Science at Trinity

Faculty of Engineering, Mathematics and Science (STEM)

TR063 Physical Sciences
Senior Fresh Handbook 2025-2026

This programme booklet applies to all students taking TR063 Physical Sciences. It is a guide to what is expected of you on the programme and the supports available to you. Please retain for future reference.

The information provided is correct at the time of publication. Any necessary revisions will be notified to students via email and the TR063 Physical Sciences web address here: https://www.tcd.ie/science/undergraduate/tr063-physical-sciences/senior-fresh/

In the event of any conflict or inconsistency between the General Regulations published in the University Calendar and the information provided in this course programme, the general college regulations will prevail: https://www.tcd.ie/calendar/undergraduate-studies/general-regulations-and-information.pdf

Produced by: The Science Course Office

Trinity College, Dublin 2

Email: Science@tcd.ie

Webpage: https://www.tcd.ie/science/undergraduate/

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TR063: Physical Sciences Introduction

Welcome to the Senior Fresh handbook for the Physical Sciences course in Trinity College! This year will see you consolidate your understanding of physics in general and the physical processes underpinning the world around you as described by physical laws. These ‘laws of physics’ based on the understanding of the physical processes are elucidated by the mathematical tools that can be used to describe them. On occasions the accepted laws of physics get superseded through paradigm shifts and new ways of looking at the world and its interactions extending our previous understanding and capable of explaining already known results, but also daring new predictions. An example of process is the emergence of special relativity, which superseded the Galilean relativity, while making new predictions. The consequences of these new predictions are far reaching and allow us to understand nuclear processes such as how nuclear fusion and fission is energetically allowed and also how stars, such as our sun, shine!

These and the other foundations of physics such as the laws of thermodynamics, the nature of oscillations, the phenomena of electricity and magnetism (all coupled with Maxwell’s theory of electromagnetism and the propagation of light), materials properties and behaviour, and our knowledge of the universe around us through astrophysical observations are the collected topics of primary concern in this second foundational year of your Physics degree. Backing these with the mathematical tools encompassing multivariable calculus, vector calculus, and Fourier analysis, all required for the mathematical description of almost all physical phenomena, will help prepare you for your choice of Moderatorship for the two remaining Sophister years of your chosen degree.

In addition, the training in more advanced experimental physics within our laboratories, inclusive of further training in computational methods, as well as your participation in group research work via poster projects and presentations will equip you with further tools to progress.

Importantly in this year, you will also receive instruction on how the scientific method developed and the philosophy of thought that underpins any scientific query. A key learning outcome is a clear understanding of how science is not closed book, but rather a set of theories and accumulated knowledge that is constantly evolving while staying anchored to empirical and experimental observations, and how predictive power is required from any viable theory. Physical theories can, indeed, be superseded, as in the above example of the paradigm from Galilean relativity to special relativity, but only if the new theory has more predictive power and can be tested to a higher level of accuracy than the previous theory. Thus, science, and physics, can advance but only through rigorous training the future generation of scientists and physicists in the power of independent, logical, and critical thinking informed by experimental data.

This year will also see you decide on which of the three possible Moderatorship degrees you wish to progress in, these being either **Physics**, or **Physics and Astrophysics** or **Nanoscience**, and is where competition for places occurs. To guide you in this, in addition to your lectures and your natural curiosity (this is why you are here?!), we intend to provide a short series of insightful prospective seminars on what these degree choices entail, so that you are well informed in making the most appropriate choice for you and for your future career as a graduate of this university.

May your journey with Physics continue!

Assist. Prof. Plamen Stamenov
Director, TR063: Physical Sciences Course

Physical Sciences overview and module (pre)-selection

The second year will build on the material covered in the first year which will help you decide on which career path to follow. Second year is divided into Semester 1 (Michaelmas term) and Semester 2 (Hilary term). You will take your previously determined modules to the value of 60 credits in the year with no more than 30 credits of module from Semester 1 and 30 credits of modules from Semester 2.

OVERVIEW OF MODULES – NOTE YOUR SELECTION IS DETERMINED DURING YOUR JF YEAR

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

PYU22P10	Physics	Semester 1	10
PYU22P20	Physics	Semester 2	10
MAU22S01	Multivariable calculus for Science	Semester 1	5
MAU22S03	Fourier analysis for Science	Semester 1	5
MAU22S02	Vector calculus for Science	Semester 2	5
PIU22992	History, Philosophy and Ethics of Science	Semester 2	5

Students also take Open modules to the value of 20 credits (10 per semester) from the following:

BYU22201	From Molecules to Cells	Semester 1	10
BYU22202	From Cells to Organisms	Semester 2	10
CHU22201	Chemistry 1	Semester 1	10
CHU22202	Chemistry 2	Semester 2	10
GSU22201	From Atoms to Rocks: Introduction to Geochemistry	Semester 1	5
GSU22205	Sedimentary Processes & Environments in a Changing World	Semester 1	5
GSU22006	Dynamic Earth	Semester 2	10

Modules and Moderatorships

First and second year TR063: Physical Science students complete a course of study which will qualify them to compete for a place in one of the following Moderatorships after the Senior Fresh year:

- Nanoscience
- Physics
- Physics and Astrophysics

Allocation of places in the Moderatorships is based on the totality of your second year mark across all modules of the second year. Allocation begins after the Semester 2 examinations for all those who have completed the year at that time. More details in a following section.

Note that there are limitations on Open module choices across the first and second years **due to prerequisites in second year that depend upon, or require, Open modules in the first year**.

All current students will have already made module choices in first year that **completely predetermine the modules** they will take in the Senior Fresh year.

Semester Structure

Semester one		Semester two	
CORE MODULES (Mandatory) – 20 per semester			
PYU22P10: Physics 1	10	PYU22P20: Physics 2	10
MAU22S01: Multivariable Calculus for Science	5	MAU22S02: Vector Calculus for Science	5
MAU22S03: Fourier analysis for Science	5	PIU22992: History, Philosophy and Ethics of Science	5

OPEN MODULES (Optional): Students choose 10 credits from each Semester

Open modules (optional)	Credits	Open modules (optional)	Credits
BYU22201: From Molecules to Cells	10	BYU22202: From Cells to Organisms	10
CHU22201: Chemistry 1	10	CHU22202: Chemistry 2	10
GSU22201: From Atoms to Rocks: Introduction to Geochemistry	5	GGU22006: Dynamic Earth	10
GSU22205: Sedimentary Processes & Environments in a Changing World	5		

Open Module Choices in Junior and Senior Fresh Years

Year 1: JUNIOR FRESH	
CORE MODULES – 40 credits 20/20	
Semester 1	**Semester 2**
PYU11P10: Physics 1	PYU11P20: Physics 2
MAU11S01: Mathematics for Scientists I	MAU11S02: Mathematics for Scientists II

Year 2: SENIOR FRESH	
CORE MODULES – 40 credits 20/20	
Semester 1	**Semester 2**
PYU22P10: Physics 3	PYU22P20: Physics 4
MAU22S01: Multi-variable calculus for Science	MAU22S02: Vector Calculus for Science
MAU22S03: Fourier analysis for Science	PIU22992: History, Philosophy and Ethics of Science

OPEN MODULES – choose 20 credits 10/10	
CHU11101: General and Physical Chemistry	CHU11102: Introduction to Inorganic and Organic Chemistry
GSU11004: Spaceship Earth: An introduction to Earth System Science	GSU11005: Geology: A Beginner's guide to Planet Earth
BYU11101: From Molecules to Cells	BYU11102: From Organisms to Ecosystems

OPEN MODULES – choose 20 credits 10/10	
CHU22201: Chemistry	CHU22202: Chemistry
GSU22201: From Atoms to Rocks: Introduction to Geochemistry	GGU22006: Dynamic Earth
GSU22005: Sedimentary …	
BYU22201: From Molecules to Cells 2	BYU22202: From Cells to Organisms

TR063: Moderatorships and Open Module Choice Diagram

Moderatorships in **Physics** or in **Physics and Astrophysics** are available to all students regardless of the choice of Open modules in the Junior Fresh and Senior Fresh years. To qualify for the Moderatorship in **Nanoscience**, a student must take all available Chemistry Open modules in both semesters of the Junior and Senior Fresh years.

Five patterns of Open Modules are available to students across Junior Fresh and Senior Fresh years. These are denoted A, B, C, D and E. **Your choice of last year determines** the subject choices: **X**, **Y** and **Z** in the TR063 Physical Sciences Senior Fresh module choice form.

	Year 1: JUNIOR FRESH			Year 2: SENIOR FRESH	
	Semester 1	**Semester 2**		**Semester 1**	**Semester 2**
A	CHU11101 General and Physical Chemistry	CHU11102 Introduction to Inorganic and Organic Chemistry	**X**	CHU22201 Chemistry 1	CHU22202 Chemistry 2
B	CHU11101 General and Physical Chemistry	GSU11005 Geology: A Beginner's Guide to Planet Earth	**Y**	GSU22201: From Atoms to Rocks: Introduction to Geochemistry GSU22205 Sedimentary …	GGU22006 Dynamic Earth
C	GSU11004 Spaceship Earth: An intro. …	GSU11005 Geology: A Beginner's Guide …	**Y**	GSU22201: From Atoms to Rocks: Introduction to Geochemistry GSU22205 Sedimentary …	GGU22006 Dynamic Earth
D	BYU11101 From Molecules to Cells	BYU11102 From Organisms to Ecosystems	**Z**	BYU22201 From Molecules to Cells	BYU22202 From Cells to Organisms
E	BYU11101 From Molecules to Cells	GSU11005 Geology: A Beginner's Guide …	**Y**	GSU22201: From Atoms to Rocks: Introduction to Geochemistry GSU22205 Sedimentary …	GGU22006 Dynamic Earth

Moderatorship

- **Nano-science** (pattern X)
- **Physics** (all patterns)
- **Physics and Astro-physics** (all patterns)

Applications to choose a specific Moderatorship after the Senior Fresh year occur via a preferred Moderatorship choice form that will be available in Semester 2 of the Senior Fresh year. There are quotas and hence competition for admission to each Moderatorship.

Open Module Choice Forms

Your Open modules in SF are entirely predetermined by your Open module choices in the JF year due to each SF modules having specified pre-requisites or dependencies on JF modules. No changes are possible. See again the module patterns for the JF and SF years on the previous page.

Please submit module choice forms online by **5pm on Friday 18th April 2025.** Forms are available online via the following link: https://forms.office.com/e/06JF0c2Z00

Progression to Junior Sophister and Moderatorships in Physical Sciences

As indicated there are three available Moderatorships in Physical Sciences which are:

- Physics - 30 places available
- Physics and Astrophysics - 24 places available
- Nanoscience - 26* places available (*10 from chemical Sciences)

Applications to choose a specific Moderatorship in the Sophister years are submitted via a preferred Moderatorship choice form that will be available in Semester 2 of the Senior Fresh year. This will occur after a detailed information session to all SF students in the Physical Sciences.

Note especially that there are quotas and hence competition for in-demand Moderatorships. Allocation of places in Moderatorships is based on student ranking of final weighted average marks across **all** Senior Fresh Core and Open modules in both semesters, i.e. the average year mark, for those who successfully complete the Senior Fresh year. In brief, places will first be allocated at the end of the Semester 2 exams to those who have completed the Senior Fresh year at that time. All remaining places will be allocated after the Supplemental examinations.

Details and full regulations pertaining to the allocation process can be found in the Physical Sciences Sophister Programme booklet or at the website: https://www.tcd.ie/science/undergraduate/tr063-physical-sciences/junior-sophister/

All qualified Physical Sciences students will be able to proceed to a Moderatorship.

College Registration

The Academic Registry issues an **'Invite to Register'** email to all 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 portal to complete the registration steps.

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

The European Credit Transfer Accumulation System (ECTS)

The European Credit Transfer and Accumulation System (ECTS) is an academic credit system based on the estimated student workload required to achieve the objectives of a module or programme of study. It is designed to enable academic recognition for periods of study, to facilitate student mobility and credit accumulation and transfer. The ECTS is the recommended credit system for higher education in Ireland and across the European Higher Education Area.

The ECTS weighting for a module is a **measure of the student input or workload** required for that module, based on factors such as the number of contact hours, the number and length of written or verbally presented assessment exercises, class preparation and private study time, laboratory classes, examinations, clinical attendance, professional training placements, and so on as appropriate. There is no intrinsic relationship between the credit volume of a module and its level of difficulty.

The European **norm for full-time study over one academic year is 60 credits**. 1 credit represents 20-25 hours estimated student input, so a 10-credit module will be designed to require 200-250 hours of student input including class contact time, assessments and examinations.

ECTS credits are awarded to a student only upon successful completion of the course year. Progression from one year to the next is determined by the course regulations. Students who fail a year of their course will not obtain credit for that year even if they have passed certain component courses. Exceptions to this rule are one-year and part-year visiting students, who are awarded credit for individual modules successfully completed.

https://ec.europa.eu/education/resources-and-tools/european-credit-transfer-and-accumulation-system-ects_en

TR063: Physical Sciences - **CORE Modules**

Tuition will consist of lectures, practicals and tutorials in physics at intermediate level. Lectures are given on oscillations, optics, electricity and magnetism, thermodynamics, special relativity, nuclear physics, materials physics, and astronomy. Practicals include set experiments, computational exercises and group study projects. This tuition may only be taken by students reading the appropriate elements of Senior Fresh mathematics as required in Physical Sciences.

Lectures in Physics in SF year are given in two modules, one in each semester. Students must take both modules, comprising Lectures, Laboratory Classes, Group Study Project, and Small Group Tutorials (see below).

Practical Laboratory Classes – both Semester 1 and 2 All SF students are required to attend one 3-hour laboratory session each week. A series of experiments and computational exercises are provided to illustrate some key results presented in the lecture courses. The experiments are longer than in the JF year and are designed to continue the development of personal initiative as well as experimental and computational skills. Students prepare written reports on these experiments, which are assessed during the year.

Group Study Projects – Semester 1 All students are required to investigate a given topic in Physics and present their findings in the form of a poster. Students work in groups of about five.

Small Group Tutorials – both Semester 1 and 2 Students are required to attend tutorials, which are intended to deepen their understanding of concepts taught in lectures.

Homework Problems – both Semester 1 and 2 Students are required to complete one homework set for each of four topics taught in each module. Problems are available and solutions are entered online. Lecturers provide a solution class after the homework submission deadline.

PYU22P10: Physics 1

Semester 1, 10 Credits

PYU22P10 Physics

(G. Cross, H. Zhang, M. Hegner, S. Dooley; Co-ordinator: Prof H. Zhang)

This module combines four elements of classical physics as follows:
Thermodynamics – 15 lectures
Electricity and Magnetism II – 14 lectures
Oscillations – 12 lectures
Materials Physics – 12 lectures

Syllabus:

- **Thermodynamics: - 15 lectures**
  Kinetic theory and the ideal gas equation. Van der Waals model for real gases. First law of thermodynamics. Internal energy, heat and work. Reversible and irreversible processes. Specific heat. Second law of thermodynamics. Heat engines, Carnot cycles. Entropy. Probability and disorder. Combined first and second laws. Central equation. H, F, G. Maxwell's relations. Energy equations. Cooling processes. Joule-Kelvin effect. Third law of thermodynamics.

- **Electricity & Magnetism II: - 14 lectures**
  Magnetism, magnetic field lines and flux; Lorentz force on moving charge; Energy of and torque on a current loop in a magnetic field; magnetic fields of moving charges; 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 illustrated by field of a straight conductor of finite thickness. Electromagnetic induction and Faraday's Law in integral form; Lenz's Law; induced electric fields and motional emf's; summary of Maxwell equations in integral form; Mutual inductance and self-inductance; Kirchhoff rules and circuit analysis methods; Thevenin theorem; R-C and R-L circuits and R-L-C circuits; AC circuits, phasor diagrams reactance, resonance, transformers and complex representation of reactance. Power analysis. R-C integration and differentiation, R-C low- and high-pass filters and active filters.

- **Oscillations: -12 lectures**
  Review of simple harmonic motion. Forced and damped oscillations. Resonance. Two coupled oscillators, modes and normal coordinates. Many coupled oscillators. Transition to continuous systems. Examples of experimental measurements using MEMS resonators. Waves. Nonlinear behaviour. Anharmonic behaviour.

- **Materials Physics: - 12 lectures**
  Foundational molecular properties, inter and intra-molecular forces, potential energy curves, polarity, translational, rotational and vibrational degrees of freedom, heat capacity, thermal expansion and thermal conductivity. Stress, strain, shear, elastic and plastic deformations of solids. Structures of solids in crystalline, glass, plastic phases. Insulators, conductors and semiconductors. Point defects and imperfections in solids – Iron/Carbon system. Density, pressure, surface tension, buoyancy and hydrodynamic-incompressible and compressible flows in fluids. Bernoulli's equation. Viscosity, diffusion, laminar and turbulent flow. Gas laws, kinetic theory and collisions, PVT diagrams, thermal expansion, surface tension. Conductive, convective and radiative transport of heat. Stefan-Boltzmann law.

PYU22P10 Learning Outcomes:
On successful completion of this module, the students will be able to:
- Solve basic problems in relation to harmonic oscillators
- Describe elementary crystal structures and the response of materials to external forces
- Describe how the laws of thermodynamics react to properties of matter
- Explain a broad variety of astrophysical phenomena with simple physics
- Employ web-based research techniques in a small group project and present the results in the form of a poster
- Either prepare an extensive report detailing methodology, data gathering and interpretation of a physical experiment and obtain, pre-process, display and analyse experimental data using software packages such as Origin or analyse, modify and run Python language programs to perform computer experiments

Laboratory Classes:
Students are required to attend one 3-hour laboratory session each week. The experiments are designed to continue the development of personal initiative and experimental and computational skills. Reports on these experiments are assessed during the year.

Group Study Projects:
Students are asked to investigate a given topic in Physics and present their findings in the form of a poster. Students work in groups of about five.

Small Group Tutorials:
Students are required to attend tutorials and to complete associated homework.

Assessment	**Weighting**
Examination	60%
Experimental / Computational laboratories	25%
Project	5%
Tutorials	10%

Important Note on Examinations, Assessments and Reassessments in Fresher years

- 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. A mark of less than 30% in either of these Examination or Laboratory components leads to a Qualified Fail, and requires reassessment examination or a repeat of the year.
- There is a maximum mark or cap of 60% on any reassessed component in this module if reassessment is required. The final module mark is calculated based on the reassessed component mark and any already achieved marks for components that did not need to be reassessed, according to the published weightings of these components.
- Re-assessment capping does not apply to deferred 1st attempts at assessment.
- These apply to all students in this module.
- For more details please see the section in the School of Physics Undergraduate Handbook on "Progression regulations applying to Physics modules and accredited Physics programmes" available in full at: https://www.tcd.ie/physics/study/current/undergraduate/handbook/ or see a summary at: https://www.tcd.ie/physics/study/current/undergraduate/progression

Examination
Information about examinations will be made available on the Examination Office's website. Each module, PYU22P10 and PYU22P20, is examined in a separate 2 and a half-hour examination paper during the relevant end of semester exam session.

Web: https://www.tcd.ie/physics/

Contact Details:

Module Coordinator:		
Professor Hongzhou Zhang		E-mail: Hongzhou.Zhang@tcd.ie
		Phone: 01 896 4655
Administrative Officer:		
Ms. Una Dowling		E-mail: dowlingu@tcd.ie
		Phone: 01 896 1675

PYU22P20: Physics 2

Semester 2, 10 Credits

PYU22P20 Physics

(J Vos, M Stamenova, E. Keane, D McCloskey: Co-ordinator: Prof David McCloskey)

This module combines four elements of modern physics as follows:

Special Relativity – 12 lectures
Nuclear and Particle Physics – 14 lectures
Astrophysics – 12 lectures
Waves and Optics II – 14 lectures

Syllabus:

- **Special relativity: - 12 lectures**
  Frames of reference and relativity principles. The Michelson-Morley experiment. Einstein's postulates. Simultaneity. The Lorentz transformations. The Fitzgerald-Lorentz contraction. Time dilation. Transformation of velocities. Relativistic dynamics - mass, energy and momentum.

- **Nuclear & Particle Physics: - 14 lectures**
  Models of the atom. Rutherford scattering. Cross-sections. Nucleons. Nuclear force. Nuclear binding. Nuclear masses. Mass defect. Mass dependence of binding energy per nucleon. Beta decay. Electron, positron emission. Electron capture. Decay chains. Alpha decay. Heavy element decay chains. Barrier penetration mechanism. Gamma decay. Radioactive decay law. Analysis of parent-daughter activity relationships. Nuclear fission. Liquid drop model. Fission products. Induced fission. Nuclear reactors. Neutron moderation. Control and delayed neutrons. Reactor types. Environmental and other concerns. Fuel cycle. Nuclear fusion. Fusion reactors. Fundamental particles, Bosons and Fermions, Leptons and Hadrons, Mesons and Baryons, Quarks. Particle interactions and conservation laws. The Standard model of particle physics.

- **Astrophysics – Observing the Universe: - 12 lectures**
  Continuous radiation of stars: flux, luminosity, magnitudes, colours. Spectral lines in stars: spectral classification, origin of spectral lines, the Hertzsprung-Russell diagram. Basic nucleosynthesis and stellar equilibrium. Life and death of stars: stellar evolution, end stages of stellar evolution, planetary nebulae, white dwarfs, supernovae, neutron stars and black holes. Close binary evolution: mass transfer, supernova Type Ia, gravitational waves. Interstellar medium. Star formation: gravitational collapse, initial mass function. Galaxies and galaxy clusters: Milk Way, galactic rotation, dark matter, galaxy classification, distribution of galaxies, expansion of the Universe, galaxy clusters, active galaxies. Cosmology and the early Universe: gravitational lensing, cosmology, the evolution of the universe, dark energy, big bang theory.

- **Waves & Optics II: - 14 lectures**
  Maxwell equations in differential form. Coulomb's and Gauss' Laws; Biot-Savart and Ampere's Laws; absence of magnetic monopoles; Faraday's Law and magnetic induction. Electric dipoles, dielectric polarisation and dielectric susceptibility; magnetic dipoles, magnetisation and diamagnetic susceptibility; continuity equation, displacement current and Maxwell's generalisation of Ampere's Law. Electromagnetic waves in vacuum and isotropic matter. Energy density in time-varying electromagnetic fields and Poynting vector. Reflection, refraction, plane,

circular and elliptic polarisation of light; dichroism, birefringence; interference, interferometers, coherence, Young's slits, near and far field diffraction.

PYU22P20 Learning Outcomes:
On successful completion of this module, the students will be able to:

- Describe how modern physics is underpinned by nuclear and particle physics; waves and optics
- Express relativistic effects as observed in different inertial reference frames
- Relate the concept of oscillations to optical properties of matter and AC circuits
- Prepare calculations and present in small groups
- Analyse, modify and run Python language programs to perform computer experiments
- Obtain, pre-process, display and analyse (fit to analytical models) actual experimental data using software packages such as Origin

Laboratory Classes:
Students are required to attend one 3-hour laboratory session each week. The experiments are designed to continue the development of personal initiative and experimental and computational skills. Reports on these experiments are assessed during the year.

Small Group Tutorials:
Students are required to attend tutorials and to complete associated homework.

Assessment	**Weighting**
Examination	60%
Experimental / Computational laboratories	30%
Tutorials	10%

Important Note on Examinations, Assessments and Reassessments in Fresher years

- 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. A mark of less than 30% in either of these Examination or Laboratory components leads to a Qualified Fail, and requires a reassessment examination or a repeat of the year.
- There is a maximum mark or cap of 60% on any reassessed component in this module if reassessment is required. The final module mark is calculated based on the reassessed component mark and any already achieved marks for components that did not need to be reassessed, according to the published weightings of these components.
- Re-assessment capping does not apply to deferred 1st attempts at assessment.
- These apply to all students in this module.
- For more details please see the section in the School of Physics Undergraduate Handbook on "Progression regulations applying to Physics modules and accredited Physics programmes" available in full at: https://www.tcd.ie/physics/study/current/undergraduate/handbook/ or see a summary at: https://www.tcd.ie/physics/study/current/undergraduate/progression

Examination
Information about examinations will be made available on the Examination Office's website. Each module, PYU22P10 and PYU22P20, is examined in a separate 2 and a half-hour examination paper during the relevant end of semester exam session.

Web: https://www.tcd.ie/physics/

Contact Details:

Module Coordinator:		
Professor David McCloskey		E-mail: dmcclosk@tcd.ie
		Phone: 01 896 1148
Administrative Officer:		
Ms Una Dowling		E-mail: dowlingu@tcd.ie
		Phone: 01 896 1675

MAU22S01: Multivariable Calculus for Science

Semester 1, 5 ECTS credits

Contact Hours: 11 weeks, 3 lectures and 1 tutorial per week
Module Prerequisite: MAU11S01 & MAU11S02

Lecturer: Prof Manya Sahni (msahni@tcd.ie)

Learning Outcomes
On successful completion of this module, students will be able to:
- Calculate limits and partial derivatives of functions of several variables
- Compute directional derivatives of functions of many variables and determine the direction of maximal growth of a function using its gradient vector; write equation of the plane tangent to its graph at a given point;
- Compute the divergence and curl of a vector function;
- Use the method of Lagrange multipliers to find local maxima and minima of a function;
- Develop polar, spherical and cylindrical coordinates;
- Compute double and triple integrals by application of Fubini's theorem or use change of variables;
- Use integrals to find quantities defined via integration in a number of contexts (such as average, area, volume, mass)
- Compute line and surface integrals

Module Content
- Polar, Cylindrical and Spherical Coordinates;
- Functions of Several Variables, Partial Derivatives;
- Tangent Planes and Linear Approximations;
- Directional Derivatives and the Gradient Vector;
- Vector functions, Divergence and Curl;
- Maxima and Minima, Lagrange Multipliers;
- Double Integrals Over Rectangles and over General Regions
- Double Integrals in Cylindrical and Spherical Coordinates;
- Triple Integrals in Cylindrical and Spherical Coordinates;
- Change of Variables, Jacobians
- Line integrals and Surface integrals

Recommended Reading:

Calculus, Late transcendentals by H.Anton, I.Bivens, S. Davies
Multivariable Calculus 7th ed. Early Transcendentals by James Stewart

Assessment Detail: This module will be examined in a 2-hour **examination** in Michaelmas term. **Continuous assessment** will contribute 20% to the final grade for the module at the annual examination.

Contact Details:

Module Coordinator:	Professor Manya Sahni	E-mail: msahni@tcd.ie
Administrative Officer:	Ms Jennifer Murray	E-mail: undergrad_maths@tcd.ie Phone: 01 896 2423

MAU22S02: Vector Calculus for Science

Semester 2, 5 ECTS credits

Contact Hours: 11 weeks, 3 lectures and 1 tutorial per week
Module Prerequisite: MAU22S01

Lecturer : Prof. Michael Peardon (mjp@maths.tcd.ie)

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

- Manipulate vectors in R^3 to evaluate dot products and cross products and investigate if vectors are linearly independent;
- Understand the concepts of vector fields, conservative vector fields, curves and surfaces in R^3;
- Find the equation of normal lines and tangent planes to surfaces in R^3;
- Evaluate line integrals and surface integrals from the definitions;
- Use Green's Theorem to evaluate line integrals in the plane and use the Divergence Theorem (Gauss's Theorem) to evaluate surface integrals;
- Apply Stokes's Theorem to evaluate line integrals and surface integrals;
- Solve first order PDEs using the method of characteristics and solve second order PDEs using separation of variables;

Module Content

- Vector algebra in R^3. Vector fields, curves and surfaces in R^3.
- Theorems of Green, Stokes and Gauss.
- PDEs of first and second order

Assessment Detail
This module will be examined in a 2-hour **examination** in Trinity term.
Continuous assessment will contribute 20% to the final grade for the module at the annual examination session.

Contact Details:

MAU22S02: Vector calculus for Science		
Module Coordinator:	Prof. Michael Peardon	E-mail: mjp@maths.tcd.ie
		Phone: 01 896 1485
Administrative Officer:	Jennifer Murray	E-mail: undergrad_maths@tcd.ie
	Phone: 01 896 2423	Phone: 01 896 2423

MAU22S03: Fourier Analysis for Science

Semester 1, 5 ECTS credits

Contact Hours:
The term lasts for 11 weeks, there are three 1-hour lectures and one 1-hour tutorial per week.

Module Prerequisites: MAU11S01 & MAU11S02, co-requisite MAU22S01.

Lecturer: Dr Anthony Brown (browna2@tcd.ie).

Learning Outcomes

- Find the real and complex Fourier series of periodic functions,
- Obtain the Fourier transforms of non-periodic functions,
- Evaluate integrals containing the Dirac delta function,
- Calculate the Fast Fourier Transform using the Cooley–Tukey algorithm,
- Solve first order ordinary differential equations using separation of variables, the integrating factor method, and by using substitution,
- Solve second order ordinary differential equations with constant coefficients, both homogeneous and non-homogeneous,
- Obtain series solutions (including using the Frobenius method) of ordinary differential equations.

Module Content

- Vector spaces and inner products,
- Fourier series,
- Fourier transforms,
- Discrete Fourier transforms,
- First order ordinary differential equations,
- Second order ordinary differential equations,
- Series solutions of ordinary differential equations.

Suggested Reference

There are many large and comprehensive methods books that cover (either some or all of) the material in this course. Examples are:

- Advanced Engineering Mathematics by Erwin Kreyszig,
- Mathematical Methods for Physicists by George Arfken,
- Advanced Modern Engineering Mathematics by Glyn James.

Assessment Detail

This module will be examined by a 2-hour examination in Michaelmas term.
Continuous Assessment consisting of three written assignments throughout the term will contribute 20% to the final grade, with the examination counting for the remaining 80%.

Contact Details:

Module Coordinator	Dr Anthony Brown	E-mail: browna2@tcd.ie Phone: 01 896 8491
Administrative Officer	Ms Jennifer Murray	E-mail: undergrad_maths@tcd.ie Phone: 01 896 2423

TR063: Physical Sciences – **OPEN Modules**

PIU22992: History, Philosophy and Ethics of Science

Semester 2, 5 credits

Contact Hours:
22 hours of lectures + 10 hours of tutorials

Module Coordinator: Richard Teague

Module Content

In this module, we will consider foundational issues in the philosophy of science. Topics to be covered will include some selection of: the nature of scientific methodology, the variety of inference methods used in science (and their benefits and drawbacks), realism and anti-realism, and the role of values in science. By the module's end, students will be well situated to engage in further independent study of the topics in philosophy of science that interest them.

Learning Aims

Students will: 1) gain a grounding in foundational issues in philosophy of science; 2) learn how to critically assess theses in science and philosophy; 3) learn about how philosophy is relevant for, and can contribute to, the practise of science; and, 4) gain the knowledge and skills requisite for engaging in further work in the philosophy of science

Learning Outcomes

By the end of this course, students will possess an understanding of the core topics and ideas in the area of philosophy of science (see module content for more information), as well as how to critically engage with them. Consequently, they will be well-placed to: apply their knowledge in future scientific work; and, branch out and engage in their own independently guided research into the philosophy of science issues which interest them most.

Assessment

For 5 ECTS:

- 4x Written Responses of 750 words [25% each]

Module Website (See Blackboard)

Contacts:

Module Coordinator:	Richard Teague	teaguer@tcd.ie
Executive Officer:	Tania Panero Garcia	philosophy@tcd.ie

BYU22201: From Molecules to Cells II

Semester 1, 10 credits

Prerequisite: BYU11101

Module coordinator: Prof Emma Creagh

Contact Hours: 34 hours lectures, 21 hours practical's

Module Personnel: E. Creagh, K. Mok, A. Khan, M. Hankir, J. Hayes, D. Nolan, M. Ramaswami, S. Martin, M. Campbell, K. Roberts

Learning Aims:
This module aims to give students a detailed understanding of cellular structure, composition and function. The molecular composition of organelles, the processes carried out in each organelle, and how these processes are integrated in cellular function are presented in detail. Students are also introduced to enzyme kinetics; cellular metabolism; DNA structure and replication, transcription and translation; the regulation of gene expression; Mendelian inheritance and genetic disease. This module also introduces students to virology – how viruses enter cells to replicate and take over cellular processes during infection.

Module content:
Programme of lectures, practical's and an essay writing exercise: four lectures a week, Monday at 13:00, Wednesday at 17:00, Friday at 9:00 and 12:00, practical's Tuesday or Wednesday

Lecture Topic	Lecturer	Practical
Introduction to Module BYU22201 "From Molecules to Cells"	E. Creagh	Practical 1. Solutions & Dilutions
Cell structure & intracellular transport	E. Creagh	
Cell cytoskeleton I	E. Creagh	
Cell cytoskeleton II	E. Creagh	
Proteins & amino acids	K. Mok	
Protein folding and purification	K. Mok	
Oxygen binding proteins	K. Mok	
Enzymes, catalysis and assays	A. Khan	
Enzyme kinetics, inhibition & regulation	A. Khan	Practical 2. Spectrophotometry & Chromatography
Glycolysis	M. Hankir	
Gluconeogenesis	M. Hankir	
TCA Cycle	M. Hankir	
Glycogen biosynthesis & degradation	M. Hankir	
Powering Life: energy transduction & life	D. Nolan	

Bioenergetics 1: oxidative phosphorylation	D. Nolan	Practical 3. Enzyme Kinetics
Bioenergetics 2: the universality of chemiosmosis	D. Nolan	
Lecture Topic	Lecturer	
Harvesting the light: photosynthesis	D. Nolan	
Lipids - fatty acids & phospholipids	J. Hayes	
Lipids – beta-oxidation & fatty acid synthesis	J. Hayes	
Summary & integration of metabolism	D. Nolan	
DNA – structure, replication, repair, recombination I	M. Ramaswami	Practical 4. Oxidative Phosphorylation (online)
DNA – structure, replication, repair, recombination II	M. Ramaswami	
DNA – structure, replication, repair, recombination III	M. Ramaswami	
Transcription – RNA types, mRNA processing	M. Ramaswami	
Reading Week		
		Oxidative Phosphorylation Lab session
Regulation of gene expression: general principles	S. Martin	Practical 6. Genetic & phenotypic variation I
Gene expression in prokaryotes and eukaryotes	S. Martin	
Chromatin and epigenetic effects on gene expression	S. Martin	
Alternative splicing and protein translation	S. Martin	
Mendelian inheritance	M. Campbell	Practical 7. Genetic & phenotypic variation II
Mapping Mendelian traits	M. Campbell	
Quantitative traits and heritability	M. Campbell	
Genetics of common diseases	M. Campbell	
Virology: Replication cycles I	K. Roberts	Online Practical exercise: Bioinformatics

Revision Week

Lecture Content:

- Introduction to the BYU22201 Module ‘from Molecules to Cells’
- Revision of Cell structure (Podcast), Membrane structure & Intracellular protein transport mechanisms. (Elements Flipped classroom)
- Cellular cytoskeleton I (Actin filaments, myosin motor protein) (combination of flipped classroom & traditional lectures material) - Principles of cellular movement & the process of muscle contraction.
- Cellular cytoskeleton II – Importance of Microtubules & Intermediate filaments for cellular function (combination of flipped classroom & traditional lectures material). Specialised microtubules involved in the motility of cilia/flagella will be discussed.
- What are proteins? The 20 amino acids and their structures and properties, acid-base equilibria, the isoelectric point. (Combined flipped classroom and traditional lectures) The polypeptide chain and general properties of proteins. The hierarchy of protein structure (primary / secondary / tertiary / quaternary structures).
- Protein folding and protein misfolding diseases / neurodegenerative diseases. Protein purification and protein characterization techniques.
- Oxygen-binding proteins as an example of protein-ligand binding. Comparison of myoglobin and haemoglobin. Cooperativity. Bis-phosphoglycerate’s role in oxygen affinity. Sickle cell anaemia.
- Catalysis and the enzyme substrate relationship; Activation energy and the transition state. Michaelis-Menten kinetics; The active site- physicochemical properties; Enzyme assays.
- Principles of enzyme catalysis; Mechanisms of catalysis with examples; Reversible Inhibition; Allosteric regulation; Enzyme inhibitors as drugs Michaelis-Menten kinetics, limiting velocity, rate/enzyme correlation. Reversible inhibition and allosteric regulation.
- Lipids-Fatty Acids and phospholipids. What are lipids? Chemical and functional properties of diverse lipids such as steroid hormones, fat soluble vitamins and ketone bodies. Fatty acids, phospholipids and membranes.
- Lipids- β-oxidation and fatty acid synthesis. Energy production through the mobilisation of fatty acids from triacylglycerols and their oxidation in mitochondria. Energy storage through the synthesis of fatty acids and storage of triacylglycerols in adipocytes.
- Catabolism and anabolism. Sources of sugars in our diet. Glycolysis, its control and regulation. Catabolism of fructose and galactose. Fermentation.
- The necessity for gluconeogenesis. Its control and regulation. Substrate sources. Reciprocal control of gluconeogenesis and glycolysis in liver.
- Pyruvate dehydrogenase and control of regulation of oxidative catabolism of substrates via the tricarboxylic acid (TCA) cycle. The TCA cycle as a source of biogenic amines. The TCA cycle as a source of anabolic substrates. Anapleurotic reactions.
- What is glycogen? Breakdown of glycogen/glycogenolysis in liver and skeletal muscle. Its control and regulation. Flight or fight! The effect of starvation. Glycogen biosynthesis.
- Powering Life: Energy transduction & life. Introduction to basics: energy transduction in biological systems: concept of displacement from equilibrium, chemical potential, electrochemical potential and redox potentials. ATP and energy coupling: key concepts: Is ATP a high energy compound?
- Bioenergetics 1: Oxidative Phosphorylation. The machinery of oxidative phosphorylation: The electron transport chain and the universal turbine of life: the F_1F_0-ATPase.
- Bioenergetics 2: The Chemiosmotic view of Life and the universality of the concept.
- Harvesting the light: Photosynthesis. The light reactions of photosynthesis: photophosphorylation, the Z scheme, PSI & II and C_1C_0-ATPase. A comparison of oxidative and photo phosphorylation.

- Summary & Integration of Metabolism
- DNA – Structure, Replication, Repair, Recombination I. Discovery of DNA as the genetic material; structure, properties and conformation(s) of DNA; mechanism for DNA replication in prokaryotes and eukaryotes: DNA polymerases and the replisome.
- DNA - Structure, Replication, Repair, Recombination II. The role of telomeres in DNA replication in eukaryotes. Spontaneous and induced mutations; mutagens and the effects of mutations.
- DNA - Structure, Replication, Repair, Recombination III. DNA repair mechanisms; non-homologous end joining and homologous recombination.
- Transcription - RNA types and processing I. Discovery of RNA; properties and classes of RNAs; types of RNA polymerases; transcription in prokaryotes: initiation, elongation and termination.
- Transcription - RNA types and processing II. Types of RNA polymerases; transcription in eukaryotes: initiation, elongation and termination.
- Regulation of gene expression. The general principles of the regulation of gene expression in prokaryotes and eukaryotes.
- Gene expression in prokaryotes and eukaryotes. Mechanisms of the regulation of gene expression in prokaryotes and eukaryotes: promoters. Sigma factors, transcription factors, enhancers, silencers, insulators
- Chromatin and epigenetic effects on gene expression. Introduction to epigenetics; structure and composition of chromatin; histone and DNA modifications and their effects on chromatin and gene expression.
- Alternative splicing – protein translation. Mechanisms of alternative splicing. Initiation, elongation and termination of translation
- Mendelian Inheritance. Mendel's laws (revision of BYU11101) and molecular basis of inheritance patterns; pedigree analysis; gene interactions: dominance, co-dominance, incomplete dominance, recessivity, penetrance, expressivity, and epistasis.
- Mapping Mendelian traits: This lecture outlines the historical methods that were used to identify mutations in genes associated with Mendelian diseases. It highlights the methodology and underlying analysis with a focus on linkage and recombination.
- Quantitative traits and heritability: This lecture will focus on more complex traits, somatic mutations and heritability and how they pertain to human disease. The lecture uses examples of conditions such as breast cancer to describe the identification of genes that ascribe relative risk scores to disease.
- Genetics of common diseases: This lecture focuses on giving a wide range of examples of human disease that show Mendelian and non-mendelian modes of inheritance. It aims to give the student a broad understanding of the complexities of these diseases and the underlying genetic causes.
- Virology I: Introduction to viral replication - we will touch upon how viruses are transmitted and then explore the different ways viruses enter cells. We will discuss the diversity of viral genomes and compare examples of viral strategies for producing mRNA.
- Virology II: Replication continued– we will explore how replication and assembly of new virions is dependent on specific locations within the cell and also the cellular processes a virus needs to utilise during replication.

Practical Content:
Practical 1 Solutions & dilutions - This numerical skills activity will prepare students for numerical calculations relevant for lab work (eg. calculating molarites, how to make up buffers, dilution factors, *etc*.).
Practical 2 Chromatography & spectrophotometry - During this practical students will perform (1) **Ion exchange Chromatography** and **(2) a spectrophotomeric enzyme assay**: increasing alcohol dehydrogenase (ADH) concentrations will be assayed - measuring the spectrophotometric production of NADH as the readout.

Practical 3 Enzyme Kinetics - Students perform a stopped enzyme assay, using increasing substrate and inhibitor concentrations. They calculate the final concentrations in the assay, calculate Km and Vmax for uninhibited series, use Lineweaver-Burk plots to demonstrate competitive inhibition, and determine the Ki.
Practical 4 Oxidative Phosphorylation
Practical's 5 and 6: Differential Gene Expression
Practical 7: Assessment of Genetic Variation through Computational Analysis
Introduction to Bioinformatics; accessing and retrieving DNA sequence information from *Genbank*; comparison of homologous gene sequences using *BLAST*; identification of polymorphisms.

Learning Outcomes:

- On completion of this module students should be able to demonstrate an understanding of fundamental concepts in the following cellular structures and processes: the structure and function of cells and organelles; structures and functions of nucleic acids, proteins, carbohydrates and lipids; the fundamental concepts and regulation of metabolism; the composition, structure, synthesis and function of DNA and RNA; regulation of gene expression in prokaryotes and eukaryotes; chromatin structure and epigenetic regulation of gene expression; the principles of genetic inheritance; genetic diseases and fundamental concepts in virology.
- Students should be able to demonstrate practical, numerical and analytical skills appropriate to modern biochemistry, genetics and microbiology.
- Students should be able to collate, synthesise and present information in written reports and essays.

Recommended Reading List:
The topics and concepts presented in this module will be found in many general textbooks on cell biology, biochemistry and genetics. The following are recommended for your guidance:

Essential Cell Biology. Alberts, Hopkin, Johnson, David Morgan, Raff, Roberts, Walter. (4th / 5th Editions). W. W. Norton & Company.
Biochemistry. Berg, Tymoczko, Gatto, Stryer (8th edition). Macmillan International.
Introduction to Genetic Analysis. Griffiths, Wessler, Carroll, Doebley (11th edition). W.H. Freeman and Co.

Assessment Details:
(A) **End of semester written examination: 50% of module mark**
The examination paper is divided into two sections, equally weighted.

- **Section 1: Essay** One essay from a choice of three**.**
- **Section 2** Ten short answer questions from across the module.

(B) **Course Work: 50% of module mark**
1. In course essay, 5% of module
2. Practical assignments 20% of module mark
3. End of Module practical exam, 15% of module
4. MCQ test of lecture material, 10% of module

To pass the module a student must obtain an overall module mark of 40%.

Contacts:

Module Coordinator:	Emma Creagh	ecreagh@tcd.ie	Ph: 01 8962539
Biology Teaching Manager:	Mirela Dardac	mdardac@tcd.ie	Ph: 01 8962895
Chief Technical Officer:	Audrey Carroll	aucarrol@tcd.ie	Ph: 01 8961620
Executive Officer:	Daniel McCormick	btcadmin@tcd.ie	Ph: 01 8961117

BYU22202: From Cells to Organisms

Semester 2, 10 credits

Prerequisite: BYU11101

Module coordinator: Prof Colm Cunningham

Contact Hours: 37 hours lectures, 15 hours practical's.

Module Personnel: C. Cunningham, N. O'Boyle, D. Zisterer, P. Murphy, Á. Kelly, T. Ryan, A. Witney, C Kröger

Learning Aims:
This module aims to bring the student from the functioning of prokaryotic unicellular organisms right up to the integrated functioning of perceiving, thinking, and acting multicellular organisms. The module will give the students an appreciation of the highly specialised and dynamic communication between cells and tissues that brings about the functioning organism.

Module content:
Programme of lectures, laboratory practical's and writing skills exercise. four lectures a week, Monday at 9:00, Tuesday at 9:00 and 13:00, Wednesday at 17:00, practical's on alternate Wednesdays.

Lecture Topic	Lecturer	Practical
Introduction to BYU22202 "From Cells to Organisms"	C. Cunningham	**Practical 1.** Adherence & the induction of bacterial gene expression Carsten Kröger
The bacterial world: diversity & unique extracellular structures	N. O'Boyle	
Energy, transport and scavenging in bacteria	N. O'Boyle	
Motility and chemotaxis in bacteria	N. O'Boyle	
Cell: Cell communication & bacterial development	N. O'Boyle	
Introduction to the bacterial cell envelope I	N. O'Boyle	
Introduction to the bacterial cell envelope II	N. O'Boyle	
Cell: Cell communication; autocrine, juxtacrine, paracrine & endocrine signalling	C. Cunningham	
Cargo packaging for export	C. Cunningham	**Practical 2.** Resting membrane and action potential Colm Cunningham
Calcium-dependent exocytosis for signal release (Neurotransmission I)	C. Cunningham	
Signalling via ligand-gated ion channels (Neurotransmission II)	C. Cunningham	

Intracellular signal-transduction: conserved mechanisms for responding to extracellular signals	D. Zisterer	
Signalling through G-protein coupled receptors	D. Zisterer	
Signalling through receptor tyrosine kinases and MAP kinases	D. Zisterer	
Conservation of signalling pathways between organisms	D. Zisterer	
Organising a body plan in multicellular organisms	P. Murphy	
Cell signalling/cell communication in the context of development	P. Murphy	**Practical 3.** Development Paula Murphy
Elaboration of positional information/progressive specification/cell lineage analysis	P. Murphy	
How a cell responds to positional information	P. Murphy	
Evolution/Development –body plan changes through evolution	P. Murphy	**Practical 4.** Writing skills Colm Cunningham
Organogenesis	P. Murphy	
Nervous control of physiological function	A. Kelly	
Pharmacology of autonomic nervous system	A. Kelly	
Reading Week		
Muscle physiology	A. Kelly	**Practical 5.** Cardiovascular physiology Áine Kelly
Endocrine regulation of physiological function	A. Kelly	
Fundamentals of cardiovascular & renal physiology I	A. Kelly	
Fundamentals of cardiovascular & renal physiology II	A. Kelly	
Pathophysiology and treatment of hypertension	A. Kelly	
The immune system and its influence on homeostasis	C. Cunningham	
Digestion & metabolism, metabolic syndrome, gut-brain axis	A. Kelly	

Integration of nervous, endocrine and immune regulation of physiology; Importance in pathophysiology.	A. Kelly	
Introduction to brain function, motor control	A. Witney	
Sensation and perception	A. Witney	
Pain, nociception and interoception	A. Witney	
Learning and memory	T. Ryan	
Emotion and motivation	T. Ryan	
Understanding brain function through pathology/disease	T. Ryan	
Summary - Revision/integration lecture	C. Cunningham	

There will be two in-course assessments of Lecture material (multiple choice format).
The first will be immediately after reading week, the second in the last week of semester.

Lecture Content:
Unicellular to multicellular life

- Examples of signalling molecules released by bacteria and their effects on individual cells and populations
- Quorum sensing as a method of communication between bacteria within a population
- Regulatory and physiological adaptations to stress in bacteria
- ATP synthesis and the generation of proton motive force in bacteria
- Nutrient uptake mechanisms and transporters in bacteria
- Motility and chemotaxis in bacteria
- Extracellular structures such as fimbriae, capsules and S-layers and their role in adaptation to the environment
- Mechanisms employed by bacteria to attach to and interact with eukaryotic cells

Cell-cell communication & Signal Transduction

- The basic mechanisms of cell-cell communication including juxtacrine, autocrine, paracrine & endocrine signaling. From gap junctions and plasmodesmata (metabolic or electrical coupling), to contact-dependent signaling, neurotransmitter release at short range to hormone release at long range
- Packaging of cargo for export: protein synthesis and export via the trans-golgi network and the secretory pathway versus vesicular transporter-mediated packaging of synaptic vesicles (with provision of online resources)
- Neurotransmission as a specialized form of calcium-dependent exocytosis. Resting membrane potential and depolarization, the action potential, voltage-dependent calcium channels (with provision of online resources).
- Signalling via ligand-gated ion channels: neurotransmitter binding and gating of ion channels. Acetylcholine and end plate potentials at the neuromuscular junction. Glutamate and GABA receptors, excitation and inhibition.
- Highly conserved components of intracellular signal-transduction pathways-G proteins used as on/off molecular switches; protein kinases/phosphatases employed in virtually all signalling pathways; second messengers carry and amplify signals from many receptors. Concept of crosstalk between signalling pathways. Signal termination.

- General elements of G protein coupled receptor systems. GPCRs that activate or inhibit adenylyl cyclase. GPCRs that activate phospholipase C. Mechanisms that downregulate signalling from GPCRs. Integrating responses of cells to environmental influences.
- Receptor tyrosine kinases (e.g. EGF). Activation of ras and MAPK pathways. The role of protein binding domains in the specific interactions between signalling molecules. Pathways that involve signal-induced protein cleavage (e.g. Notch/Delta signalling).
- Signalling networks that respond to changes in nutrient and energy status of cell (e.g. SnRK1 and TOR kinases in plants). Signalling pathway conservation between organisms. Defects in signalling pathways leading to disease with emphasis on cancer.

Development

- **Organising a body plan in multicellular organisms:** The concepts of multicellular life and how an organized body plan, composed of different cell types and tissues, is established. Examples of relatively simple (hydra) organisms to the most complex (examples of drosophila, mouse, human and others) will be used. Fundamental similarities and differences in the organisation of animals and plants will be covered. Molecular and biophysical mechanisms governing cellular behaviour will be discussed.
- **Cell signalling/cell communication in the context of development**. Cell communication is fundamental to building an organized body plan. The main developmental signalling pathways (Wnt, BMP, Hedgehog, FGF, YAP/hippo etc) will be introduced with examples of how they guide development. Pathway conservation and elaboration through evolution related to developmental complexity will be examined.
- **Elaboration of positional information over time.** Exploration of key concepts, moving from the "French flag model" to more sophisticated ways of thinking. The concept of gradients and graded influence across tissues. Progressive specification and how information builds over developmental time. Cell lineage analysis and tracing a cell through time. Stem cells and how stem cell niches are established during development.
- **How a cell responds to positional information**. Transcriptional and post-transcriptional regulation leading to cellular differentiation. The integration of different types of information at the cellular level determining how a cell responds. The importance of the cellular context and epigenetics. Hox genes and how they relate to positional information – the concept of a positional code. Mutations that change the body plan.
- **Evolution & Development**: How body plans can change through evolution. The concept of "the Toolkit" for building an organism and "tinkering with the toolkit" – genetic changes that can lead to major body plan shifts such as loss of limbs or acquisition of specialised structures such as a turtle shell.
- **Organogenesis**: Development of organ and organ systems; e.g. heart, kidney, lung etc. building on the concepts and mechanisms involved in building complex structures, current knowledge on how specific organs are established will be presented and explained.

Human Physiology

- Nervous control of physiological function: sensory and autonomic nerves. CVS as model system.
- Muscle function and its nervous control. Disorders of skeletal muscle, cardiac hypertrophy (physiological via exercise & pregnancy; pathophysiological via hypertension)
- Neuropharmacology, with specific emphasis on pharmacology of the autonomic nervous system; effect of toxins on neuromuscular junction
- Endocrine regulation of physiological function, highlighting endocrine disorders.
- Fundamentals of cardiovascular and respiratory physiology and their interaction (homeostatic responses to altitude, exercise)

- Fundamentals of cardiovascular and renal physiology and their interaction (regulation of blood pressure and volume, acid-base balance)
- Pathophysiology and treatment of hypertension (pharmacology of ANS, role of exercise in prevention and treatment)
- Digestion and metabolism, metabolic syndrome, the gut-brain axis.
- Immune regulation of physiological function (innate vs adaptive, role of inflammation in infection and cancer. Regulation of tissue homeostasis and role in obesity, diabetes and brain injury/neurodegenerative disease.
- Pathophysiology of diseases of the nervous system (MS, AD, PD, encompassing nervous, endocrine and immune regulation of physiology).

Neuroscience and Behaviour

- Sensation and perception. Students will gain an understanding of how the brain makes sense of sensory input. They will be aware of and able to explain fundamental discoveries (e.g. Hubel & Wiesel). They will be able to describe neuronal circuitry that enables us to distinguish between sensory input from the external world and that which is internally generated (sensory cancellation and efference copy mechanisms).
- Pain, nociception, and interoception. Students will attain and understanding of the internal awareness of the animal body to states such as pain.
- Motor coordination and control. Students will learn how the complexity of an animal's movement is constrained by the underlying neural circuitry. Simple behaviours in simpler animals and their underlying neural control (e.g. CPGs) through to complex voluntary action and manipulative tasks.
- Emotion and motivation. Students will develop an understanding of how we empirically study animal behaviours that can be attributed to motivational drives and emotional states and will attain knowledge of how environment experience and genetic background can alter these behaviours.
- Learning and memory. Students will be able to describe the basic learning theory models in the context of Pavlovian and operant conditioning, and basic invertebrate and vertebrate experimental models of learning-induced brain plasticity and memory storage.
- Understanding brain function through pathology/disease. Students will gain an understanding of how clinical studies of humans with brain damage and disease, when combined with careful behavioural and psychiatric analysis, and give us new insights into brain function at a systems level. An introduction to the use of animal disease models and a few highlights of how animal models have been used to develop an understanding of disease processes.

Practical Content:
Practical 1: Bacterial Adherence to Eukaryotic Cells & the Induction of Bacterial Gene Expression during Infection
Examination of buccal epithelial cells to observe adherence of resident microbial flora to cells. Determination of the induction speed of the acid-responsive *asr* gene of *Salmonella enterica* in the human stomach using Green Fluorescent Protein as a biosensor.
Practical 2: Simulation of resting membrane potential and action potential using Metaneuron.
Students will use a downloadable application to simulate neuronal behaviour. This will be used to examine the contribution of sodium and potassium ions to the resting membrane potential; contribution of sodium flux and alteration of membrane potential in induction of the action potential; relationship between stimulus intensity and stimulus delay in the refractory period
Practical 3: 3D Imaging and database research of embryonic development

Students will use online 3D databases of developing embryos, to investigate and describe changes in anatomical features during the formation of a 3D body plan and begin to explore the molecular changes that underpin morphological change.
Practical 4: Writing Skills Activity: A topic from the lecture series will be selected and students given approximately two weeks to prepare a first draft essay. Students will bring their drafts to a supervised session where they will peer review the drafts in small groups (under supervision) and attend a masterclass on writing skills. Final essays will be submitted a few days later.
Practical 5: Cardiovascular and respiratory physiology. In this class, fundamental cardiovascular and respiratory physiology parameters will be measured. Students will be trained in the use of standard physiological equipment and will explore regulation of heart rate, blood pressure and blood flow, along with respiratory volumes and control of breathing.

Learning Outcomes:

On successful completion of this module students will be able to:
- Describe the regulatory and physiological adaptations that bacteria undergo to acquire nutrients, respond to stress, and describe the structure, function and importance of bacterial extracellular structures and their roles in modulating cell-cell interactions. Utilise phenotypic tests and microscopy to characterise bacteria in the laboratory (Practical).
- Demonstrate an understanding of the role of signalling in bacterial communication in forming communities and the mechanisms used by bacteria to interact with eukaryotic cells.
- Describe the multiple ways in which cells communicate with each other over short and long distances.
- Demonstrate an understanding of how biological signals are prepared for export, are temporally and spatially controlled, are sent, received, transduced and amplified in the cellular context (signal transduction), and provide examples as to how this is achieved in cells.
- Utilise online tools and databases to explore fundamental concepts relating to neurotransmission and to answer specific questions related to embryonic development including an appreciation of the power of using shared data in research (Practical's).
- Articulate the concepts of how biological complexity is established as the body plan of multicellular organisms emerge and integrate these concepts in the context of how body plans have evolved.
- Describe the contribution of the nervous, endocrine and immune systems to regulation of whole-body physiological homeostasis in humans and detail cell, tissue and organ integration in the cardiovascular, respiratory, immune, renal and digestive systems.
- Describe how alterations in physiological variables as a result of exercise, changes in barometric pressure or pathophysiological processes impact on homeostasis in different organ systems
- Measure and understand fundamental cardiovascular and respiratory variables in human subjects (Practical).
- Articulate how the brain achieves basic functions for the animal using examples from invertebrate & vertebrate neurobiology.
- Provide explanatory accounts of movement and motor control; sensation and interoception; emotion and memory, and how brain injury in human patients can inform us about brain function.
- Describe, integratively, how the fundamental physiology of neural circuits can be used to explain behavioural function in both vertebrates and invertebrates.
- Demonstrate good practice in essay writing: including planning, drafting, responding to constructive review and timely submission of a final draft (Practical, graded for continuous assessment).
-

Recommended Reading List:

The topics and concepts presented in this module can be found in selected chapters of the following textbooks:

- Biology, A global Approach. Campbell *et al.* 12^{TH} Edition. Pearson.
- Prescott's Microbiology 10^{th} edition. McGraw Hill.
- Biochemistry. Berg, Tymoczko, Gatto, Stryer 8^{th} edition. Macmillan International.
- Molecular Cell Biology. Lodish *et al*.., 8th edition. Macmillan International.
- Principles of Development. Wolpert, Tickle, Martinez-Arias. 5th Edition Oxford University Press.
- Developmental Biology. Gilbert, Barresi, 11th Edition. Sinauer, Oxford University Press
- Human Physiology from Cells to Systems. Sherwood. 9^{th} Edition. Cengage Learning.
- Principles of Neurobiology. Liqun Luo. 1^{st} edition. Garland Science.

Assessment Details:
Marks are allocated across two components, course work (50% of module mark) and end-of-module examination (50% of module mark). The end-of module examination will be two hours duration. Students must answer three out of five questions. **To pass the module a student must obtain an overall module mark of 40%.**

Contacts

Module Coordinator:	Colm Cunningham	colm.cunningham@tcd.ie	Ph: 01 896 3964
Biology Teaching Manager:	Mirela Dardac	mdardac@tcd.ie	Ph: 01 8962895
Chief Technical Officer:	Audrey Carroll	aucarrol@tcd.ie	Ph: 01 8961620
Executive Officer:	Daniel McCormick	btcadmin@tcd.ie	Ph: 01 8961117

CHU22201: Chemistry 1

Semester 1, 10 Credits

Contact Hours: **50 hours lectures and tutorials and 27 Labs hours.**
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 core Inorganic and Organic Chemistry topics at an intermediate level, which further develop the material covered in the JF year and are the basis for further detailed studies in the Sophister years.

Content Layout

Teaching Week	Topic
1-4 (14 L)	**Inorganic Course Title: Introduction to Inorganic Chemistry 2** The aim of this module is to introduce molecular symmetry and cover aspects of group theory in order to help develop an understanding of electronic spectroscopy of transition metal complexes. The student will learn basic concepts in electronic spectroscopy to develop an understanding of the UV/Vis spectra of transition metal complexes, the influence of the metal and its oxidation state, the nature of the ligand and the coordination number and geometry of the complex on its electronic properties. The application of UV-visible absorption spectroscopy to the characterisation of metal complexes and the effective interpretation of spectra is also discussed in detail developing skills in the manipulation of data and in spectral analysis. **Electronic Spectroscopy of Transition Metal Compounds:** Lecture 1: An introduction to molecular symmetry. Symmetry operations and symmetry elements Lecture 2: Point groups; Determining the point group of a molecule or molecular ion Lecture 3: An introduction to character tables Lecture 4: Why do we need to recognize symmetry elements? Lecture 5: Introduction to electronic spectroscopy. Absorption of light by transition metal complexes. Review of ligand field splitting for octahedral, tetrahedral and square planar geometries, factors affecting the magnitude of splitting. Limitations of ligand field theory – interelectron repulsion. Lecture 6: Coupling of orbital and spin angular momenta, Russell-Saunders coupling, application to first row transition metal ions. Formation of microstates in metal ions and generation of term symbols Lecture 7: Use of Hund's first and second rules to identify the ground term

	Lecture 8: Crystal field splitting of free ion terms; Orgel diagrams for the weak-field limit (D and F ground term diagrams), the hole formalism. Interpretation of weak field spectra using Orgel diagrams. *Tutorial 1 & 2: Point group assignments. Determination of ground term. Assignment of UV-Vis spectra of transition metal complexes.* Lecture 9: Quantum mixing. Calculation of quantum mixing term *x* and Racah parameter *B* Lecture 10: Selection rules for electronic transitions. d^5 spectra. Understanding and reasons for the broadening of electronic transitions. Molecular vibrations, Franck-Condon Principle. Spin-orbit coupling, Jahn-Teller distortion Lecture 11: Tanabe-Sugano diagrams, the high-spin/low spin transition, calculation of octahedral splitting, *E* and *B*, use of Tanabe-Sugano diagrams to predict the positions of missing bands. Lecture 12: Origins and consequences of the nephelauxetic effect. Spectra of pseudooctahedral complexes e.g. D_3 complexes such as $Cr(en)_3^{3+}$ – analysis as a small perturbation from the octahedral case, limitations. Continuation of problem-based exercises using Tanabe Sugano Diagrams Lecture 13: Ligand-to-metal and metal-to-ligand charge transfer transitions Lecture 14: Excited state complexes and their resulting emissive properties. • Tutorial 3&4: *Assignment of UV-Vis spectra of transition metal complexes. Charge transfer transitions.*
4-5 (5L)	Molecular Spectroscopy • This course will focus on the major techniques employed in the identification of chemical entities (although some are not spectroscopic techniques). • Why is spectroscopy important? • Nuclear Magnetic Resonance Spectroscopy (NMR): Nuclear spin, chemical shift, shielding and spin-spin coupling. Both ^1H and ^{13}C NMR are covered. A brief consideration of MRI is included. • Ultraviolet Spectroscopy: Effect of π-conjugation. • Infra-red Spectroscopy: Molecular vibrations, detection of characteristic functional groups • Mass spectrometry: Uses and application • X-Ray Diffraction: How X-ray diffraction can be employed to aid structural elucidation.
6-9 (12 L) Week 7 Study week	Introduction to Organic Synthesis • In-depth discussion of stereochemistry including definition of chemo-, region- and stereoselectivity. Identification of stereoisomers and assignment of absolute configuration. Resolution of racemic mixtures. Biological relevance of stereochemistry.

	• Conformational analysis, including Newman projections diagrams. Conformation of cyclohexane including chair, boat, twist-boat. Concept of allylic strain. • Introduction to carbohydrate chemistry and a discussion of common protecting groups in organic chemistry. • Applications of radical reactions in Organic synthesis. • In-depth discussion of aldol, carbonyl and beta-dicarbonyl chemistry for the formation of C-C bonds. • Aldol and carbonyl chemistry. • HSAB theory, the Michael addition reaction and Diels-Alder reaction.
10-12(9L)	• Aromatics • Why is aromatic chemistry important? An overview of important drugs, dyestuffs and polymers that are based on aromatic compounds. • Recap: An overview of JF Aromatic Chemistry I: The structure of benzene and a reminder of the mechanism of electrophilic aromatic substitution (EAS) reactions. • How and why substituents on an aromatic ring influence the regiochemical outcome of EAS reactions: How do electron donating groups and electron withdrawing groups cause the substitution patterns that they do? • Nucleophilic Aromatic Substitution: Introduction to NAS and the differences to EAS. The three different mechanisms of NAS and their use in synthesis. • Organometallic chemistry: Introduction to metallation reactions, directed metallation as a method of controlled synthesis, metal catalysed coupling reactions. • Synthetic considerations: How to plan successful synthetic strategies to prepare aromatic compounds. • Other important aromatic systems: A brief look at some of the less common compounds and their chemistry. • Aromatic chemistry in the body - a brief look at some important aspects including biosynthesis, hormones, drug metabolism and the production of toxic metabolites. • Tying it all together: An overview of the synthesis of an important aromatic compound.
13	Student Revision/Study week – tutorials only
14	Student Assessments

Reading list/ Indicative Resources

- Organic Chemistry, by Jonathan Clayden and Nick Greeves; Publisher: OUP Oxford; 2 ed.
- Inorganic Chemistry, Catherine E. Housecroft and Alan G. Sharpe, Pearson Education Limited 2005 (An introduction to molecular symmetry - Chapter 3; d-Block chemistry: coordination complexes – Chapter 20)
- Characterisation Methods in Inorganic Chemistry, M. T. Weller, N. A. Young, Oxford University Press, 2017. (Electronic Spectroscopy – Chapter 5)
- Inorganic Chemistry: Principles of Structure and Reactivity, J. E. Huheey, E. A. Keiter, R. L. Keiter, HarperCollins, 1997, 4th Ed. (Electronic Spectroscopy – Chapter 11)

- Inorganic Chemistry, M. Weller, T. Overton, J. Rourke, F. Armstrong, Oxford University Press, 2018, 7th Ed. (Electronic Spectroscopy – Chapter 20)

Methods of Assessment
In-course assessment: 25% of Final Grade
Written Examination: 75% of Final Grade

Lab Hours = 9 x 3 hours = 27 hours. Organic Chemistry (6 experiments), Inorganic (3 experiments)

Learning Outcomes
1. Explain the basics of symmetry operators and symmetry elements
2. Explain the basics of group theory
3. Be able to show how one given molecule belongs to a specific point group.
4. Summarize the process for the absorption of light and the mechanism by which this leads to electronic rearrangement in a transition metal complex
5. Explain the implications that absorption has for the origin of the wide-ranging and characteristic optical properties of coordination complexes.
6. State the importance of both the wavelength and intensity of the light absorbed in determining the nature of the transitions between electronic energy levels involving the metal centre
7. Describe the influence of the metal and its oxidation state, the nature of the ligand and the coordination number and geometry of the complex on its electronic properties.
8. Describe the application of UV-visible absorption spectroscopy in the characterisation of metal complexes and the effective interpretation of spectra.
9. Illustrate the skills required to manipulate relevant data sets and in analyzing spectra.
10. Illustrate the main principles of homogeneous catalysis by transition metals complexes, mechanisms and catalytic cycles.
11. Identify and explain stereochemical features of organic molecules.
12. Describe strategies for controlled formation of stereochemical centres in organic synthesis.
13. Formulate reasonable retrosynthetic pathways for the design of simple organic molecules.
14. Explain the principles of standard organic spectroscopy techniques.
15. Determine information about the structure of unknown organic materials using spectroscopic data.
16. Categorise and explain the principle reactions of aromatic molecules.

Contacts:

Module Coordinator Professor Mike Southern	E-mail: southerj@tcd.ie Phone: 01 896 3411
Coordinator Fresh Teaching Dr Noelle Scully	E-mail: pnscully@tcd.ie Phone: 01 896 1972
Administrative Officer Ms AnneMarie Farrell	E-mail: farrea25@tcd.ie Phone: 01 896 1726

CHU22202: Chemistry 2

Semester 2, 10 credits

Contact Hours: **52 hours lectures and tutorials and 27 lab hours.**

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: Chemistry 2 module consists of core Physical and Inorganic Chemistry topics at an intermediate level, which further develop the material covered in the JF year and are the basis for further detailed studies in the Sophister years.

Content Layout

Teaching Week	Topic
1-4 (16 L)	**Chemical Thermodynamics** • Review (calculus based) of: First Law, Internal Energy and Enthalpy, Enthalpy as a function of temperature: use of differentials, 2nd Law: entropy, entropy as a function of temperature. • pV diagrams: isotherms and adiabatics, Carnot cycle, Engine efficiencies • 3rd Law: limiting values of Cv and Cp, Residual entropy, Free energy functions, Maxwell Relations • Chemical potentials and equilibria: The Chemical potential, activities, phase equilibria, Gibbs phase rule, Clausius Clapeyron, Homogeneous equilibria, Van't Hoff isochore • Chemical potentials in ideal solutions: Liquid vapour equilibrium, Henry's law, Raoult's law, Liquid-solid equilibrium, ideal solubilities, colligative properties • Non-ideal systems: Non-ideal gases, Fugacity of a van der Waals' gas, Mixture of gases
5-9 (14L) 7 study week	**Chemical Kinetics** • Basic concepts: collisions and gas phase reactions, Boltzmann distribution, Rate constant and Arrhenius equation, factors control rate • Chemical bond breaking and making, Morse potentials, forces on atoms, potential energy surface, transition state, simple harmonic oscillator, quantisation • Description of chemical reaction Definition of rate, initial rate, reaction order, rate constant, effect of concentration and temperature, experimental measurement • Derivation of integrated rate equations: zero, first and second order, graphical analysis to evaluate rate constant, half life • Activated processes, activation energy, Arrhenius equation, evaluation of activation energy, extension to other processes, diffusion, adsorption /desorption • Multistep reactions, rate determining step, reactive intermediates, reaction mechanism, consecutive and competitive reactions, Simple reversible reactions, quasi-equilibrium, quasi steady state, thermodynamic vs kinetic control, yield • Application of kinetics to catalysis (bio and surface), Langmuir-Hinshelwood, Michaelis-Menten, adduct formation, turnover frequency • Unimolecular gas phase kinetics, reactions in solution, diffusion vs activation control. • Collision theory mean free path, collision frequency, activated complex theory, Eyring equation, activation parameters, relationship to Arrhenius, interpretation of pre-factor. • Kinetic isotope effect

9-12 12L)	**Introduction to Main Group Chemistry** • This module serves as the foundation for the Main Group Elements Chemistry. It focuses on the fundamental concepts and principles that underpin the chemistry of main group elements, which comprise the s- and p-block elements of the periodic table. Main group elements are essential components of various chemical compounds and play a critical role in diverse fields, including materials science, biology, and environmental science. • Periodic trends on main group elements: The organization of the periodic table and the significance of main group elements in the table. Discussion how periodic trends (e.g., atomic radius, ionization energy, and electron affinity) are related to their position in the periodic table. Discussion of the reactivity patterns of main group elements, including their tendency to gain or lose electrons in chemical reactions. • Representative Main Group Elements: Studies of specific main group elements (in detail, including their properties, and the compounds they form. • Hydrogen: Industrial hydrogen production, hydrogen storage, ortho- and para-hydrogen, isotopes of hydrogen and isotope effects, general features of hydrogen chemistry, metal hydrides and their application. • Main group 1 and 2: Representative features of alkali metal chemistry, liquid ammonia solutions of alkali metals, lithium chemistry and Li-Mg diagonal extension of lithium, Grignard reagents, general features of alkaline earth metals and their reactivities. • Main groups group 13 elements: Unique features of boron chemistry, electron deficiency in diborane, B – Al contrast in halides, main features of Al, Ga, In, Tl chemistry, complexes of Al and Ga, stability of Tl(I) state and inert pair effect. Main group 14 elements: Main trends of the group 14 , general features of carbon chemistry, allotropies of carbon, carbon oxides, chemistry of Si, Ge, Sn and Pb. • Main groups 15 elements: Main trends of the group 15, Hydrogen compounds EH_3, oxygen compounds, halogen compounds, applications. • Main groups 16 elements: general trends of the group 16, dioxygen species and ozone, sulfur allotropes, hydrogen compounds, chalcogenide polyanions and • Polycations, applications • Main group 17 elements: main trends of the group 17, reactivity of elements, hydrogen halides, interhalogens, polyhalogen compounds, oxides and oxoacids, applications. **Structural Inorganic & Materials Chemistry** • Introduction, Classification of solids, Degree of order in solids; Definition of terms: Crystal structure, unit cell and lattice; Crystal systems; Structure of Metals and close packing of atoms: hpc, fcc, bcc, primitive packing (alpha-Po), deviations from ideal structures; phase transitions, Goldschmidt rule; • Alloys and solid solutions, Interstitial phases (Hägg-Phases), Phase diagrams, Carbides, nitrides and hydrides; Frank-Kasper and Laves phases. • 8-N Rule and Elemental Modifications; Examples of this concept form Group 17, 16, 15 and 14 of the Periodic Table (I2, S, P, As Bi, Po, C); Principle of maximum connectivity, pressure homologue rule and examples (i.e. Sn); pressure distance paradoxon; Binary diamond-type compounds with ZnS structure; Properties of these materials (semiconductors); Temperature-dependences;

	• Concept of interstices in close packings; AB, AB2, AB3-type structures; A2B3 oxides; structures of normal and inverse spinels; • Synthetic concepts to hybrid organic-inorganic materials that replicate the topologies of purely inorganic default structures (reticular synthesis concept); properties of the resulting solid state materials; zeolite-type materials; •
13	Student Revision/Study week – tutorials only
14	Student Assessments

Reading list/ Indicative Resources

- The elements of physical chemistry by P.W. Atkins J. de Paula, 6 ed. OUP (2013),
- C.E. Housecroft, A.G. Sharpe, "Inorganic Chemistry", 4th and 5th Edition.
-
- 'Inorganic Structural Chemistry', Ulrich Muller; 2nd Edition, Wiley, Weinheim, ISBN: 978-0-470-01864-4 ''
- Shriver & Atkins, "Inorganic Chemistry", 5th edition.
- N. N. Greenwood and A.E. Earnshaw, Chemistry of the Elements, 2nd edition.
- A.G. Massey, "Main Group Chemistry", 2nd edition, Wiley, 2000.

Methods of Assessment

In-course assessment: 25% of Final Grade.
Written Examination: 75% of Final Grade
Lab Hours = 9 x 3 hours = 27 hours

Proposed practical's

Inorganic (3 experiments), Physical Chemistry (6 experiments)

Learning Outcomes

1. Analyse and apply chemical kinetic principles to simple, multi-step reactions and complex reactions.
2. Illustrate basic theory of chemical reaction rates.
3. Review and apply the laws of thermodynamics to the solution of problems in Physical Chemistry.
4. Define the concept of ideal and non-ideal systems and the use of chemical potentials.
5. Understanding of the structural principles of inorganic molecules and solids using traditional concepts, simple electron counting rules as well as modern approaches.
6. Understanding of systematic ordering of the recognized structure types, relationships among them, and the link between structure and properties.
7. Understand the periodic table and its organization, including trends in atomic size, ionization energy, and electron affinity within the main group elements.
8. Explain the bonding behaviour of main group elements, including covalent, ionic, and metallic bonds.
9. Explain the reactivity patterns of main group elements, focusing on their ability to form compounds and participate in chemical reactions.

10. Discuss specific representative main group elements in detail, including their chemical properties, and common compounds.
11. Discuss the reactivity patterns of main group elements, focusing on their ability to form compounds and participate in chemical reactions.

Contacts:

Module Coordinator: Professor Mike Southern	E-mail: southerj@tcd.ie Phone: 01 896 3411
Coordinator Fresh Teaching Dr Noelle Scully	E-mail: pnscully@tcd.ie Phone: 01 896 1972
Administrative Officer Ms AnneMarie Farrell	E-mail: farrea25@tcd.ie Phone: 01 896 1726

GSU22201: From Atoms to Rocks: Introduction to Geochemistry

Semester 1, 5 credits
Contact Hours
2 x 1-hour lectures / week for 10 weeks = 20 hours
1 x 3 hours laboratory / week for 10 weeks = 20 hours

Module Personnel: Dr. Michael Stock and Dr Juan Diego Rodriguez-Blanco

Module Outline
Geochemistry is a branch of Earth Sciences that uses chemical principles to study how the geosphere, hydrosphere, atmosphere and biosphere interact to process and distribute elements. This module will introduce fundamental chemical concepts, using geological examples to demonstrate their importance in Earth Science. The module provides an overview of high- and low-temperature geochemistry, outlining both how elements are processed in the Earth's crust/mantle, and providing an overview of the interaction between dissolved elements in natural waters and the rocks which they come in contact.

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

- Illustrate the importance of geochemistry in Earth Sciences and the relationship between geochemistry and geology, environmental chemistry, oceanography, soil sciences and biology.
- Describe the electronic structure of atoms and ions, as well as the periodic table and the arrangement of atoms to form solids.
- Describe the main geochemical reservoirs Earth and the processes responsible for distributing elements within the crust and mantle.
- Outline the most relevant physicochemical phenomena occurring when minerals are dissolved in melts and aqueous solutions.
- Illustrate the most important processes occurring during the interaction of minerals/rocks with water and their relevance to environmental quality and therefore to humans.
- Define radiogenic and non-radiogenic isotope systematics and their importance in Earth Science.
- Relate the relevance of the carbon cycle and carbonate minerals with life, ocean evolution, climate and availability of elements.

Method of assessment
Theory examination (80%; 2 hrs) and in-course practical assessment (20%).

Recommended reading lists
Ryan, P. (2014) Environmental and Low Temperature Geochemistry. Wiley-Blackwell.
White, W. M. (2013) Geochemistry. Wiley-Blackwell.

Contacts:

Module Coordinator:	Dr Michael Stock	MICHAEL.STOCK@tcd.ie
TR062 Executive Officer:	Debora Dias	Tr062Admin@tcd.ie

GSU22205: Sedimentary Processes & Environments

Semester 1, 5 credits
Contact Hours
Lectures = 20 hrs
Lab Practicals = 8 hrs

Module Personnel
Dr Micha Ruhl, Prof Jerry Dickens, Dr Robin Edwards

Module Aims
Sediments and sedimentary rocks hold a rich history of how physical, chemical, and biological processes have changed over space and time. This module is designed to give basic information, so that the evolution of Earth's surface can be understood. We will share how one can take sediments and sedimentary rocks and reconstruct the past and appreciate the processes that led to what we can see today. This module will provide the fundamentals of sediments and sedimentary rocks, and how to think about Earth evolution.
The module will develop understanding of:

- Geological time
- Basic sedimentary rock-analyses: from observation, to interpretation
- How sediments are generated transported, deposited & preserved
- Different sedimentary depositional environments across the Earth system (past & present; continental & marine)
- How sedimentary archives provide records of (changes in) the past Earth system and past environmental & climate change processes

Module Content

Earth's climate and environments have changed on multiple temporal and spatial scales throughout its history, which significantly impacted on physical, chemical and biological processes across Earth's surface. Information on past climates and environments, stored in sedimentary archives, informs our understanding on present-day conditions at Earth's surface and provides constraints on future changes. Sedimentary materials storing such information can be found across most of the Earth's crust, both on land and in the oceans, and much of our understanding of Earth history comes from their examination.
This Module will introduce key physical, chemical, biological and sedimentary processes, deposits and examples of contemporary sedimentary depositional environments. It will analyse and explain the generation, transport and preservation of sediments, as diagnostic tools to link surface processes with the geological records of Earth history, as well as modern environmental change.
To achieve the module learning aims, the module will introduce examples of environmental change, and their impact on the sedimentary depositional environment at that time, such as Snowball Earth, Oceanic Anoxic Events, Hyperthermals, the Messinian Salinity Crisis, and Quaternary Glacial-Interglacial Cycles.
The above described module will prepare the student for related modules in Stratigraphy, Climate Change, Oceanography, as well as fieldwork, in Junior and Senior Sophister.

Learning Outcomes

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

- Classify sediments and sedimentary rocks
- Provide technical descriptions of common sedimentary rock types and textures from hand samples and thin sections
- Explain the basic concept of "source-to-sink", and how this links weathering of mountains, and transport and deposition of sediments

- Describe changes in sedimentary archives from outcrop observations, stratigraphic logs and/or petrological evidence
- Describe (changes in) in sedimentary archives, and interpret these in regard to changes in physical, geochemical and biological Earth surface processes, and changing environments
- Distinguish and describe temporal and spatial variability in Earth surface processses and how this links to sediment deposition locally
- Illustrate how Global Change processes (physical/ geochemical/biological) (have) shape(d) Earth's surface, in the past, present, and future

Method of assessment

Laboratory practicals (50%); In-course problem solving exercises and tests (50%)

Module Coordinator: GSU22202: Sedimentary Processes & Environments		
Dr Micha Ruhl		E-mail: MICHA.RUHL@tcd.ie
		Phone: 01 896 1165
Executive Officer:		E-mail: TR062Admin@tcd.ie
Debora Dias		Phone: 01 896 1074

GGU22006: Physical Geography: Dynamic Earth

Semester 2, 10 credits

Contact Hours
4 x 1 hr lectures / week for 10 weeks = 40 hrs

Module Personnel
Dr Pete Akers, Dr John Connolly, Dr Margaret Jackson, Prof Iris Möller, Dr. Mary Bourke

Module Content:
Physical geography is an exciting scientific discipline that examines the Earth and how it functions. Geographers have already contributed substantially to scientific efforts to understand the emergence of truly globally significant human– environmental linkages. Physical Geography has thus been fundamental to investigating and modelling long-term changes to Earth surface process and dynamics. This type of knowledge is critical in allowing humans to live sustainably on planet Earth. In this module you study a wide variety of environmental systems, ranging from climate and weather to soils, beaches and rivers, to name just a few. The focus is to understand the location and character of landscape features such as mountain ranges and river valleys, and to explain why they came to be and how and why they vary depending on their geographic context. An underlying theme is to examine how aspects of physical geography affect human lives and, in turn, how people impact the dynamics of the physical landscape. This module will give students an understanding of key physical geography concepts. You will build on keys areas of Geography from the JF Spaceship Earth and Anthropocene modules. Elements of the module are designed to prepare students for Sophister geography modules.

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

- Critically evaluate the influence of climate, topography and humans on the variability of landforms.
- Explain the theories underlying how and why specific landforms vary over space and time.
- Draw on specific example of landforms and landscapes to demonstrate the influence of climate, topography, and humans.
- Evaluate the complex and reciprocal relationships between physical and human aspects of environments and landscapes.
- Assess the relative importance of infrequent/extreme versus frequent/moderate events in driving landform change.
- Discuss the potential application of geographical concepts, techniques and expertise as a means of addressing a range of issues facing the Earth and its people at a global and local scale.
- Explain the importance and relevance of physical systems and landforms to the future of human society.

Assessment Details:
In course tests and assessment (100%)

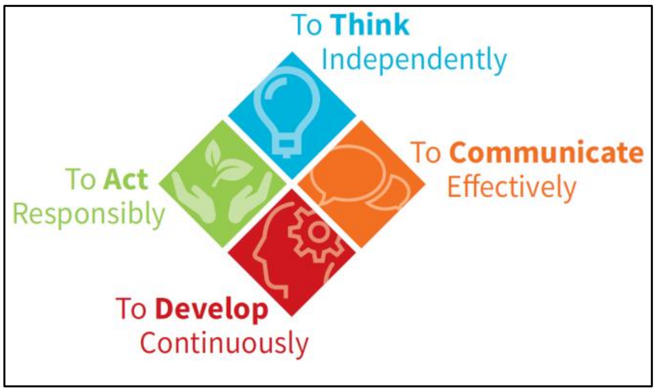
Module coordinator - GGU22006: Physical Geography: Dynamic Earth		
Dr Pete Akers		E-mail: pete.akers@tcd.ie
Executive Officer		E-mail: TR062Admin@tcd.ie
Debora Dias		Phone: 01 896 1074

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.

Important information

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

An overview of the progression regulations within the Physics programme are detailed here.

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.

A) Minimum mark requirement and Qualified Fails in Fresher years

i. These regulations apply to the Fresher JF and SF 10 credit modules that are core to Physical Sciences (TR063) and Theoretical Physics (TR035), and which are available as Open modules to JF and SF Chemical Sciences (TR031) students.
These modules are JF: PYU11P10, PYU11T10, PYU11P20, PYU11T20; and in SF: PYU22P10, PYU22T10, PYU22P20, PYU22T20. *(This does not include PYU11F10, PYU11F20, PYU11H20).*

ii. In these Fresher modules there is a **minimum mark requirement of 30%** separately in both the Examination component and the Laboratory component, in order for either a Pass or a Qualified Pass mark in the module to be granted. The Progression threshold is not simply an overall module mark of 40% or higher, but requires minimum marks in these components.

iii. A mark of less than 30% in either the Examination or Laboratory components leads to a Qualified Fail. A Qualified Fail requires reassessment in that component before progression to the next year can occur. Reassessment of the exam component is in the reassessment examination period; reassessment of the laboratory component occurs before the beginning of the reassessment examination period.

iv. If a mark of less than 30% occurs or recurs in the examination or laboratory component following the reassessment period, the student cannot progress and must repeat the year. This necessarily applies to students who had deferred their first attempt at examinations to the reassessment period.

v. Students who fail a module with a module mark of <40%, but >=35% are not eligible for Pass by Compensation, or a Qualified Pass, if either of the examination or laboratory components is less than 30%.

vi. For context only, two points are repeated from the general Undergraduate Progression and Awards regulations. The first is that as much as 10 credits can be eligible for a Qualified Pass or a pass by compensation with marks of 35% or higher, provided the other 50 credits of module marks are 40% or higher, and there is an overall pass. Secondly, students who fail a given module can only be reassessed in failed components of the module.

B) Capping of reassessed components in the reassessment session in Fresher and Sophister years

- In reassessments, a cap (maximum mark) of 60% will apply to
  - i) all the reassessed components for core Junior Fresh and Senior Fresh Physics modules delivered as part of the Physical Sciences and Theoretical Physics courses (and available to students in the Chemical Sciences course as Open modules) which are listed above in A(i).
  - ii) all reassessed components of all modules in the Sophister years (except Trinity Electives) within the four accredited degree programmes Physics, Physics & Astrophysics, Nanoscience, and Theoretical Physics, irrespective of the owning School. Accreditation of these degree programmes is by the Institute of Physics (IoP).
- The abovementioned capping will apply to re-assessed components of the affected School of Physics (PYU code) modules irrespective of the degree stream of the student, registration or visiting student status, or year of first admission. The Sophister PYU modules are not available to any other non-accredited Sophister degree programmes.
- Re-assessment capping does not apply to deferred 1st attempts at assessment.

The capped reassessments are required of College and the School of Physics by the Institute of Physics (IoP) for continued accreditation of our degree programmes in Physics, Physics with Astrophysics, Nanoscience and Theoretical Physics. This was to ensure the continued integrity and quality of our degree programme, results and outcomes. It should be noted that uncapped resits are not the norm in other universities either in Ireland or elsewhere that have degrees accredited by the IoP, where the usual capping level of reassessed components or exams is at 40%. The reassessment capping level agreed with the IoP is a compromise between ensuring the quality of our degree recipients and degree results against the intended purpose of the uncapped resits elsewhere in College. That policy was to encourage students to achieve the intended learning outcomes in the reassessment by engaging fully with learning in order to do their best, and this is still possible as students are rewarded for doing more than the minimum required to pass.

Examples in Junior Fresh or Senior Fresh of Qualified Fails:

- Example of a qualified fail at the first attempt:
  - *Student A in their Semester 1 JF module obtains a mark of 60% in their labs, 80% in their assignments but 25% in their examination with weightings of 30%, 10% and 60% respectively. Their module mark is thus (60*0.3) + (80*0.1) + (25*0.6) = 18+8+15 = 41%. This however is a Qualified Fail as they obtained a mark <30% in their examination. They do not pass the module and must present for reassessment.*
  - *Student B in their Semester 2 JF module obtains a mark of 60% in their labs, 80% in their assignments but 20% in their examination with weightings of 30%, 10% and 60% respectively. Their module mark is thus (60*0.3) + (80*0.1) + (20*0.6) = 18+8+12 = 38%. This is a Fail mark in the module, and this mark is not eligible to be a Qualified Pass as this student obtained a mark <30% in their examination. They do not pass the module and must present for reassessment.*

    Compensation rules otherwise apply to module marks >=35% provided 50 credits of modules have achieved a pass mark and no more than 10 credits of module are equal to or above 35% and none are below 35%, provided that the annual average mark is 40% or higher.

- Example of a qualified fail at the **second attempt**:
    - *If either Student A or Student B above obtained those marks in their reassessment examination at their second attempt, i.e. obtaining a Qualified Fail or being ineligible for a Qualified Pass, they must repeat the year. Instead of a full repeat year on-books there is the possibility to apply through their Tutor to take the following year as an Off-Books student taking Assessment in this module, if they are eligible to do so.*

- Example of a capped reassessment:
    - *Student C in their Semester 2 SF module obtains a mark of 50% in their labs, 80% in their assignments but 20% in their examination with weightings of 30%, 10% and 60% respectively. Their module mark is thus (50*0.3) + (80*0.1) + (20*0.6) = 15+8+12 = 35%. This is a Fail and they are reassessed in the failed component, and not eligible for compensation or a Qualified Pass as they had a mark <30% in their examination.*
    - *In their reassessed exam, having engaged at length with the material they perform well in their examination and would obtain a mark of 80%. This exam mark component is capped at 60% while the other component marks remain as they were.*
    - *The final mark is thus calculated as: (50*0.3) + (80*0.1) + (**60***0.6) = 15+8+36 = 59% for the module.*

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 noticeboards 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. The school, department or course office, whichever is relevant, publishes its requirements for attendance at lectures and tutorials on noticeboards, and/or in handbooks and elsewhere, as appropriate.

Assessment: Procedures For the Non-Submission of Coursework and Absence from Exams

All students must fulfil the course 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.

Full regulations on non-submission of coursework can be found via the following:

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

Our policy on 'Attendance/Non-attendance Regulations for Junior and Senior Fresh Students 'can be found here:

https://www.tcd.ie/media/tcd/science/pdfs/Science-ABSENCE-NON-SATISFACTORY-regulations---TSPMC-August-2024.pdf

Guidelines on Marking for Junior and Senior Fresh Courses

Class	Mark Range	Criteria
I	90-100	**EXCEPTIONAL ANSWER:** This answer will show original thought and a sophisticated insight into the subject, and mastery of the available information on the subject. It should make compelling arguments for any case it is putting forward and show a rounded view of all sides of the argument. In exam questions important examples will be supported by attribution to relevant authors and while not necessary giving the exact date, should show an awareness of the approximate period. In essays the references will be comprehensive and accurate
	80-89	**OUTSTANDING ANSWER**: This answer will show frequent originality of thought and make new connections between pieces of evidence beyond those presented in lectures. There will be evidence of awareness of the background behind the subject area discussed, with evidence of deep understanding of more than one view on any debatable points. It will be written clearly in a style which is easy to follow. In exams authors of important example s may be provided. In essays all important examples will be referenced accurately.
	70-79	**INSIGHTFUL ANSWER:** Showing a grasp of the full relevance of all course material discussed and will include one or two examples from wider reading to extend the arguments presented. It should show some original connections of concepts. There will be only minor errors in examples given. All arguments will be entirely logical and well written. Referencing in exams will be sporadic but referencing should be presented and accurate in essays.
II-1	65-69	**VERY COMPREHENSIVE ANSWER:** Good understanding of the concepts supported by broad knowledge of the subject. Notable for synthesis of information rather than originality. Evidence of relevant reading outside lecture notes and coursework. Mostly accurate and logical with appropriate examples. Occasional lapse in detail.

	60-64	**LESS COMPRESHENSIVE ANSWER**: Mostly confined to good recall of coursework. Some synthesis of information or ideas. Accurate and logical within a limited scope. Some lapses in detail tolerated. Evidence of reading the assigned course literature.
Class	**Mark Range**	Criteria
II-2	**50-59**	**SOUND BUT INCOMPLETE ANSWER**: Based on coursework alone but suffers from significant omission, error or misunderstanding. Usually lacks synthesis of information or ideas. Mainly logical and accurate within its limited scope with lapses in detail
	50-54	**INCOMPLETE ANSWER:** Suffers from significant omissions, errors and misunderstandings, but still understanding of main concepts and showing sound knowledge. Several lapses in detail.
III	**45-49**	**WEAK ANSWER:** Limited understanding and knowledge of subject. Serious omissions, errors and misunderstandings, so the answer is no more than adequate
	40-44	**VERY WEAK ANSWER:** A poor answer, lacking substance but giving some relevant information. Information given may not be in context or well explained, but will contain passages and words, which indicate a marginally adequate understanding.
Fail	**35-39**	**MARGINAL FAIL:** Inadequate answer with no substance or understanding but with a vague knowledge relevant to the question.
	30-34	**CLEAR FAILURE:** Some attempt made to write something relevant to the question. Errors serious but not absurd. Could also be a sound answer to the misinterpretation of a question.
	0-29	**UTTER FAILURE**: With little hint of knowledge. Errors serious and absurd. Could also be a trivial response to the misinterpretation of a question.

Academic Integrity Policy

Trinity College Dublin, the University of Dublin, is committed to upholding academic integrity, and recognises that it underpins all aspects of university life, including all activities relating to research, learning, assessment, and scholarship.

Trinity therefore considers academic misconduct to be serious and academically fraudulent and an offence against academic integrity that is subject to the Trinity procedures in cases of suspected misconduct.
The Academic Integrity Policy (https://www.tcd.ie/media/tcd/about/policies/pdfs/academic/Academic-Integrity-Policy.pdf) should be read in conjunction with (and is subject to) the University Calendar, Part II on Academic Integrity (This policy replaces the Plagiarism Policy).

Other sources of information are available:
https://www.tcd.ie/calendar/undergraduate-studies/
https://libguides.tcd.ie/academic-integrity
https://www.tcd.ie/teaching-learning/academic-affairs/academic-integrity/
https://www.tcd.ie/teaching-learning/academic-affairs/academic-integrity/mandatory-academic-integrity-training/

Guidance on the use of AI and Generative-AI in College

The advent of commonly available artificial intelligence tools are disruptive in both positive and negative ways. Before using them in your studies it is important that you familiarise yourself with College policies on its use. Unless otherwise instructed for particular modules or assessments, **the default expectation would be that you do not submit AI generated content as an attempt at an assessment**.
Below is some basic overview of the College policy on AI and GenAI. This has been taken from the more detailed policy which is informative and wide ranging. You are expected to have read and familiarised yourself with this policy.
https://www.tcd.ie/academicpractice/resources/generative_ai/

Artificial Intelligence (AI)
Artificial intelligence is generally understood to be a set of technologies that enable computers to perform a variety of functions usually perceived as requiring human intelligence – for example, understanding speech, recognising objects in images, composing written answers and problem reasoning. A more formal definition of an AI system from the European Union AI Act (2024) is:
...a machine-based system designed to operate with varying levels of autonomy and that may exhibit adaptiveness after deployment and that, for explicit or implicit objectives, infers, from the input it receives, how to generate outputs such as predictions, content, recommendations, or decisions that can influence physical or virtual environments[.] (EU AI Act 2024)

Generative Artificial Intelligence (GenAI)
Generative AI is the sub-area of AI, involving AI systems which generate content — for example, human dialogue, speech, images and video. GenAI systems are capable of generating such content based on a user's request or instruction. More formally, GenAI is defined by UNESCO **as "an artificial intelligence (AI) technology that automatically generates content in response to prompts written in natural-language conversational interfaces" (UNESCO 2023).**

AI and GenAI in Trinity

As Ireland's leading university and as a world leader in AI research, Trinity recognises that AI and GenAI offer new opportunities for teaching, learning, assessment and research. We also recognise that these technologies present challenges and risks, including to academic integrity, ethics, privacy, impartiality, intellectual property and sustainability.

Acknowledging these opportunities and challenges, Trinity commits to supporting the opportunity for students and staff to become AI literate and fluent, thereby helping them to navigate and respond to the challenges and risks of AI and GenAI in order to harness the potential of (Gen)AI to enhance teaching, learning, assessment and research – and to be prepared for future challenges as these technologies evolve. We also commit to providing ongoing resources and guidance to support students and staff to use AI and GenAI in ways that are appropriate, responsible and ethical – and to ensure that academic integrity is maintained in its usage.

College aspires to develop best practice guidelines in this area. In addition to the resources and supports that College provides and recognising that appropriate uses of AI and GenAI tools vary across academic disciplines, Schools will have some flexibility to customise their own discipline-specific practices in line with this institutional statement, other institutional policies as they develop, and national and international regulation. The College goal is to enable overall consistency in the regulation of GenAI usage, while also respecting where disciplines or degree programmes require specific restrictions in GenAI usage in assessment preparation and execution. Thus, where disciplines or degree programmes wish to refine specific regulations on student use of GenAI for learning, general as well as programme-specific regulations should be communicated in the relevant discipline/degree programme handbook.

Such regulation could range from how student GenAI usage is acknowledged or cited within student assessment submissions, to prohibition of GenAI usage in the production of student assessment submissions.

Absence from College – Medical and Absence Certificates

The online SCIENCE ABSENCE FORM must be completed for all types of absences.

You can specify what type of absence once you start completing the form.

You will find the link to the form on the following page Science Absence Form

Absence from Laboratories, Continuous Assessments Tests and Non-Submission of Lab Reports (must read)

The online absence form covers the following…

1. Medical Certificates/Absence due to Illness

Where a student misses an assigned laboratory practical class through illness, they should

(a) fill in the online absence form.

(b) upload supporting documentation from a Doctor/ GP or hospital.

(c) If your absence is going to be longer than three days, you should inform your Course Organiser

2. 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).

Excuses for absence presented after the event, will not be accepted.

Please note that filling in this form is **not** a guarantee that you will be afforded any accommodations with regard to marks or assignment of an alternative lab or tutorial session. In such cases decisions on what action/accommodations will be given is purely at the discretion of the individual disciplines concerned. The Science Course Office do not have any jurisdiction in this situation.

Students who will not be in attendance for any extended duration during term time must have permission from Senior Lecturer via their tutor to be absent from College.

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).

NOTE: Please note that these regulations do not apply to absence from examinations. Students who are absent from examinations must contact their tutor as a matter of urgency and present any medical information/documentation to them.

Student Services

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

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

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

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

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

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

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

For contact information or to make an appointment please contact the Disability Services – contact details are available via the following webpage:https://www.tcd.ie/disability/contact/

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

If you wish to make an appointment with the Student Counselling Service, please consider one of the options below. If you have any other queries you can call into reception on the 3rd floor of 7-9 South Leinster Street or contact us on:
Phone: (01) 8961407
Email: student-counselling@tcd.ie

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

Useful College Websites:

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

Academic Registry
The Academic Registry is responsible for services that support the complete student lifecycle of Trinity College Dublin – from application to graduation.

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/

Student Accommodation
The Accommodation Office is open Monday to Friday from 8.30am to 1pm and 2pm-5pm each day. Queries can be emailed to residences@tcd.ie, or you can telephone 01 8961177 during office hours. After hours you can contact Front Gate at 01 8963978 in case of difficulties or key problems. In Goldsmith Hall attendants are on duty in the residential area at weekends and overnight and they will assist with local problems. In the event of a serious emergency, particularly where you require the attendance of ambulance, fire or police services please telephone College Security at 8961999 (internal 1999). To ensure a co-ordinated response please do not call these services directly. We recommend that you programme these numbers into your mobile phone using the prefix “01” before the number. https://www.tcd.ie/accommodation/

Academic Year Structure 2025-26

Key Dates:

Semester 1 teaching term begins:	Monday 15 September 2025
Study/revision week Semester 1:	Monday 27 October - 31 October 2025
Semester 1 teaching term ends:	Friday 05 December 2025
Semester one examinations:	*Monday 15 December to 19th December 2025
Semester 2 teaching term begins:	Monday 19 January 2026
Study/Revision week Semester 2	Monday 02 March to Friday 06 March 2026
Semester 2 teaching term ends:	Friday 10 April 2026
Revision week	*Monday 13 April to Friday 17 April 2026

* To be confirmed by Academic registry. All 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/ or the Science webpage: https://www.tcd.ie/courses/undergraduate/courses/physical-sciences/

Teaching Term Dates 2025-2026

Michaelmas Term Monday 15 September 2025 - Friday 05 Dec 2025			**Hilary Term Monday 19 January 2026 - Friday 10 April 2026**		
Teaching wk. 1	Week 04	15 Sept – 19 Sept	Teaching wk. 1	Week 22	19 Jan - 23 Jan
Teaching wk. 2	Week 05	22 Sept – 26 Sept	Teaching wk. 2	Week 23	15 Jan – 30 Jan
Teaching wk. 3	Week 06	29 Sept – 03 Oct	Teaching wk. 3	Week 24	02* Feb – 6 Feb
Teaching wk. 4	Week 07	06 Oct – 10 Oct	Teaching wk. 4	Week 25	09 Feb – 13 Feb
Teaching wk. 5	Week 08	13 Oct – 24 Oct	Teaching wk. 5	Week 26	16 Feb – 20 Feb
Teaching wk. 6	Week 09	20 Oct - 24 Oct	Teaching wk. 6	Week 27	12 Feb – 27 Feb
Study week	**Week 10**	**27 Oct – 31 Oct**	**Study week**	**Week 28**	**02 Mar – 06 Mar**
Teaching wk. 8	Week 11	03 Nov – 07 Nov	Teaching wk. 8	Week 29	09 Mar – 13 Mar
Teaching wk. 9	Week 12	10 Nov – 14 Nov	Teaching wk. 9	Week 30	16* Mar – 20 Mar
Teaching wk. 10	Week 13	17 Nov – 28 Nov	Teaching wk. 10	Week 31	23 Mar – 27 Mar
Teaching wk. 11	Week 14	24 Nov – 28 Nov	Teaching wk. 11	Week 32	30 Mar - 03 Apr *
Teaching wk. 12	Week 15	01 Dec – 05 Dec	Teaching wk. 12	Week 33	06* Apr – 10 Apr

October bank holiday – Monday 27th October 2025
February bank holiday – Monday 2nd February 2026
St Patrick's Day - Tuesday 17th March 2026
Good Friday – 3rd April 2026
Easter Monday – 6th April 2026

Dates are correct at time of publication, however; they are subject to change in line with College policies and procedures. All changes will be reflected on the Science Course Office webpages: www.tcd.ie/Science and on the College Calendar website: https://www.tcd.ie/calendar/academic-year-structure/academic-year-structure.pdf

TR063: Physical Sciences Contact Details

Physical Sciences Course Director

Professor Plamen Stamenov | Ph: 01 8964350
E-mail: Stamenov.Plamen@tcd.ie

Senior Fresh Physics Coordinator

Professor David McCloskey | Ph: 01 8961148
E-mail: Davic.McCloskey@tcd.ie

Administrative Officer

Ms. Una Dowling | Phone: 01 896 1675
E-mail: dowlingu@tcd.ie

Science Course Office

Professor Fraser Mitchell | Email: Fraser.Mitchell@tcd.ie

Associate Dean of Undergraduate Science Education

Ms Ann Marie Brady | E-mail: ennisa@tcd.ie

Science Course Office Manager | Ph: 01 896 2829

Ms Helen Sherwin Murray | E-mail: sherwinh@tcd.ie

Administrative Officer | PH: 018962799

Ms Romarey Segura Orea | Email: segurar@tcd.ie

Executive Officer | Ph: 01 8962022

Ms Andressa Dos Santos Melo | Email: dossanta@tcd.ie

Executive Officer | Ph: 01 8961970

Appendix 1

Item	Reference/Source
General College Regulations	Calendar, Part II, General Regulations and Information,Section II, Item 12
Emergency Procedures	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 studentshave at least one emergency contact in their phone under ICE (In Case of Emergency).
Health and Safety	Faculty of Science, Technology, Engineering and Mathematics website - https://www.tcd.ie/stem/undergraduate/health-safety.php School Handbooks will have School/Discipline information on Health and Safety.
Data Protection	https://www.tcd.ie/dataprotection/ https://www.tcd.ie/dataprotection/assets/docs/dataprotectionhandbook/DP_Handbook_15042021.pdf
Academic Integrity	https://www.tcd.ie/teaching-learning/academic-integrity/
Research Ethics	https://www.tcd.ie/research/support/ethics-integrity.php
Blackboard	Blackboard
Explanation of Weightings	https://www.tcd.ie/teaching-learning/ug-egulations/Academic_credit_system.php
Assessment and Progression Regulations	https://www.tcd.ie/media/tcd/about/policies/pdfs/academic/assess-acad-prog-nov2021.pdf https://www.tcd.ie/teaching-learning/academic-affairs/ug-prog-award-regs/ Calendar, Part II, General Regulations and Information,Section II, Item 35
Academic Awards	https://www.tcd.ie/teaching-learning/academic-policies/assets/academic-awards-jan2021.pdf
Equality, Diversity and Inclusion	https://www.tcd.ie/equality/
Prizes, medals, and other scholarships	https://www.tcd.ie/calendar/undergraduate-studies/prizes-and-other-awards.pdf

Item	Reference/Source
Teaching and Learning Study Abroad	https://www.tcd.ie/study/study-abroad/
Marking Scales	Calendar, Part II, General Regulations & Information,Section II, Item 30 Please consult Schools or Disciplines directly or programme handbooks for further information.
Framework of qualifications Trinity Pathways	https://www.qqi.ie/national-framework-of-qualifications Trinity PathwaysTrinity Courses
Capstone (UG Programmes)	https://www.tcd.ie/teaching-learning/ug-regulations/Capstone.php
Careers Information	https://www.tcd.ie/Science/careers/ For further information refer to School/Discipline Handbooks.
Careers Advisory Service	https://www.tcd.ie/Careers/
Attendance Requirements	Calendar, Part II, General Regulations and Information,Section II, Items 17-23 Calendar, Part III, General Regulations and Information,Section I 'Attendance and Off-Books'; Section II 'Attendance'; Section III 'Attendance, Registration, Extensions'; Section IV
Student Cases	https://www.tcd.ie/academicregistry/student-cases/
Student complaints procedures	https://www.tcd.ie/media/tcd/about/policies/pdfs/Student-Complaints-Procedure-21.07.22.pdf
General Examination Guidelines	Exam Guidelines - Academic Registry - Trinity College Dublin
Feedback and Evaluation	Student Evaluation andFeedback Procedure for the conduct ofFocus Groups
Academic Policies and Procedures	https://www.tcd.ie/teaching-learning/academic-policies/
Registration	https://www.tcd.ie/academicregistry/student-registration/
Student supports	https://www.tcd.ie/students/
STEM Schools and Disciplines	https://www.tcd.ie/structure/faculties-and-schools/#d.en.2024679
GradIreland Career advice, graduate jobs and internships	https://gradireland.com/

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

Science Course Office

Faculty of Science, Technology, Engineering and Mathematics (STEM), Trinity College Dublin 2, Ireland.

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

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

tcd.ie/science