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

Science at Trinity

Faculty of Engineering, Mathematics and Science

TR061
Chemical Sciences
Junior Fresh Programme 2018 - 2019

tcd.ie/science

This handbook applies to all students taking TR061 Chemical Science. It provides a guide to what is expected of you on this programme, and the academic and personal support available to you. Please retain for future reference.

The information provided in this handbook is accurate at time of preparation. Any necessary revisions will be notified to students via email and the Science 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.

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Welcome to Science at Trinity

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 among four Moderatorships as exit routes, namely:

- Chemistry (C)
- Medicinal Chemistry (MC)
- Chemistry with Molecular Modelling (CMM)
- Nanoscience (N).

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 23 academic staff and 15 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 building includes two lecture theatres and four recently refurbished 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), which was completed in 2000, 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), which was formally opened in January 2008 and (ii) the Trinity Biomedical Sciences Institute (TBSI), which was inaugurated in July 2011.

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 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.

Students entering Science must attend the orientation and module registration session on Monday 3rd September before they complete College registration.

The following presentations will take place in LTEE2 Theatre, Hamilton Building.

11.00 - 11.10 Prof Aine Kelly, Associate Dean of Undergraduate Science Education
11.10 - 11.20 Prof Paula Colavita, Director TR061 Chemical Sciences

Following the presentations, students should proceed directly to the Hamilton atrium where they will meet with an academic to advise on module choices. Students in the JF year of TR061 can take modules in Chemistry (CHU), Biology (BYU), Physics (PYU) and Mathematics (MAU); when choosing module combinations students need to be aware of specific requisites associated with their preferred Moderatorships (see next section).

At the module registration session, students will be provided with:

- The TR061 Junior Fresh Programme 2018/19 (first year);
- A module choice form to complete, following advice from an academic adviser.

On completion of the module registration, students will meet their S2S (Student to Student) Mentor Groups who will assist with integration into college life and will address any queries that students may have.

In their JF 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 Moderatorship in C, 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 Moderatorship in C, CMM, N)			
PYU11P10	Physics 1	1	10
PYU11P20	Physics 2	2	10

TR061: Chemical Sciences pathways

In the Junior and Senior Fresh years TR061 students complete a course of study which will qualify students to apply for places in one the following Moderatorships after their Senior Fresh year:

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

The curriculum in the four Moderatorships is tailored and balanced to offer a general Chemistry degree (C), a degree with greater 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 outlined in the previous section 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 four Moderatorships.

Moderatorship pre-requisites			
Chemistry	**Chemistry with Molecular Modelling**	**Medicinal Chemistry**	**Nanoscience**
Pattern JF.1 OR Pattern JF.2	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 approved modules, however it is important to note that approved 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**

Semester structure

TR061: CHEMICAL SCIENCES

CORE MODULES (mandatory) – 20 credits per semester

SEMESTER 1 – Michaelmas term 10 September 2018 – 30 November 2018	SEMESTER 2 – Hilary Term 21 January 2019-12 April 2019
CHU11101: General and Physical Chemistry	CHU11102: Introduction to Inorganic and Organic Chemistry
MAU11S01: Mathematics for Scientists 1	MAU11S02: Mathematics for Scientists 2

APPROVED 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

Change of APPROVED modules

If, after a couple of weeks, a student feels that they have perhaps made the wrong choice of approved module, they should seek **advice immediately** from a Tutor, Course Director or the Science Course Office. It may be possible to change from one module to another within your course, subject to permission from the Associate Dean of Undergraduate Science Education. Once a decision has been made to change modules, it should be done **quickly** - it can be difficult to try to catch up with work in a new module when more than two or three weeks of lectures have been missed. Change of module forms are available from the Science Course Office or on the Science website: http://www.tcd.ie/Science/TR060/tr060-module-choice-form.php

Faculty of Engineering Mathematics and Science

TR061: Chemical Sciences

Junior Fresh module choice form – September 2018

Following the introductory session **in LTEE2, Hamilton Building on Monday 3rd September 2018** students will be required to submit this module choice form to the Science Course Office by 12.00 noon on Tuesday 4th September 2018.

BLOCK CAPITALS PLEASE

Name: _____ CAO No: _____

Date: _____ Student No: _____

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

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

PTO

SECTION C: JUNIOR FRESHMAN MODULES FOR 2018/19
(To be completed with help of Adviser)

Please tick appropriate box

Module Code	Module Title	Semester	Credits	Tick Box
Core modules – 20 credits per semester				
CHU11101	General and Physical Chemistry	1	10	MANDATORY
CHU11102	Introduction to Inorganic and Organic Chemistry	2	10	
MAU11S01	Mathematics 1	1	10	
MAU11S02	Mathematics 2	2	10	
Approved modules – 10 credits per semester **Pattern JF.1**				
BYU11101	From Molecules to Cells	1	10	
PYU11F20	Foundation Physics for Life and Earth Scientists 2	2	10	
OR **Pattern JF.2**				
PYU11P10	Physics 1	1	10	
PYU11P20	Physics 2	2	10	
Total Credits: 30 per semester (20 core and 10 approved)				

Signature of advisor: _____

Signature of student: _____

Date: _____

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.

Learning outcomes
- 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 (25% of the final mark) and a 3 h paper at the end of semester 1 (75% of the final mark).

CHU11102: Introduction to Inorganic and Organic Chemistry

Semester 2, 10 credits

Rationale and Aims:

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

Learning outcomes

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

Module Prerequisite:

CHU11101 General and Physical Chemistry (First Semester)

Assessment details:

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

Course Director:
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Phone:01 896 3562

Coordinator Fresh Teaching
Dr Noelle Scully — E-mail: pnscully@tcd.ie
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Senior Executive Officer
Ms AnneMarie Farrell — E-mail: farrea25@tcd.ie
Phone: 01 896 1726

MAU11S01: Mathematics for Scientists 1

Semester 1, 10 credits

Contact hours:

11 weeks, 6 lectures + 2 tutorials per week

This is the first semester module of a two semester sequence. It leads on to module MAU11S02 in the second semester.

Module Personnel

Prof. Kirk Soodhalter and Prof. Anthony Brown

Learning outcomes:

On successful completion of this module students will be able to

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

Module content:

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

Calculus with applications for Scientists

The lecturer for this part will be Prof. Anthony Brown. The main textbook will be [Anton] and the syllabus will be approximately 7 Chapters of [Anton] (numbered differently depending on the version and edition)

Chapter headings are

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

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

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

Recommended reading list:
[Anton]
Combined edition: Calculus: late transcendentals: Howard Anton, Irl Bivens, Stephen Davis 10th edition (2013) (Hamilton Library 515 P23*9)
Or
Single variable edition.
[AntonRorres]
Howard Anton & Chris Rorres, Elementary Linear Algebra with supplementary applications. International Student Version (10th edition). Publisher Wiley, c2011. [Hamilton 512.5 L32*9;-5, S-LEN 512.5 L32*9; 6-15]

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

Module Coordinators for MAU1S001

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

MAU11S02: Mathematics for Scientists 2

Semester 2, 10 credits

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

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

Learning outcomes:

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

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

Module content:

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

Calculus with applications for Scientists
The lecturer for this part will be Prof Miriam Logan

- Application of definite integrals in geometry (area between curves, volume of a solid, length of a plane curve, area of a surface of revolution).
- Methods of integration (integration by parts, trigonometric substitutions, numerical integration, improper integrals).

- Differential equations (separable DE, first order linear DE, Euler method).
- Infinite series (convergence of sequences, sums of infinite series, convergence tests, absolute convergence, Taylor series).
- Parametric curves and polar coordinates.

Discrete Mathematics for Scientists

The lecturer for this part will be Prof Colm O Dunlaing
Module Content:

Linear Algebra

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

Probability

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

Recommended reading lists:

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

(Anton)

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

Or

- Single variable edition.

(AntonRorres)

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

Recommended References:

(Kreyszig)

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

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

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

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

Module Coordinators for MAU1S002

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

TR061 Chemical Sciences - APPROVED MODULES

BYU11101: From Molecules to Cells

Semester 1, 10 credits

Module learning aim:

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

Learning outcomes:

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

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

Module content:

Lectures **Topic and Content**

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

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

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

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

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

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

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

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

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

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

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

ONLINE ASSESSMENT OF SECTION 1 via MCQ

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

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

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

Lecture 16: Proteins and protein structure (Professor Luke O'Neill)

- Concept that shape dictates function
- Hierarchical organization of protein structure: concept of primary, secondary, tertiary and quaternary structure.
- Introduction to forces that stabilize protein structure

Lecture 17: Protein function (Professor Luke O'Neill)

- Major functional classes of protein
- Introduction to bioinformatics: Proteins and evolution; relationships between proteins: similarity and identity.

Lecture 18, 19: Enzymes: the catalysts of life (Professor Vincent Kelly)

- Enzyme structure & function
- Enzyme reaction mechanism (co-factors and vitamins)
- Enzyme kinetics
- Regulation of enzyme activity

Lecture 20: Lipids and membranes (Professor Vincent Kelly)

- Lipid structures: fatty acids, phospholipids etc.
- Membranes: chemical and physical properties
- Membrane proteins
- Transport across membranes
- Concept of compartmentation and membrane traffic

Lecture 21, 22: Metabolism & major metabolic pathways (Professor Vincent Kelly)

- The starting point: introduction to carbohydrates and fatty acids
- Organization, energetic principles, key steps and links between the main metabolic pathways.
- Glycolysis, TCA cycle, beta oxidation
- Outline of the reversing catabolic pathways: gluconeogenesis and fatty acids synthesis.

Lecture 23: Mitochondria & Respiration (Professor Vincent Kelly)

- Mitochondria, redox reactions and energy transduction
- Electron transport and the electron transport chain
- Oxidative phosphorylation
- Coupling of oxidation to phosphorylation: chemiosmotic view of energy transduction (in brief).

Lecture 24: Chloroplasts and Photosynthesis (Professor Vincent Kelly)

- Chloroplasts: architecture and function
- Overview of the light and dark reactions of photosynthesis

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

ONLINE ASSESSMENT OF SECTION 2 via MCQ

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

Lecture 26: Introduction to Genetics (Professor Jane Farrar)

- Introduction to the course content: An outline of some core concepts from classical genetics to the present will be presented. A whistle stop tour of key discoveries in the history of genetics.

Lecture 27: Mendelian Genetics: (Professor Jane Farrar)

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

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

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

Lecture 30: Identification of DNA as hereditary material (Professor Jane Farrar)

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

Lecture 31: Quantitative Genetics (Professor Jane Farrar)

- An overview of some concepts relating to discrete variation versus continuous variation. Experiments demonstrating that quantitative traits are inherited.
- Examples of some quantitative traits in humans. Concepts regarding the use of GWAS to elucidate the genetics architecture of complex traits using an example of one or more disorders.

Lecture 32: DNA, Structure and Function (Professor Tony Kavanagh)

- The double helix - discovery of the structure of DNA – DNA composition - DNA replication semi-conservative replication, replication forks, leading and lagging strand synthesis, DNA polymerases.
- DNA replication in prokaryotes and eukaryotes.

Lecture 33 - 35: Information flow in the cell - The Central Dogma (Professor Tony Kavanagh)**.**

- Transcription, RNA Polymerases in prokaryotes and eukaryotes.
- Promoters, repressors, terminators – the *lac* operon; transcription factors, enhancers.
- Decoding the information in mRNA
- Translation (Protein synthesis).
- Ribosomes in prokaryotes and eukaryotes, tRNAs and aminoacyl tRNA synthetases, the genetic code; translation;
- Introduction to the regulation of gene expression – positive and negative regulation

Lecture 36: DNA –Mutation and its consequences (Professor Tony Kavanagh)

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

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

ONLINE ASSESSMENT OF SECTION 3 via MCQ

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

Recommended reading lists:

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

Contact Hours/Methods of Teaching and Student learning.

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

Method of assessment

Continuous assessment 50%

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

Written Examination 50%

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

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

Module coordinator - BYU11101 From Molecules to Cells

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PYU11F20: Foundation Physics for Life and Earth Sciences
Semester 2, 10 credits

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

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

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

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

Module Structure:

Contact Hours: 42 lectures/tutorials, three-hour practical laboratories, online homework.

Module Personnel: Lecturers: Prof. Lewys Jones; Prof. Martin Hegner; Prof. Matthias Möbius

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

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

Assessment of the laboratory: Student's experiments are assessed through both at-the-bench laboratory notebook assessment and through submission of written experimental reports. These must include and require a 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: Required reading: "Physics for the Life Sciences" - Authors: M. Zinke-Allmang et al - It is a requirement that students purchase the mandatory e-textbook which includes student access to online homework assignments.
http://www.nelson.com/catalogue/productOverview.do?N=197+4294967212+4294961008&Ntk=P_EPI&Ntt=171810329217138545478672127298457286 4&Ntx=mode%2Bmatchallpartial

Online Assignments: Online assignments are submitted through the Cengage system where electronic access is associated with the required text book.
https://www.cengagebrain.co.uk/shop/index.html

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 in order to further clarify concepts met in the textbook and lectures thus reinforcing learning.

Weekly homework assignments, typically alternating between topics, are submitted by students through an online system and corrected, with some limited feedback to the student available through the online system post deadline. The lecturer has oversight of the scores and responses to each assignment and can address these in subsequent lectures and tutorials.
Finally, a number of lecturers use class based polling of student responses to questions using the available “clicker” technologies.

Methods of Assessment:
Assessment is by a combination of examination and continuous assessment and will include multiple choice tests (MCQs) examination paper; laboratory practical work; and online tutorial homework assignments.

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

Foundation Physics Course Coordinator:	
Prof. Lewys Jones	E-mail: Lewys.Jones@tcd.ie Phone: 01 896 4171
Junior Fresh Physics Coordinator:	Prof. Matthias Möbius E-mail: mobiusm@tcd.ie
General Enquiries:	E-mail: Physics@tcd.ie Phone: 01 896 1675
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) and small group tutorials (1 hr every second week)

Lecture Topics

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

Learning outcomes

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

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

Syllabus

Introduction to Physics: 1 lecture

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

The Physics of Motion: 22 lectures

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

Waves and Optics I: 20 lectures

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

Statistics: 10 lectures

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

Methods of Teaching and Student Learning:

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

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

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

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

Methods of Assessment and Weighting

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

Reading List:

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

Online Assignments:

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

Online Resources:

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

Module Website:

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

PYU11P20: Physics 2

Semester 2, 10 credits

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

Structure and contact hours:

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

Lecture Topics:

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

Learning Outcomes:

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

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

Syllabus:

Electricity and Magnetism I: 20 lectures

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

Quantum Physics: 18 lectures

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

Gravitation and Astrophysics: 12 lectures

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

Methods of Assessment and Weighting:

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

Reading List:

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

Online Assignments:

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

Online Resources:

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

Module Website:

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

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

Summary of Laboratory Practicals

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

Laboratory Practicals

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

Online Resources:

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

Assessment of the laboratory

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

Junior Fresh Physics Coordinator

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Senior Executive Officer

Ms Una Dowling

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Graduate Attributes

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

The four Trinity Graduate Attributes are:

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

Why are the Graduate Attributes important?

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

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

How will I develop these Graduate Attributes?

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

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

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

Dates to Note:

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

TR061: Chemical Sciences Course meeting:

3rd September 2018 in LTEE2 followed by a reception outside the cocker lab in the Student concourse, Panoz institute

Academic Year Structure 2018/19

Key Dates:

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

Formal Assessment weeks

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

College registration

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

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

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

Closing Dates for Course Transfer

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

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

Progression and Awards

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

Attendance

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

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

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

Absence from College – Medical and Absence Certificates

MEDICAL CERTIFICATES

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

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

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

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

OTHER ABSENCES

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

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

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

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

Non-satisfactory attendance and course work

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

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

Plagiarism- 2018/19

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

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

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

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

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

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

Trinity Tutorial Service

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

Opening Hours

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

Appointments

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

What is a Tutor?

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

When should I go to see my Tutor?

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

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

Disability Services

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

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

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

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

Student Counselling

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

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

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

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

Useful College Websites:

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

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

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

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

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

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

Science Course Office

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

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

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