896 1726

Science Course Office

Associate Dean of Undergraduate Science Education

Professor Fraser Mitchell

E-mail: fmitchll@tcd.ie

Ph: 01 896 2025

Science Course Office Manager

Ms. Ann Marie Brady

E-mail: ennisa@tcd.ie

Ph: 01 896 2829

Administrative Officer

Ms. Helen Sherwin Murray

E-mail: sherwinh@tcd.ie

Ph: 01 896 2799

Executive Officer

Ms. Andressa dos Santos Melo

E-mail: dossanta@tcd.ie

Ph: 01 896 1970

Executive Officer

Ms. Inelda Shinko Rama

E-mail: ishinkor@tcd.ie

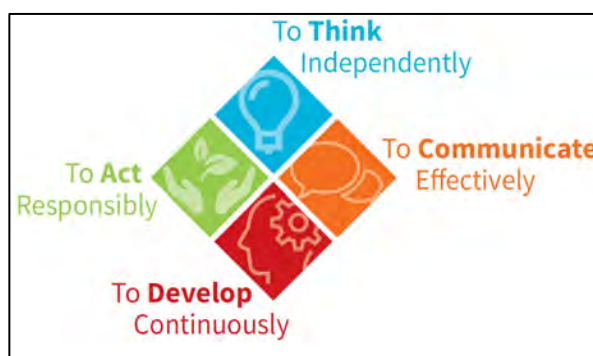
Ph: 01 896 2022

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 1

| Appendix 1: General Information | |
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| ITEM | REFERENCE/Source |
| General Regulations | <p>Calendar, Part II - General Regulations and Information, Section II, Item 12: https://www.tcd.ie/calendar/undergraduate-studies/general-regulations-and-information.pdf</p> <p>Calendar, Part III, General Regulations, Section 1.20 https://www.tcd.ie/calendar/graduate-studies-higher-degrees/complete-part-III.pdf</p> <p>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</p> <p>Absence from Examinations Calendar, Part II, General Regulations and Information, Section II, Item 35 https://www.tcd.ie/teaching-learning/academic-policies/assets/assess-nonsub-absence-sep2020.pdf</p> <p>Calendar – General Regulations: https://www.tcd.ie/calendar/undergraduate-studies/general-regulations-and-information.pdf</p> <p>Academic Integrity: https://libguides.tcd.ie/academic-integrity</p> |
| General Information | <p>Timetable are available via my.tcd.ie portal: https://my.tcd.ie/urd/sits.urd/run/siw_lgn</p> <p>Blackboard: https://tcd.blackboard.com/webapps/login/</p> <p>Academic Registry: https://www.tcd.ie/academicregistry/</p> <p>Data Protection: https://www.tcd.ie/info_compliance/data-protection/student-data/</p> <p>Dignity & Respect Policy https://www.tcd.ie/equality/policy/dignity-and-respect-policy/</p> |
| Foundation Scholarship | <p>Foundation and Non Foundation Scholarship: Calendar, Part II www.tcd.ie/calendar/undergraduate-studies/foundation-and-non-foundation-scholarships.pdf</p> <p>Science Foundation Scholarship information sheet: https://www.tcd.ie/Science/assets/documents/PDF/foundation-scholarship/TR061/TR061-foundation-scholarship-information-22-23.pdf</p> |

Appendix 1: General Information

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| Teaching and Learning | <p>Academic Policies: https://www.tcd.ie/teaching-learning/academic-policies/</p> <p>Student Learning and Development: https://www.tcd.ie/Student_Counselling/student-learning/</p> <p>Student Complaints Procedure: https://www.tcd.ie/about/policies/160722_Student%20Complaints%20Procedure_PUB.pdf</p> <p>Dignity & Respect Policy https://www.tcd.ie/equality/policy/dignity-respect-policy/</p> <p>Student Evaluation and Feedback: https://www.tcd.ie/teaching-learning/quality/quality-assurance/evaluation.php</p> <p>Academic Integrity: https://libguides.tcd.ie/academic-integrity</p> <p>National Framework for Qualifications: https://www.qqi.ie/what-we-do/the-qualifications-system/national-framework-of-qualifications</p> |
| Student support | <p>Student Support Services: https://www.tcd.ie/students/supports-services/</p> <p>Student Services Booklet: www.tcd.ie/students/assets/pdf/Student%20Services%20Booklet%20(web%20version).pdf</p> <p>Senior Tutor & Tutorial Service www.tcd.ie/students/assets/pdf/Student%20Services%20Booklet%20(web%20version).pdf</p> <p>Graduate Studies https://www.tcd.ie/graduatestudies/</p> <p>Mature Student Office https://www.tcd.ie/maturestudents/</p> |
| Co-curricular activities | <p>Central Societies Committee: https://www.tcd.ie/calendar/general-information/students-unions-societies-and-clubs.pdf</p> <p>DUCAC: https://www.tcd.ie/Sport/student-sport/student-representation/ducac/ https://www.tcd.ie/Sport/student-sport/</p> |

Appendix 1: General Information

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|-------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Information on TCDSU, Including student representative structures | TCDSU https://www.tcdsu.org/ |
| Emergency Procedure | <p>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.</p> <p>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.</p> <p>It is recommended that all students save at least one emergency contact in their phone under ICE (In Case of Emergency).</p> |

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



E-mail:
Web:

science@tcd.ie
www.tcd.ie/Science

tcd.ie/science