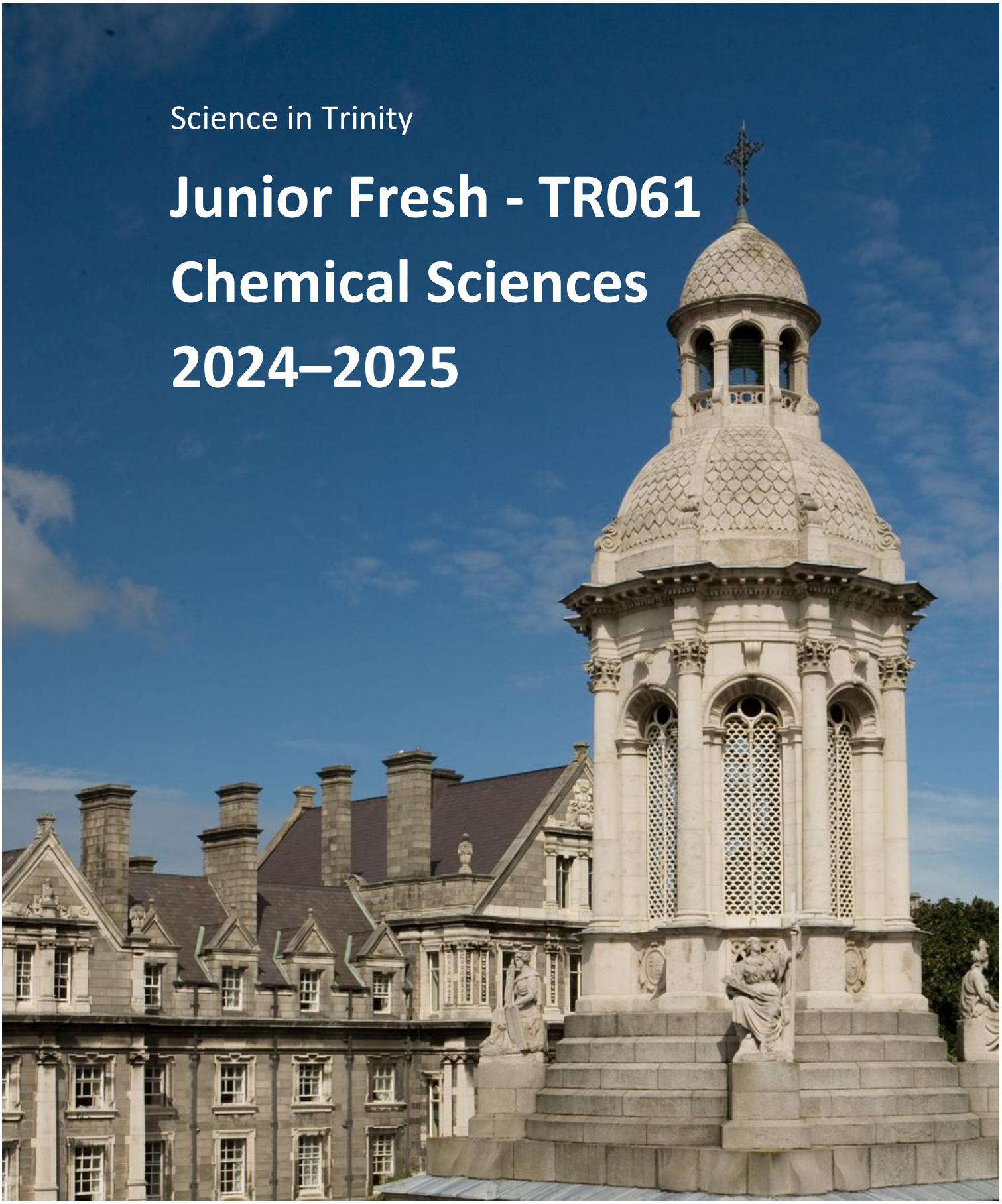
Trinity College Dublin
Coláiste na Tríonóide, Baile Átha Cliath
The University of Dublin



Science in Trinity

Junior Fresh - TR061 Chemical Sciences 2024–2025

Contents

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 Fresh 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 m^2 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 LCTTM (TOF) mass spectrometer, thermogravimetric analysis and differential scanning calorimetry, dynamic light scattering, several spectrofluorometers for steady-state and time-resolved fluorescence measurements, circular and linear dichroism, and a large range of wave generators and potentiostats for cyclic voltammetry.

Professor Valeria Nicolosi

Director, TR061 Chemical Sciences

TR061 Chemical Sciences overview session and module selection

All Chemical Sciences students **must** attend their introductory session **on Monday 16th September 2024 in the Chemistry Large Lecture Theatre from 11.00 to 12.00** hrs where they will receive important course information and 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 Fresh years TR061 students complete a course of study that will qualify them for a place in one the following Moderatorships after their Senior Fresh 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 Fresh 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 (23rd September – 25th November 2024)	**SEMESTER 2 – Hilary Term (20th January – 07th April 2025)**
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 Fresh year may influence your choices in the Senior Fresh year.**
- Please read this booklet carefully, paying particular attention to the information on pages 3 and 5 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 jfsco@tcd.ie and we will be happy to help. Please note that the online module choice forms will **not** open until **13.00 hrs on Monday the 16th of September** after the introductory session. **Forms must be submitted by 13.00 hrs on Tuesday the 17th of September 2024.**
- 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

Capping

If a student is required to be reassessed in the module, a capped mark of 60% will apply to any component that is reassessed in this chemistry module.

Rationale and Aims

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

Content Layout

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

	General Chemistry: Structure, Bonding, and Periodicity • The electronic theory of chemistry: • The spectrum of atomic hydrogen; wave properties of particles; the structures of many-electron atoms. • Orbital energies. • building-up principle. • Lewis structures of polyatomic molecules. • Bond parameters. • Charge distribution in compounds. • Assessing the charge distribution. • Polarization. Ionic and atomic radii. • A survey of periodic properties; Periodicity and trends cross the periodic table; Electronic and physiochemical changes of metals, metalloids and non-metals across the periodic table. • Periodic nature of ionic and atomic radii, Ionization energy and Electron Affinity, Electronegativity. • The electron-pair bond. Lewis acids and bases. • The Shapes of Molecules. • Valence Shell Electron Repulsion theory. • The arrangement of electron pairs. • Polar molecules. • Hybridization. • A perspective on chemical bonding.
5-12 (24 L)	**Introduction to Physical Chemistry** • The ideal gas law • Kinetic molecular theory of ideal gases • Differences between real and ideal gases • The First Law of Thermodynamics • Internal Energy, Enthalpy and Calorimetry • Cp and Cv, expansion/compression of gases. Adiabatics. • The Second Law of Thermodynamics: entropy • The Carnot cycle • Gibbs' Free Energy • Chemical Equilibrium • Boltzmann's Factor • Acids-Bases and Titrations • Electrochemistry: Nernst equation, electrochemical potential, galvanic cells, electrolysis • Phases of state • Intermolecular forces – origin, distance-dependence and effect on properties • Structure and packing of solid structures and their properties • Properties of liquids – viscosity, surface tension, vapour pressure • Water – the universal solvent • Phase transitions and phase diagrams

	• Thermodynamics and phase transitions • Solutions: liquids in liquids, gases in liquids, solids in liquids • Thermodynamics of solvation • Colligative properties

Reading list/ Indicative Resources

- Chemistry & Chemical Reactivity Hardcover by Paul Treichel, John Kotz, John Townsend, David Treichel; Publisher: Brooks Cole; 9 ed.
- Atkins, P.W. & de Paula, J. (2011) Physical Chemistry for the Life Sciences, 2nd Edition, W H Freeman & Co
- Inorganic Chemistry, by C. E. Housecroft and A. G. Sharpe, Publisher: Pearson, 2018, 5th ed.
- Inorganic Chemistry by Gary *Miessler*, Paul *Fischer*, Donald *Tarr*, Publisher: Pearson, 2021, 5th 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.
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
- Describe the chemical and physical properties of elements as a function of their position in the periodic table.
- Identify, 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.
- 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).

Contacts Details

Course Director: Professor Valeria Nicolosi	nicolov@tcd.ie Phone:01 896 4408
Coordinator of Fresh Teaching: Dr Noelle Scully	jfchem@tcd.ie Phone: 01 896 1972
Administrative Officer: Ms Anne Marie Farrell	farrea25@tcd.ie Phone: 01 896 1726

CHU11102: Introduction to Inorganic and Organic Chemistry

Semester 2, 10 credits

Capping

If a student is required to be reassessed in the module, a capped mark of 60% will apply to any component that is reassessed in this chemistry module.

Content Layout

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

	group, keto-enol tautomerism, the enolate anion, resonance, haloform reaction, aldol condensation. • Carboxylic acids, acid strength, carboxylate anions, esters, acid halides, acid anhydrides, amides, emphasis on electrophilic nature of the carbonyl group, mechanism of esterification and hydrolysis.
9-12 (14 L)	• Introduction to Inorganic Chemistry 1 • This section of the module covers an introduction to inorganic chemistry, with emphasis on bonding, molecular orbital treatment of bonding, and an introduction to coordination chemistry. • Introduction to Molecular Orbital Theory (7 L) • Atomic orbitals (s,p,d) as wave functions; their representation as enclosed boundary surfaces and as radial distribution functions. The relationship of these ideas to the Bohr model for atomic hydrogen. Relative energies of these orbitals; orbital angular momentum in non-hydrogen-like atoms; penetration and shielding. • Hybridisation of atomic orbitals and the hybrids associated with various geometries; VSEPR treatment of molecular structures. • Bonding as the linear combination of atomic orbitals, including non-bonding and anti-bonding interactions. Labelling of molecular orbitals as sigma, pi (g or u), molecular orbital diagrams of homonuclear diatomic molecules of the first and second row of the Periodic Table. Mixing of molecular orbitals and its effect on the relative energies of the resulting molecular orbital diagram. Molecular orbital approach for simple molecules including H_2O, BeH_2 and BCl_3. Reactivity of CO in terms of the molecular orbital energy diagram for this molecule. Appreciation of the Molecular Orbital basis of the spectrochemical series. • Introduction to Coordination Chemistry • Brief introduction - why study metal complexes? • What is a metal complex? Overview of concepts and definitions: Lewis Acid-base concept. • Formation and stability of metal complexes: Complex formation and dissociation; cumulative stability constants and trends; the 'chelate effect'; factors affecting stability. • Classification of common ligands: Donor atoms and functional groups. Multidentate and chelating ligands; stereochemistry and formation of chelate rings. • Stereochemistry of metal complexes. Coordination numbers 2-6 and geometry of metal complex; square planar, tetrahedral; trigonal bi-pyramid; square based pyramid; octahedral; distortion of geometries. • Electronic structure and properties of transition metal complexes: Ionic vs. covalent bonding models; crystal field theory; energy level diagrams in tetrahedral - octahedral fields.

	• 18-electron rule, Molecular Orbital Diagrams for Octahedral Complexes, M-L σ and π bonding • Consequences and applications of orbital splitting: Electronic configurations of metal complexes; crystal filed stabilization energies (CFSE); Factors effecting Delta; spectrochemical series; HS and LS configurations; magnetic properties and the spin-only formula. • Electronic spectra of metal complexes: UV-vis. Spectra; interpretation of data; Laporte and spin selection rules; extinction coefficients and wavelength; Jahn-Teller effect.

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.
- Inorganic Chemistry, by C. E. Housecroft and A. G. Sharpe, Publisher: Pearson, 2018, 5th ed.
- Inorganic Chemistry by Gary *Miessler*, Paul *Fischer*, Donald *Tarr*, Publisher: Pearson, 2021, 5th 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.
- Understand particle wave duality, the contribution of quantum mechanics to understanding atomic and molecular orbits, formation of bonds and how molecular orbitals can be derived using atomic orbitals.
- Discuss Lewis Acid-Base concept and classify different ligands.
- Understand the chelate effect and factors which affect metal complex stability.
- Analyse common geometries and distortion.
- Explain different bonding models and Crystal Field Theory.
- Predict and explain d-orbital splitting in transition metal complexes and its effects on the geometry and electronic properties.

- Calculate crystal field stabilization energies (CFSE) and high-spin and low-spin configurations.
- Interpret extinction coefficients and selection rules in understanding electronic spectra of complexes.

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).

Contact Details:

Course Director: Professor Valeria Nicolosi	nicolov@tcd.ie Phone:01 896 4408
Coordinator of Fresh Teaching: Dr Noelle Scully	jfchem@tcd.ie Phone: 01 896 1972
Administrative Officer: Ms Anne Marie Farrell	farrea25@tcd.ie Phone: 01 896 1726

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 Rn.
- 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.

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.

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.

Contact Details:

Module Coordinator: Dr. Chaolun Wu — E-mail: chaolunwu@maths.tcd.ie

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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 2x2 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, inverting matrices using cofactors.
- Vector spaces, bases.
- Row space, column space and nullspace of a matrix.
- Orthogonal and orthonormal bases in two and three dimensions.
- Matrices of linear transformations.
- Eigenvalues and eigenvectors for 2x2 matrices, matrix exponentials, systems of linear differential equations.

- Least squares approximations, straight lines, quadratic curves.
- Probability distributions: uniform, binomial, Poisson, normal.
- Central limit theorem.
- Confidence intervals, z-intervals, t-intervals.
- 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 (not necessary, only for extra reading)
- *Linear algebra an its applications by David Lay* (not necessary, only for extra reading)
- *Biocalculus: Calculus, Probability and Statistics for the life sciences by James Stewart and Troy Davis* (not necessary, only for extra reading)

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.

Contact Details:

Module Coordinators for MAU11S02

Professor Miriam Logan	E-mail: loganmi@tcd.ie
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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. Online learning resources, assignments, submission instructions and information concerning the day-to-day running of the module will be published in Blackboard. 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. Nucelotides, Amino Acids & Peptides	Luke O'Neill	Enzyme Purification (Chromatography)
14. Protein Structure	Ken Mok	
15. Protein Function	Ken Mok	
16. Enzymes	Vincent Kelly	
17. Enzymes	Vincent Kelly	Enzyme Characterisation (Kinetics)
18. Lipids & Membranes	Vincent Kelly	
19. Metabolism	Vincent Kelly	
20. Metabolism	Vincent Kelly	
21. Mitochondria & Respiration	Vincent Kelly	
22. Chloroplasts & Photosynthesis	Vincent Kelly	
Section 3 Biological Information – Genetics, Heredity & DNA		
23. Introduction to Genetics	Jane Farrar	Mendelian Genetics
24. Mendelian Genetics	Jane Farrar	
25. Linkage & recombination 1	Jane Farrar	
26. Linkage & Recombination 2	Jane Farrar	
27. Identification of DNA as Hereditary Material	Jane Farrar	
28. Quantitative Genetics	Jane Farrar	
29. DNA – Structure & Function	Kevin Mitchell	
30. Information Flow – The Central Dogma	Kevin Mitchell	
31. Information Flow – The Central Dogma	Kevin Mitchell	
32. Information Flow – The Central Dogma	Kevin Mitchell	
33. Mutation & the Consequences	Kevin Mitchell	

Lecture Content:

- **Origin of Life:** What is Life? How did it arise? The Origin of Life from a chemical and cellular perspective; the abiotic world; the prebiotic world; Miller-Urey experiment; the first cell; photosynthesis and oxygen – mass extinction; origin of first eukaryotic cell; multicellular life; cell specialization.
- **Cellular basis of life:** Cell structure – prokaryotes, archaea, eukaryotes – animal and plant
- organelles & their prokaryotic origin – mitochondria, chloroplasts, mitosis and meiosis – cell division – regulation of cell division.
- **Diversity of Microbial Life:** the tree of life; bacteria, archaea, fungi & protists, cell structure, morphology, function and habitat; extremophiles; viruses
- **Relationship between life forms**: the good, the bad and the ugly; concepts of symbiosis and parasites; plant and animal diseases.
- **Structural principles for small molecules:** elements and chemical groups in life, bonds, bond energies, bond lengths; forces between biological molecules and chemical groups; asymmetry; four classes of biomolecules: amino acids, nucleotides, carbohydrates & lipids
- **Nucleotides, Amino acids and peptides**: DNA, RNA, chromatin and chromosome structure, properties of amino acids, chemical features and physical properties of the R-groups; the peptide unit and peptide bond
- **Proteins and protein structure:** the concept that shape dictates function; hierarchical organization of protein structure; concept of primary, secondary, tertiary and quaternary structure; introduction to forces that stabilize protein structure.
- **Protein function**: functional classes of protein; introduction to bioinformatics; proteins and evolution; relationships between proteins; similarity and identity.
- **Enzymes:** structure & function; reaction mechanisms; co-factors and vitamins; kinetics; regulation of enzyme activity
- **Lipids and membranes:** lipid structures, fatty acids, phospholipids; membranes, chemical and physical properties, membrane proteins; transport across membranes; concept of compartmentation and membrane traffic.
- **Metabolism & major metabolic pathways:** the starting point: introduction to carbohydrates and fatty acids; organization, energetic principles, key steps and links between the main metabolic pathways; glycolysis, TCA cycle, beta oxidation; outline of the reversing catabolic pathways, gluconeogenesis and fatty acids synthesis.
- **Mitochondria & Respiration:** mitochondria, redox reactions and energy transduction; electron transport and the electron transport chain; oxidative phosphorylation; coupling of oxidation to phosphorylation; chemiosmotic view of energy transduction (in brief).
- **Chloroplasts and Photosynthesis: c**hloroplast, architecture and function, overview of the light and dark reactions of photosynthesis.
- **Introduction to Genetics:** an outline of some core concepts from classical genetics to the present; a whistle stop tour of key discoveries in the history of genetics.
- **Mendelian Genetics**: Mendel's laws, the 1st law of segregation and the 2nd law of independent assortment using monohybrid and dihybrid crosses; concepts relating to genetic analysis and the use of model systems; inheritance patterns for single gene disorders – pedigree analysis.

- **Linkage and recombination:** Meiosis and the role of 'crossing over' in gene mapping; a brief recap regarding Mendelian genetics – for example, highlighting that genetic linkage breaks Mendel's 2nd law of independent assortment; outline of key concepts underlying the generation of genetic maps; classical work by Sturtevant / Morgan.
- **Identification of DNA as hereditary material;** key experiments establishing DNA as the genetic material; bacterial transformation and its significance (Griffith / Avery, McLeod & McCarthy / Hershey-Chase); the concept of horizontal gene transfer (mechanisms transformation, conjugation, transduction); differences in vertical and horizontal gene transfer.
- **Quantitative Genetics:** an overview of concepts relating to discrete variation versus continuous variation; experiments demonstrating that quantitative traits are inherited, examples of quantitative traits in humans; concepts regarding the use of GWAS to elucidate the genetics architecture of complex traits using an example of one or more disorders.
- **DNA, Structure and Function:** the double helix – discovery of the structure of DNA – DNA composition – DNA replication – semi-conservative replication, replication forks, leading and lagging strand synthesis, DNA polymerases; DNA replication in prokaryotes and eukaryotes.
- **Information flow in the cell – The Central Dogma:** transcription, RNA polymerases in prokaryotes and eukaryotes; promoters, repressors, terminators – the *lac* operon; transcription factors, enhancers; decoding the information in mRNA, translation; ribosomes in prokaryotes and eukaryotes, tRNAs and aminoacyl tRNA synthetases, the genetic code; introduction to the regulation of gene expression – positive and negative regulation
- **DNA –Mutation and its consequences:** mechanisms by which mutations are generated – including errors in DNA replication; the action of chemical and physical mutagens; errors in chromosome construction and distribution; an outline of the different types of mutation (missense, nonsense, frameshift mutations) and their molecular consequences in relation to gene expression and protein function; mutations causing inherited diseases and cancer; DNA repair – mechanisms of DNA repair, repair deficiency and disease.

Recommended Textbook

Campbell Biology, 12th Edition by Lisa A. Urry, Michael L. Cain, Steven A. Wasserman, Peter V. Minorsky, Jane B. Reece (Published by Pearson (2021)

Assessment Details:

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

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

Contacts Details:

Module Coordinator: Kevin Mitchell	kevin.mitchell@tcd.ie Phone: 01 8963067
Biology Course Coordinator: Mirela Dardac	mdardac@tcd.ie Phone: 01 8962895
Laboratory Manager: Audrey Carroll	aucarrol@tcd.ie Phone: 01 8961049
Executive Officer: Daniel McCormick	dmccorm2@tcd.ie Phone: 01 8961117

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/

Contac Details:

Foundation Physics Course Coordinator:	
Prof. Martin Hegner	Martin.Hegner@tcd.ie
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Junior Fresh Physics Coordinator:	
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	Phone: 01 896 1055
General Enquiries:	Physics@tcd.ie
	Phone: 01 896 1675
Senior Executive Officer:	dowlingu@tcd.ie
Ms Una Dowling	Phone: 01 8961675

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).

Progression regulations applying to Physics modules and accredited Physics programmes

The full text of these derogations from the College Progression and Award rules can be found at: https://www.tcd.ie/teaching-learning/academic-affairs/ug-prog-award-regs/derogations/by-school.php Select the year and scroll to the School of Physics.

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.

Contact Details:

Junior Fresh Physics Coordinator: Professor Evan Keane — Evan.Keane@tcd.ie

Administrative Officer: Ms. Una Dowling — dowlingu@tcd.ie

Ph: 01 896 1675

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).

Progression regulations applying to Physics modules and accredited Physics programmes

The full text of these derogations from the College Progression and Award rules can be found at: https://www.tcd.ie/teaching-learning/academic-affairs/ug-prog-award-regs/derogations/by-school.php Select the year and scroll to the School of Physics.

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.

Contact Details:

Physics Undergraduate Laboratory Coordinator: Professor Karsten Rode	RodeK@tcd.ie Ph: 01 896 3649
Junior Fresh Physics Coordinator: Professor Evan Keane	Evan.Keane@tcd.ie
Administrative Officer: Ms. Una Dowling	dowlingu@tcd.ie Ph: 01 896 1675

Important information

College registration

You will complete College registration online via the website my.tcd.ie. Registration will open on a course-by-course basis. A communication will be sent to the e-mail address you supplied during the application process inviting you to log in to the Academic Registry website to register. When you receive your TCD email address, check it regularly Please check your TCD email address regularly as that will then be the address to which all Trinity communications will be sent.

All information regarding College registration is available at the following link:
http://www.tcd.ie/academicregistry/registration/

Please Note: Students who have already accessed the my.tcd.ie website should continue to access it using your current username and password as this will not change. For those who have not previously logged on, a username and password has been created to give you immediate access.

Closing Dates for Course Transfer

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

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

Progression and Awards

Information on progression and awards can be found via the following webpage:
https://www.tcd.ie/teaching-learning/academic-affairs/ug-prog-award-regs/index.php

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

Attendance/Non-attendance Regulations for Junior and Senior Fresh Students

The following regulations will apply to Junior and Senior Fresh student in the following Science Courses:
TR060: Biological and Biomedical Science
TR061: Chemical Sciences
TR062: Geography and Geoscience
TR063: Physical Sciences

All students must begin attendance for their course no later than the first day of teaching term and must fully take part in the academic work of their course. Attendance at Lectures, Labs, Field trips and tutorials is **compulsory** in both core and open modules. Timetables are published through the my.tcd.ie portal and the onus lies with the student to inform themselves of dates, times and venues by consulting the timetable regularly.

It is extremely important that students meet all the requirements of their course and that they submit all continuous assessments, Laboratory practical/Field course reports and assignments by the required deadlines. Students should ensure that they make themselves aware of the module weightings which are outlined in the relevant booklets available from the Science Course Office website: https://www.tcd.ie/science/undergraduate/

Laboratory Practicals, Field courses and Tutorials

The primary function of laboratory practicals, compulsory field courses and tutorials is to equip students with the skills and knowledge necessary to be successful at sophister level in their chosen moderatorship. Therefore, they are an extremely important part of the student educational experience in Science. The learning outcomes for these components are intrinsically linked with the physical actions of being present. Students who do not attend at least 2/3 of the compulsory sessions in a module will be returned as "non-satisfactory attendance and may be excluded from taking their exams: see section below.

Coursework/assignments

Students must complete and submit all coursework, laboratory write ups, field course notes in full by the published submission date. Deductions for late submission will be applied as follows:
Biology – 10% reduction from final grade per week
Chemistry – 10% for the first 24 hours and 5% ever day after that
Geoscience – 10% reduction from final grade per week

Module handbooks will detail penalties for late submission of individual pieces of continuous assessment.

It is therefore essential, that students who think they will not be in a position to meet a certain deadline, contact the module Coordinator or Course Director before the due date. We recognise that there are times when students will struggle with deadlines, and problems identified at the time are more easily dealt with than retrospectively when assignments start piling up.

Module coordinators/Course Director details can be found in the Blackboard modules or in the relevant handbooks available for download from the Science webpage: https://www.tcd.ie/science/undergraduate/

Absence through illness:

Where a student misses an assigned laboratory/field course/compulsory tutorial class through illness, they must **(a)** submit an absence report and upload a med cert via the Science Absence form: https://forms.office.com/Pages/ResponsePage.aspx?id=jb6V1Qaz9EWAZJ5bgvvlK2pn-Bcn6aBJpJezeqwuYapUMkpaU1E5SDY5TDZaTUhYU01PMlhBV0kxSyQlQCN0PWcu **on the day of their return to College** and **(b)** inform the laboratory practical supervisor of their absence at the earliest opportunity and certainly at the next session.

Note: submission of a medical certificate does not automatically initiate excusal from an activity. The student must obtain excusal from the module coordinator or Course Director after they have submitted a medical cert.

Other absences:

Students who have sports commitments to the College should supply confirmation from the appropriate committee to the Module Coordinator/Course Director well in advance of any event.
Students who anticipate that their sporting commitments may necessitate more than an occasional absence from College (e.g., Sports Scholars etc.) should discuss their situation with their tutor and the Associate Dean of Undergraduate Science Education (ADUSE).

Students who have unexpected family commitments should request excusal from the Module Coordinator/Course Director. Excuses for absence presented after the event, will not be accepted.

Vacations/Holidays/Weddings during teaching term

Students who are absent from College during teaching term for planned vacations/holidays/weddings etc. must ask the Senior Lecturer, through their tutor, for permission to be absent from college. No special accommodations will be made for such students. No replacement tutorials, laboratory/field courses will be scheduled, and no lecture material will be recorded. The onus in such cases lies with the student to catch up on the worked missed.

The general regulations outlined above will apply however, individual cases will be reviewed on their own merits.

Non-Satisfactory attendance in Science

All Junior and Senior Fresh students must fulfil the course and module requirements as set out above with regard to attendance. At the end of teaching term students who have not satisfied these regulations may be reported as non-satisfactory for that term. Students whose attendance is reported as non-satisfactory may be refused permission to take their semester one or semester two examinations and may be required to repeat the year.

Science students will be considered non-satisfactory in a module if:

They fail to attend at least 2/3 of the laboratory practicals/field trips in a module.
OR
They fail to submit at least 2/3 of the required coursework/assignments in a module.

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: https://www.auckland.ac.nz/en/law/current-students/llb-information/academic-information/cheating-plagiarism-turnitin.html

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 Service – contact details are available via their 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/

Helpful College Websites:

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/

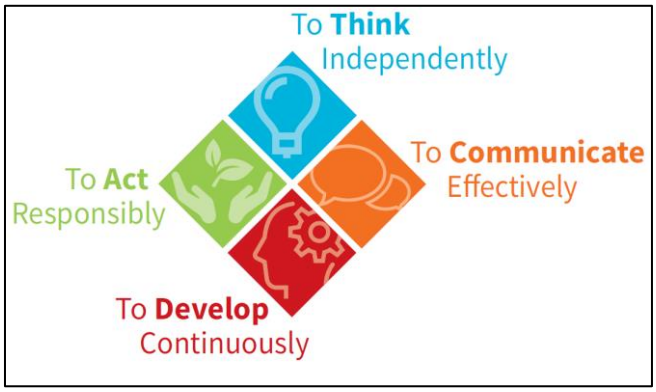
For information on Registration, Fees, Grants, ID Cards etc. visit the Academic Registry (AR) in the Watts Building or the visit the AR website: https://www.tcd.ie/academicregistry/

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 of study.

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

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

Dates to Note:

Fresh Orientation: 16th September to 20th September 2024

Semester one term dates: 09th September to 29th November 2024

Study Week Semester 1: 21st to 25th October 2024

Semester one examinations: 09th December to 13th December 2024

Semester two term dates: 20th January 2024 to 11th April 2025

Study week semester 2: 03rd to 07th March 2025

Semester two examinations: 22nd April to 25th April 2025

TEACHING TERM DATES 2024-2025					
Michaelmas Term Monday 9 September - Friday 29 Nov 2024			**Hilary Term Monday 20 January 2025 - Friday 11 April 2025**		
Teaching wk. 1	Week 03	09 Sept – 13 Sept	Teaching wk. 1	Week 22	20 Jan - 24 Jan
Teaching wk. 2	Week 04	*16 Sept - 20 Sept	Teaching wk. 2	Week 23	27 Jan – 31 Jan
Teaching wk. 3	Week 05	**23 Sept - 27 Sept	Teaching wk. 3	Week 24	*03 Feb - 07 Feb
Teaching wk. 4	Week 06	30 Sept – 04 Oct	Teaching wk. 4	Week 25	10 Feb - 14 Feb
Teaching wk. 5	Week 07	07 Oct - 11 Oct	Teaching wk. 5	Week 26	17 Feb - 21 Feb
Teaching wk. 6	Week 08	14 Oct – 18 Oct	Teaching wk. 6	Week 27	24 Feb – 28 Feb
Study week	**Week 09**	**21 Oct - 25 Oct**	**Study week**	**Week 28**	**03 Mar - 07 Mar**
Teaching wk. 8	Week 10	*28 Oct - 01 Nov	Teaching wk. 8	Week 29	10 Mar - 14 Mar
Teaching wk. 9	Week 11	04 Nov - 08 Nov	Teaching wk. 9	Week 30	*17 Mar - 21 Mar
Teaching wk. 10	Week 12	11 Nov - 15 Nov	Teaching wk. 10	Week 31	24 Mar - 28 Mar
Teaching wk. 11	Week 13	18 Nov - 22 Nov	Teaching wk. 11	Week 32	*31 Mar - 04 Apr
Teaching wk. 12	Week 14	25 Nov – 29 Nov	Teaching wk. 12	Week 33	07 Apr - 11 Apr

*** Orientation week for new entrants**

**** Teaching begins for all Junior Fresh Students**

October bank holiday – Monday 28th October 2024

February bank holiday – Monday 3rd February 2025

St Patrick's Day - Monday 17th March 2025

TR061: Chemical Sciences

Contact details:

Course Director TR061: Chemical Sciences	E-mail: nicolov@tcd.ie
Professor Valeria Nicolosi	Phone:01 896 4408
Coordinator FreshTeaching	E:mail: jfchem@tcd.ie
Dr Noelle Scully	Ph: 01 896 1972
Administrative Officer	E-mail: farrea25@tcd.ie
Ms. Anne Marie Farrell	Ph: 01 896 1726

Science Course Office

Associate Dean of Undergraduate Science Education	E-mail: fmitchll@tcd.ie
Professor Fraser Mitchell	Ph: 01 896 2025
Science Course Office Manager	E-mail: ennisa@tcd.ie
Ms. Ann Marie Brady	Ph: 01 896 2829
Administrative Officer	E-mail: sherwinh@tcd.ie
Ms. Helen Sherwin Murray	Ph: 01 896 2799
Executive Officer	E-mail: dossanta@tcd.ie
Ms. Andressa dos Santos Melo	Ph: 01 896 1970
Executive Officer	E-mail: segurar@tcd.ie
Ms. Romarey Segura	Ph: 01 896 2022

Appendix 1: General Information

ITEM	REFERENCE/Source
General Regulations	Calendar, Part II - General Regulations and Information, Section II, Item 12: https://www.tcd.ie/calendar/undergraduate-studies/general-regulations-and-information.pdf Calendar, Part III, General Regulations, Section 1.20 https://www.tcd.ie/calendar/graduate-studies-higher-degrees/ Attendance Requirements: Calendar, Part II, General Regulations and Information, Section II, Items 17-23 Calendar, Part III, General Regulations and Information, Sections 1.23; 2.11; and 3.2 Absence from Examinations Calendar, Part II, General Regulations and Information, Section II, Item 35 Calendar, Part III, Section 3.5 https://www.tcd.ie/teaching-learning/academic-policies/assets/assess-nonsub-absence-sep2020.pdf Plagiarism Policy and information: https://www.tcd.ie/teaching-learning/UG_regulations/Plagiarism.php https://libguides.tcd.ie/friendly.php?s=plagiarism
General Information	Timetables are available via my.tcd.ie portal:https://my.tcd.ie/urd/sits.urd/run/siw_lgn Blackboard: https://tcd.blackboard.com/webapps/login/ Academic Registry: https://www.tcd.ie/academicregistry/ Data Protection: https://www.tcd.ie/info_compliance/data-protection/student-data/ Dignity & Respect Policy https://www.tcd.ie/equality/policy/dignity-and-respect-policy/
Foundation Scholarship	Foundation and Non-Foundation Scholarship: Calendar, Part II Science Foundation Scholarship information sheet: https://www.tcd.ie/media/tcd/science/pdfs/TR061-CHEM-Foundation-Scholarship-information-2024-25.pdf
Teaching and Learning	Academic Policies: https://www.tcd.ie/teaching-learning/academic-policies/ Student Learning and Development: https://www.tcd.ie/Student_Counselling/student-learning/

Appendix 1: General Information

	Student Complaints Procedure: https://www.tcd.ie/about/policies/160722_Student%20Complaints%20Procedure_PUB.pdf Dignity & Respect Policy https://www.tcd.ie/equality/policy/dignity-and-respect-policy/ Student Evaluation and Feedback: https://www.tcd.ie/teaching-learning/quality/quality-assurance/evaluation.php Academic Integrity: https://libguides.tcd.ie/academic-integrity National Framework for Qualifications: National Framework of Qualifications | Quality and Qualifications Ireland (qqi.ie)
Student support	Student Support Services: https://www.tcd.ie/students/supports-services/ Student Services Booklet: www.tcd.ie/students/assets/pdf/Student%20Services%20Booklet%20(web%20version).pdf Senior Tutor & Tutorial Service www.tcd.ie/students/assets/pdf/Student%20Services%20Booklet%20(web%20version).pdf Graduate Studies https://www.tcd.ie/graduatestudies/ Mature Student Office https://www.tcd.ie/maturestudents/
Co-curricular activities	Central Societies Committee: https://www.trinitysocieties.ie/ DUCAC: Dublin University Central Athletic Club - Trinity Sport - Trinity College Dublin (tcd.ie) Student Sport - Trinity Sport - Trinity College Dublin (tcd.ie)
Information on TCDSU, Including student representative structures	TCDSU https://www.tcdsu.org/
Emergency Procedure	In the event of an emergency, **dial Security Services on extension 1999** Security Services provide a 24-hour service to the college community, 365 days a

	year. They are the liaison to the Fire, Garda and Ambulance services and all staff and students are advised to always telephone extension 1999. (+353 1 896 1999) in case of an emergency. Should you require any emergency or rescue services on campus, you must contact Security Services. This includes chemical spills, personal injury or first aid assistance. It is recommended that all students save at least one emergency contact in their phone under ICE (In Case of Emergency).

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