



**University College Dublin
National University of Ireland, Dublin**

Science

Session 2003/2004

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***Scholarships and Prizes Awarded
in the Faculty of Science***

Scholarships

Entrance Scholarships – Based on Leaving Certificate

The University offers a number of entrance scholarships, valued at €1,270 for one year, on the basis of points achieved at the Leaving Certificate examination. All new entrants to Science who achieve a CAO points total on or above 550 points, will be guaranteed a scholarship. In addition, all Entrance Scholars will be given priority in the application for places in student residences on the Belfield Campus.

Scholarships on the Results of the First University Examination in Science

One scholarship, of value €635, may be awarded in each of the subjects: Biology, Chemistry, Computer Science, Experimental Physics and Geology. One scholarship will be awarded jointly with results in the Faculty of Arts in Honours Mathematics and in Mathematical Physics. These scholarships are awarded to students gaining first place in their class and obtaining a First Class Honours mark.

Scholarships on the Results of the Second University Examination in Science

One scholarship, of value €635, may be awarded in each subject of the Second University Examination in Science which leads to an Honours Degree. These scholarships are awarded to students gaining first place in their class and obtaining a First Class Honours mark.

Scholarships on the Results of the Third University Examination (Honours and Topical) in Science

A scholarship, of value €635, will be offered on the marks obtained at the Third University Examination in Science in the major subject or in a Topical Degree course. These scholarships are awarded to students gaining first place in their class and obtaining a First Class Honours mark.

Scholarship on the Results of the Third University Examination (Honours) in Science in the Joint Honours Degree Courses

One scholarship, of value €635, will be awarded. These scholarships are awarded to students gaining first place in their class and obtaining a First Class Honours mark.

Open Scholarship in Science

One second year or one third year or one fourth year scholarship, of value €635, may be awarded in special circumstances to a student of Science who is ineligible for a normal award.

IRCSET Postgraduate Scholarships Award

This scheme will offer opportunities for suitably qualified students to pursue a postgraduate degree by research supported by a scholarship awarded by the Irish Research Council for Science, Engineering and Technology. The scholarship award will be up to €9,050 per annum.

Research Demonstratorships

Up to one hundred and fifty Research Demonstratorships may be awarded to students registered for postgraduate degree programmes in the Faculty of Science.

Open Postgraduate Scholarships

The scholarships are awarded on the basis of academic merit and are available equally to graduates of University College Dublin and other universities. They are tenable for one year of full-time postgraduate study at University College Dublin. Application forms are available from the Office of Postgraduate Studies, University College Dublin, Library Building, Belfield, Dublin 4.

Prizes	
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Biochemistry	– Alltech Travel Award
	– Joy Carey Prize
	– Michael G. Harrington Medal
Chemistry	– Eva Philbin Medal
	– Hugh Ryan Memorial Medal
Computer Science	– John Kelly Memorial Medal
Experimental Physics	– Thomas E. Nevin Medal and Prize
Geology	– Patrick J. O'Donoghue Prize
Mathematical Physics	– Conway Medal
	– Keating Prize
	– McCrea Medal
	– Orr Prize
	– Fr Ciaran Ryan Prize
Pharmacology	– ICI Pharmaceuticals Division Prize

All details on Scholarships and Prizes are available in the Student Awards Booklet, available from the Fees and Grants Office.

Academic Advisory Meetings

First Science Students: Wednesday, 10 September 2003 – 2.45 p.m., Theatre A.

First Science students must attend this meeting. The advisory meeting commences with a talk from the Dean in Theatre A, Science Lecture Building. Representatives of the Science Departments will be available on the Science Lecture Building concourse during the afternoon for consultation on the course options in Science. While First Science students register before the start of the academic year, they are not required to finalise their subject choices until the end of the first week of term. Students register their subject choices on-line during the week of 15-19 September 2003, and must also register their subject choices (signed by their Mentor) with the Faculty of Science Office.

Pre-Second Science: Wednesday, 18 February 2004 – 2.00 p.m., Theatre A.

Additional information may be available from some departments around this time.

Third Science Students: Friday, 12 September 2003 – 2.30 p.m., Theatre A.

Compulsory meeting. The advisory meeting commences with a talk from the Dean in Theatre A, Science Lecture Building. Academic staff will be available on the Science Lecture Building concourse during the afternoon for consultation on the selection of course units. Students must complete and have staff sign their Course Registration Forms. Registration is completed when these forms have been handed into the Science Faculty Office on Tuesday, 16 September 2003.

Dates for Academic Session 2003/2004

Michaelmas Term (First Semester): 15 September 2003 – 6 December 2003

Hilary/Trinity Terms (Second Semester): 5 January 2004 – 31 March 2004
23 March 2004 – 17 April 2004

Degree Programmes in Science and Career Opportunities

Applied and Computational Mathematics

This is a new degree in Science that follows the rules of the Topical Degree programme. It can be taken at the Honours or Pass level. The student will take courses in Mathematics, Mathematical Physics and Statistics. The emphasis is on applicable mathematics and the mathematical modelling of real-world problems. The objective of the degree is to produce graduates who will be able to use mathematical tools to analyse and solve real-world problems in a wide range of contexts.

What sort of careers do Applied and Computational Mathematics graduates have?

Career directions for graduates include the following areas: software design, mathematical and statistical modelling, the financial sector, meteorology, agricultural, veterinary, medical and pharmaceutical research, the power industry (oil, electricity etc.), environmental services.

Biochemistry

This is a Second Science Subject leading to an Honours Degree Programme.

Biochemistry is often defined as the Chemistry of Life because it aims to explore and understand every aspect of the structure and function of all living things at the molecular level.

Biochemists study all kinds of plants, animals and microorganisms. They work with whole organisms, with isolated cells, with extracts of the cells and with purified components of cells. Any aspect of living tissue that can be studied in terms of chemical and physical principles is a subject for biochemical investigation. For example: biotechnology, extraction of energy from foods, photosynthesis, genetics and molecular biology, growth and reproduction, diseases such as cancer and AIDS.

What sort of careers do Biochemistry graduates have?

Graduates of the Department of Biochemistry have found jobs in biochemical, chemical, pharmaceutical, food and biotechnology industries; research institutes throughout the world, including UCD and other third level institutions; second level education; clinical laboratories; forensic science.

Biochemistry graduates have also made careers in diverse areas including management, marketing, accountancy, journalism and other aspects of the media, patenting, the diplomatic service and consultancy.

Biology

This introductory Biology Course is organized and run by the Departments of Botany, Industrial Microbiology and Zoology. Students wishing to pursue biological courses should choose any combination including Biology in First Science.

Botany

This is a Second Science Subject leading to an Honours Degree Programme.

Botany is the study of plants and fungi. Plants and fungi provide food, medicines, timber, paper, raw materials, and a healthy environment.

Botany embraces the complete range of plant sciences, including plant biochemistry, genetic engineering, vegetation science, mycology, taxonomy, biotechnology, photosynthesis, nutrition, cell and tissue culture for production of drugs, ecology, biodiversity, and remediation of polluted environments.

Botany is a diverse subject, encompassing all aspects of life. Botany students are interested in fundamental and practical aspects of everything from genes, biochemistry, molecular biology and development to reproduction, whole organism growth, physiology and ecology.

What sort of careers do Botany graduates have?

Botany graduates pursue careers as environmental consultants, pollution biologists, plant molecular geneticists, cell biologists, wildlife officers, national parks supervisors, conservation biologists, University lecturers, research scientists and quality control scientists in the food industry.

UCD Botany graduates are employed in all walks of life, not just for their excellence in plant sciences, but because they have also acquired skills of critical thinking, effective communication, and the use of modern information technology.

Cell and Molecular Biology

This is a Topical Degree Programme, which means that the entry requirements at Third Science are different from those of the single subject Honours Degrees in Biological Sciences. Students who pass Second Science, with at least two biological subjects, are eligible to enter. In practice, competition for places means that students who reach a qualifying standard of 55% in one or more subjects are more likely to receive a place.

At the end of Third Year, all students must pass the examinations with an average of at least 55% across six of the eight core units to proceed to Fourth Year Honours. Those who pass Third Science, but fail to reach 55% will graduate with a General BSc Degree.

This Degree Programme depends on the teaching staff of many departments, all of whom have a strong interest in Cell and Molecular Biology. This subject has grown very rapidly over the past ten years.

What sort of careers do Cell and Molecular Biology graduates have?

There are good career prospects for cell biologists in universities, industry and healthcare institutions.

Chemistry

All materials and living things consist of atoms and molecules that are linked together in many different ways. Chemistry is a study of these atoms and molecules and how they interact with each other and the role they play in living things. In fact, Chemistry is everywhere!

Many students choose to specialise in Chemistry, as a detailed knowledge of the subject is essential for entry to many interesting and challenging careers. For instance, chemists are creative and can discover new substances, which can have a range of applications such as medicines (e.g. aspirin, penicillin) that fight disease or as materials (e.g. PVC, Teflon) which are very important in everyday life.

What sort of careers do Chemistry graduates have?

There are many opportunities for Chemistry graduates in industry. Chemists in industry are involved in the production and analysis of chemicals. Those in research work on the discovery of new medicines, new devices and materials and on advancing our knowledge of the world and development chemists can work with engineers and business people to turn discoveries into commercially valuable products. Chemists also have roles to play in environmental protection.

There are also teaching opportunities for chemists in second and third level education. Government Agencies such as the Civil Service, research institutes and semi-state bodies all offer employment to Chemistry graduates. In addition, some graduates have gone on to become accountants, or work in banking or marketing.

So, pursuing a career in Chemistry can lead to a significant variety of challenging careers and good opportunities in the future!

Computer Science

Computer Science is the investigation and exploration of the theory, practice and use of computers and computation. It covers topics that span the theory of computation, software construction, hardware design, computer operating systems and the applications of computers in the communications, scientific and commercial systems fields. Staff and graduates have been successful in establishing several international high-tech companies.

What sort of careers do Computer Science graduates have?

Among the career opportunities available for Computer Science graduates are: Computer Systems Analysts, Programmers, Web designers and developers, Digital circuit designers, Computer communication engineers, Computing for financial markets, Computer control systems for mission critical applications e.g. Aircraft navigation, Robotics, Neural science research or Designing new Computer Languages.

**Computer Science (SCBDF0015)
(denominated entry course)**

Students follow a different course to the DN008 Computer Science Course.

The BSc (Computer Science) allows students to study Computer Science, as a Science degree, with a significant emphasis on Computer Science per se. It is for students who specifically want to study Computer Science. It educates students to be software developers covering the core Computer Science subjects from hardware through to advanced software systems, along with a wide variety of advanced topics (e.g., intelligent internet systems, parallel computing).

The BSc (Hons) Computer Science program is designed to give students maximal exposure to topics within Computer Science. From the first year, BSc CS students are exposed to both applied and theoretical material. The first two years lay down a basic foundation, and in third and fourth years, students can choose many of their courses from a broad range.

This degree differs from that taken by general Science students, in that first and second year students do more Computer Science (see below) and less of other Science subjects. It is therefore most suitable for those who know or suspect in advance that Computer Science is a discipline which suits them.

Environmental Biology

Environmental Biology is the scientific study of the interactions between organisms and their natural and man-made environments. The disciplines of animal ecology, conservation biology, ecophysiology, ecotoxicology, microbial ecology, plant ecology, pollution biology, vegetation science and wildlife ecology all contribute to the understanding of environmental biology. Knowledge of environmental biology is central to man's ability to understand and manage the world's environmental problems.

What sort of careers do Environmental Biology graduates have?

Environmental biologists pursue a variety of scientific careers, such as aquaculture and fisheries managers; environmental consultants; habitat ecologists (peatland, wetland, grassland, aquatic, etc.); national park supervisors; pollution biologists; rare species conservation officers; technical and scientific officers; university professors; wildlife officers; conservation biologists and administrators.

UCD Environmental Biology graduates are also employed in non-scientific occupations, in business, management and administration, where their scientific, numeric and analytical skills are highly valued.

Environmental Geochemistry

Environmental Geochemistry is the study of how natural and man-made pollutants migrate and interact with each other and with near-surface geological materials (e.g. soils, rocks, glacial deposits, groundwater and surface waters). Many Environmental Science degrees emphasise biological interactions, whereas this topical degree programme focuses on the geological and chemical factors that influence the movement, effects and ultimate fate of pollutants. The programme also deals with whole-Earth issues that have a strong geochemical dimension including problems such as global warming, ozone depletion and sea-level rise. Geochemistry is central to modern Earth Sciences and is able to provide quantitative answers to fundamental questions. These include the age of planet Earth and its place in the solar system, its chemical evolution through time, the consequences of catastrophic events (e.g. volcanic eruptions, meteorite impacts), the nature and timing of natural climate change, the changing composition of the atmosphere and consequences for the habitability of the planet in the future.

What sort of careers do Environmental Geochemistry graduates have?

Environmental Geochemistry graduates are employed by environmental consultancy firms, government environmental protection agencies, mineral exploration companies and by universities and research institutes.

Experimental Physics

Physics is concerned with the fundamental laws that govern the construction and functioning of the Universe and is a key field within Science and Technology. It lies at the heart of Science, Engineering and much of our everyday lives. The laws of Physics govern living as well as non-living organisms. These laws help to explain the origin of the universe and behaviour of the smallest parts of matter. Electrical and nuclear power, the laser, the transistor, magnetic resonance imaging, the microchip, superconductivity, all derive from the insights of Physics. Physics is a basic Science involving the mathematical description of nature; it also serves as a foundation in the study of other Sciences, as well as in Engineering, Architecture, Agriculture, Medicine and Veterinary Medicine.

What sort of careers do Experimental Physics graduates have?

Our recent physics graduates have pursued careers in diverse areas. They include industry (electronics, computers, telecommunications), hospitals (medical imaging, nuclear medicine, radiotherapy), government and semi-state services, national laboratories, banking, insurance, and academic research. Second level physics teachers are always in demand.

Related fields employing physicists include geophysics, chemical physics, biophysics, computer science and materials science.

Genetics

Students select combinations (a), (d) or (g) in First Science.

This programme is designed as both a joint Honours programme (Molecular Genetics and a Biological Subject) and a Topical Degree programme (Cell and Molecular Biology and Plant Genetic Engineering) following the completion of Second Science and leading to the award of an honours degree.

Molecular genetics and molecular biology are core components of modern biology, medicine and biotechnology. Research in areas such as the genetic manipulation of agricultural plants and cloning of animals impacts on society at large. The genetics course covers exciting new developments such as genetic engineering, transgenic

animals containing genetic material transferred from another species), genetically modified plants, medical genetics, gene therapy, prions, developmental biology and informatics.

What sort of careers do Genetics graduates have?

Many genetics graduates go on to study for a higher degree (MSc/PhD) and work in all sorts of areas, such as university and industrial research laboratories. Other graduates obtain jobs in agribiotech and other biotechnology companies, in the pharmaceutical sector, and in hospital diagnostic laboratories.

One new area of employment is in Bioinformatics – the junction between molecular genetics and information technology. Bioinformaticists use computer technology to analyse molecular data, and are employed by companies to aid in drug design and to study the inheritance of disease.

Finally, many students cross over from genetics to areas such as accountancy, business, management and law.

Geology

Geology is the study of planet Earth and planetary systems. It is concerned with the nature and origin of materials that make up the Earth and planets and the processes that are or have been active on the surface and also at depths beneath the surface. Without Geology and geologists we would not have the raw materials from which to build our roads and factories, our cars and computers, or the fuel that supplies most of our energy.

Geology also seeks to answer fundamental questions regarding the structure and age of the Earth, how it has evolved, its processes and the history of life. The study of the Earth is exciting, interesting and stimulating in itself, and the more we know about our planet and how it works, the better equipped we are to manage it soundly. Studying Geology will open your eyes to the planet on which we live, and will make you more aware of the natural environment around you.

What sort of careers do Geology graduates have?

Graduates with degrees in Geology and related subjects (Geophysical Science and Environmental Geochemistry) have found interesting and rewarding employment in organisations ranging from government agencies to petroleum and mining exploration companies in Ireland and abroad. Graduates work as Geological Surveyors, Exploration Geologists in the petroleum and mining industries, Mine Geologists, Hydrogeologists, University lecturers and researchers, Oceanographers,

Geochemists, Environmental consultants, Engineering Geologists, Palaeontologists, and Structural Geologists. Some of our graduates run their own Geological and Environmental consultancy firms. A BSc degree in Geology is also an excellent basis from which to undertake more specialised MSc training programmes in fields such as Engineering Geology, Hydrogeology, Remote Sensing (satellite image interpretation), Petroleum/Mineral Exploration and Environmental Science. In addition, a degree in Geology or a related area also provides valuable training for many non-geological careers.

Geophysical Science

Students select combinations: (c), (e), (i), or (n) in First Science.

This programme is designed as a Topical Degree programme following the completion of Second Science and leading to the award of an honours degree.

Geophysicists apply principles from physics to study the Earth and Earth processes, for example earthquakes and volcanoes, by measurements of physical properties. They can also build up 'pictures' of the Earth's internal structure by looking at earthquake waves, gravity effects, magnetic effects and electrical changes, allowing us to discover which processes are operating within the Earth. This is leading to a better understanding of how the Earth works, including topics such as plate tectonics and earthquake forecasting.

We can also use some of these methods to assist in our search for oil, gas and minerals and in the evaluation of our environment, particularly in relation to waste disposal.

What sort of careers do Geophysical Science graduates have?

This course is currently filling a niche in the jobs market, since there is a greater demand for Geophysicists than there are qualified graduates available. The employment record for graduates from this course is excellent. Career options are in the petroleum, minerals, ground water, site investigation and environmental monitoring industries, in addition to postgraduate research.

Industrial Microbiology

Microbiology is the study of microorganisms e.g. bacteria, fungi and viruses and Industrial Microbiology is one of the most exciting developments in science and industry. It is a corner stone of the biological sciences, in particular of modern biotechnology. Microorganisms and microbial enzymes can be used in new industrial

processes to carry out reactions that are not economically feasible by chemical means. Industrial Microbiology offers the possibility of major improvements in the way medicines are developed and manufactured, it may help to find ways to produce food for livestock and people and help exploit new energy sources. It will provide new specialised industrial enzymes and a range of pharmaceutical and other products. Currently bacteria are being engineered to produce novel therapeutic proteins and antibodies and microorganisms are used extensively in recombinant DNA technology and molecular biotechnology.

What sort of careers do Industrial Microbiology graduates have?

In Ireland, Industrial Microbiologists are employed principally in the healthcare/ pharmaceutical, fine chemical, brewing and distilling, food and food related industries etc. where they are involved in research and development, in process design and control, in management and in quality control. Graduates in Industrial Microbiology also work in research in universities and research institutes, in teaching at second and third level, in hospitals and public health laboratories and in many other areas of the public and private sectors.

Mathematical Physics

Mathematical Physics combines the areas of Applied Mathematics and Theoretical Physics. Applied Mathematics involves the mathematical modelling and solution of real-world scientific problems. Theoretical Physics aims to provide a unified description of the fundamental laws of nature through Mathematics. These laws govern the behaviour of all physical objects in the universe.

What sort of careers do Mathematical Physics graduates have?

Because both areas of Mathematical Physics provide a good training in Mathematical Modelling, our graduates are well prepared to find employment in a diverse range of professions both in Ireland and abroad. There is always a high demand for graduates and postgraduates with skills in Mathematical Modelling. Those of our students who have not become professional Applied Mathematicians or Theoretical Physicists have pursued careers in a wide variety of professions, for example in the Financial and Banking Sector, in Software Design and in Meteorology.

Mathematical Science

The four-year Degree in Mathematical Science was set up in response to the growing demands from Industry, Commerce, Science and Technology for professional Mathematicians. In an increasing number of these areas, Mathematics is the only effective language for the analysis of problems and communication of results and ideas. This is recognition that Mathematics is now essential in many areas and plays a critical role.

What sort of careers do Mathematical Science graduates have?

The Financial and Banking Sector; Software Design; Meteorology; Pharmaceutical Research; Government Statistics; Agricultural and Veterinary Research; Health Care; Mathematical and Statistical Modelling in for example the Oil Industry, Electricity Supply and Environmental Services.

At present there is a high demand for Mathematical Science graduates and postgraduates

Mathematics

Mathematics has been solving problems since people first learnt how to count and measure. Since then, mathematics has grown steadily in content, playing a key role in the quest to fully describe and understand the natural world. Today mathematics is a basic tool in all scientific subjects, economics, engineering, geography, computer science, banking business, statistics, social science, and in many other fields.

“Applicable Mathematics” is used by scientists to solve the mathematical problems presented by their subjects, while “pure Mathematics” involves the study of mathematical problems independent of their applications. These two types of Mathematics are not independent of each other but are complementary. Many of the “pure Mathematics” results of the past have become the “applicable” techniques of the present.

What sort of careers do Mathematics graduates have?

Having Mathematics as a subject in your degree, or even just as a first year subject, can greatly increase your career prospects and is a prerequisite for graduate studies in a variety of disciplines. Each year sees new applications of sophisticated mathematical models and procedures, using computers, in insurance and actuarial services, the stock market, banking, industry, etc. Employers in all of these areas seek mathematics graduates.

The precision of Mathematics is highly prized in a range of professions, as indeed are the proven problem-solving skills of any Mathematics graduate. Our recent graduates have found work in diverse areas including: actuarial science, banking and financial services, civil service executive and administrative grades, coding and cryptography, the computer industry, management consultancy, market surveying, mathematical modelling, meteorology, operations research, statistics, teaching and television.

Occupational Safety and Health

Students must take Combination (a) in First Science.

This course is available as a Third Science Single Subject General option and builds on knowledge gained in First and Second Science. It focuses on scientific and legal principles related to Health and Safety in the workplace. It is part of a co-ordinated multidisciplinary training programme aimed at meeting the academic competency requirements of the Safety, Health and Welfare legislation. In addition to project work, and individual work placements, the course includes the following units of study:

Safety & Health Legislation	Human & Organisational Behaviour at Work
Health and Safety Management	Statistics in Health and Safety
Occupational Health	Projects
Occupational Hygiene	Industrial Placements
Chemical Safety & Toxicology	
Safety Technology	

What sort of careers do Occupational Safety and Health (OSH) Professionals have?

Because Occupational Safety and Health is concerned with the safety and health of people at work everywhere, OSH professionals come from and work in a wide range of disciplines and there are a number of specialist areas in the field. Under OSH legislation every employer must safeguard the safety, health and welfare of employees. This means that graduates may find opportunities in any sector or area of industry, in small or large companies, in Irish or multinational organisations, in the public or private sector. The course has a multidisciplinary approach and potential positions for graduates include Health and Safety Officer, Health and Safety Manager, or Health and Safety Advisor.

Pharmacology

Pharmacology is one of the main disciplines underpinning Biomedical Science and the pharmaceutical industry, which is one of Ireland's largest manufacturing sectors. There are many disciplines within the Biomedical sciences and Pharmacology specifically focuses on the study of drug action.

Pharmacology is the study of the nature, actions and uses of drugs. A drug is any substance that is given to humans or animals with the intention of changing the state of body functioning: to relieve pain, treat cancer, eliminate infection or improve health in any way or to investigate the functions of the body. The work of the science-based pharmacologist is concerned mainly with drug action.

Toxicology is an important component of the Pharmacology discipline. Toxicology is the study of the harmful effects of chemicals on living organisms. Toxic substances include certain drugs, pesticides, heavy metals, plant and microbial toxins and many organic chemicals. Such substances may have an adverse effect on the health of humans and other species.

What sort of careers do Pharmacology graduates have?

Research opportunities are available for Pharmacology graduates in research institutes, universities, and in the pharmaceutical industry. There are opportunities for postgraduate work in the Department of Pharmacology in UCD and there are currently 66 postgraduate students pursuing research projects in the Department or in associated laboratories. Careers in management, research and product developments are available for graduates in the Pharmaceutical Industry. Pharmacology graduates may also pursue careers in teaching in secondary schools, institutes of technology and universities; in regulatory agencies, e.g. drug information/registration and in publishing in science journalism.

Physiology

Physiology is an important life science that asks and answers questions about the way that cells, tissues and organs work in people, animals and plants. At UCD, Physiology concentrates on mammalian systems with a special emphasis on how the systems that make up the human body carry out their normal functions. For example, Physiologists are concerned with the functions and workings of the brain, heart and lungs. They also consider how body processes respond to changes in the environment such as temperature, altitude or motion. As well as being a branch of Science in its own right Physiology is an Applied Science in the field of medicine and fields allied to medicine such as Physiotherapy, Radiography or Sports Studies.

What sort of careers do Physiology graduates have?

Physiologists have the opportunity to follow many different career paths. Like other science graduates, physiologists gain experience in the generation, analysis and presentation of scientific information. These skills are transferable to most career paths. Options available to those wishing to remain in the field of physiology include: research (in universities and Civil Service); pharmaceutical industry (laboratory research, clinical trials, marketing); clinical scientists in the health service; publishing/science journalism; food science industry; teaching (secondary or tertiary level) and sports science.

Plant Genetic Engineering

Prerequisite Combination: (a), (d) or (g) in First Science.

This Topical Degree course is offered by the Botany Department, in conjunction with other Departments in the Faculty of Science and with other Faculties within the University. The aim of the course is not just to study the techniques of Plant Genetic Engineering but in addition to place these techniques within the broader context of Plant Science and Food Safety. As with other Topical Degree Programmes, entry into the course is at Third Year. Entry is restricted to students who at Second Year have taken Botany and Biochemistry. At Third Year students take courses in various aspects of Plant Molecular Biology, Genetics and Plant Ecology. These courses lead to the General B.Sc. Degree at the end of Third Year. Admission to Fourth Year Honours in Plant Genetic Engineering is dependent on a good performance in the Third Year. Fourth year students take specialist courses on a range of topics including Plant Food Safety, Genetically Modified Organisms in the Environment, Plant Developmental Biology, Applied Molecular Biology and Plant Breeding. In addition, the Fourth Year course includes a research project working with postgraduate students and scientists.

What sort of careers do Plant Genetic Engineering graduates have?

There is an increasing demand for graduates with a grasp of not only the molecular aspects of plant genetic engineering but for scientists who can understand the biological context of genetic engineering. In addition to further postgraduate studies graduates from this course are ideally positioned for careers that demand a knowledge of plant genetic engineering, such as regulatory authorities, food safety laboratories, plant biotechnology companies and agencies monitoring the release of GMOs.

Psychology

Only available as a degree programme in Science until September 2003

Psychology is the systematic study of mental life, behaviour and relationships. It asks how we develop over our lifetime and how we differ from one another. It studies how we see, hear, reason and remember. It investigates how we behave in groups such as families or work teams. It studies how the brain and nervous system subserve psychological functioning and how this functioning may be affected by injury to the brain or by the use of drugs.

Psychology is a diverse subject and people study it for many reasons. Some wish to use psychological knowledge to train and help people. Others have a primarily theoretical interest and are curious to know how children acquire mathematical concepts or how brain injury may affect speech. Others again are interested in the psychology of how people behave in groups, or in how cultures shape the psychology of individuals.

An undergraduate course in Psychology seeks to impart basic knowledge and theory. To practise as a psychologist in the health services, in work organisations or in a university requires the completion of a postgraduate degree. This will involve between two and six years' further study or supervised experience.

What sort of careers do Psychology graduates have?

The diversity of psychology is reflected in the kind of work that psychologists do. Clinical psychologists deal with psychological problems in hospitals or in private practice. Educational psychologists deal with the various aspects of teaching and learning in schools. Occupational psychologists deal with human performance in the workplace. A small number of psychologists work in areas like forensic psychology or sports psychology. There are also many psychologists who teach and research in universities and colleges.

Statistics

Statistics is the Science that deals with the collection, analysis and interpretation of numerical data and more than ever before, is a part of our everyday lives. It is an important tool used by researchers in actuarial science, agriculture, biotechnology, computer science, ecology, economics, marketing, mathematics, medicine, psychology, social science, veterinary medicine and many other disciplines. Statisticians also develop mathematical models for uncertainty, and investigate their properties and applicability. The power of modern computing has had a major impact on both the development and usefulness of statistical methods.

What sort of careers do Statistics graduates have?

Statisticians find job opportunities in many diverse areas of society. The Central Statistics Office is an obvious source of a career, but other Government Departments like the Departments of Health, Education and Environment, and government agencies like Bord Fáilte, Teagasc and the Meteorological Service also make good use of statisticians. Pharmaceutical companies employ many statisticians, and the whole area of industrial quality control provides many opportunities for those qualified in statistics. Statisticians are also needed for research in marketing, medicine, agriculture and veterinary medicine. Insurance companies often hire statistics graduates, and in particular a lot of the training of an actuary is based on statistical methodology. There are opportunities for postgraduate study and research projects in the Department of Statistics in UCD.

Theoretical Physics

The aim of Theoretical Physics is to provide a unified description of the fundamental laws of nature. These laws govern the behaviour of all physical objects in the universe. This course provides an introduction to all the major areas of Theoretical Physics, including: Relativity Theory, Quantum Mechanics, Atomic Physics, Nuclear Physics and Computational Physics. Advanced topics are covered in the final two years. These include General Relativity, Electromagnetic Theory, Quantum Gravity, Quantum Field Theory, Statistical Mechanics, Theoretical Astrophysics, Fluid Mechanics High Energy Physics, Condensed Matter Physics. In addition the relevant expertise of Theoretical Physics, the course provides an excellent training in problem-solving and computing skills that can be applied in a wide variety of careers in industry, business, government, and university.

What sort of careers do Theoretical Physics graduates have?

Research opportunities are available to Theoretical Physics graduates in UCD and in other universities. Theoretical Physics graduates may also pursue careers in meteorology, software development, stock-market analysis, environmental analysis, internet/network consultancy, financial risk analysis as well as careers in teaching in secondary schools, institutes of technology and universities.

Zoology

Zoology is the study of animals, from the level of individual molecules to how populations of animals interact with their environment. Classically, Zoology is thought of in the context of David Attenborough and treks into the wild to study rare and endangered species. However, modern Zoology is much more, dealing with all

aspects of animals from genetics and cell biology to ecology and animal behaviour. The Department of Zoology in UCD prides itself on maintaining a diverse curriculum allowing students to choose from a wide range of disciplines, including marine and fresh water biology, immunology, ecology, population genetics, developmental biology and zoonotic and other diseases. The policy of a broad curriculum extends into the department's research activities where post-graduates undertake research that crosses many traditional disciplines. The central goal of research is to gain a greater understanding of how animals develop and interact with their environment both as individuals and as populations.

What sort of careers Zoology graduates have?

Zoology equips students for careers in education, industry (especially with companies developing pharmaceutical or food products), research, fisheries, agriculture and aquaculture, and increasingly, in conservation and environmental management. Employers in Ireland include Government Departments e.g. Education, Wildlife service, Office of Public Works, Department of Fisheries, Health Service, Forensic Laboratories, Eolas, National Museum, Semi-state bodies such as ESB, BIM and the Salmon Research Trust; Private companies and conservation bodies, and a wide range of medical, veterinary, and health related research-based companies.

Undergraduate Programmes

The following undergraduate degree programmes are offered in the Faculty of Science:

Four-Year Degrees:

Bachelor of Science Honours in Computer Science	(DN030)
Bachelor of Science Honours in Mathematical Science	(DN032)
Bachelor of Science Honours in Theoretical Physics	(DN031)
Bachelor of Science Omnibus Entry	(DN008)

The Bachelor of Science Omnibus Entry may be offered either as a four year single honours, joint honours, or honours topical degree, or as a three year one subject or two subject general, or general topical degree as follows:

Four year BSc Single Honours offered in the following subjects:

Biochemistry	Mathematics
Botany	Mathematical Physics
Chemistry	Pharmacology
Computer Science	Physiology
Experimental Physics	Psychology*
Geology	Statistics
Industrial Microbiology	Zoology

Four Year BSc Joint Honours offered as follows:

- **Genetics and a Biological Subject**
Genetics and one of the following biological subjects: Biochemistry, Botany, Industrial Microbiology, Pharmacology, Zoology.
- **Any Two Subjects in the Science Programme**
Joint Honours Degrees may be taken in any two subjects offered in the Faculty of Science, provided the student has qualified to proceed to the Honours course in both subjects and has the approval of the two Departments concerned.

* Not available from 2003/2004 academic year.

BSc Topical Degree Programmes

The BSc Topical Degree may be defined as a degree programme encompassing more than one subject area. Students need to qualify for the honours degree at the end of Third Science.

Applied and Computational Mathematics	Geophysical Science
Cell and Molecular Biology	Environmental Geochemistry
Environmental Biology	Plant Genetic Engineering

Three-Year Degrees:

Bachelor of Science (BSc) – One Subject General or Two Subject General offered in either one or two of the following subjects:

Biochemistry	Mathematics
Botany	Mathematical Physics
Chemistry	Occupational Safety and Health*
Computer Science	Pharmacology
Experimental Physic	Physiology
Geology	Statistics
Industrial Microbiology	Zoology

Part-Time Degree:

Bachelor of Science (BSc) in Occupational Safety and Health Management.

Applicants to this part-time BSc degree course must have completed and achieved a high standard in the NUI Diploma in Safety, Health and Welfare at Work or equivalent.

*** Bachelor of Science (BSc) in Occupational Safety and Health**

Available as a Third Science option following the successful completion of the previous years. Students wishing to follow this degree course must take Combination A in First Science.

Examination Regulations for Undergraduate Science Students

Regulations governing all examinations are contained in Marks and Standards. Students should consult this publication, copies of which are available in the Library or at <http://www.ucd.ie/~exams>.

Course Regulations for Undergraduate Science Students

Students should be aware that syllabus changes may be initiated at any time during their course of study at University College Dublin.

Students entering the Faculty of Science are notified that entry to subjects in all years is dependent on the availability of places. Where more students indicate preferences than there are places, allocation will be made by Faculty on the basis of academic performance.

First Science
(SCBDF0001)

Regulations for First Year Science Students

1. Selection of Courses

Students entering First Science must select **four** First Science subjects from among **Biology, Chemistry, Computer Science, Experimental Physics, Geology, Mathematics** and **Mathematical Physics**. They must attend for one academic year and present themselves for examination. The following combinations of First Science subjects are available:

First Science Subject Combinations

First Science Subjects							
(a)*	Biol	Chem		ExpPhys		Maths	
(b)		Chem		ExpPhys		Maths	MathPhys
(c)		Chem		ExpPhys	Geology	Maths	
(d)	Biol	Chem			Geology	Maths	
(e)				ExpPhys	Geology	Maths	MathPhys
(f)			CompSc	ExpPhys		Maths	MathPhys
(g)	Biol	Chem	CompSc			Maths	
(h)		Chem	CompSc		Geology	Maths	
(i)			CompSc	ExpPhys	Geology	Maths	
(j)		Chem	CompSc	ExpPhys		Maths	
(k)			CompSc		Geology	Maths	MathPhys
(l)		Chem			Geology	Maths	MathPhys
(m)		Chem	CompSc			Maths	MathPhys
(n)	Biol			ExpPhys	Geology	Maths	
(o)	Biol		CompSc	ExpPhys		Maths	

No other combination is acceptable.

Students in the Mathematical Science denominated entry programme must select from the First Science subject groupings (f), (k) or (m).

Students in the Theoretical Physics denominated entry programme must select from the First Science subject groupings (b), (e) or (f).

Students in the Computer Science denominated entry programme must select the two First Science Computer Science courses (COMP 1001, 1002), pass Mathematics and one of the following subjects: Biology, Chemistry, Experimental Physics or Mathematical Physics.

* Students wishing to pursue a BSc in Occupational Safety and Health must take Combination (a)

2. Examinations

The First University Examination in Science is completed in the Summer. A Supplemental Examination is held in the Autumn (The regulations governing this examination are contained in Marks and Standards, available for consultation in the Library or on the web: <http://www.ucd.ie/~exams/>). Departments may hold examinations and continuous assessments throughout the year.

Award of Honours at Examinations

Honours are awarded at the Summer Examination only. General papers are set in Biology, Chemistry, Computer Science, Experimental Physics, Geology and Mathematical Physics. Honours may be awarded if the appropriate standards are reached. To be eligible for Honours in Mathematics candidates must take the Honours paper in that subject. Repeat students are not eligible for Honours.

Carry Forward

Students who reach a passing mark in only one subject in the summer examination may carry this mark forward to the autumn. A mark carried forward from summer to autumn may be used for compensation.

Exemption

Students who fail the examination as a whole but reach a passing grade in at least two subjects, will be exempt from further examination in those subjects. Where exemptions have been given, the remaining subject(s) must be passed at the same examination.

Pass by Compensation

Students may be allowed to pass their First Science Examination by passing three subjects (minimum 40% with minimum excess marks of 5%), and achieve 35-39% in the fourth subject, where the deficiency is compensated by excess marks in the other subjects*.

Two-Year Rule

Students who do not complete the First University Examination in Science within **two years** from the date of entering the courses will be ineligible to remain in the Faculty of Science. Exemption from this regulation may be granted for grave reasons by the Academic Council on the recommendation of the Faculty of Science.

* Please note the special requirements for some courses in '4' below.

Transfer students from other faculties in the University are subject to a one-year rule. Exemption from this regulation may be granted for grave reasons by the Academic Council on the recommendation of the Faculty of Science.

3. Re-Attendance at First Science

Students must apply to the Faculty of Science for permission to re-attend First Science courses. Generally students have satisfied practical requirements the first time around. Re-attendance at practical classes is at the discretion of the departments.

4. Special Requirements for First Year Students wishing to proceed to some Second Year Courses

Computer Science

Students should be aware that they will not be permitted to enter the Second Year course in Computer Science unless they have gained a **clear pass** in Computer Science in the First Science Examination.

Computer Science Denominated Entry

Students should be aware that they will not be permitted to enter the Second Year course in Computer Science (DN030) unless they have gained a **clear pass** in COMP 1001 and COMP 1002.

Four Year Honours Degree in Mathematics

Students wishing to pursue a Four-Year Honours Degree in Mathematics are required to attend the Honours course in that subject in First and subsequent years. In order to proceed to the Honours course in Second Science, a qualifying mark of at least **50%** in the subject concerned must be obtained in the First Science examination, summer or autumn.

Mathematical Science

Students in the Mathematical Science stream must pass the First Science examination and obtain a minimum of **50%** in the Honours course in Mathematics and **50%** in the Mathematical Physics course. Students of Mathematical Science passing the First Science examination but gaining marks below these requirements revert to the General Science stream in Second Year.

Theoretical Physics

Students in the Theoretical Physics stream must pass the First Science examination and obtain a minimum of **50%** in the Experimental Physics and Mathematical Physics courses, and **50%** in the Honours course in Mathematics. Students of Theoretical Physics passing the First Science examination but gaining marks below these requirements revert to the General Science stream in Second Year.

Syllabus of First Year Courses in Science (SCBDF0001)
(DN008, 030, 031, 032)

Applied and Computational Mathematics

This programme is designed as a Topical Degree programme following the completion of Second Science and leading to the award of an honours degree.

Students planning on following this Degree Programme may choose any allowable First Science combination.

Biochemistry

Prerequisite Combination: (a), (d) or (g) in First Science

This is a Second Science Subject leading to an Honours Degree Programme.

Biology – BIOL 1001

Three lectures and one practical class of three hours per week undertaken by the Division of Biosciences which includes the Departments of Botany, Industrial Microbiology and Zoology.

1. Cell Biology and Genetics: History of cell theory; macromolecules; preparation of tissues for light and electron microscopy; structure and function of cells; cell cycle; mitosis, meiosis; DNA structure and replication; gene expression; Mendel's Laws; Mendelian inheritance patterns in humans.
2. Diversity of Life: The structure, reproduction and evolutionary relationships of living organisms: bacteria, fungi and viruses – their relevance in the biosphere, as parasites and agents of disease, and their use in biotechnological processes: protists: animals – classification, study of the increasing complexity of multicellular organisation from the Porifera (sponges) through Coelenterates, Platyhelminthes, Nematodes, Annelids, Arthropods, Molluscs, Echinoderms and Chordates: plants – structure and function of plant cells, tissues and organs; plant tissue culture; life cycles of bryophytes, pteridophytes and seed plants.
3. Animal and Plant Physiology: Bioenergetics, tissue respiration and photosynthetic pathways; nutrition; circulatory systems; respiratory

systems; excretion; muscles and movement; nervous systems; hormones; reproduction.

4. Environmental Biology: Plant and animal ecology; climate and biome distribution; adaptation of plants and animals in major biome types; environmental problems – desertification, destruction of rain forests; ecosystem ecology, energy transfers, ecosystem models and nutrient cycling.
5. Evolution: Darwin, neodarwinian theory, sources of evidence for evolution, macroevolution, outline of the fossil record, evolution of primates.

Botany

Prerequisite Combination: (a), (d) or (g) in First Science.

This is a Second Science Subject leading to an Honours Degree Programme.

Cell and Molecular Biology

Prerequisite Combination: (a), (d) or (g) in First Science. Combination (a) preferred.

This programme is designed as a Topical Degree programme following the completion of Second Science and leading to the award of an honours degree.

Chemistry – CHEM 1001

Three lectures and one practical class per week.

1. Introduction

Early chemical discoveries, the atomic theory and atomic structure. Electron configurations of the elements. The periodic law and the periodic table. Atomic radius, ionisation energy and electron affinity. Chemical bonding, ionic and covalent bonds, stoichiometric equation, the Avogadro constant, Chemical reactions and the mole.

2. Physical Chemistry

States of matter, properties of gases and the kinetic theory of gases. Energy changes in chemical reactions, the first law of thermodynamics, endothermic and exothermic reactions, entropy and free energy. The nature of chemical equilibrium, the law of mass action, external effects on equilibria. The importance of chemical equilibrium and catalysis in biological and industrial applications.

3. Inorganic Chemistry

Periodic classification of the elements; electron configuration and reactivity; ionic, covalent and giant network compounds; electron counting and Lewis structures. Electronegativity, assignment of oxidation number, oxidation and reduction, balancing equations. Chemistry of selected elements including hydrogen, the group 1 and 2 metals Li, Na, Mg, K and Ca and the non-metals fluorine and chlorine, carbon and silicon, oxygen and sulphur, nitrogen and phosphorus. Some aspects of the chemistry of groups 13 and 18 and the transition metals.

4. Organic Chemistry

Why is life based on carbon? Types of organic compounds. Shapes of molecules, stereochemistry and chirality. The importance of chirality in biological systems and drug design. Reactions of organic compounds, concepts of reactivity in terms of energy and steric control. Survey of reactions of functional groups in organic chemistry with examples from biological processes and the synthesis of new materials.

5. Laboratory Work

Instrumental techniques employed in the analysis of unknown compounds and mixtures, including volumetric analysis, mass spectrometry, fluorimetry, atomic absorption, uv-visible and infrared spectroscopy. Experimental studies of equilibria, thermochemistry and organic synthesis; qualitative analysis of inorganic anions and cations.

<p><i>Computer Science – COMP 1001</i></p>

This course is taken by all students taking Computer Science as a subject in First Science.

There are three lectures per week plus programming practicals and tutorials.

1. Introduction to Computer Programming

Algorithms, Basic programming in Java, datatypes, sequence, selection and iteration constructs, elementary data structures, basic sorting and searching algorithms, complexity analysis, object-oriented program design, exceptions, streams.

2. Introduction to Information Technology

Basic concepts in computer hardware and architecture. Information representation. History of computing. Fundamentals of Software Systems and Information technology.

Hardware and Software Development – COMP 1002

This course is taken by students in the Computer Science denominated entry programme, in addition to COMP 1001.

There are three lectures per week plus programming practicals and tutorials:

1. Formal Foundations

The role of mathematics and logic in Computer Science; Logic fundamentals: propositional and predicate logic and proof techniques.

2. Hardware

Boolean algebra. Introduction to combinational and sequential circuits.

3. Software Development

A group software development project.

Environmental Biology

Prerequisite Combination: (a), (d) or (g) in First Science.

This programme is designed as a Topical Degree programme following the completion of Second Science and leading to the award of an honours degree.

Environmental Geochemistry

Prerequisite Combination: (c), (d), (h), or (l) in First Science.

This programme is designed as a Topical Degree programme following the completion of Second Science and leading to the award of an honours degree.

Experimental Physics – EXPH 1001

Lectures: Three lectures and one three-hour practical class per week.

A thematic approach to Experimental Physics is adopted in this introductory course, which does not assume any previous knowledge of the subject. Topics include: Physics at the atomic, molecular and macroscopic levels. Mechanics and the dynamics of large scale systems. Gravitation. Physics of fluids. Thermodynamics and thermal physics. Waves. Sound. Optics. Spectroscopy. Physics of solids. Electrons at rest and in motion. Electric fields. Electrical potential and capacitance. Magnetism and magnetic fields. Electromagnetic induction and alternating current flow. Photons and waves. Atomic physics. Nuclear physics and nuclear energy. In addition,

contemporary developments in physics are used to illustrate the course content, where possible.

The practical component of the first science Experimental Physics course is a very important integral part of the subject. Students are required to attend a two hour Experimental Physics laboratory practical each week. These laboratory sessions provide an opportunity to conduct experiments in a wide range of topics in physics. In addition to the two hour practical, students are also required to attend a one hour Micro-electronics laboratory per week, which involves computer interfacing and basic electronics. Students will be assessed continuously throughout the year.

Genetics

Prerequisite Combination: (a), (d) or (g) in First Science.

Genetics is designed to be taken either as a Joint Honours Programme (Molecular Genetics and a Biological Subject) or a Topical Degree programme (Cell and Molecular Biology and Plant Genetic Engineering) following the completion of Second Science and leading to the award of an honours degree.

Geology – GEOL 1001

Three lectures and one two-hour practical class per week. The course is designed to provide a broad background in all the major aspects of Geology and to be interesting and stimulating. No previous knowledge of the subject is required. Four afternoon field classes to areas of particularly spectacular geology in the Dublin area are held in place of laboratory classes in the early and later part of the academic year.

1. The Earth's surface features and processes. Their origin and controls on their formation and development.
2. Shallow and deeper earth structures and processes. The crust, mantle and core. Geophysics and lithosphere plates. Formation and classification of faults, joints and folds.
3. Minerals. Their occurrence, identification and properties.
4. Rocks. Occurrence, classification, distribution and environments of igneous, sedimentary and metamorphic rocks.
5. Earth resources. Minerals, hydrocarbons, water resources, engineering geology and environmental geology.
6. Geologic time. Concepts, measurement of relative and absolute time. Radiometric dating, other concepts of relative dating and their historical development.

7. Origin of life and evolution. The fossil record, mass extinctions, sea level changes and ice ages. Development of floras and faunas through geological time.
8. Evolution of the Irish geological landscape, changing geological environments through time. Climates, marine incursions, volcanoes and mountains.

Geophysical Science

Prerequisite Combination: (c), (e), (i), or (n) in First Science.

This programme is designed as a Topical Degree programme following the completion of Second Science and leading to the award of an honours degree.

Industrial Microbiology

Prerequisite Combination: (a), (d) or (g) in First Science

This is a Second Science Subject leading to an Honours Degree Programme.

Mathematical Physics – MAPH 1000

Six lectures/tutorials per week

1. Mathematical Modelling and Numerical Methods

First order differential equations: Examples of modelling leading to differential equations; homogeneous equations with constant coefficients; separable equations; integrating factors. Inhomogeneous equations. Linear second order differential equations: Independent solutions and Wronskians; reduction of order; variation of parameters; initial and boundary value problems. Systems of equations: phase plane, classification of critical points. Approximate solutions of nonlinear equations. Chaotic dynamics.

Numerical methods: Solutions of ordinary differential equations, quadrature formulae, root finding.

2. Introduction to Mechanics

Motion in a line, displacement-time graphs, velocity-time graphs and acceleration. Motion with constant acceleration, free fall under gravity. Introduction to vectors, scalar product, relative velocity. Force, momentum and Newton's laws of motion. Statics and friction.

Kinetic and potential energy, work and power. Elastic strings and springs, Hooke's law and elastic potential energy. Projectiles. Impulse, collisions and the law of

restitution. Circular motion. Simple harmonic motion, motion in a plane and under variable forces. Stability and small oscillations.

Coplanar forces in equilibrium. Centre of gravity and moments of inertia. Dynamics of a rigid body in two dimensions. The compound pendulum. Polar coordinates. Central forces, angular momentum and orbits. Satellite motion.

Mathematical Science

Students select combinations (f), (k) or (m).

Students in the Mathematical Science stream must pass the First Science examination and obtain a minimum of 50% in the Honours course in Mathematics and 50% in the Mathematical Physics course. Students of Mathematical Science passing the First Science examination but gaining marks below these requirements revert to the General Science stream in Second Year.

Mathematics – MATH 1100 and MATH 1200

MATH 1200: Mathematics Pass course
MATH 1100: Mathematics Honours course*

For the purposes of assigning students to Second Science subjects on the basis of First Science Examination results, marks awarded in Honours Mathematics carry a higher weighting than in Pass Mathematics. The precise formula is given in an information sheet available on request from the Mathematics Department.

Either the Pass or the Honours course must be attended.

Pass Course: Four lectures per week.

Algebra

Vectors in two, three and more dimensions. Matrices and systems of linear equations. Introduction to complex numbers.

Calculus

Functions and Sets. Differential calculus, graphing and optimization. Integration, areas and volumes. Introduction to differential equations.

Honours Course Four lectures per week.

* Weighting of Honours Mathematics marks for entry to Second Science

Algebra

Induction, solutions of systems of linear equations, matrix algebra, determinants, vectors in three-dimensional space, lines and planes in three-dimensional space, eigenvalues and eigenvectors.

Calculus

Limits of functions and continuity. Differentiation, extreme values, mean value theorem, applications. Riemann integration. Differential equations.

Four Year Honours Degree in Mathematics

Students wishing to pursue a Four-Year Honours Degree in Mathematics are required to attend the honours course in that subjects in First and subsequent years. In order to proceed to the honours course in Second Science, a qualifying mark of at least 50% in the subject concerned must be obtained in the First Science examination, summer or autumn.

Occupational Safety and Health

Prerequisite Combination: (a) in First Science.

This is available as a Third General option.

Pharmacology

Prerequisite Combination: (a), (d) or (g) in First Science.

This is a Second Science Subject leading to an Honours Degree Programme.

Physiology

Prerequisite Combination: (a), (d) or (g) in First Science.

This is a Second Science Subject leading to an Honours Degree Programme.

Plant Genetic Engineering

Prerequisite Combination: (a), (d) or (g) in First Science.

This programme is designed as a Topical Degree programme following the completion of Second Science and leading to the award of an honours degree.

Statistics

No prerequisite needed in First Science.

This is a second science subject leading to an honours degree programme.

Theoretical Physics

Students select combinations (b), (e), or (f).

Students in the Theoretical Physics stream must pass the First Science examination and obtain a minimum of 50% in the Experimental Physics and Mathematical Physics courses, and 50% in the Honours course in Mathematics. Students of Theoretical Physics passing the First Science examination but gaining marks below these requirements revert to the General Science stream in Second Year.

Zoology

Prerequisite Combination: (a), (d) or (g) in First Science.

This is a Second Science Subject leading to an Honours Degree Programme.

Second Science
(SCBDF0002)

Regulations for Second Year Science Students

1. Admission to Second Science

Students must have passed the First University Examination in Science.

All First Science students must indicate their preference by completing an Application for Admission to Second Science Subjects Form. These forms are available from the Faculty Office following the advisory meetings and must be returned as directed.

Students will be assigned to Second Science subjects by the Faculty based on the results of the First Science examinations.

Although every effort is made to accommodate students in the subjects of their choice, entry to a number of the Second Science subjects is limited owing to laboratory space and staffing restrictions.

2. Transferring from other UCD Faculties to Second Science

The closing date for applications is 9 July 2004. Application should be made using the 'Internal Transfer Form'. Such transfers are dependent on the availability of places in Second Science. Information is available from the Admissions Office, Michael Tierney Building, UCD (Tel. +353 1 716 1425).

Actuarial and Financial Studies Students

Actuarial and Financial Studies students in the Faculty of Commerce wishing to transfer to Second Science in Computer Science, Mathematics and Statistics must have passed their First University Examination. Application for such acceptance must be made via an 'Internal Transfer Application Form'.

Engineering Students

Engineering students wishing to transfer to Second Science must pass their First University Examination in Engineering and with the permission of the Faculty of Science may proceed to subject combinations that include three of the following: Chemistry, Experimental Physics, Mathematics, Mathematical Physics, Statistics. Application for such acceptance must be made via an 'Internal Transfer Application Form'.

3. Selection of Subjects

Students in Second Science study **three subjects**. Each subject consists of **four course units**, i.e. students take a total of **12 units**. Each unit comprises **48 contact hours** (maximum) made up of lectures, laboratory practicals, field practicals and/or tutorials. Examination papers in any subject may be designed to test integrated

knowledge, i.e. a single question may require knowledge drawn from more than one unit in that subject.

Second Science subjects are offered in Sets (see Table 1). Some subjects may have prerequisite First Science subjects. Students select three subjects, one from three of these Sets.*

Table 1. Second Science Sets

Set 1 Mathematics
Set 2 Mathematical Physics, Zoology
Set 3 Botany, Experimental Physics, Pharmacology
Set 4 Chemistry, Psychology
Set 5 Computer Science, Industrial Microbiology, Physiology
Set 6 Biochemistry, Geology, Statistics

* See subjects grouped under each Second Science Subject. Students should note that certain subjects may not be taken together due to timetable or other restrictions as decided by the Faculty of Science.

Table 2. First Science Pre-requisites for admission to Second Science Subjects

Second Science Subjects							
	Biol	Chem	CS	EP	Geol	Maths	MP
Biochemistry	X	X				X	
Botany	X	X				X	
Chemistry		X				X	
Computer Science			X			X	
Experimental Physics				X		X	
Geology					X	X	
Industrial Microbiology	X	X				X	
Mathematics						X	
Mathematical Physics						X	X
Pharmacology	X	X				X	
Physiology	X	X				X	
Psychology						X	
Statistics						X	
Zoology	X	X				X	

4. Special requirements for Second Year students wishing to proceed to some Third Year courses

In selecting their subjects, students should be aware of additional requirements for entry to some Third Science Honours courses.

Biochemistry: Students wishing to pursue an Honours Degree in Biochemistry are recommended, but not required, to take Chemistry in second year.

Cell and Molecular Biology: Students wishing to pursue a Topical Degree in Cell and Molecular Biology are required to take two biological subjects and one other subject in second year.

Computer Science: Students wishing to pursue an Honours Degree in Computer Science are required to take Mathematics in second year.

Environmental Biology: Students wishing to pursue a Topical Degree in Environmental Biology are required to choose two subjects out of Botany, Industrial Microbiology or Zoology and one other subject in second year.

Experimental Physics: Students wishing to pursue an Honours Degree in Experimental Physics are required to take Mathematics in second year¹.

Industrial Microbiology: Students wishing to pursue an Honours Degree in Industrial Microbiology are recommended, but not required, to take Chemistry in second year.

Plant Genetic Engineering: Students wishing to pursue a Topical Degree in Plant Genetic Engineering are required to take Biochemistry, Botany and another subject in second year.

5. Second Science Computer Science (Denominated Entry) Programme

Students in computer science (denominated entry) programme take the prescribed courses in computer science and mathematics.

6. Second Science Theoretical Physics Programme

Students in the Theoretical Physics programme take the prescribed courses in Experimental Physics, Mathematics and Mathematical Physics.

7. Second Science Mathematical Science Programme

Students in the Mathematical Science programme take the prescribed courses in Mathematics, Mathematical Physics and Statistics.

8. Examinations

The Second University Examination in Science is completed in the Summer. A Supplemental Examination is held in the Autumn. (The regulations governing this examination are contained in Marks and Standards, available for consultation in the Library or on the web: (<http://www.ucd.ie/~exams/>)) Some departments may hold examinations and continuous assessments throughout the year.

Award of Honours

Honours are awarded at the Summer Examination of the first year of sitting only. To be eligible for Honours in Mathematics students must take the Honours papers.

Qualifying for Third Honours Courses

Students qualify for admission to a Third Year Honours course on the results of the Second University Examination in Science by passing all three subjects at the same examination (either summer or autumn) and reaching a minimum of **55%** in the subject that the student proposes to study at honour level. A minimum of **60%** will apply if the examination is passed in an academic year later than the

¹ Students who take Honours Mathematics with Mathematical Physics in First Science are permitted to substitute the Mathematics requirement for Mathematical Physics.

academic year of entry to the courses or if it is passed by compensation. Exemption from this regulation may be granted for grave reasons by the Faculty of Science.

For further details please see 'Admission to Third Science Courses' on page 72.

Exemption

Students who receive a mark of 40% in any subject may be recommended by the Examiners for exemption from further examination in that subject (c.f. Marks and Standards).

Students should be aware that where such exemptions have been awarded, they must present for examination in all three subjects if they wish to be considered for admission to a Third Science Honours course.

Pass by Compensation

Students may be allowed to pass their Second Science Examination by passing two subjects (minimum 40%), and achieve 35-39% in the third subject, where the deficiency is compensated by excess marks in the other subjects.

Two-Year Rule

Students must pass the Second University Examination in Science within two years of entering the courses. Exemption from this regulation may be granted for grave reasons by the Academic Council on the recommendation of the Faculty of Science.

9. Re-Attendance at Second Science Courses

Students may re-attend their courses with the approval of the department(s) concerned, provided that places remain available in the relevant subject. Where a student wishes to change a subject, formal permission of the Faculty must be sought.

Repeating for Honours

If a student wishes to repeat to qualify for honours all three Second Science subjects must be repeated.

Syllabus of Second Year Courses in Science

Each unit comprises 48 contact hours (maximum) made up of lectures, laboratory practicals, field practicals and/or tutorials.

Note: Not all units may be on offer in any one year.

Applied and Computational Mathematics

Second Year- any Second Science combination which includes Mathematics.

Note 1 Mathematics at General level is sufficient

Note 2 For this degree it is not necessary to have taken either Mathematical Physics or Statistics in Second Science

Biochemistry

Prerequisite Combination: (a), (d) or (g) in First Science

Available subject groups with Biochemistry:

Biochem	Botany	Chem
Biochem	Botany	IndMicro
Biochem	Botany	Maths
Biochem	Botany	Zool
Biochem	Chem	IndMicro
Biochem	Chem	Maths
Biochem	Chem	Pharm
Biochem	Chem	Zool
Biochem	ExpPhys	Maths

Biochem	IndMicro	Maths
Biochem	IndMicro	Pharm
Biochem	IndMicro	Zool
Biochem	Maths	Pharm
Biochem	Maths	Physiol
Biochem	Maths	Zool
Biochem	Pharm	Physiol
Biochem	Pharm	Zool
Biochem	Physiol	Zool

Second Year Course for General and Honours Degrees

BIOC 2001 Biomolecules I

Cellular architecture; introduction to macromolecules; amino acids and proteins including antibodies, receptors, haemoglobin, molecular motors; associated techniques.

BIOC 2002 Biomolecules II

Enzymes and cofactors; glycoproteins and bacterial cell walls; lipids and membranes; transport mechanisms; signal transduction.

BIOC 2003 Metabolism

Biogenetics; carbohydrate metabolism; photosynthesis; lipid transport and metabolism; oxidative metabolism; amino acid metabolism; metabolic control.

BIOC 2004 Molecular Genetics and Biotechnology

Structures of nucleotides and nucleic acids; nucleotide metabolism; transcription, translation and DNA sequencing; regulation of gene expression; molecular biotechnology.

Botany

Prerequisite Combination (a), (d), or (g) in First Science

Available subject groups with Botany:

Botany	Biochem	Chem
Botany	Biochem	IndMicro
Botany	Biochem	Maths
Botany	Biochem	Zool
Botany	Chem	Geology
Botany	Chem	IndMicro
Botany	Chem	Maths

Botany	CompSc	Maths
Botany	Geology	Maths
Botany	Geology	Zool
Botany	IndMicro	Maths
Botany	IndMicro	Zool
Botany	Maths	Psych
Botany	Maths	Zool

Second Year Course for General and Honours Degrees

BOTN 2001 Biology of Fungi

A course dealing with growth, development and physiology of fungi. Characteristic and noteworthy features of fungal structure and growth; osmotrophy and extracellular enzymes; nutritional requirements; responses to environment; hyphal tip growth, mycelium, differentiation and reproduction; spore characteristics, dispersal and germination.

BOTN 2003 Plant Anatomy and Morphology

Anatomical development of plants. The range and distribution of cell types, relationships between structure and function, structural aspects of cell differentiation. The structure and identification of woods. Development and morphology of vegetative and reproductive structures in conifers and flowering plants. Identification of plants in the Irish flora.

BOTN 2004 Environment, Plants and Vegetation

Plant/environment interactions: plant ecotoxicology; soil; rhizosphere; nutrients; effects of and tolerance to salt, drought, waterlogging and pollutants. Vegetation and environment: saltmarshes, sand-dunes, heathlands, peatlands, grasslands and woodlands.

BOTN 2005 Plant Signalling Molecules in Growth and Development

Introduction to the five major groups of signalling molecules, auxin, gibberellins, cytokinins, abscisic acid, ethylene and other biologically-active signalling molecules; the influence of signalling molecules on different categories of development such as, apical dominance, differentiation of vascular tissue, embryogenesis, root hair development and senescence.

<i>Cell and Molecular Biology</i>
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Prerequisite Combination: (a), (d) or (g) in First Science. Combination (a) preferred.

Any Second Science group that includes two biological subjects.

This programme is designed as a Topical Degree programme following the completion of Second Science and leading to the award of an honours degree.

<i>Chemistry</i>

Prerequisite for all units: First Science Chemistry.

Available subject groupings with Chemistry:

Chem	Biochem	Botany
Chem	Biochem	IndMicro
Chem	Biochem	Maths
Chem	Biochem	Pharm
Chem	Biochem	Zool
Chem	Botany	Geology
Chem	Botany	IndMicro
Chem	Botany	Maths
Chem	CompSc	Maths
Chem	ExPhys	Maths
Chem	Geology	MPhys
Chem	Geology	Maths

Chem	Geology	Zool
Chem	IndMicro	Maths
Chem	IndMicro	Pharm
Chem	IndMicro	Stats
Chem	IndMicro	Zool
Chem	MPhys	Maths
Chem	MPhys	Stats
Chem	Maths	Pharm
Chem	Maths	Stats
Chem	Maths	Zool
Chem	Pharm	Stats

Second Year Courses for General and Honours Degrees
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Prerequisite for all units: First Science Chemistry.

CHEM 2101 Organic Chemistry

Synthesis and Reactivity of Organic Compounds: The preparation and reactions of molecules containing double bonds. Reactivity and stereochemistry of ionic and free-radical additions to alkenes and alkadienes; resonance and aromaticity; electrophilic and nucleophilic aromatic substitution. Chemistry of aldehydes and ketones. Chemistry of carboxylic acids and their derived amides, esters, halides and anhydrides including nucleophilic acyl transfer reactions. Acidity of carboxylic acids. Mechanism of Base hydrolysis of an ester. The Grignard synthesis of tertiary alcohols. Chemistry of amines, amino acids.

CHEM 2102 Physical Chemistry

Bonding. Quantum mechanics: the Schrodinger equation and atomic wave functions; molecular orbitals, linear combination of atomic orbitals. *Spectroscopy.* Interaction of electromagnetic radiation with atoms and molecules; rotational and vibrational spectroscopy, electronic spectra of atoms and molecules.

Kinetics. Elementary and complex reactions; molecularity, reaction order and rate equations; elucidation of reaction mechanisms from kinetic studies. *Solution Chemistry.* Strong and weak electrolytes; conductivity, analytical applications of conductance measurements; electrolysis, redox reactions; Faraday's laws of electrolysis.

CHEM 2103 Introductory Inorganic Chemistry

Origin of the elements, overview of the Periodic Table; introduction to point group symmetry; Werner-type coordination compounds; solid state chemistry – ionic, layer and molecular structures.

CHEM 2104 Chemistry and Biology

The objective of this course is to provide a broader perspective on chemistry by considering the central role that chemistry plays in many important biological processes. Particular attention will be paid to the properties of biomolecules, including amino acids, peptides, proteins and bioinorganic compounds.

Computer Science

Prerequisite: First Year Computer Science and Mathematics.

Available subject groupings with Computer Science:

CompSc	Botany	Maths
CompSc	Chem	Maths
CompSc	ExPhys	Maths
CompSc	Geology	MPhys*
CompSc	Geology	Maths
CompSc	MPhys	Maths

CompSc	MPhys*	Psych
CompSc	MPhys*	Stats
CompSc	Maths	Psych
CompSc	Maths	Stats
CompSc	Maths	Zool

Students must take Mathematics and one other subject.

Second Year Courses for General and Honours Degrees

Core Courses

COMP 2001 Data Structures and Algorithms I

Object Oriented design, Data abstractions, lists, queues, stacks, trees, graphs and operations on them using Java programming language.

COMP 2002 Computer Architecture: Systems

Microcomputer architecture; bus systems; i/o interface adaptors; parallel and serial devices; interrupts: types; handling of; polling and vectored interrupts; direct memory access; putting systems together; advanced memories: associative cache, virtual, multiprocessor architectures; programming.

COMP 2003 Functional Programming

Programming and problem-solving with recursive functions: an introduction to functional programming concepts using Common Lisp. The Fundamentals of LISP: binding, conditionals, looping, mapping. Case Study in Lisp – functional programming examples for the development of complex solutions.

COMP 2011 Data Structures and Algorithms II

Trees; graphs; pattern matching; sorting; specification techniques; complexity analysis; application.

* Those students who took Mathematical Physics and Honours Mathematics in First Science may substitute Mathematical Physics for Mathematics.

Computer Science 2100 (Denominated Entry) – (SCBDF0015)

Mathematics

Students follow the Second Science honours or pass course in Mathematics.

Computer Science

In Computer Science students take the following courses:

COMP 2001 Datastructures and Algorithms I

For details of this unit see under Computer Science

COMP 2002 Computer Architecture: Systems

For details of this unit see under Computer Science

COMP 2003 Functional Programming

For details of this unit see under Computer Science

COMP 2006 Databases and Information Systems

Types of information system; database organisation; data models; the relational model; data definition and manipulation languages; relational algebra and calculus; SQL; database design; normalisation; database systems vs. information retrieval systems.

COMP 2008 Multimedia Systems

Introduction to the World Wide Web; web design and authoring tools; web servers; HTML; java script; GCI scripting; typography; page and graphic design; graphics formats; dynamic HTML; cascading style sheets; audio and video on the web; future trends.

COMP 2009 Program Design and Verification

Propositional and predicate calculus; theorem proving; the correctness of programs; WP-calculus; derivation of loop programs; efficiency considerations; strengthening invariants.

COMP 2011 Datastructures and Algorithms II

For details of this unit see under Computer Science

COMP 2012 Unix Operating System

Introduction to UNIX Operating System, Unix File System, Unix Shell, Unix Tools, Unix Scripts.

Environmental Biology

Prerequisite Combination: (a), (d) or (g) in First Science.

In Second Science students must choose a group that includes any two of the subjects Botany, Industrial Microbiology or Zoology.

This programme is designed as a Topical Degree programme following the completion of Second Science and leading to the award of an honours degree.

Environmental Geochemistry

Prerequisite Combination: (c), (d), (h), or (l) in First Science.

In Second Science, students must choose a group that includes Chemistry, Geology and one other subject.

This programme is designed as a Topical Degree programme following the completion of Second Science and leading to the award of an honours degree.

Experimental Physics

Prerequisites for all units: First Science Experimental Physics and Mathematics

Available subject groupings with Experimental Physics

ExPhys	Biochem	Maths	ExPhys	MPhys	Maths
ExPhys	Chem	Maths	ExPhys	Maths	Physiol
ExPhys	CompSc	Maths	ExPhys	Maths	Stats
ExPhys	Geology	Maths			

Students must take Mathematics and one other subject. Those students who took Mathematical Physics and Honours Mathematics in First Science may substitute the Mathematics requirement with Mathematical Physics.

Prerequisites for all units: First Science Experimental Physics and Mathematics

Second Year Courses for General and Honours Degrees

Laboratory

Students work either singly or in pairs, on a range of modern experiments designed to complement the 2nd Year lecture course syllabus and enhance understanding of topics in optics, solid state physics, quantum and atomic physics and electromagnetism. In addition, measurements of fundamental physical constants are made in classic physics experiments, such as the Cavendish experiment to measure the universal gravitational content and the Millikan oil-drop experiment to determine

the charge on the electron. Students become familiar with a variety of practical techniques, e.g. computerised instrument control, scanning tunnelling microscopy and photographic development, while reinforcing their understanding of difficult concepts encountered in the lecture courses. Continuous assessment of the laboratory component is based on students' performance in the laboratory and on written reports.

EXPH 2001 Optics and Topics in Modern Physics.

A brief review of geometrical optics. Wave motion. Superposition. Electromagnetic theory of light. Light propagation (reflection, Fermat's principle). Polarisation. Interference. Amplitude splitting and wave front splitting interferometers. Fraunhofer diffraction. Introduction to topics in modern physics, such as astrophysics, particle physics, quantum physics and applied optics.

EXPH 2002 Electromagnetism

Introduction. Electrostatics. Conservative nature of the electric field. Divergence theorem and Stokes' theorem. Faraday's laws of electromagnetic induction. Inductance and eddy currents. Symmetry principles applied to network S and complex circuits. DC and AC circuits. Complex impedance, resonance, power transfer and impedance matching. Effect of electric fields on materials.

EXPH 2003 Atomic and Quantum Physics

Introduction. Distribution functions. Blackbody radiation. Quantisation. The Bohr atom. Wave-particle duality. The wave packet. Heisenberg's uncertainty principle. The Schrödinger wave equation and simple systems. Applications of Quantum Mechanics to different scale systems, i.e. solids, atoms, nuclei. In addition, The Compton effect, Rutherford scattering and Brownian motion are modelled as exercises.

EXPH 2004 Solid State Physics and Devices

Introduction to the physics of materials in the solid state, with particular reference to electron behaviour. Electronic band structure of conductors, semiconductors and insulators. Intrinsic and extrinsic conductivity and doping in semiconductors. The p-n junction. Practical semiconductor devices, including FET transistors and the solid state laser. Computer modelling of devices. Superconducting properties of materials at low temperatures.

Genetics

Prerequisite Combination: (a), (d) or (g) in First Science.

Genetics is designed to be taken either as a Joint Honours Programme (Molecular Genetics and a Biological Subject) or a Topical Degree programme (Cell and Molecular Biology and Plant Genetic Engineering) following the completion of Second Science and leading to the award of an honours degree.

Students seeking admission to the Joint Honours Degree in Genetics and a Biological Subject, select one of the following biological subjects: Biochemistry, Botany, Industrial Microbiology, Pharmacology and Zoology. They must:-

- follow a Second Science programme containing at least two biological subjects, one of which must be Biochemistry or Industrial Microbiology or Zoology and
- pass the Second Science examination, obtaining the qualifying standard for admission to the Honours course in their chosen biological subject.

Geology

Prerequisite for all units: First Science Geology

Available subject groupings with Geology:

Geology	Botany	Chem
Geology	Botany	Maths
Geology	Botany	Zool
Geology	Chem	MPhys
Geology	Chem	Maths

Geology	Chem	Zool
Geology	CompSc	Maths
Geology	ExPhys	Maths
Geology	MPhys	Maths
Geology	Maths	Zool

Second Year Courses for General and Honours Degrees

GEOL 2001 Mineralogy and Petrography

Crystal optics and the use of the polarising microscope; examination and identification of minerals from their optical properties and in hand specimen. Atomic structure, properties and occurrence of minerals – silicates, oxides, sulphides, sulphates, carbonates and others.

GEOL 2002 Structure and Sedimentology

Brittle, ductile and viscoelastic behaviour. Conditions for brittle failure, faults and fault geometrics. Folds and fold classification. Simple shear

belts and their features. Kink bands, boudinage. General consideration of pure shear. Sediment generation and deposition. Clastic sedimentary rocks. Fluid dynamics, sediment transport and sedimentary structures. Gravity driven sediment transport and turbidity currents. Diagenesis, depositional environments of mudrocks and carbonates. Chemical sediments.

GEOL 2003 Igneous and Metamorphic Petrology

The occurrence, composition, origin and classification of igneous and metamorphic rocks. Granite structures and intrusion mechanisms. Experimental petrology. Generation of magmas in a variety of tectonic settings. Physics of magmatic systems. Metamorphic grade, zones and facies. Metapelite, metabasite and calc-silicate assemblages. Description and interpretation of textures. Pre-, syn- and post-tectonic (static) metamorphic mineral growth. Compositional dependence of metamorphic assemblages. Phase diagrams. The Phase Rule. Regional and contact metamorphism.

GEOL 2004 Field Studies and Tectonics

Half of this course consists of formal lectures and practical classes and half consists of field investigations. Interplay between tectonics and sedimentation. Strain theory and measurement. Depositional environments and reconstruction of ancient sedimentary basins. Practical work will consist of map problems and exercises in sedimentological interpretation. There are two one-day field classes and one seven-day field class held in the Spring vacation which is devoted to mapping techniques.

<p><i>Geophysical Science</i></p>
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Prerequisite combination: (c), (e), (i) or (n) in First Science.

Students take Mathematics, Experimental Physics and Geology.

This programme is designed as a Topical Degree programme following the completion of Second Science and leading to the award of an honours degree.

<i>Industrial Microbiology</i>

Prerequisite combination: (a), (d) or (g) in First Science.

Available subject groupings with Industrial Microbiology

IndMicro	Biochem	Botany	IndMicro	Chem	Pharm
IndMicro	Biochem	Chem	IndMicro	Chem	Stats
IndMicro	Biochem	Maths	IndMicro	Chem	Zool
IndMicro	Biochem	Pharm	IndMicro	Maths	Pharm
IndMicro	Biochem	Zool	IndMicro	Maths	Stats
IndMicro	Botany	Chem	IndMicro	Maths	Zool
IndMicro	Botany	Maths	IndMicro	Pharm	Stats
IndMicro	Botany	Zool	IndMicro	Pharm	Zool
IndMicro	Chem	Maths			

Second Year Courses for General and Honours Degrees
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Students are recommended, not required to take Chemistry in Second Science.

INDM 2001 The Microbial World

An introduction to the biodiversity of microorganisms; contrasts between prokaryotic and microeukaryotic organisms; systems for classifying bacteria and fungi together with the biology of the main groups; an examination of growth, reproduction and survival of microorganisms and their applications.

Corequisite: INDM 2002.

INDM 2002 Nutrition and Metabolism

Growth, energy and nutrition; carbon utilisation in aerobic and anaerobic growth; fermentation and respiration; ATP generation and growth rate. Key metabolic intermediates and their relevance in industrial microbiology. Protein structure, classification, quantification and properties of enzymes. Introduction to enzyme technology.

Corequisite: INDM 2001.

INDM 2003 Microbial Genetics

Nucleic acid structure and functions. The bacterial chromosome and reproduction. Extrachromosomal genetic elements. Gene transfer in bacteria. Mutagenesis. Control of gene expression. Diploids and merodiploids. Phenotype expression.

Prerequisites: INDM 2001, INDM 2002.

INDM 2004 Microbes, Man and Environment

Assessment of microbial activity in the environment with reference to important environmental processes mediated by microorganisms. Microorganisms and the infection cycle. Microorganisms and the food chain. Industrial products of economic significance from microorganisms.

Prerequisites: INDM 2001, INDM 2002, INDM 2003.

Mathematical Physics

Prerequisite for all units: First Science Mathematical Physics

Available subject groupings with Mathematical Physics

MPhys	Chem	Geology	MPhys	ExPhys	Maths
MPhys	Chem	Maths	MPhys	Geology	Maths
MPhys	Chem	Stats	MPhys	Maths	Psych
MPhys	CompSc	Maths	MPhys	Maths	Stats

Second Year Courses for General and Honours Degrees

MAPH 2111 Methods A

VectorCalculus: Vector differentiation (Frenet-Serret formulae). Directional derivatives, Grad, Div, Curl. Vector integration (line, surface, volume integrals). Integral theorems (Divergence and Stokes' theorems). Grad, Div and Curl in orthogonal curvilinear coordinates. Variational problems, Lagrange multipliers.

Calculus of Variations: Euler's equation, geometric examples, extension to higher number of variables, conditional variation.

MAPH 2120 Mechanics and Special Relativity

Mechanics: Dynamics of rigid bodies, rotating earth, spinning top, moments of inertia, principal axes, Euler's equations of motion.

Special Relativity: Inertial frames, Lorentz transformations, space-time, tensors, relativistic mechanics, energy-momentum conservation.

MAPH 2130 Analytical and Quantum Mechanics

Analytical Mechanics: Lagrange's equation, variational principles. Small oscillations, normal modes. Hamilton's equations, canonical transformations, Poisson brackets.

Quantum Mechanics: Introduction, Postulates of Quantum Mechanics, One-dimensional examples: Potential well and harmonic oscillator, the Heisenberg uncertainty principle, Quantum tunnelling.

MAPH 2140 Ordinary Differential Equations

Analytical methods: Existence of solutions. Linear differential equations: linearly independent solutions, dimension of solution space, Wronskians, Green's functions. Singular points. Solution in series.

Numerical methods: Runge-Kutta methods. Adaptive techniques. Applications to satellite motion, the three-body problem and the Lorenz model.

<p><i>Mathematical Science (SCBDF0014)</i></p>

Students take the following courses.

Mathematics

- MATH 2101 Vector Spaces and Linear Transformations
- MATH 2105 Number Theory and Group Theory
- MATH 2106 Introduction to Analysis
- MATH 2104 Functions of Several Variables

Mathematical Physics

- MAPH 2111 Methods A
- MAPH 2120 Mechanics and Special Relativity
- MAPH 2130 Analytical and Quantum Mechanics
- MAPH 2140 Ordinary Differential Equations

In addition, students study

Euclidean Spaces:

Convergence, Bessel's inequality, Parseval's equality. Fourier series (Piecewise continuous functions, Riemann-Lebesgue lemma, Weierstrass approximation theorem, Pointwise convergence). Orthogonal series of polynomials (Legendre polynomials, Hermite polynomials, Laguerre polynomials, Bessel functions).

Statistics

- STAT 2205 Statistical Theory I: Probability
- STAT 2206 Statistical Theory II: Statistical Inference
- STAT 2207 Statistical Theory III: Bayesian Statistics and Stochastic Processes
- STAT 2221 Introduction to Statistical Methods

<i>Mathematics</i>

Available subject groupings with Mathematics:

Maths	Biochem	Botany
Maths	Biochem	Chem
Maths	Biochem	ExPhys
Maths	Biochem	IndMicro
Maths	Biochem	Pharm
Maths	Biochem	Physiol
Maths	Biochem	Zool
Maths	Botany	Chem
Maths	Botany	CompSc
Maths	Botany	Geology
Maths	Botany	IndMicro
Maths	Botany	Psych
Maths	Botany	Zool
Maths	Chem	CompSc
Maths	Chem	ExPhys
Maths	Chem	Geology
Maths	Chem	IndMicro
Maths	Chem	MPhys
Maths	Chem	Pharm
Maths	Chem	Stats
Maths	Chem	Zool
Maths	CompSc	ExPhys
Maths	CompSc	Geology

Maths	CompSc	MPhys
Maths	CompSc	Psych
Maths	CompSc	Stats
Maths	CompSc	Zool
Maths	ExPhys	Geology
Maths	ExPhys	MPhys
Maths	ExPhys	Physiol
Maths	ExPhys	Stats
Maths	Geology	MPhys
Maths	Geology	Zool
Maths	IndMicro	Pharm
Maths	IndMicro	Stats
Maths	IndMicro	Zool
Maths	MPhys	Psych
Maths	MPhys	Stats
Maths	Pharm	Physiol
Maths	Pharm	Psych
Maths	Pharm	Stats
Maths	Pharm	Zool
Maths	Physiol	Psych
Maths	Physiol	Stats
Maths	Psych	Stats
Maths	Stats	Zool

Second Year General Courses

MATH 2201 Calculus of Several Variables

Functions of several variables. Partial derivatives. Optimization and Lagrange multipliers. Double integrals. Gradient, divergence, curl.

MATH 2202 Linear Algebra

Vector spaces, bases and dimensions. Linear transformations. Diagonalization of real symmetric matrices.

MATH 2203 Infinite Series

Convergence tests for sequences and series. Power series. Taylor series and Fourier series. Series solutions of ordinary differential equations.

MATH 2204 Probability and Statistics

Random variables, expected values and variance. Conditional probability. Sampling, confidence intervals and hypothesis testing.

Second Year Honours Courses

MATH 2101 Vector spaces and linear transformations

The internal structure of a vector space. Vector spaces homomorphisms. Matrices and linear transformations.

MATH 2104 Functions of several variables

Partial and directional derivatives. Taylor series. Critical points and Lagrange multipliers. Implicit function theorem. Line integrals and multiple integrals.

MATH 2105 Number Theory and Group Theory

Euclid's algorithm. The algebra of congruences. Groups, subgroups and homomorphisms. Lagrange's theorem. The Fermat-Euler theorem.

MATH 2106 Introduction to Analysis

The supremum axiom, sequences and series. Properties of continuous functions. Power series.

<i>Occupational Safety and Health</i>
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Prerequisite Combination: (a) in First Science.

This is available as a Third General option.

Pharmacology

Prerequisite Combination: (a), (d) or (g) in First Science

Available subject groupings with Pharmacology

Pharm	Biochem	Chem
Pharm	Biochem	IndMicro
Pharm	Biochem	Maths
Pharm	Biochem	Physiol
Pharm	Biochem	Zool
Pharm	Biochem	Physiol
Pharm	Chem	IndMicro
Pharm	Chem	Maths
Pharm	Chem	Stats
Pharm	IndMicro	Maths

Pharm	IndMicro	Stats
Pharm	IndMicro	Zool
Pharm	Maths	Physiol
Pharm	Maths	Psych
Pharm	Maths	Stats
Pharm	Maths	Zool
Pharm	Physiol	Psych
Pharm	Physiol	Stats
Pharm	Psych	Stats
Pharm	Psych	Zool

Second Year Courses for General and Honours Degrees

PHAR 2001 Introduction to Pharmacological Principles

Membrane structure and transport of drugs across cell membranes. Drug disposition including drug routes of administration, absorption, distribution, metabolism and excretion. Pharmacokinetics. Drug receptors and receptor theory. Introduction to nerve and muscle pharmacology.

PHAR 2002 Neuropharmacology I

Structure and function of autonomic nervous system. Autonomic pharmacology. Cholinergic and adrenergic drugs. Structure and function of central nervous system. Introduction to CNS pharmacology: Membrane stabilizing drugs and neurotransmitter modulators with CNS activity.

PHAR 2003 Cardiovascular, Respiratory, Renal and Gut Pharmacology

Body fluids. Cardiovascular system. Introduction to antihypertensive therapy. Respiratory system. Antiasthmatic drugs. Renal pharmacology. Diuretics. Alimentary tract, gut movements, digestion and absorption.

PHAR 2004 Introductory Endocrine Pharmacology and Immunopharmacology

Chemotherapy. Introduction to endocrinology, insulin and cortisol. The immune system: Immunopharmacology. Inflammation. Anti-inflammatory drugs. Introduction to chemotherapeutic agents.

<i>Physiology</i>

Prerequisite Combination: (a), (d) or (g) in First Science.

Available subject groupings with Physiology in Second Science

Physiol	Biochem	Maths
Physiol	Biochem	Pharm
Physiol	ExPhys	Maths
Physiol	Maths	Pharm
Physiol	Maths	Psych

Physiol	Maths	Stats
Physiol	Pharm	Psych
Physiol	Pharm	Stats
Physiol	Psych	Stats

Second Year Courses for General and Honours Degrees
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PHYS 2004 General Physiology

Cell structure, intracellular organelles. Body fluids. Cell membrane receptors, second messenger systems. Connective tissue. Epithelia: absorption, secretion, mucosa, skin. Muscle: skeletal, cardiac, smooth. Neural structure and function. Intercellular communication; synaptic transmission, hormones, chemical messengers.

PHYS 2005 Circulation and Respiration

Blood; structure and function. Introduction to mechanisms of immunity. Organisation of the circulation. Heart as a pump. Structure and function of blood vessels. Capillary exchange. Structure of the respiratory system. Mechanics of breathing. Transport of gases in the blood.

PHYS 2006 Digestion and Excretion

Structure and functions of the alimentary tract; movement, secretion, digestion, absorption, excretion. Structure and functions of the pancreas and liver. Kidneys; homeostatic functions, structure, blood vascular system. Glomerular filtration, tubular reabsorption and secretion, concentration of urine, micturition.

PHYS 2007 Nervous and Endocrine Systems

Structure of the nervous system. Sensation. Spinal reflexes and reflex arcs. Hormonal control of physiological function, metabolism, growth and reproduction.

Plant Genetic Engineering

Prerequisite Combination: (a), (d) or (g) in First Science. Combination (a) preferred.

Any Second Science combination that includes Botany and Biochemistry.

This programme is designed as a Topical Degree programme following the completion of Second Science and leading to the award of an honours degree.

Psychology

There are no prerequisites for students wishing to take Psychology. Please note that this subject is restricted to 25 places in Second Science.

Available subject groupings for Psychology Second Science

Psych	Botany	Maths
Psych	Botany	Zool
Psych	CompSc	Maths
Psych	MPhys	Maths
Psych	Maths	Pharm
Psych	Maths	Physiol

Psych	Maths	Stats
Psych	Pharm	Physiol
Psych	Pharm	Stats
Psych	Pharm	Zool
Psych	Physiol	Stats
Psych	Stats	Zool

Second Year Courses for General and Honours Degree

PSY 2201 General Psychology

History of Psychology and biological foundations of behaviour.

PSY 2202 Introductory Cognitive Psychology

Information processing and visual and auditory perception.

PSY 2203 Developmental and Social Psychology

Introduction to developmental and social psychology.

PSY 2204 Statistics/Psychology & Society

Notes for Students:

Participation in tutorials and essay writing is an important feature of the course.

Statistics

There are no prerequisites for students wishing to take Statistics.

Available subject groupings in Second Science Statistics

Stats	Chem	IndMicro
Stats	Chem	MPhys
Stats	Chem	Maths
Stats	Chem	Pharm
Stats	CompSc	Maths
Stats	ExPhys	Maths
Stats	IndMicro	Maths
Stats	IndMicro	Pharm
Stats	MPhys	Maths

Stats	Maths	Pharm
Stats	Maths	Physiol
Stats	Maths	Psych
Stats	Maths	Zool
Stats	Pharm	Physiol
Stats	Pharm	Psych
Stats	Physiol	Psych
Stats	Psych	Zool

Second Year Courses

STAT 2201 Descriptive Statistics and Statistical Computing

Types of variables and data. Stem-and-leaf displays. Frequency distributions. Histograms. Samples and populations. Transforming data. Numerical summary measures. Summarising bivariate data. Introduction to statistical programming and MINITAB.

STAT 2202 Introduction to Probability and Statistical Inference

Probability concepts. Random variables and probability distributions. The binomial distribution. The normal distribution. Checking for normality. The distribution of a sample mean. Point and interval estimation using a single sample. Hypotheses and test procedures. Errors in hypothesis testing. Tests for population means and proportions using a single sample. P-values.

STAT 2203 Statistical Inference and Goodness-of-fit

Tests and estimation procedures for a difference between two population means or proportions using two independent samples. Tests and estimation procedures for differences using paired data. Distribution free procedures. One- and two-way frequency tables. Hypothesis testing for proportions and independence. Testing the fit for a population model.

STAT 2204 Linear Regression and Analysis of Variance

The simple linear regression model. Inferences based on the estimated regression line. Inferences on the population correlation. Checking model adequacy. Single factor ANOVA. Multiple comparisons. Randomized block experiment. Two-factor ANOVA.

The following four units may only be taken by Second Mathematical Science students:

STAT 2205 Statistical Theory I: Probability

Probability Theory. Combinatorics. Random Variables: univariate, bivariate and multivariate. Moment Generating Functions. Functions of a random variable. Standard Probability Laws.

STAT 2206 Statistical Theory II: Statistical Inference

(a) Estimation Theory: Chebyshev Inequality. Law of Large Numbers. Central Limit Theorem. Methods of moments and maximum likelihood. Point estimation and interval estimation.

(b) Hypothesis Testing: Neyman Pearson Lemma. Likelihood ratio tests.

STAT 2207 Statistical Theory III: Bayesian Statistics and Stochastic Processes

Bayesian statistical inference. Stochastic processes. Poisson processes. Birth and death processes. Branching processes.

STAT 2221 Introduction to Statistical Methods

Data reduction and representation. Probability distributions. Sampling. Confidence intervals. Hypothesis testing. Independent and paired samples. Sample size calculations. Design of experiments. Correlation. Linear regression.

<p style="text-align: center;"><i>Theoretical Physics (SCBDF0012)</i></p>
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Second Year Courses

(MAPH 2200)

Students follow the Second Year Honours course in Mathematics and Second Year course in Experimental Physics. In Mathematical Physics students take the following courses:

MAPH 2111	Methods A
MAPH 2120	Mechanics and Special Relativity
MAPH 2130	Analytical and Quantum Mechanics
MAPH 2140	Ordinary Differential Equations

In addition, students study

Computational Physics

Monte-Carlo Methods: Uniform and non-uniform deviates. Integration. Random walks.

Computational Methods in Quantum Mechanics: Shooting and matching methods. Energy levels of one-dimensional potentials.

and

attend seminars in Experimental Physics

Zoology

Prerequisite Combination in First Science: (a), (d), and (g)

Available subject groupings for Second Science Zoology

Zool	Biochem	Botany
Zool	Biochem	Chem
Zool	Biochem	IndMicro
Zool	Biochem	Maths
Zool	Biochem	Pharm
Zool	Botany	Geology
Zool	Botany	IndMicro
Zool	Botany	Maths
Zool	Botany	Psych
Zool	Chem	Geology

Zool	Chem	IndMicro
Zool	Chem	Maths
Zool	CompSc	Maths
Zool	IndMicro	Maths
Zool	IndMicro	Pharm
Zool	Maths	Pharm
Zool	Maths	Stats
Zool	Pharm	Psych
Zool	Psych	Stats

Second Year Courses for General and Honours Degrees
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ZOOL 2005 Animal Form and Function 1

Comparative anatomy and physiology of invertebrate and vertebrate systems (digestion; respiration/circulation; excretion/osmoregulation; reproduction). Enzymology and metabolism. Correlation between form and function. Adaptation to environment.

ZOOL 2006 Cell and Molecular Zoology

Topics covered include chromosome organisation and genome stability; mutation, repair and recombination; genetic linkage and chromosome mapping; gene expression and its regulation; protein targeting; cytoskeleton and extracellular matrix (ECM); cell-cell and cell-ECM interactions; cell-cycle regulation, apoptosis and cancer.

ZOOL 2007 Animal Ecology

Biotic and abiotic determinants and limiting factors in growth and control of animal populations/communities. Food webs, decomposition processes, nutrient cycling. Features, habitats and fauna of terrestrial, freshwater and marine ecosystems.

ZOOL 2008 Invertebrate Diversity

The Bauplan concept, constraints in body design and comparative biology of the following invertebrate phyla: Protista, Porifera, Cnidaria, Platyhelminthes, Nematoda, Annelida, Mollusca and Echinodermata. Species of economic and medical importance.

Third Science

Regulations for Third Year Science Students

Application for Honours or Topical Degrees

Students will be assigned to places in Third Science courses by the relevant Department Head/Course Director based on the results of the Second Science examinations in Summer. Students interested in pursuing a Topical Degree should note that they must register their interest with the Course Director before the summer examinations as well as fill out a subject choice form.

Students reaching the qualifying standard at the repeat Autumn examinations will be accommodated in an Honours/Topical course provided places are still available. Such students should contact the relevant Department Head/Course Director.

Special Requirements for Admission to some Third Science Courses

Availability of Places in some Third Science Honours Courses

The number of places available in some Third Science Honours courses is limited by the availability of laboratory space, staffing and facilities. Qualification in a particular subject will not necessarily guarantee a place. Students should consult with the Heads of the Departments regarding the availability of places.

Single Honours

Students qualify for admission to a Third Year honours course on the results of the Second University Examination in Science by passing all three subjects at the same examination (either Summer or Autumn) and reaching a minimum of 55% in the subject that the student proposes to study at honours level. A minimum of 60% will apply if the examination is passed in an academic year later than the academic year of entry to the courses or if it is passed by compensation. Exemption from this regulation may be granted for grave reasons by the Faculty of Science.

Single or Joint Honours – Mathematics

To qualify for admission to an honours course in Mathematics students must take the honours papers in these subjects.

Mathematical Science

To qualify for admission to the Third Year of the Mathematical Science degree, students must qualify for the third Science Honours Courses in at least two of the subjects, Mathematics, Mathematical Physics and Statistics, and, in addition, must obtain a minimum of 50% in the other subject. These qualifying standards must be

gained at a single sitting, at either the Summer or Autumn examination. Students passing the examinations but gaining marks less than the requirements revert to the general Science stream.

Theoretical Physics

To qualify for admission to the Third Year of the Theoretical Physics degree, students must obtain the qualifying standard for admission to Honours courses in both Experimental Physics and Mathematical Physics, and in addition, must obtain a minimum of 50% in the Honours course in Mathematics. These qualifying standards must be gained at a single sitting, at either the Summer or Autumn examination. Students passing the examinations but gaining marks less than the requirements revert to the general Science stream.

Joint Honours Degrees

Students wishing to proceed to a Joint Honours Degree course must pass the Second Science Examination and reach a qualifying standard in the two subjects in which they wish to follow a joint honours degree at a single sitting of the Examination, Summer or Autumn. The approval of the Heads of the relevant departments must be obtained.

Genetics and a Biological Subject

Students seeking admission to the Joint Honours Degree in Genetics and a Biological Subject, select one of the following biological subjects: Biochemistry, Botany, Industrial Microbiology, Pharmacology and Zoology. They must:-

- Have followed a Second Science programme containing at least two biological subjects, one of which must be Biochemistry or Industrial Microbiology or Zoology and
- Pass the Second Science examination, obtaining the qualifying standard for admission to the Honours course in their chosen biological subject.

Topical Degrees

Students wishing to proceed to a Topical Degree Course follow the Second Science programme outlined in the relevant Course Syllabus for that Topical Degree.

Admission to the Third Year of the Topical Degrees is granted by the Course Director, following consultation with the relevant departments. Admission is based on academic merit, subject to space and number restrictions in the departments concerned. Students must show a clear ability at the Second Science University Examination in the two subjects that form the core of the Topical Degree in Third Science.

Description of Third Science Degree Programmes

In Third Science, students study 10 units. Each unit comprises 48 contact hours (maximum) made up of lectures, laboratory practicals, field practicals and/or tutorials.

Single Honours Degree (SCBDF0005)

1. Selection of Units

Students admitted to honours courses must attend, for one academic year, eight units in their major subject and two other units. The choice of optional units is at the discretion of the honours subject department. These optional units may be Third Year units from the honours subject or from other Third Year units offered in the Faculty of Science, including language units.

2. Examinations

The examination is taken in ten units.

The examination must be passed at the first attempt.

Honours Standards:

- First Class Honours 70%
- Second Class Honours (Grade I) 62%
- Second Class Honours (Grade II) 55%

Honours may be awarded at the Summer Examination of the first year of sitting only.

Pass Standard:

The pass standard in each unit is 40%. In units including written and practical assessment candidates may be rejected or debarred from passing by compensation on grounds of extreme weakness in one or other part of the examination, in which case a pass mark for the unit will not be granted.

Candidates who attain a mark of 40% overall but who do not attain at least 45% overall will not be permitted to continue in the honours course but will be graduated with the BSc (General) Degree.

Compensation:

A pass by compensation may be granted provided the candidate has reached the pass mark in six units and achieved an overall average of at least 40%.

Award of Honours

Honours are awarded (in the major subject) at the Summer Examination of the first year of sitting only.

Minimum required to continue in Honours Courses

To continue in the Honours course, students must obtain a minimum average of at least 45% in their ten units. Students who have passed the examination but obtain an average of less than 45% will be graduated with a BSc (General) Degree.

3. Theoretical Physics

Students following the Theoretical Physics Degree programme will take a combination of Third and Fourth year courses as set out in the syllabus. The choice of courses is approved by the Heads of the Departments of Experimental Physics and Mathematical Physics.

4. Mathematical Science

Students following the Mathematical Science Degree programme will take ten units from the Third year Honours programme of the three subjects with at least two units from each subject. The choice of courses must be approved by the Course Director.

Joint Honours Degree (SCBDF0006)

1. Approval of Subjects and Units for Joint Honours Degrees

The combination of two subjects for a Joint Honours Degree must have the approval of the Heads of the two departments concerned. Students should pursue five units in each of the two subjects with an overall maximum total of ten units. The selection of units must be approved by the two departments concerned.

2. Award of Honours

Honours are awarded at the Summer Examination of the first year of sitting only.

BSc Topical Degree Programmes (SCBDF0007/8)
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1. Definition of a Topical Degree

The BSc Topical Degree may be defined as a degree programme encompassing more than one subject area. Students need to qualify for the honours degree at the end of Third Science.

2. Degrees Awarded from Topical Programmes

The BSc Topical Degree may be awarded as a General BSc Degree, following three years of study, or as an Honours BSc Degree, following four years of study.

3. Selection of Units

The BSc General Topical Degree will be taken in ten units made up of eight core units and an additional two units. The Course Directors will advise students on their choice of units.

4. Examinations

The BSc General Topical Degree Examination will be held in the ten selected units following completion of the courses. A Supplemental Examination will be held in Autumn.

5. Award of Honours

Honours are awarded based on performance at the Summer Examination of the first year of sitting only. (The regulations governing this examination are contained in Marks and Standard, available for consultation in the Library or at <http://www.ucd.ie/~exams.>)

6. Qualification for Final Honours Year

Students wishing to proceed to a BSc Honours Topical Degree must pass the BSc General Topical Degree Examination at the first attempt, obtaining a minimum average of 55% in six of the eight core units. Students who fail to reach this standard but pass the examination will be awarded the BSc General Topical Degree.

General Degree – One OR Two Subject Programme (SCBDF0003/4)
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1. Selection of Units

Students taking the BSc General Degree study *ten units* as part of either (a) a two subject programme consisting of *four units from each of two subjects* together with *two optional units*, or (b) a one subject programme made up of *eight units in one subject* together with *two optional units*.

The two optional units must be taken at the Third Science level. The main subject departments will advise students on the choice of units and must approve the students' ten units before they can be registered.

Examinations

The Final Examination for the Degree of BSc (General) will be held in the ten selected units in the Summer following completion of the units. A Supplemental

Examination will be held in the Autumn. (The regulations governing this examination are contained in Marks and Standards, available for consultation in the Library or on the web: <http://www.ucd.ie/~exams/>).

Exemption

Students who receive a mark of 40% in any unit may be recommended by the Examiners for exemption from further examination in that unit (c.f. Marks and Standards).

Pass by Compensation

A pass by compensation may be granted at the discretion of the Board of Examiners provided a candidate has passed at least seven units and has an overall average of 40%.

Re-Attendance at Courses

Permission to re-attend courses may be granted on application to the Faculty of Science and the relevant department(s).

4. Admission to Honours Courses based on the BSc (General) Degree

Students who complete the BSc (General) Degree Examination at their first sitting and reach specified standards may be admitted to Honours courses, subject to the availability of places. Faculty does not allow admission to Honours courses based on supplemental or repeat BSc General examinations.

From a one-subject programme

Students who obtain an average of 55% in six of the major subject units and pass the examination may be admitted to a Fourth Science Honours course, subject to the approval of the Department concerned.

Experimental Physics

In the case of Experimental Physics, students who obtain an average of 55% in four of the major subject units and pass the examination, in either the two-subject or one-subject programme, may only be admitted to the Third Science Honours course, subject to the approval of the Department concerned.

From a two-subject programme

Students who obtain an average of 55% in four of the major subject units and pass the examination may be admitted to a Third Science Honours course. The permission of the Head of Department of the major subject is required. Students so admitted to a Third Science Honours course must attend a minimum of six units as recommended by the major subject Department.

In the case of Botany and Computer Science, students who obtain an average of 55% in six appropriate units from the major subject and pass the examination may be admitted to a Fourth Science Honours course. Permission of the Head of Department is required.

Students following a two-subject programme will not be considered for admission to the Honours course in Industrial Microbiology.

Syllabus of Third Year Courses in Science

Applied and Computational Mathematics

Core units are marked with the letter **C**. Descriptions of the units may be obtained from the Third Year courses in Mathematical Physics, Mathematics and Statistics. Students must include the 8 core units as stated and two of the optional units, as recommended by the department.

MATH 3201	Complex Analysis	C
MATH 3204	Groups and Vector Spaces	C
MATH 3223	Differential Equations	C
MAPH 3071	Numerical Methods	C
MAPH 2111	Methods A	C
STAT 3205	Statistical Theory I	C
STAT 3206	Statistical Theory II	C
STAT 3207	Statistical Theory III	C
Students choose 2 optional units as recommended by the Department:		
STAT 3221	Biostatistics	
STAT 3224	Statistics and Visualisation	
MATH 3207	Graph Theory	
MAPH 3180	Dynamical Systems and Chaos	

Biochemistry

Courses for General and Honours Degrees

Third Year Honours and Single Subject General Degree share the same core and optional units. Core units are marked with the letter **C**. Students must include the 8

core units as stated and two of the optional units, as recommended by the department. Details of the optional units may be obtained from the relevant departments.

BIOC 3001	The role of nitrogen compounds in health and disease	C
BIOC 3002	Biochemical Catalysis	C
BIOC 3003	Biochemist's Toolkit	C
BIOC 3004	Gene Manipulation & Regulation	C
BIOC 3005	Disease and Disease Resistance	C
BIOC 3006	Cell Communication and Immunology	C
BIOC3008	Biochemistry and Environment	C
BIOC 3009	Bioinformatics and Proteomics	C
CHEM 3005	Chemistry of Biomolecules	
Students choose two optional units as recommended by the Department:		
STAT 3221	Biostatistics	
PHIL 3008	History and Philosophy of Science	
LANG 3001	Beginners German for Science	
LANG 3002	Beginners Japanese for Science	
LANG 3003	Advanced French for Science (Post-Leaving Certificate)	
LANG 3004	Advanced German for Science (Post-Leaving Certificate)	
LANG 3005	Beginners Spanish for Science	
LANG 3006	Beginners Chinese for Science	

Third Year 2-Subject General Degree take 10 units. Core units are marked with the letter C. Students must include the 8 core units as stated (four Biochemistry units and four units from one other subject) and two of the optional units, as recommended by the department.

BIOC 3001	The role of nitrogen compounds in health and disease	C
BIOC 3002	Biochemical Catalysis	C
BIOC 3003	Biochemist's Toolkit	C
BIOC 3004	Gene Manipulation & Regulation	C
Plus four units from one other subject and two from the following optional units:		
BIOC 3005	Disease and Disease Resistance	
BIOC 3006	Cell Communication and Immunology	
BIOC3008	Biochemistry and Environment	
BIOC 3009	Bioinformatics and Proteomics	

Third Year Joint Honours Degree take 10 units, 5 from Genetics and 5 from Biochemistry. Core units are marked with the letter C. Students must include the 8 core units as stated and two of the optional units, as recommended by the

department. Details of the Genetics units may be obtained under the heading Genetics.

BIOC 3001	The role of nitrogen compounds in health and disease	C
BIOC 3002	Biochemical Catalysis	C
BIOC 3003	Biochemist's Toolkit	C
BIOC 3004	Gene Manipulation & Regulation	C
BIOC 3009	Bioinformatics and Proteomics	C
GENE 3001	Genetics	C
GENE 3002	Genome Structure	C
GENE 3003	Gene Expression	C
Students choose 2 optional units as recommended by the Department:		
BIOC 3005	Disease and Disease Resistance	
BIOC 3006	Cell Communication and Immunology	
BIOC3008	Biochemistry and Environment	

Description of Biochemistry units:

BIOC 3001 The role of nitrogen compounds in health and disease

Protein digestion, amino acid and nucleotide metabolism, diseases resulting from enzyme deficiencies, role of ATP in biosynthesis reactions, nitrogen cycle and protein nutritional requirements in humans.

BIOC 3002 Biochemical Catalysis

Enzyme assays, kinetics and inhibition. Specificity and mechanisms of biocatalysts. Methods for determining catalytic properties.

BIOC 3003 Biochemist's Toolkit

Survey of techniques and methods required for a modern biochemical approach to problems of biology, including absorption and emission spectroscopy such as NMR and fluorescence; separation techniques; techniques for analysis and manipulation of nucleic acids and proteins, etc.

BIOC 3004 Gene Manipulation & Regulation

DNA replication; control of gene expression in prokaryotes and eukaryotes; recombinant DNA technology in industry and medicine; cloning and expression of heterologous genes; generation of transgenic organisms; PCR and DNA fingerprinting.

BIOC 3005 Disease and Disease Resistance

Discussion of the biochemical basis of selected diseases such as prion-related diseases, AIDS, cancer, immune disorders; the cardiovascular system in health and disease. Discussion of inherited disorders and approaches to gene therapy.

BIOC 3006 Cell Communication and Immunology

Membranes, signal transduction and signalling cascades; hormones and the integration of metabolism; neurotransmission; immunology.

BIOC 3007 Advanced Enzymology

An introduction to advanced methods for the analysis of enzymes and enzyme reactions including, the kinetic analysis of multisubstrate enzymes, rapid reaction kinetics, the effects of pH, and the analysis of the allosteric regulation of enzymes.

BIOC 3008 Biochemistry and Environment

The environment as an entity; pollution as a challenge to biochemistry. Biochemical approaches to environmental remediation, protection and enhancement. Xenobiotics; the biochemical effects and transformations of compounds foreign to organisms and the environment.

BIOC 3009 Bioinformatics and Proteomics

Computational molecular biology. Introduction to genomics (studying the entire genome of an organism) and proteomics (the study and analysis of all proteins in a pathway, organ or organism). Extracting information from biological databases; application of genome biology to evolution, anthropology and medicine; drug target identification and validation; pharmacogenomics.

<p><i>Botany</i></p>

<p>Courses for General and Honours Degrees.</p>
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Students must take the following 8 core units and choose from an optional list of units, available from the Department. Core units are marked with the letter C. Details of the optional units may be obtained from the relevant departments.

BOTN 3001	Diversity and Ecology of Fungi	C
BOTN 3002	Plant Population Biology	C
BOTN 3003	Plant/Soil Interactions in Wetlands	C
BOTN 3004	Growth & Nutrient Assimilation	C
BOTN 3006	Seed Plant Reproduction	C
BOTN 3007	Vegetation Ecology and Biogeography	C
BOTN 3008	Plant Biotechnology	C
BOTN 3009	Bioinformatics, Genomics and Proteomics	C
Students also choose two optional units to be decided in consultation with the Department		
GENE 3001	Genetics	
STAT 3221	Biostatistics	
PHIL 3008	History and Philosophy of Science	
LANG 3001	Beginners German for Science	
LANG 3002	Beginners Japanese for Science	
LANG 3003	Advanced French for Science (Post-Leaving Certificate)	
LANG 3004	Advanced German for Science (Post-Leaving Certificate)	
LANG 3005	Beginners Spanish for Science	
LANG 3006	Beginners Chinese for Science	
STAT 3221	Biostatistics	

Description of Botany Units

BOTN 3001 Diversity and Ecology of Fungi

Life cycles, morphology, and ecology of fungi. Examples of important fungal pathogens causing diseases of plants and animals along with aspects of host/pathogen relationships and control. Ecology of soil fungi including those associated with roots of plants.

BOTN 3002 Plant Population Biology

Plant census – origins and development. Modular nature of plant growth and its demographic consequence. Life history – birth, growth, death; varieties of life history, including clonal growth. Population and metapopulation structure and dynamics. Demography and conservation of rare populations.

BOTN 3003 Plant/Soil Interactions in Wetlands

Geochemistry of wetland soils: oxidation/reduction processes, chemical speciation and availability of nutrients. The rhizosphere: root/soil interactions, rhizosphere oxidation by wetland plants. Nutrient cycling.

Behaviour of heavy metals and metalloids in soil and plants: uptake and translocation in plants, turnover by vegetation.

BOTN 3004 Growth & Nutrient Assimilation

Growth measurement patterns of growth in response to the environment. Plant growth regulators: assays, synthesis, transport and metabolism. Tropisms, problems with mechanics. Photosynthetic metabolism: interaction with light and nutrient supply. Nitrogen assimilation of plants; nitrogen fixation.

BOTN 3006 Seed Plant Reproduction

Breeding systems of gymnosperms and angiosperms. Genetic control of flower formation. Development of female gametophytes and pollen grains. Pollination, pollen tube growth mechanisms, gamete formation, fertilization and zygote development. Incompatibility systems and male sterility. Sexual selection, pre- and post-zygotic. Species isolation mechanisms and their breakdown.

BOTN 3007 Vegetation Ecology and Biogeography

Vegetation description and analysis: field methods; the Braun-Blanquet (Zürich-Montpellier) approach to phytosociology; ordination – principles and computer-based techniques. Biogeography – studying plant distributions, Irish biogeography, ecology of the Burren.

BOTN 3008 Plant Biotechnology

Commercial exploitation of biosynthetic capacities of plants. Seed and gene plasma banks. Tissue and organ culture and its use in propagation and production of secondary metabolites: plant cell transformation, molecular probes in study of plant differentiation and development. Micro organisms as biofertilisers and biocontrol agents. Basic aspects of business administration.

BOTN 3009 Bioinformatics, Genomics and Proteomics

Computational molecular biology, Introduction to genomics (studying the entire genome of an organism) and proteomics (the study and analysis of all proteins in a pathway, organ or organism). Extracting information from biological databases; application of genome biology to evolution, anthropology and medicine; drug target identification and validation; pharmacogenomics.

Cell and Molecular Biology

Core units are marked with the letter **C**. Students must include the 8 core units as stated and two of the optional units, as recommended by the department. Details of the units may be obtained from the relevant departments.

BOTN 3009	Plant Specific Cell Biology and Metabolism	C
GENE 3001	Genetics	C
GENE 3002	Genome Structure	C
GENE 3003	Gene Expression	C
PHAR 3001	Chemotherapeutic Agents	C
ZOOL 3010	Animal Development	C
ZOOL 3012	Immunology	C
CELB 3001	Cytoskeletons	C
Students choose two of the following optional units as recommended by the department:		
BIOC 3003	Biochemist's Toolkit	
BIOC 3004	Gene Manipulation & Regulation	
BIOC 3005	Disease and Disease Resistance	
BIOC 3008	Biochemistry and Environment	
BOTN 3004	Growth & Nutrient Assimilation	
BOTN 3006	Seed Plant Reproduction	
BOTN 3008	Plant Biotechnology	
ZOOL 3015	Evolutionary Biology	
STAT 3208	Statistical Methods I	
STAT 3221	Biostatistics	
LANG 3001	Beginners German for Science	
LANG 3002	Beginners Japanese for Science	
LANG 3003	Advanced French for Science (Post- Leaving Certificate)	
LANG 3004	Advanced German for Science (Post-Leaving Certificate)	
LANG 3005	Beginners Spanish for Science	
LANG 3006	Beginners Chinese for Science	

Chemistry

Courses for General and Honours Degrees

Honours students in Chemistry and students following a single subject BSc (General) Degree programme are required to take the seven core units CHEM 3101 to CHEM 3107 inclusive. Core units are marked with the letter **C**. Students also take two of the additional Chemistry units and one other unit as recommended by the

Department. Students following a two subject BSc (General) Degree programme will normally take CHEM 3101, CHEM 3104, CHEM 3105 as Core Units.

CHEM 3101	Transition Metal and Organometallic Chemistry	C
CHEM 3102	Quantum Mechanics, Reaction Kinetics and Electrochemistry	C
CHEM 3103	Synthesis and Reactivity of Organic Compounds	C
CHEM 3104	Structure Determination by Spectroscopic Methods	C
CHEM 3105	Chemistry of the Main Group Elements	C
CHEM 3106	Thermodynamics, Colloid and Surface Chemistry	C
CHEM 3107	Stereochemistry and Mechanism in Organic Chemistry	C
Additional Units		
CHEM 3108	Environmental Chemistry	
CHEM 3109	Chemistry of Materials	
CHEM 3110	Chemistry of Biomolecules	
CHEM 3111	Topics in Organic Synthesis	
Optional Units – details of which may be found under the relevant departments		
CHEN 3025	Process Engineering*	
STAT 3220	Statistics for Chemists	
MATH 3202	Mathematical Techniques	

*Details may be found under optional unit below

Description of Chemistry Units

CHEM 3101 Transition Metal and Organometallic Chemistry

Chemistry of the d-block elements, metal complexes and bioinorganic chemistry. Introduction to organometallic chemistry, metal carbonyls, sandwich compounds, alkene and alkyne complexes.

CHEM 3102 Quantum Mechanics, Reaction Kinetics and Electrochemistry

Quantum Mechanics. Failures of classical mechanics, particle-wave duality. uncertainty principle, particle in a box, tunnelling. Harmonic oscillator and vibrational motion. Angular momentum and rotational motion. Pauli principle. Born-Oppenheimer approximation.

Reaction Kinetics. Consecutive, parallel and opposing reactions. Steady state assumption and numerical integration. Linear and branched chain reactions, explosion limits. Photophysical and photochemical processes. Diffusion controlled reactions, reactions involving ions, solvent effects.

Electrochemistry. Electrolytic dissociation and solvation; conductance measurements including Kohlrausch's Laws; transport numbers and ionic mobility; redox reactions at electrode surfaces including Faraday's Laws; electrode potential and the Nernst equation.

CHEM 3103 Synthesis and Reactivity of Organic Compounds

Introduction to the philosophy and practice of organic synthesis with emphasis on the disconnection approach. Carbonyl reactions, including aldol and Claisen condensations. The Michael, Wittig and Mannich reactions; the alkylation of enolates under thermodynamic or kinetic control. Heterocyclic compounds: formation and substitution reactions; their importance in biology. Syntheses of target molecules, including naturally occurring compounds, pharmaceuticals and fine chemicals.

CHEM 3104 Structure Determination by Spectroscopic Methods

Applications of Spectroscopy. The use of mass spectrometry, ultraviolet/visible spectroscopy, infrared spectroscopy and, in particular, advanced methods of nuclear magnetic resonance spectroscopy for determining the structure of organic compounds.

Introduction to group theory. Applications of group theory to spectroscopy.

CHEM 3105 Chemistry of the Main Group Elements.

Structure and bonding of the main group elements and their compounds. Bonding in ionic solids, metals, semiconductors and insulators with reference to the Born-Haber cycle, Born-Landé and band theory. An introduction to X-ray methods and heterogeneous catalysis will follow.

CHEM 3106 Thermodynamics, Colloid and Surface Chemistry

Solution thermodynamics; partial molar quantities; chemical potential; the Gibbs-Duhem relationship; ideal and real solutions; activity and the activity coefficient; Gibbs phase rule; liquid-vapour equilibrium and phase diagrams.

Dispersions, emulsions, gels, solutions of polymers and copolymers, surfactants. Interfaces and surface tension. Colloidal interaction. Brownian motion. Stability and self-organisation of colloid systems. Monomolecular films. Applications in biotechnology, food, pharmaceutical and other industries.

CHEM 3107 Stereochemistry and Mechanism in Organic Chemistry

Properties and analysis of stereoisomers. Stereoselectivity in organic reactions. Comparative discussion of the structure, preparation and reactivity of alicyclic compounds. Aspects of organic reaction mechanisms.

Additional Units

CHEM 3108 Environmental Chemistry

Atmospheric Pollution. Analytical techniques for the measurement of critical pollutant concentrations in the atmosphere. Chemistry and pollution of the atmosphere: types of pollutants, atmospheric dispersion and transfer of pollutants, photochemical smog, acid deposition, the effect of halocarbon and nitrogen oxide emissions on stratospheric ozone.

Chemical pollution of freshwater and the oceans. Types of pollutants and their effects. The effects of chemical releases on the aqueous environment. Sources of pollution, their fate and analysis; factors influencing the choice of control procedures.

CHEM 3109 Chemistry of Materials

The Preparation and Properties of polymers. Characterization and applications of polymers. The chemistry of new functional materials. Nanostructured materials with emphasise on their use in electronics and drug delivery technology.

CHEM 3110 Chemistry of Biomolecules

Structure, preparation and chemical reactivity of biomolecules, including carbohydrates, amino acids, peptides and bioinorganic compounds. Biopolymers and their chemical interactions with small molecules, including mechanisms of drug-target interaction. Drug discovery and development.

CHEM 3111 Topics in Organic Synthesis

This unit will build on CHEM 3007 and deal with special topics including the use of organometallic compounds in synthesis, further aspects of heterocyclic chemistry, reactive intermediates in synthesis, scale-up and large-scale synthesis.

Optional Unit

CHEN 3025 Process Engineering

Introduction to industrial processes; description of typical processes, flow sheets, flow and batch systems, general concepts of unit operations, stoichiometry. Principles of analysis of distillation units and crystallisers and of chemical reactors.

<i>Computer Science</i>

Third Year Single Honours Degree Programme.
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Core units are marked with the letter **C**. Students must include the 8 core units as stated and two of the optional units in agreement with the department. Details of the optional units may be obtained from the relevant departments.

Students are reminded that choice of third year options may constrain fourth year options available to them. Students must confirm their units with the department before registering them.

Joint-honours students and General students are reminded that selections restrictions do apply and are available from the department.

COMP 3001	Computer Architecture: Digital Systems	C
COMP 3002	Operating Systems I	C
COMP 3006	Program Design & Verification 1	C
COMP 3007	Formal Syntax	C
COMP 3011	Object Oriented Programming	C
COMP 3013	Software Engineering Project	C
COMP 3017	Foundations of Computing	C
MATH 3208	Mathematical Logic	C

Students choose two of the following optional units as recommended by the Department:		
COMP 3003	Visual Computing: Graphics	
COMP 3004	Software Design & Development I	
COMP 3005	Information Systems I	
COMP 3008	Computer Networks	
COMP 3009	Artificial Intelligence	
COMP 3012	Object Oriented Design	
MATH 3207	Graph Theory	
STAT 3224	Statistics and Visualization	
PHIL 3901	History and Philosophy of Science	

Description of Computer Science Units
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COMP 3001 Computer Architecture: Digital Systems

Logic Design; gates; multiplexors; decoders; arithmetic circuits; flip-flops, synchronous/asynchronous circuits, clocks, counters, registers; buses; integrated circuits; field programmable gate arrays; bit slices; memory elements; testing, hardware description language.

Prerequisite: COMP 2002

COMP 3002 Operating Systems I

Introduction to OSs, OS Structure, Hardware features and OSs. Processes: Independent and Co-operative processes, Synchronisation Mechanisms, Deadlocks and Starvation. Memory Management: Binding and Relocation, Memory Organisations (fixed and variable partitions), Paging Technique, Segmentation Technique, Virtual Memory. File Management: File System structures, Files, Directories, File System Implementation. Introduction to Security and Protection: Basic Issues, Security Problem, Authentication, Encryption, Protection Problem, Trusted Systems. Case Studies: Unix, Win NT.

COMP 3006 Program Design & Verification 1

Propositional and predicate calculus; theorem proving; the correctness of programs; WP-calculus; derivation of loop programs; efficiency considerations; strengthening invariants.

COMP 3007 Formal Syntax

Formal languages and their descriptions; grammars; Chomsky hierarchy; regular language; finite state automata; context free grammars; push-down automata; top-down/bottom-up parsing.

COMP 3011 Object Oriented Programming

Fundamental object-oriented concepts: classes, objects, messages, encapsulation, inheritance, polymorphism, dynamic binding; elementary object-oriented design; practical programming in an object-oriented language, e.g. C++.

COMP 3013 Software Engineering Project

A group project in software engineering building a complete system based on the application of analysis, design and implementation techniques.

COMP 3017 Foundations of Computing

Mathematical notation and terminology; finite automata and regular languages; definitions and properties, regular expressions; universal models and computability theory; Turing machines, primitive recursive functions; complexity of algorithms: efficiency of algorithms, complexity classes, complexity analysis in practice.

Optional Units

COMP 3003 Visual Computing: Graphics

Graphics hardware and languages; colour models; window to viewport transformation. clipping algorithms; two dimensional transformations; three-dimensional object representation; parallel and perspective projections; image enhancement; grey level histogram stretching, equalisation, specification; filtering; edge detection.

COMP 3004 Software Design & Development I

Information systems: Users, the technology, the value of information, systems development life cycle (overview): analysis and design methodologies; structured methods; selected system analysis and design techniques; designing structured programs; data environments; programming; software development tools, project management (overview); systems justification.

COMP 3005 Information Systems I

Kinds of information system; DBMS: concepts; 3-level architecture; entity-relationship model; network model and CODASYL; relational model; SQL; database design; normalisation. Information retrieval: classification (heuristic – automatic classification) – graph-theoretic – cluster-based retrieval – user models.

COMP 3008 Computer Networks

Network types, functions, topologies, transmission, switching, routing, management, reference models, architectures, protocols and standards; network user applications; flow and congestion control strategies; design and implementation considerations.

Prerequisite: COMP 2002

COMP 3009 Artificial Intelligence

Predicate calculus, Logic, Problem solving and search: knowledge representation; search techniques, expert systems, machine learning, case-based reasoning, natural language processing, applications of AI, case studies.

Prerequisite: COMP 2003

COMP 3012 Object-Oriented Design

Survey of existing software development methodologies; The Unified Modelling Language; Use cases; Modelling static and dynamic aspects of a system; Case studies; Product and process quality.

Computer Science (Denominated Entry)

Denominated entry students are required to take seven core units, excluding COMP 3006, plus three additional Computer Science units. Details of these units are available from the department.

Environmental Biology

The Third Year Environmental Biology programme comprises ten course units. Eight core units (four from Botany and/or Industrial Microbiology and/or Zoology) are combined with two optional units from the Faculty of Science programme. Core units are marked with the letter C. Selection of core units depends on the student's Second Year subject combination. Selection of all units, both core and optional, must be agreed by the Programme Directors.

Details of the course units are available under the subject listings for Botany, Industrial Microbiology and Zoology.

Core Units in Environmental Biology (8 in total to be chosen from two of the subjects)

Botany core course units^{*1}

BOTN 3001	Diversity and Ecology of Fungi	C
BOTN 3003	Plant/Soil Interactions in Wetlands	C
BOTN 3004	Plant Growth and Nutrient Assimilation	C
BOTN 3007	Vegetation Ecology and Biogeography	C

AND/OR Industrial Microbiology¹ core course units

INDM 3001	Bacteriology and Mycology	C
INDM 3002	Physiology and Biochemistry	C
INDM 3004	Environmental Microbiology	C
INDM 3007	Gene Expression and Regulation	C

AND/OR Zoology core course units

ZOOL 3011	Arthropoda	C
ZOOL 3014	Systems Ecology	C
ZOOL 3016	Diversity of Vertebrates	C
ZOOL 3017	Fisheries and Wildlife Management	C

* Students taking Botany as part of their core course must attend the Burren Field Course (BOTN 4021) after the Summer Examination in their Third Year.

¹Students taking Botany and Industrial Microbiology as their core courses should discuss the choice of units with the Course Director

Students choose two optional units as recommended by the Course Director:

STAT 3221	Biostatistics*	C
BOTN 3002	Plant Population Biology	
INDM 3003	Industrial Microbiology	
INDM 3005	Healthcare Microbiology	
LANG 3001	Beginners German for Science	
LANG 3002	Beginners Japanese for Science	
LANG 3003	Advanced French for Science (Post-Leaving Certificate)	
LANG 3004	Advanced German for Science (Post-Leaving Certificate)	
LANG 3005	Beginners Spanish for Science	
LANG 3006	Beginners Chinese for Science	
PHIL 3901	History and Philosophy of Science	
ZOOL 3013	Animal Behaviour	
ZOOL 3015	Evolutionary Biology	
ZOOL 3017	Wildlife and Fisheries Management	

*All students take STAT 3221, Biostatistics

Environmental Geochemistry

Core units are marked with the letter **C**. Descriptions of the units may be obtained from the Third Year courses in Chemistry and Geology.

The Third Year Environmental Geochemistry programme comprises ten units. Eight core units (three from Chemistry and five from Geology) are combined with two optional units from the Faculty of Science programme to be decided in consultation with the Course Director.

Students please note that the optional units are for guidelines only. Should a student wish to take an alternative unit, they should contact the Department directly. Please note that in certain instances prerequisites apply for certain units. Check the individual departments for details.

CHEM 3001	Organic and Polymer Chemistry	C
CHEM 3002	Inorganic Chemistry	C
CHEM 3018	Environmental Chemistry	C
GEOL 3002	Phanerozoic Stratigraphy	C
GEOL 3003	Precambrian and Geotectonics	C
GEOL 3004	Applied Geology	C
GEOL 3005	Geochemistry	C
GEOL 3013	Applied Geochemistry	C

Students choose 2 optional units as recommended by the Department		
LANG 3001	Beginners German for Science	
LANG 3002	Beginners Japanese for Science	
LANG 3003	Advanced French for Science (Post-Leaving Certificate)	
LANG 3004	Advanced German for Science (Post-Leaving Certificate)	
LANG 3005	Beginners Spanish for Science	
LANG 3006	Beginners Chinese for Science	
PHIL 3901	History and Philosophy of Science	
GEOL 3001	Invertebrate Palaeontology	
GEOL 3005	Geochemistry	
MATH 3203	Advanced Calculus	
MATH 3204	Groups and Vector Spaces	
MAPH 3071	Numerical Methods	
STAT 3208	Statistical Methods I	

Description of Geochemistry Unit:
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GEOL 3013 Applied Geochemistry

Geochemistry of groundwaters, rivers, lakes, estuaries, coasts and the marine environment. Kinetics of mineral-water interactions. Role of particulates, colloids, sorption, desorption, ligand interactions in the hydrosphere. Eh-pH diagrams. Role of organics and organometallic compounds. Bioavailability. Mechanisms and timescales of pollutant recycling and dispersal.

The Third Year course involves geological field classes.

<i>Experimental Physics</i>

2-Subject General Degree

Due to the nature of the course, it is not possible for students to take a Single Subject General Degree Programme in Experimental Physics. Instead, students take a *Two Subject General Degree Programme*.

Students will be required to take a minimum of 4 units or a maximum of 6 units from the following units plus four units (minimum) in the second subject (10 units in total)

EXPH 3001	Electromagnetism, Optics and Special Relativity	
EXPH 3005	Instrument Science	
EXPH 3006	Thermodynamics	
EXPH 3010	Electronics	
EXPH 3012	Nuclear Physics	
EXPH 3016	Atomic, Molecular and Materials Physics	
EXPH 3017	Space and Planetary Science	
Students also choose a minimum of 4 units from the second subject as agreed by both Departments.		

Students please note that they must get the permission of both departments before embarking on a 2-Subject General Degree Programme.

Third Year Single Honours

Students taking an Honours Degree in Experimental Physics will be required to take modules EXPH 3006 to EXPH 3013 inclusive or other modules as may be recommended by the Head of Department.

Advanced Laboratory I

Students are required to complete an appropriate number of mini practical projects. These projects are designed to provide an opportunity to explore a range of areas of physics independently in a supportive environment. In addition to laboratory projects, students will generally undertake a computational and an electronics project. Students will also be required to present a short seminar on some aspect of physics of their choice.

Students taking Experimental Physics units as additional (non-major) units will be required to complete one mini project for each Experimental Physics unit undertaken.

EXPH 3006	Thermodynamics and Statistical Physics	C
EXPH 3007	Solid State Physics	C
EXPH 3008	Electromagnetism	C
EXPH 3009	Optics	C
EXPH 3010	Electronics	C
EXPH 3011	Classical Mechanics and Special Relativity	C
EXPH 3012	Nuclear Physics	C
EXPH 3013	Quantum Mechanics	C

Students choose two optional units as recommended by the Department		
MATH 3201	Complex Analysis	
MATH 3203	Advanced Calculus	
MATH 3204	Groups and Vector Spaces	
MAPH 3071	Numerical Methods	
MAPH 3111	Methods B	
MAPH 3120	Methods C	
Or one unit from the above optional units plus one unit from the following:		
LANG 3001	Beginners German for Science	
LANG 3002	Beginners Japanese for Science	
LANG 3003	Advanced French for Science (Post-Leaving Certificate)	
LANG 3004	Advanced German for Science (Post-Leaving Certificate)	
LANG 3005	Beginners Spanish for Science	
LANG 3006	Beginners Chinese for Science	
PHIL 3901	History and Philosophy of Science	

Third Year Joint Honours Degree Programme

Students must take 5 units from Experimental Physics EXPH 3006-3013 and 5 units from the other subject. Students note that Joint Honours Programmes must only be taken following approval from both departments.

EXPH 3006	Thermodynamics and Statistical Physics	
EXPH 3007	Solid State Physics	
EXPH 3008	Electromagnetism	
EXPH 3009	Optics	
EXPH 3010	Electronics	
EXPH 3011	Classical Mechanics and Special Relativity	
EXPH 3012	Nuclear Physics	
EXPH 3013	Quantum Mechanics	
Students also choose 5 units from the second subject as agreed by both Departments		

Description of Experimental Physics Units
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EXPH 3001 Electromagnetism, Optics and Special Relativity

Maxwell's equations. Electromagnetic waves. The Poynting vector. Fresnel's equations. Non-reflecting and high-reflecting films. Evanescent waves. Transmission lines. Waveguides. Interference and coherence. Michelson interferometer. Fourier transform spectroscopy. Fabry-Perot interferometer. Lasers. Introduction to Special Relativity.

EXPH 3005 Instrument Science

Introduction to measurement systems. Instrument definition, static and dynamic characteristics. Zero, first and second order instrument systems. Deterministic and random noise. Noise reduction and signal processing techniques. Digital-to-analogue and analogue-to-digital conversion. Sensor conversion processes. Mechanical, electrical, electronic, optical and opto-electronic transducers. Thermoelectric and piezo-electric systems.

EXPH 3006 Thermodynamics and Statistical Physics

Temperature. First law of thermodynamics. Work and energy. Second law. Carnot cycle. International temperature scale. Entropy. Maxwell relationships. Applications of thermodynamics. Phase changes. Thermal radiation. Introduction to statistical physics. Maxwell-Boltzmann statistics and applications. Fermi-Dirac statistics. Bose-Einstein statistics. Planck's Law. B-E condensation. Properties of liquid helium.

EXPH 3007 Solid State Physics

Binding forces in crystals. Lattice dynamics – vibrational modes. Acoustic and optical branches, phonons. Lattice specific heats – Einstein and Debye models. Classical free electron gas; quantum effects; Fermi energy; pressure of an electron gas; specific heat of a degenerative electron gas. Periodic lattices; Bloch functions; Kronig-Penney model – band structures. Paramagnetism.

EXPH 3008 Electromagnetism

Vector and scalar fields. The vectors **E**, **D**, **B**, **H**, **M** and **P**. Maxwell's equations. Lorentz gauge. Electromagnetic waves. The scalar and vector potentials. Field-defining equations. Energy transport. Wave propagation in dielectrics and metals. Dispersion. Plasma frequency. Refractive index of plasmas and metals. Transmission lines. Resonant cavities. Waveguides.

EXPH 3009 Optics

Geometrical optics – thin lenses, aperture and field stops, thick lenses, aberrations, optical instruments. Matrix optics, Fourier theory and Fraunhofer diffraction. Fresnel diffraction. Coherence. Convolution and correlation. Optical processing and imaging. Holography. Interferometers.

Prerequisite: EXPH 2001.

EXPH 3010 Electronics

An introduction to analogue electronics with emphasis on operational amplifiers and their applications to analogue signal processing. Topics covered include negative feedback, analogue computation, linear and non-linear circuits. An introduction to digital electronics is also presented with emphasis on the TTL logic family, in particular, gates, monostables, counters and applications. The influence of noise in electronic circuits is also discussed.

EXPH 3011 Classical Mechanics and Special Relativity

Classical mechanics – Variational principles and Lagrange's equations. The central force problem. Hamilton's equations. Special relativity – classical background. Michelson-Morley experiment. Einstein's postulates. Lorentz transformation equations experimental confirmation. Geometrical representation. Four vectors and relativistic invariance. Energy-momentum transformation equations. Relativistic momentum energy relationship. The transformation of force.

Prerequisite: EXPH 2003

EXPH 3012 Nuclear Physics

Introduction and basic concepts. Natural and artificial radioactivity. Interaction of radiation with matter. Alpha decay. Beta decay and the electron neutrino. Parity and its non-conservation. Gamma decay. Internal conversion. γ – γ correlation. Liquid drop model of the nucleus. Spontaneous and induced fusion. Fission reactors. Neutron activation analysis. Nuclear reactions.

EXPH 3013 Quantum Mechanics

Postulates of Quantum Mechanics. Operators, observables and eigenfunctions. Co-ordinate and momentum representations. Hermitian operators. Matrix methods. Uncertainty Principle. Ehrenfest's theorem. Harmonic oscillator. Ladder operators. Angular momentum. Schrödinger theory of the hydrogen atom. Degeneracy. Fine structure. Normal Zeeman effect. Pauli theory of electron spin. Stern-Gerlach experiment. Spin-orbit interaction. Total angular momentum. Clebsch-Gordan coefficients.

EXPH 3016 Atomic, Molecular and Materials Physics

Brief review of Quantum Mechanics. Hydrogen atom: spectrum and structure. Spin, the Zeeman effect and spin orbit interaction. Structure

and spectra of many electron atoms. Covalent, ionic and van der Waals bonding. Molecular structure and spectra. Lithography, epitaxy and other semiconductor fabrication processes. Impurity and defect analysis in surfaces and bulk materials. Gallium arsenide, silicon and diamond structures. Quantum wells, wires and dots. Magnetic properties of materials. New magnetic materials.

EXPH 3017 Space and Planetary Science

Introduction to the solar system and its constituents: the Sun; the planets and their moons; comets; asteroids; meteorites and dust. The Oort cloud and the Kuiper belt. Impacts. The formation, evolution and dynamics of the solar system. The solar wind and aurorae. Coronal mass ejections. Space weather. Solar system exploration missions of NASA and ESA. Extrasolar planets. Spectroscopic and photometric planetary detection techniques. Exobiology.

<i>Genetics</i>

Students seeking admission to the Joint Honours Degree in Genetics and a Biological Subject, select one of the following biological subjects: Biochemistry, Botany, Industrial Microbiology, Pharmacology and Zoology. They must: -

Have followed a Second Science programme containing at least two biological subjects, one of which must be Biochemistry or Industrial Microbiology or Zoology.

Pass the Second Science examination, obtaining the qualifying standard for admission to the Honours course in their chosen biological subject.

Courses for General and Honours Degrees
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GENE 3001 Genetics

Mendelian Genetics: comprehensive treatment of basic concepts; genetic crosses; continuous variation; partial and co-dominances; gene interactions; linkage and chromosome mapping.

Molecular Genetics: DNA structure; transcription; chromatin structure. Recombinant DNA technology: restriction enzymes; DNA cloning; sequence analysis; PCR.

Applied Molecular Genetics: Map based cloning. Tools for genetic analysis; mini-satellites; RFLPs. Genetic analysis of human diseases: cystic fibrosis.

GENE 3002 Genome Structure

Gene 3002 outlines the structure of the Eukaryotic genome with an emphasis on the dynamic nature of the evolving genome. The unit covers topics in gene splicing, C-value and multigene family paradoxes, repetitive elements, and examples of programmed genetics variation such as the mechanism underpinning antibody diversity.

GENE 3003 Gene Expression

Regulation of gene expression: transcription, termination, anti-termination, attenuation, translational feedback control, antisense RNA. Bacteriophage lambda as a model system. Regulation of gene expression in eukaryotes: basal transcription complex; enhancers, signal chain transduction in plants. Genomic imprinting. Mechanisms of recombination: gene conversion, transposition, retroposons and retroviruses. Homologous recombination, its use in transgenesis.

BIOC 3004 Gene Manipulation, Regulation and Evolution

For details of unit see under Biochemistry.

<i>Geology</i>

Courses for General and Honours Degrees

Honours students in Geology take GEOL 3001 to 3009 inclusive. Students following a two subject BSc (General) degree programme will normally take GEOL 3001 to 3004 inclusive. Students following a single subject BSc (General) degree programme will take GEOL 3001 to 3009 inclusive.

Core units are marked with the letter C.

Third Year General and Single Honours Degree Programmes

Students please note that the optional units are for guidelines only. Should a student wish to take an alternative unit, they should contact the Department directly. Please note that in certain instances prerequisites apply for certain units. Check the individual departments for details.

GEOL 3001	Invertebrate Palaeontology	C
GEOL 3002	Phanerozoic Stratigraphy	C
GEOL 3003	Precambrian and Geotectonics	C
GEOL 3004	Applied Geology	C
GEOL 3005	Geochemistry	C
GEOL 3006	Sedimentology and Volcanology	C
GEOL 3007	Structural, Petroleum Geology	C
GEOL 3008	Igneous, Metamorphic Petrology	C
GEOL 3009	Applied Geophysics	C
Students choose one of the following optional units as recommended by the department		
CHEM 3018	Environmental Chemistry	
GEOL 3010	Seismology, Global Geophysics	
GEOL 3013	Applied Geochemistry	
LANG 3001	Beginners German for Science	
LANG 3002	Beginners Japanese for Science	
LANG 3003	Advanced French for Science (Post-Leaving Certificate)	
LANG 3004	Advanced German for Science (Post-Leaving Certificate)	
LANG 3005	Beginners Spanish for Science	
LANG 3006	Beginners Chinese for Science	
PHIL 3901	History and Philosophy of Science	
ZOOL 3014	Systems Ecology	

Third Year 2-Subject General Degree Programme

Core units are marked with the letter C. Students will be required to take a minimum of 4 units shown below, plus four units (minimum) in the second subject (10 units in total). Students note that a 2-Subject General Programme may only be taken with the permission of the two departments.

GEOL 3001	Invertebrate Palaeontology	C
GEOL 3002	Phanerozoic Stratigraphy	C
GEOL 3003	Precambrian and Geotectonics	C
GEOL 3004	Applied Geology	C

Description of Geology Units

GEOL 3001 Invertebrate Palaeontology

Classification, evolution, adaptive morphology and stratigraphical range of the following invertebrate phyla: Mollusca (Bivalvia, Cephalopoda, Gastropoda), Echinodermata (Crinoidea, Echinoidea), Brachiopoda, Cnidaria, Arthropoda (Trilobita), and Porifera. Microfossils, trace fossils,

mass-extinctions and colonising of the land by plants. Practical work involves description and recognition of major forms from each phylum.

GEOL 3002 Phanerozoic Stratigraphy

Stratigraphic principles. Study of Cambrian to Recent stratigraphy of Britain and Ireland, using the concept of orogenic cycles and plate tectonic models. Pleistocene stratigraphy and climate. Practical work includes geological survey map sheets.

Prerequisite: Second Science Geology

GEOL 3003 Precambrian and Geotectonics

Introduction to radiogenic isotope systems and geochronology. Precambrian time subdivisions. Precambrian geological evolution of Canada, Scandinavia, Britain and Ireland. The Dalradian Supergroup. Seafloor spreading. Plate motion studies: Magnetic, seismic and geological methods. Rifts. Destructive plate margins. Accretionary prisms. Orogenic belts: Caledonian, Variscan (Hercynian), Alpine-Himalayan. Practical work on geological survey maps.

Prerequisite: Second Science Geology

GEOL 3004 Applied Geology

Occurrence, mode of formation of metallic ore and industrial mineral deposits. Geochemistry exploration. Petroleum Geology and seismic interpretation. Coal Geology. Hydrogeology and Engineering Geology.

Prerequisite: Second Science Geology

GEOL 3005 Geochemistry

Radiogenic and stable isotope geochemistry. Geochronology. Analytical methods. Use of geochemical variation diagrams in crystal-liquid systems. Meteorites and the composition of the solar system; composition and chemical evolution of the Earth and Moon. Element partitioning between crystals and melts; partial melting and fractional crystallization. Silicate magma structure. Chemical weathering, sediment geochemistry and provenance. Use of stable isotopes.

Prerequisite: Second Science Geology

GEOL 3006 Sedimentology and Volcanology

Principals of facies and sequence analysis. Earth surface processes. Depositional models. Sedimentary structures and deposits of the main continental, paralic and marine environments. Palaeocurrents and

provenance. Volcano eruption mechanisms, pyroclastic and epiclastic deposition. Stratigraphic and plate tectonic context of volcanic and volcanoclastic rocks. Volcanic hazards.

Prerequisite: Second Science Geology

GEOL 3007 Structural, Petroleum Geology

Coaxial and non-coaxial deformation and the brittle and ductile structures produced. Volume change and slaty cleavage. Transpression and transtension. Recognition of shear sense and kinematic indicators. Multiple deformation. Shallow and deep crustal structure. Basin development and analyses. Seismic reflection profiling and seismic stratigraphy. Origin, migration and accumulation of hydrocarbons. Oil exploration.

Prerequisite: Second Science Geology.

GEOL 3008 Igneous, Metamorphic Petrology

Classification of igneous rocks. Petrogenesis of mid-ocean ridge, subduction-related, intraplate, rift-related, potassic, ultrapotassic and granitic rocks. Magmatic processes in layered basic intrusions, ophiolites and Alpine peridotites. Geothermobarometry, equilibrium thermodynamics and Schreinemakers' method. Metamorphic reactions, isograds and metamorphic zonal schemes for pelites. Scottish and Irish Dalradian. Blueschist and Granulite facies. Migmatites. Metamorphism of ultramafic rocks. PTt paths and tectonic setting of regional metamorphism.

Prerequisite: Second Science Geology

GEOL 3009 Applied Geophysics

Gravity methods. Magnetic methods. Engineering and exploration seismology. Applied tomography. Electromagnetic exploration techniques. Electrical methods in exploration. Side scan sonar. Borehole methods. Ground penetrating radar. Survey design. Position fixing.

Geophysical Science

The Third Year Geophysical Science programme comprises ten units. Eight core units (three from Experimental Physics and five from Geology) are combined with two optional units from the Faculty of Science programme to be decided in consultation with the Course Director.

Students please note that the optional units are for guidelines only. Should a student wish to take an alternative unit, they should contact the Department directly. Please note that in certain instances prerequisites apply for certain units. Check the individual departments for details.

EXPH 3005	Instrument Science	C
EXPH 3008	Electromagnetism	C
EXPH 3010	Electronics	C
GEOL 3002	Phanerozoic Stratigraphy	C
GEOL 3003	Precambrian and Geotectonics	C
GEOL 3008	Igneous, Metamorphic Petrology	C
GEOL 3009	Applied Geophysics	C

and either

GEOL 3010	Seismology, Global Geophysics	
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or

GEOL 4013	Data Processing and the Crust	
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Students choose 2 of the following optional units as recommended by the Department:

LANG 3001	Beginners German for Science	
LANG 3002	Beginners Japanese for Science	
LANG 3003	Advanced French for Science (Post-Leaving Certificate)	
LANG 3004	Advanced German for Science (Post-Leaving Certificate)	
LANG 3005	Beginners Spanish for Science	
LANG 3006	Beginners Chinese for Science	
PHIL 3901	History and Philosophy of Science	
GEOL 3001	Invertebrate Palaeontology	
GEOL 3007	Structural, Petroleum Geology	
GEOL 3010	Seismology, Global Geophysics	
CHEN 3025	Process Engineering	

Description of Geophysics Unit

GEOL 3010 Seismology, Global Geophysics

Material flow properties, strain rate and viscosity. Time and temperature effects on rheology. Earthquake location, quantification, source mechanisms. Models for earthquake genesis. Friction. Fracturing, failure, brittle-ductile transitions. Seismic cycle, earthquake prediction. Seismotectonics. Seismic radiation and deep structure. Wave attenuation. Tomography. Long period oscillations of the Earth.

The Third Year courses involve both geological and geophysical field classes.

History and Philosophy of Science

This course may be taken as an optional unit in Third Science. Students should consult with their course director before signing up for this course.

PHIL 3901 History and Philosophy of Science

What is Science? Origins and growth of 'western' natural philosophy from ancient Greece to seventeenth century Europe. Philosophy of Science, including empiricism, induction, conjecture and refutation, scientific revolution and incommensurability, realism, constructive empiricism. Role of Mathematics in Natural Philosophy, ancient to modern; foundations of Mathematics.

Industrial Microbiology

Courses for General and Honours Degrees

Prerequisite for all units: INDM 2001 to INDM 2004 inclusive.

Students not taking Industrial Microbiology as a full subject but wishing to select optional units from the Industrial Microbiology programme, must have the approval of the Head of the Department of Industrial Microbiology.

INDM 3001	Bacteriology and Mycology	C
INDM 3002	Physiology and Biochemistry	C
INDM 3003	Industrial Microbiology	C
INDM 3004	Environmental Microbiology	C
INDM 3005	Healthcare Microbiology	C
INDM 3006	Medical Microbiology	C
INDM 3007	Gene Expression and Regulation	C
INDM 3008	Applied Enzymology	C
INDM 3011	Special Topics	C
STAT 3221	Biostatistics	C

Description of Industrial Microbiology Units

INDM 3001 Bacteriology and Mycology

Structure-function relationships within the prokaryotic cell. Methods of studying cell structure and function. The contribution of organelles to bacterial activities. Fungal nutritive modes. Fungi as agents of decay and disease in plants and animals. Bacteria and fungi as producers of secondary metabolites.

INDM 3002 Physiology and Biochemistry

Biosynthesis of amino acids and nucleotides. Metabolic pathways and molecular biotechnology. Industrial production of amino acids. Principles of microbial growth and cultivation. Fermentation systems – development and application of batch, fed-batch and continuous culture techniques. Environmental factors influencing microbial growth.

INDM 3003 Industrial Microbiology

Principles of biotechnological processing: Bioreactor design, process analysis and models. Case studies from the brewing and fermentation industries. Food Microbiology: Microbial sources of contamination. Food spoilage and factors influencing it. Traditional and alternative methods of preservation.

INDM 3004 Environmental Microbiology

Ecology and environmental interactions of microorganisms in diverse ecosystems. An assessment of microbial activities within the soil, freshwater and marine environments. Pollution of natural waters and the role of microorganisms in waste treatment. Microorganisms in extreme environments.

INDM 3005 Healthcare Microbiology

Microbial spoilage. Prediction of product shelf-life. Antiseptics, disinfectants and preservatives. Principles and practice of sterilisation. Application of microorganisms in biotransformation/synthesis of pharmaceuticals. Quality function in the healthcare industry. Process monitoring and validation. Controlled environments, clean-air maintenance and standards. Antibiotics, activity spectra and mechanisms of anti-microbial action. Infectious drug resistance.

INDM 3006 Medical Microbiology

Basic immunology and antigen/antibody reactions. Spread of infection and 'host-parasite' relationships. Bacteriology: Anaerobic infections, zoonoses, enterobacteria, bacterial chemotherapy and sterilisation. Virology: Introduction, morphology, replication and classification of DNA and RNA viruses. Enteroviruses, herpes-viruses, myxoviruses, tumor viruses, hepatitis and diagnostic virology.

INDM 3007 Gene Expression and Regulation

Theory and practice of mutation. Principles and practice of gene manipulation. Industrial strain development. Gene expression in prokaryotes and eukaryotes. Overexpression of cloned genes.

INDM 3008 Applied Enzymology

Enzymes as industrial catalysts. Enzyme development for large scale processes – screening, production, purification and applications. Kinetics and applied enzymology.

INDM 3011 Special Topics

A wide range of topics covering the special interests of the staff in the Department will be offered and students will be expected to undertake a literature survey on one of those topics and make written and oral presentations.

Languages

The Applied Language Centre offers a number of courses, one of which may be selected as an optional unit by Third Science students. Students should consult with their course director before signing up for this course.

LANG 3001	Beginners German for Science
LANG 3002	Beginners Japanese for Science
LANG 3003	Advanced French for Science (Post- Leaving Certificate)
LANG 3004	Advanced German for Science (Post-Leaving Certificate)
LANG 3005	Beginners Spanish for Science
LANG 3006	Beginners Chinese for Science

For Beginners courses, no previous knowledge of the language is needed. The following topics are covered: oral communication in everyday situations; introduction to scientific reading texts; basic grammatical structures; functional writing.

For Post-Leaving Certificate courses, students should note that Leaving Certificate or the equivalent standard is required. Courses cover the following topics: communicating in face-to-face professional situations; making oral presentations; skills in listening comprehension; functional writing skills, e.g. report-writing, correspondence, etc.

Mathematical Physics

2-Subject General Degree Programme

Due to the nature of the course, the Single Subject General Degree Programme is not offered in Mathematical Physics. Instead, students take the 2-Subject General Degree Programme.

Students take a maximum of 10 units. Core units are marked with the letter C. Students must take a minimum of four units: MAPH 3011, MAPH 3021, MAPH 3030 and either MAPH 3041 or MAPH 3071, along with the second subject, chosen in agreement with the two departments. Core units are marked with the letter C.

MAPH 3011	Mechanics and Special Relativity	C
MAPH 3021	Analytical and Quantum Mechanics	C
MAPH 3030	Electrostatics/Quantum Mechanics	C

And one of the following units:		
MAPH 3041	Methods 3	
MAPH 3071	Numerical Methods	
Students also choose a second subject in agreement with the two departments		

Third Year Single Honours Degree Programme

Core units are marked with the letter **C**. Students must include the 8 core units as stated and two of the optional units, as recommended by the department. Details of the optional units may be obtained from the relevant departments.

Students who have taken the Second Year Honours courses take MAPH 3111, MAPH 3120, MAPH 3130, MAPH 3141, MAPH 3151, MAPH 3161, MAPH 3171, MAPH 3180. Students who have not taken the Second Year Honours courses take MAPH 3010, MAPH 3021, MAPH 3111, MAPH 3120, MAPH 3130, MAPH 3161, MAPH 3171 and MAPH 3180.

Students who have taken Second Year Honours courses:		
MAPH 3111	Methods B	C
MAPH 3120	Methods C	C
MAPH 3130	Thermal and Statistical Physics	C
MAPH 3141	Potential Theory	C
MAPH 3151	Electromagnetic Theory	C
MAPH 3161	Quantum Mechanics	C
MAPH 3171	Fluid Mechanics	C
MAPH 3180	Dynamical Systems and Chaos	C
Students who have not taken Second Year Honours courses:		
MAPH 3011	Mechanics and Special Relativity	C
MAPH 3021	Analytical and Quantum Mechanics	C
MAPH 3111	Methods B	C
MAPH 3120	Methods C	C
MAPH 3130	Thermal and Statistical Physics	C
MAPH 3161	Quantum Mechanics	C
MAPH 3171	Fluid Mechanics	C
MAPH 3180	Dynamical Systems and Chaos	C
Plus two optional units chosen in agreement with the Department		

Third Year Joint Honours Degree Programme

Students take 10 units, 5 from Mathematical Physics as stated and 5 from another subject in agreement with the two departments. Core units are marked with the letter C.

Students should consult the Department about prerequisites. Units MAPH 3081, MAPH 3211, MAPH 3220, MAPH 3231 and MAPH 3241 may not be offered every year.

MAPH 3111	Methods B	C
MAPH 3120	Methods C	C
MAPH 3130	Thermal and Statistical Physics	C
MAPH 3160	Quantum Mechanics	C
MAPH 3171	Fluid Mechanics	C

Description of Mathematical Physics units:

MAPH 3011 Mechanics and Special Relativity

Mechanics: Dynamics of rigid bodies, rotating earth, spinning top, moments of inertia, principal axes, Euler's equations of motion.

Special Relativity: Inertial frames, Lorentz transformations, space-time, tensors, relativistic mechanics, energy-momentum conservation.

MAPH 3021 Analytical and Quantum Mechanics

Analytical Mechanics: Lagrange's equation, variational principles. Small oscillations, normal modes. Hamilton's equations, canonical transformations, Poisson brackets.

Quantum Mechanics: Introduction, Postulates of Quantum Mechanics, One-dimensional examples: Potential well and harmonic oscillator, the Heisenberg uncertainty principle, Quantum tunnelling.

MAPH 3030 Electrostatics/Quantum Mechanics

Electrostatics: Electrostatic potential; Gauss's law; Poisson's equation; dielectrics; electrostatic energy.

Quantum Mechanics: Postulates of quantum mechanics, uncertainty principle, one-dimensional systems including the harmonic oscillator, angular momentum, hydrogen atom, time evolution.

MAPH 3041 Methods 3

Partial Differential Equations of Physics

First order ordinary differential equations. Systems of first order linear and non-linear ordinary differential equations; critical points and stability. First order linear and non-linear partial differential equations and the method of characteristics. Classification of second order linear partial differential equations. Integral transforms.

MAPH 3071 Numerical Methods

Solution of equations by iteration. Numerical integration and differentiation. Numerical methods for differential equations. Systems of linear equations. Gauss elimination.

MAPH 3081 Computational Physics

Ordinary differential equations; initial value (satellite motion and chaotic systems) and boundary value problems (energy eigenvalues of Schrödinger's equation). Partial differential equations; finite differences and finite elements (wave motion, heat transfer equation, Schrödinger's equation and Poisson's equation). Monte Carlo methods; kinetic theory of gases and the Ising model for ferromagnetism.

MAPH 3091 Mathematical Modelling

Methods of Mathematical Modelling: Non-dimensionalisation, asymptotics, perturbation methods.

Mathematical Models: Diffusion models, viscous fluid flow, solid mechanics, electromagnetic wave propagation.

MAPH 3111 Methods B

Complex Variables:

Cauchy-Riemann equations, singular points. Complex integration (Cauchy's theorem, line integrals). Taylor and Laurent series. The Residue Theorem.

Euclidean Spaces:

Convergence, Bessel's inequality, Parseval's equality. Fourier series (Piecewise continuous functions, Riemann-Lebesgue lemma, Weierstrass approximation theorem, Pointwise convergence). Orthogonal series of polynomials (Legendre polynomials, Hermite polynomials, Laguerre polynomials, Bessel functions).

MAPH 3120 Methods C

First order partial differential equations. Second order linear partial differential equations – classification, uniqueness, stability. The wave equation, diffusion equation and Laplace’s equation. Separation of variables, Laplace and Fourier transforms. Green’s functions. Perturbation methods.

MAPH 3130 Thermal & Statistical Physics

Thermodynamics: Laws of thermodynamics, temperature, entropy, Clausius’s theorem, Maxwell’s relations.

Kinetic Theory: Maxwell’s distribution, the Boltzmann equation, Maxwell-Boltzmann distribution.

Introduction to Statistical Mechanics: The microcanonical, canonical and grandcanonical ensembles, the classical ideal gas, quantum statistical mechanics, the ideal Fermi and Bose gases, the imperfect Fermi gas.

MAPH 3141 Potential Theory*

Electrostatics: electrostatic potential; Gauss’s law; Poisson’s equation; dielectrics; electrostatic energy. Magnetic fields due to steady currents: vector potential; Ampère’s circuital law; magnetic materials.

MAPH 3151 Electromagnetic Theory*

Maxwell’s equations. Energy and momentum: Poynting vector. Plane waves in non-conducting and conducting media. Wave guides. Radiation from bounded sources. Liénard-Wiechert potentials. Relativistic formulation of electro-magnetic theory.

MAPH 3160 Quantum Mechanics

Hilbert spaces, Hermitian and unitary operators, observables, probability measures, spectral measures. Postulates of quantum mechanics, uncertainty principle, harmonic oscillator, creation and annihilation operators, angular momentum, hydrogen atom. Perturbation theory and Rayleigh’s variational principle. WKB approximation. Time evolution in the Schrödinger picture and Heisenberg picture.

* Units MAPH 3141 and MAPH 3151 must be taken together.

MAPH 3171 Fluid Mechanics

Representation of fluid flow, elementary physical considerations, Stokes' analysis, velocity potential for irrotational flows, stream functions for incompressible flows, Navier Stokes' equations, inviscid flow equations, motion of a sphere through an incompressible fluid, 2D incompressible flows, conformal transformations, sound waves, water waves.

MAPH 3180 Dynamical Systems and Chaos

Phase portraits, flows and evolution

Linear systems: Classification of linear systems, phase portraits of linear systems.

Non-linear systems in the plane: Local and global behaviour, fixed points, linearization, stability of fixed points, limit points and limit cycles, Poincaré-Bendixson theory.

Non-linear systems in higher dimensions: Hyperbolic and non-hyperbolic fixed points, closed orbits, attracting sets and attractors.

Chaotic orbits.

MAPH 3211 General Relativity & Cosmology

This course is an introduction to General Relativity and Cosmology:

Tensor calculus. Einstein's field equations. Static and stationary black holes. Energy extraction from rotating black holes. Cosmological models.

MAPH 3220 Electromagnetic Theory (Minor)

Electrostatics. Magnetostatics. Maxwell's equations. Plane electromagnetic waves. Scalar and vector potentials, radiation. Relativistic formulation of electromagnetic theory.

MAPH 3231 Gauge Field Theory

This course is an introduction to Gauge Field Theory:

Introduction to Lie groups and Lie algebras. Yang-Mills field equations. Magnetic monopole and instanton solution. Gauge theory of the standard model of Electro-Weak interactions.

Mathematical Science

Students take ten units with at least two units from each subject. The combination of courses must be approved by the Course Director. Details on each unit may be found under the relevant subjects.

Mathematics		
MATH 3102	Field Theory	
MATH 3104	Functions of One Complex Variable	
MATH 3105	Logic and foundation of Mathematics	
MATH 3106	Algorithms	
MATH 3107	History of Mathematics	
MATH 3109	Advanced Linear Algebra	
MATH 3110	Metric Spaces	
Mathematical Physics		
MAPH 3120	Methods C	
MAPH 3130	Thermal and Statistical Physics	
MAPH 3141	Potential Theory	
MAPH 3151	Electromagnetic Theory	
MAPH 3160	Quantum Mechanics	
MAPH 3171	Fluid Mechanics	
MAPH 3180	Dynamical Systems and Chaos	
Statistics		
STAT 3208	Statistical Methods I	
STAT 3209	Statistical Methods II	
STAT 3210	Data Analysis and Statistical Software	
STAT 3216	Actuarial Statistics I	
STAT 3217	Actuarial Statistics II	
STAT 3222	Stochastic Processes I	

<i>Mathematics</i>

2-Subject General Degree

Due to the nature of the course, it is not possible to take a Single Subject General Degree Programme in Mathematics. Students take a 2-Subject General Degree following agreement with the department.

MATH 3201	Complex Analysis	
MATH 3203	Advanced Calculus	
MATH 3204	Groups and Vector Spaces	
MATH 3205	Combinatorial Mathematics	
MATH 3207	Graph Theory	
MATH 3208	Mathematical Logic	
MATH 3202*	Mathematical Techniques	

* Available only to students who have **not** taken Second Year Mathematics

Third Year Single Honours.

Students take a total of 10 units, 6 core units, 2 additional Mathematics units and 2 optional units as recommended by the Department

MATH 3102	Field Theory	C
MATH 3104	Functions of One Complex Variable	C
MATH 3105	Logic and Foundations of Mathematics	C
MATH 3106	Algorithms	C
MATH 3109	Advanced Linear Algebra	C
MATH 3110	Metric Space	C

Students choose 2 additional units:

MATH 3107	History of Mathematics	
MATH 3203	Advanced Calculus	
MATH 3205	Combinatorial Mathematics	
MATH 3207	Graph Theory	
Students choose 2 optional units as recommended by the Department		

Third Year Joint Honours.

Students take the following core courses. Students note that joint honours programmes must only be taken with the permission of both departments.

MATH 3102	Field Theory	C
MATH 3104	Functions of One Complex Variable	C
MATH 3105	Logic and Foundations of Mathematics	C
MATH 3109	Advanced Linear Algebra	C
MATH 3110	Metric Space	C

Description of Mathematics Units:
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MATH 3201 Complex Analysis

Analytic functions. Cauchy's theorem and Cauchy's integral formula. Integrals and residues.

MATH 3202 Mathematical Techniques

Functions of one and several variables. Partial derivatives and differential equations. Eigenvectors and eigenvalues. Applications to chemistry.

This course is not available to students who have taken Second Year Mathematics.

MATH 3203 Advanced Calculus

Vector fields. Green's theorem. Stokes's theorem and the divergence theorem. Fourier and Laplace transforms with applications to differential equations.

MATH 3204 Groups and Vector Spaces

Permutation groups, matrix groups and symmetry groups. General properties of groups. Representations of groups by matrices.

MATH 3205 Combinatorial Mathematics

Congruences and finite fields. Error-detecting and error-correcting codes. Hamming codes, Huffman codes, RSA codes. Information and entropy. Shannon's first theorem.

MATH 3206 Linear Programming

Formulation of linear programmes problems. The simplex algorithm. Duality.

MATH 3207 Graph Theory

Trees. Paths and circuits in graphs. Planar and dual graphs. Graph-theoretic algorithms.

MATH 3208 Mathematical Logic

Formal systems and rules of deduction. Consistency and completeness. First order languages. Godel-Henkin completeness theorem. Resolution in the propositional calculus.

MATH 3209 Special Topics

Courses on special topics may be offered, depending on demand. Students may also be given permission to take part of an Honours course as a Special Topic.

Honours Courses

MATH 3102 Field Theory

A review of ring theory. Construction of fields. Roots of polynomials. Finite fields . Galois theory.

MATH 3104 Functions of one complex variable

Cauchy-Riemann equations, Cauchy's integral theorems, Taylor and Laurent expansions, identity theorem for analytic functions, residues, applications to evaluation of integrals and summation of series, maximum-modulus principle, Schwarz's lemma, principle of the argument.

MATH 3105 Logic and Foundations of Mathematics

Binary logic, predicates and quantifiers, axiomatic systems, consistency and completeness, axiomatic set theory, cardinality, axiom of choice.

MATH 3106 Algorithms

Graph-theoretic algorithms. Greedy algorithms. Divide and conquer methods. Number-theoretic algorithms. Matrix problems and linear systems. Efficiency and complexity.

MATH 3107 History of Mathematics

Mathematics of ancient civilizations. Number systems. Euclid and Archimedes. Development of algebra. Discovery of calculus. Geometric construction problems. Greek astronomy.

MATH 3108 Special Topics

MATH 3109 Advanced Linear Algebra

Endomorphism algebras, matrix algebras, characteristic and minimal polynomials, direct sums, canonical forms of matrices.

MATH 3110 Metric Spaces

Euclidean spaces, metrics, normed linear spaces, convergence, continuity and uniform continuity, compactness, completeness, Banach fixed point theorem, connectedness, examples.

<p><i>Occupational Safety and Health (SCBDF0013)</i></p>

Students who pass Second Science in any combination of subjects, having taken Combination (a) in First Science, may apply for admission to this Degree course. These courses are only available to students taking the BSc in Occupational Safety and Health. Students take all ten courses. Applications should be made to the Faculty of Science as per other courses and NOT the course director.

Admission is granted by the Course Director and is subject to space and number restrictions.

SHWW 3001 Safety and Health Legislation

This unit provides an opportunity for understanding the important developments in legislation relating to safety and health in the workplace at both Irish and European Union levels.

SHWW 3004 Occupational Hygiene

This unit is concerned with the recognition, evaluation and control of physical (e.g. noise) and chemical (e.g. gases) agents in the workplace. Basic monitoring equipment is demonstrated practically.

SHWW 3005 Chemical Safety and Toxicology

Chemical actions and interactions in the human body and the toxic effects of major classes of toxicants are examined. The principles of chemical hazards and risk assessment are addressed and appropriate control and preventative strategies for toxic chemicals.

SHWW 3009 Industrial Placement

SHWW 3010 Projects

Teaching and assessment for the project unit formally introduces students to generic and transferable skills: information search and

retrieval, professional and academic report writing; presentation skills; study skills and examination techniques.

SHWW 3022 Health and Safety Management

This unit introduces students to the systematic management of occupational health and safety, including the development and implementation of effective systems to reduce the risk of injury and loss.

SHWW 3023 Occupational Health

This unit addresses the effects of work on health and enables students to identify risks to health in the workplace, and to advise on methods to investigate the incidence and reduce the risk of ill health. Occupational disease prevention, surveillance and management are addressed.

SHWW 3026 Human and Organisational Behaviour at Work

This unit examines human and organisational behaviour in relation to safety and health at work, and applies this knowledge to the improvement of the working environment and the promotion of safe work practices.

SHWW 3027 Safety Technology

This unit examines aspects of safety technology to ensure the provision of a safe place of work and the development of safe systems of work, including developing and implementing emergency response systems in the workplace.

SHWW 3028 Statistics in Health and Safety

An overview of the epidemiological approach to the monitoring of health and safety in the workplace is given. Data collection methods, the choice of appropriate study design, the interpretation and use of statistics and the role of computers in the research and information management process are examined.

Pharmacology

Third Year Single Subject and 2-Subject General Degree Programme.

Students choose 10 units in total. Core units are marked with the letter **C**. Students choose the 4 core units as shown and the remaining units as recommended by the Department.

PHAR 3001	Chemotherapeutic Agents	C
PHAR 3002	Neuropharmacology II	C
PHAR 3003	Endocrine and Reproductive Pharmacology. Autocoids	C
PHAR 3004	Toxicology	C

Third Year Single Honours Degree Programme

Students must include the 9 core units as stated and one optional unit, as recommended by the department. Details of the optional units may be obtained from the relevant departments.

PHAR 3001	Chemotherapeutic Agents	C
PHAR 3002	Neuropharmacology II	C
PHAR 3003	Endocrine and Reproductive Pharmacology. Autocoids	C
PHAR 3004	Toxicology	C
PHAR 3005	Topics on Novel Aspects	C
PHAR 3006	Topics on Novel Aspects	C
PHAR 3008	Molecular Biological Analysis of Therapeutic Targets	C
STAT 2331	Biostatistics	C
GENE 3001	Genetics	C

Students choose one optional unit as recommended by the Department

Third Year Joint Honours Degree Programme

Joint Honours students pick 5 units of Pharmacology from the Single Honours List shown above and 5 units from a second subject. Students note that Joint Honours Degree Programmes may only be chosen with the agreement of both departments.

Description of Pharmacology Units

PHAR 3001 Chemotherapeutic Agents

Introduction to microbial cell biology. Mechanism of action of antibacterial drugs. Antimicrobial therapy. Cytotoxic drugs and cancer treatments.

PHAR 3002 Neuropharmacology II

Advanced pharmacology including structure activity relationships of drugs affecting peripheral and central nervous systems. Behavioural and psychopharmacology.

PHAR 3003 Endocrine and Reproductive Pharmacology. Autocoids.

Pharmacology of the endocrine and reproductive systems. Autocoids, local hormones, biogenic amines, prostaglandins, kinins, substance P.

PHAR 3004 Toxicology

General principles, statistical evaluation, toxicity testing, routes of entry, metabolism, excretion, pollutants, pesticides, heavy metals, food additives. Mutagenesis, teratogenesis, carcinogenesis.

Courses for Honours Degree Students
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PHAR 3005 Topics covered with associated tutorials and reference lists on novel aspects include: advanced central nervous system Pharmacology (neuroactive agents); advanced central nervous system Pharmacology (dopamine receptors); advanced renal Pharmacology and Toxicology; and muscle Pharmacology.

PHAR 3006 Topics covered with associated tutorials and reference lists on novel aspects include: intracellular signalling (heterotrimeric G-proteins, tyrosine kinases and estrogen receptor action) and peptide Pharmacology.

PHAR 3008 Molecular biological analysis of therapeutic targets

General structure and function of a group of membrane receptors and kinases; 3-D structural analysis of these proteins; primary structure of receptor proteins – functional and structural motifs; receptor encoding genes, structure and expression; cloning of receptor genes/gene families and bioinformatic and functional characterisation of the cloned genes; recombinant receptors as drug discovery tools; receptor and kinase gene polymorphisms and their analysis; natural receptor mutations and associated diseases; strategies for mutant receptor replacement by gene therapy; pharmacogenomics (selected topics).

<i>Physiology</i>

Third Year Honours and Single Subject General Degree share the same core units. Core units are marked with the letter **C**. Students must include the 8 core units as

stated and two of the optional units, as recommended by the department. Details of the optional units may be obtained from the relevant departments.

Please note that it is not possible to take Physiology as part of a 2-Subject General or Joint Honours Degree Programme.

PHYS 3002	Regulatory Mechanisms	
PHYS 3003	Circulation and Respiration	
PHYS 3004	Digestion, Absorption, Excretion	
PHYS 3005	Neurophysiology I	
PHYS 3006	Cardiorespiratory Integration	
PHYS 3007	Neurophysiology II	
PHYS 3009	Physiological Measurement	
STAT 3221	Biostatistics	
Students choose 2 optional units as recommended by the Department		

Description of Physiology Units:

PHYS 3002 Regulatory Mechanisms

Ion channels and membrane potential, mechanisms of action potential generation, receptors, second messengers and signal transduction, regulation of excitation-contraction coupling (skeletal, cardiac and smooth), mechanisms of synaptic transmission, gap junctions, transmembrane/cellular transport of solutes and water, secretion, homeostasis, control systems, feedback and feed-forward control.

PHYS 3003 Circulation and Respiration

Cardiac electrophysiology. Regulation of myocardial contractile function. Arterial circulation; short- and long-term control of pressure. Microcirculation; Capillary exchange and regulation of tissue blood flow. Venous circulation. Respiratory mechanics; resistance and compliance. Blood gas transport. Pulmonary circulation and gas exchange. Introduction to the control of breathing.

PHYS 3004 Digestion, Absorption, Excretion

Alimentary canal; control of motility. Salivary, gastric, intestinal, pancreatic and biliary secretions. Digestion and absorption. Dietary factors, dietary disorders. Metabolic rate, energy balance, body temperature. Hormonal regulation of metabolism: insulin, glucagon, thyroid hormones, glucocorticoids. Control of growth. Renal circulation,

glomerular filtration, tubular functions. Renal regulation of water and electrolyte balance.

PHYS 3005 Neurophysiology I

Neuroanatomy of somatosensory pathways, excitation/inhibition in the central nervous system, signalling in nerve trunks, single ion channel physiology, visual system, auditory and vestibular function, olfaction, gustation.

PHYS 3006 Cardiorespiratory Integration

Cardiovascular and respiratory systems; sensory receptors and efferent control mechanisms. Brain stem and supramedullary systems in cardiorespiratory control. Integrated cardiorespiratory responses to hypoxia, hypovolaemia, exercise and altitude.

PHYS 3007 Neurophysiology II

Cortical control of movement, corticospinal tracts and extrapyramidal system, brainstem, basal ganglia, cerebellum, control of posture, learning and memory, sleep, cellular mechanism and neurotransmitters, synaptic plasticity.

PHYS 3009 Physiological Measurement

Signals and signal processing. Instrumentation; transducers, amplifiers, filters, recorders. Analogue to digital conversion. Computers and data analysis. Measurements of pressure, flow, volume, concentration and potential difference. Assay techniques and their limitations. Methods in microscopy, cell physiology, neurophysiology, cardiovascular physiology, respiratory physiology and biochemical physiology. Literature searching and critical review. The peer review process and formal scientific communication.

Plant Genetic Engineering

Third Year General Topical Degree Programme

Students choose 10 units in total. Core units are marked with the letter **C**. Students must include the 7 core units as stated and three of the optional units, as recommended by the department. Details of the units may be obtained from the relevant departments.

BOTN 3006	Seed Plant Reproduction	C
BOTN 3007	Vegetation Ecology and Biogeography	C
BOTN 3008	Plant Biotechnology	C
BOTN 3010	Plant Development and Metabolism	C
GENE 3001	Genetics	C
GENE 3002	Genome Structure	C
GENE 3003	Gene Expression	C

Students choose three optional units as recommended by the Course Director

BOTN 3001	Diversity and Ecology of Fungi	
BOTN 3002	Plant Population Biology	
BOTN 3003	Plant/Soil Interactions in Wetlands	
BOTN 3004	Growth & Nutrient Assimilation	
BOTN 3004	Growth & Nutrient Assimilation	
STAT 3221	Biostatistics	
LANG 3001	Beginners German for Science	
LANG 3002	Beginners Japanese for Science	
LANG 3003	Advanced French for Science (Post- Leaving Certificate)	
LANG 3004	Advanced German for Science (Post-Leaving Certificate)	
LANG 3005	Beginners Spanish for Science	
LANG 3006	Beginners Chinese for Science	

Psychology

Third Year Single Honours Degree Programme. Core units are marked with the letter C. Students must include the 8 core units as stated and 2 optional units, as recommended by the department. Details of the units may be obtained from the relevant departments.

Please note that it is not possible to take Psychology as part of a 2-Subject General or Joint Honours Degree Programme.

PSY 3201	Biopsychology	C
PSY 3202	Personality and Philosophical	C
PSY 3203	Cognitive Psychology	C
PSY 3204	Developmental Psychology	C
PSY 3205	Social Psychology and Language	C
PSY 3206	Psychology of Special Needs	C
PSY 3207	Psychological Statistics and Experimental Research Methods	C
PSY 3208	Design and Application of Research	C

Students choose two optional units as recommended by the Department

Description of Psychology Units:

- PSY 3201 Biopsychology**
Physiological psychology and psychopharmacology.
- PSY 3202 Personality & Philosophical**
Introduction to personality theory; Philosophical questions relevant to psychology.
- PSY 3203 Cognitive Psychology**
Perception and learning.
- PSY 3204 Developmental Psychology**
Cognitive, language, social and emotional development.
- PSY 3205 Social Psychology and Language**
Introduction to social psychology; psychology of language.
- PSY 3206 Psychology of Special Needs**
Developmental disabilities and persons with exceptional needs: abnormal psychology.
- PSY 3207 Psychological Statistics and Experimental Research Methods**

PSY 3208 Design & Application of Research

Additional Third Year Course for Honours Degree

In addition to all of the above third year courses, Honours Psychology students are required to take the following course. (This course is not available to students taking individual units of Psychology).

Laboratory Practicals in Psychology

Honours Psychology students are required to attend two laboratory sessions per week. Laboratory work covers experimental techniques employed in psychological research and students are required to submit written reports of experimental work.

Notes for Students:

- Students are required to attend tutorials and departmental seminars, and to submit essays.
- Practical work may also be required in certain courses.
- Up to 25% of the marks allocated to any unit may be awarded for practical work.
- It is strongly recommended that students taking individual third year courses will have taken PSY 2201 – PSY 2204.
- Some courses may not be offered in a particular year.

<p><i>Statistics</i></p>

Third Year Honours and Single Subject General Degree share the same core units. Core units are marked with the letter C. Students must include the 8 core units as stated and two of the optional units, as recommended by the department. Details of the optional units may be obtained from the relevant departments.

Students are free to select any optional units allowed by the timetable and subject to the student satisfying the prerequisites and with the recommendation of the Department.

STAT 3205	Statistical Theory I: Probability	C
STAT 3206	Statistical Theory II: Statistical Inference	C
STAT 3207	Statistical Theory III: Bayesian Statistics and Stochastic Processes	C
STAT 3208	Statistical Methods I	C
STAT 3209	Statistical Methods II	C
STAT 3210	Data Analysis and Statistical Software	C
STAT 3218	Survey Sampling	C
STAT 3224	Statistics and Visualisation	C
If not already taken, students also choose the following units. Otherwise students choose two optional units as recommended by the Department		
MATH 2201	Calculus of Several Variables	
MATH 2202	Linear Algebra	

2-Subject General.

Students choose 10 units with a minimum of 4 core units in Statistics and the other units chosen in agreement with the two Departments.

STAT 3208	Statistical Methods I	C
STAT 3209	Statistical Methods II	C
STAT 3210	Data Analysis and Statistical Software	C
STAT 3218	Survey Sampling	C

Joint Honours.

Students choose 10 units with 6 core units in Statistics and the other units chosen in agreement with the two Departments.

STAT 3205	Statistical Theory I: Probability	C
STAT 3206	Statistical Theory II: Statistical Inference	C
STAT 3207	Statistical Theory III: Bayesian Statistics and Stochastic Processes	C
STAT 3208	Statistical Methods I	C
STAT 3209	Statistical Methods II	C
STAT 3210	Data Analysis and Statistical Software	C

Descriptions of Statistics Units:
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STAT 3205 Statistical Theory I: Probability

Probability Theory. Combinatorics. Random Variables: univariate, bivariate and multivariate. Moment generating functions. Functions of a random variable. Standard Probability Laws.

This unit is not available to students who have taken STAT 2205.

STAT 3206 Statistical Theory II: Statistical Inference

(a) Estimation Theory: Chebyshev Inequality. Law of large numbers. Central Limit theorem. Methods of moments and maximum likelihood. Point estimation and interval estimation.

(b) Hypothesis testing: Neyman Pearson Lemma. Likelihood ratio tests.

This unit is not available to students who have taken STAT 2206.

STAT 3207 Statistical Theory III: Bayesian Statistics and Stochastic Processes

Bayesian statistical inference. Stochastic processes. Poisson processes. Birth and death processes. Branching processes.

This unit is not available to students who have taken STAT 2207.

STAT 3208 Statistical Methods I

Simple linear regression. Hypothesis testing and inferences concerning the regression equation. Polynomial and multiple regression. Regression diagnostics and transformations. Selecting the best regression model.

STAT 3209 Statistical Methods II

One- and two-way analysis of variance. Fixed random and mixed effect models. Contrasts. Interaction. Multiple comparison procedures. Introduction to experimental design. Nonparametric statistics. Introduction to generalized linear models.

STAT 3210 Data Analysis and Statistical Software

Data screening and cleaning. The SAS software package for data analysis.

STAT 3216 Actuarial Statistics I

Decision theory. Loss distributions. Reinsurance. Risk models. Run off triangles and experience rating systems.

STAT 3217 Actuarial Statistics II

Ruin theory. Bayesian statistics. Credibility theory. Introduction to generalised linear models.

STAT 3218 Survey Sampling

Elements of the sampling problem. Simple random sampling. Stratified random sampling. Ratio estimation. Cluster sampling. Systematic sampling.

Prerequisite: MATH 2104 or Second Science Statistics.

STAT 3219 Quality Control and Reliability

Aims of quality control. Acceptance sampling. Operating characteristic curves. Sampling schemes. Sampling by variables. Control and Cusum charts.

Prerequisite: MATH 2104 or Second Science Statistics.

STAT 3220 Statistics for Chemists

Probability. Basic distributions. Measures of precision. Sample size determination. Estimation of differences. Regression and calibration. Analysis of variance. Quality and process control. Introduction to statistical software.

STAT 3221 Biostatistics

Data reduction and representation. Probability distributions. Sampling. Confidence intervals. Hypothesis testing. Independent and paired samples. Sample size calculations. Design of experiments. Correlation. Linear regression.

STAT 3222 Stochastic Processes I

An introduction to the classification and simulation of stochastic processes. Discrete and continuous time models. Stochastic calculus.

STAT 3223 Official Statistics

Collection of official statistics including macro-economics, business, demographic and social statistics. Accessing official statistics and their applications. Estimation, imputation and seasonal adjustment.

STAT 3224 Statistics and Visualization

Descriptive statistical and graphical methods for displaying data. From data to information. Visualization and presentation of data. Aspects of multivariate analysis. Simulation. S-plus software.

<p style="text-align: center;"><i>Theoretical Physics</i> <i>(SCBDF0012)</i></p>
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Students must take the Core Courses and one of the Optional Courses listed below.

Details of the core course units are presented under the subject listings for Experimental Physics, and Mathematical Physics.

MAPH 3111	Methods B	C
MAPH 3120	Methods C	C
MAPH 3141	Potential Theory	C
MAPH 3151	Electromagnetic Theory	C
MAPH 3161	Quantum Mechanics	C
MAPH 3171	Fluid Mechanics	C
EXPH 3006	Thermodynamics and Statistical Physics	C
EXPH 3007	Solid State Physics	C
EXPH 3013	Quantum Mechanics	C
Students choose 1 optional units as recommended by the Department:		
MAPH 3180	Dynamic Systems and Chaos	
MAPH 4120	Differential Geometry	
MAPH 4130	Mathematical Foundations of Quantum Mechanics	
MAPH 4171	General Relativity	
EXPH 4002	Quantum Mechanics and Nuclear Physics	
EXPH 4004	Atomic and Molecular Physics	
EXPH 4005	High Energy Particle Physics	
EXPH 4009	Perspectives in Modern Astrophysics	
EXPH 4010	Atomic Structures and Spectra	
EXPH 4011	Physics of Ionized Gases	
EXPH 4013	Condensed Matter Physics	

Zoology

Third Year Honours and Single Subject General Degree share the same core and optional units. Core units are marked with the letter **C**. Students must include the 9 core units as stated and one of the optional units, as recommended by the Department. Details of the optional units may be obtained from the relevant departments.

ZOOL 3009	Functional Morphology	C
ZOOL 3010	Animal Development	C
ZOOL 3011	Arthropoda	C
ZOOL 3012	Immunology	C
ZOOL 3013	Animal Behaviours	C
ZOOL 3014	Systems Ecology	C
ZOOL 3015	Evolutionary Biology	C
ZOOL 3016	Diversity of Vertebrates	C
ZOOL 3017	Wildlife and Fisheries Management	C
Students choose one of the following optional units as recommended by the Department:		
GENE 3001	Genetics	
STAT 3221	Biostatistics	
GEOL 3001	Invertebrate Palaeontology	

Third Year Joint Honours and 2-Subject General

Students choose 5 units from the following list (4 core and 1 optional) and 5 units from the second subject in agreement with the two Departments.

Students note that in order to take a Joint Honours or 2-Subject General Degree programme, permission is required from both Departments.

ZOOL 3009	Functional Morphology	
ZOOL 3010	Animal Development	
ZOOL 3011	Arthropoda	
ZOOL 3012	Immunology	
ZOOL 3013	Animal Behaviours	
ZOOL 3014	Systems Ecology	
ZOOL 3015	Evolutionary Biology	
ZOOL 3016	Diversity of Vertebrates	
ZOOL 3017	Wildlife and Fisheries Management	

Zoology and Genetics Joint Honours Degree Programme

For a Joint Honours Degree Programme with Genetics, students must choose the 5 units of Zoology as shown above along with the following Genetics units:

GENE 3001	Genetics	C
GENE 3002	Eukaryotic Genome, Structure and Function	C
GENE 3003	Gene Expression and Recombination	C
BIOC 3004	Gene Manipulation and Regulation	C
ZOOL 3015	Evolutionary Biology	C

Descriptions of Zoology Units:

ZOOL 3009 Functional Morphology

Anatomy/biochemistry of muscle, bone-muscle systems, supporting tissues, aquatic and terrestrial locomotion, flight, brain and sensory systems, temperature and energy metabolism, thermal strategies of animals.

ZOOL 3010 Animal Development

Pattern formation, cell signalling, sex determination, differentiation, morphogenesis, evolution and development. Morphological and genetic basis of development, in model organisms such as *C. elegans*, *Drosophila*, sea urchin, zebrafish and mouse.

ZOOL 3011 Arthropoda

Diversity, classification, biology, functional morphology, life cycles and strategies for survival of arthropods and related taxa; cladistics and phylogenetic relationships; impacts of pest, parasitic and beneficial species.

ZOOL 3012 Immunology

Antigens, antibody structure and function, B cells, Tcells, MHC, diversity, cytokines, complement, inflammation, immunity to viruses, bacteria and parasitic infections, polyclonal, monoclonal and phage display antibodies.

ZOOL 3013 Animal Behaviour

Sensory inputs. Chemical cues and escalating responses, stereotyped and modifiable. Integration of information. Evolution of behaviour. Social systems. Measuring behaviour. Genes and environment. Learning. Dominance. Aggression. Cooperation. Mating systems.

ZOOL 3014 Systems Ecology

Global change, greenhouse effect, carbon cycle, nitrogen cycle, acid precipitation, stream and lake ecology/succession, stream habitats, indicator species, water quality, marine ecology, deep-sea and polar systems, larval ecology, benthic ecology.

ZOOL 3015 Evolutionary Biology

Quantitative genetics; Gene flow in populations; Genetic drift; Heterozygosity; Heredity; Selection Models, Fitness/Relative Fitness; Molecular Evolution; Evolutionary Ecology; Species Concept; Speciation.

ZOOL 3016 Diversity of Vertebrates

Study of phylogeny/diversity, pre-vertebrate chordates, vertebrate skeletons, transition from water to land, phylogeny, diversity, radiation and biogeography of fishes, amphibians, reptiles, birds and mammals.

ZOOL 3017 Wildlife and Fisheries Management

The necessity of management, estimating population size, using models (types and estimation of parameters), habitat analysis and GIS, species re-introductions, the use of Protected Areas, case studies.

Fourth Science

Regulations for Fourth Year Honours Science Students

1. Selection of Courses

All Fourth Year Honours Science students select courses of study as indicated by the relevant Head of Departments or Course Directors.

2. Examinations

Having passed the Third Year Honours Examinations, students must attend, for one academic year, courses in the major subject, and must present at the end of that academic year for the Final Examination for the Degree of BSc (Honours). The distribution of marks for the Final Examination will be provided to students by the Departments concerned.

Candidates may present only once for the BSc (Honours) Degree Examination or the BSc Honours Topical Degree Examination. Exemption from this regulation may be granted for grave reasons by the Academic Council on the recommendation of the Faculty of Science.

The BSc (Honours) Degree may be awarded with First Class Honours; Second Class Honours, Grade I; Second Class Honours, Grade II; Third Class Honours or at a Pass standard.

Syllabus of Courses for Fourth Year Science

Applied and Computational Mathematics

Ten units to be taken, selected from the following, subject to the approval of the course director.

MATH 4108	Financial Mathematics	(1 unit)
MATH 3205	Combinatorial Mathematics	(1½ units)
MATH 3106	Algorithms	(1½ units)
MATH 4201	Matrix Analysis	(1 unit)
MATH 4115	Transforms	(1 unit)
MAPH 3171	Fluid Mechanics	(1 unit)
MAPH 3091	Mathematical Modelling	(1 unit)
MAPH 3120	Methods C	(1 unit)
MAPH 4110	Non-linear waves and solitons	(1 unit)
STAT 3208	Statistical Methods I	(1 unit)
STAT 3209	Statistical Methods II	(1 unit)
STAT 3210	Data Analysis and Statistical Software	(1 unit)
STAT 4213	Applied Statistics II	(1 unit)

Biochemistry – BIOC 4000

BIOC 4001 Biochemical Immunology

Structure and function of ion-channels. Aetiology of Type-I & Type-II diabetes. Antigen presentation and activation of the adaptive immune system. Mechanisms of T-lymphocyte activation, deletion and anergy. Receptor and non-receptor Tyrosine kinases and signal transduction in cells of the immune system. Cytokine networks.

BIOC 4002 Redox enzymes

The properties of redox centres found in enzymes are surveyed, with an emphasis on recent work. The redox properties of flavoproteins are studied in detail, using the electron carrier flavodoxin to illustrate how these properties are modulated by interactions with protein.

BIOC 4003 Neurochemistry I

Topics include release, transport, synthesis and metabolism of amino acid neurotransmitters. Structure, function and diversity of amino acid receptors in the CNS. Mechanisms of excitotoxicity and neurodegenerative disease.

BIOC 4006 Oxygen and Life

“Fitness” of dioxygen. Electronic structure, redox potentials, ionisation constants. Fenton, Haber-Weiss reactions. Dioxygen reduction products: production, toxicity, detoxification. Dioxygen activating enzymes: superoxide dismutase. Singlet oxygen. Oxidative stress, lipid peroxidation. Oxygen free radicals in cell defence. Consumption and production: mitochondrial respiration, photophosphorylation and their regulation.

BIOC 4007 Complex modes of gene regulation

Investigation of aspects of regulation of gene expression: DNA topology and nucleosome structure; interaction of transcription factors with chromatin; identification of nuclear localisation signals; regulated nuclear localisation of transcription factors; nuclear gradients in *Drosophila* development; comparison of immune response pathways in *Drosophila* and mammals; effect of phosphorylation on nuclear transport.

BIOC 4008 Biological NMR

Basic NMR theory, relaxation mechanisms in small and large molecules, optimising signal-to-noise, 1D-pulse sequences used in biological NMR, ¹³C-NMR of biological molecules, protein structure determination.

BIOC 4009 Cell Signalling

This course details the signal transduction cascades of G-protein coupled receptors and heterotrimeric G proteins; growth factor receptor tyrosine kinases; monomeric G proteins; mitogen activated protein kinase (MAPK) and stress activated protein kinases (SAPKs). Attention is paid to structure/function aspects of signalling components and to integration of the various cascades.

BIOC 4010 Proteases and inhibitors

Introduction to classes and mechanisms of proteases and protease inhibitors. Extracellular and intracellular proteolytic events including plasma cascades, proteasome protein degradation and antigen processing. Mechanisms of programmed cell death (apoptosis).

PHAR 4003 Cancer Studies

Details of this course are available from the Department of Pharmacology.

BIOC 4012 Protein engineering

Academic and practical reasons for engineering proteins. Alternatives. Prerequisites: High-resolution structure, homology, conserved residues? Tyrosyl tRNA synthetase: H-bonds. Subtilisin: thermostability. Homology-based engineering: coenzyme specificity in disulphide reductases. Substrate specificity in α -hydroxyacid dehydrogenases. Engineering without 3-D structure: E2 lipoyl domains. Criteria of success. Limitations. Hybrid approaches; SDM/random. Amino acid dehydrogenases.

BIOC 4014 Bioinformatics

This course is composed of a series of computer-based practical classes and tutorials. Areas covered include interrogation of literature and molecular databases; BLAST searches; pairwise and multiple alignments of DNA and protein sequences; design of cloning and PCR experiments; analysis of motifs; introduction to protein structure prediction.

Two supervised projects are carried out, a library project and a laboratory-based research project. Oral and written reports are required for both of these and contribute to the final assessment.

BIOC 4015 Neurochemistry II

The course will cover the biogenic amine neurotransmitters serotonin, dopamine and noradrenaline; the functions of biogenic amines in the brain; structure, function and regulation of monoamine receptors and transporters; molecular basis of neurological disorders, such as depression, Parkinson's disease and drug addiction; molecular mechanisms of antidepressants and drugs of abuse.

STAT 4230 Statistics – Laboratory Assays

Botany – BOTN 4000

The following courses are offered in a range of topics, reflecting the specialist interests of the Department's staff. Students must select their courses in consultation with the Head of Department.

BOTN 4001 Peatland Ecology and Conservation

Characteristics of peatland habitats. Ecology of peatland plants. European and world distribution of peatlands. Peatland classification systems. Variation in European peatlands. Peatland vegetation types.

Irish peatlands – distribution, ecology, vegetation, habitat destruction, restoration and conservation.

BOTN 4002 Ecotoxicology

Pollutants in ecosystems. The behaviour of pollutants in, and their effects on, ecosystems; predictions of effects of pollutants in ecosystems, and biomonitoring of pollutants in the environment.

BOTN 4003 Evolution in Plant Populations

The existence of infraspecific genetic variation: ecotypes, clines. Gene flow in populations; neighbourhood size. Spatial and temporal scales of population differentiation. Natural selection in plant populations: life-cycle components of selection.

BOTN 4004 Mycorrhizal Symbiosis

Structure and function of the main mycorrhizal types. Mycorrhizal populations in forest, heathland and grassland ecosystems. The role of mycorrhizal associations in improving the nitrogen and phosphorus nutrition of trees, crops and heathland plants.

BOTN 4005 Light Utilisation by Plants

Optical properties of cells, colonies and tissues. Consequences of variations in cell/pigment/tissue characteristics on light absorption. Case studies on 1) the ‘package effect’ in phytoplankton, 2) unusual strategies for enhancing light absorption by understory plants, and 3) the significance of leaf movements on light utilisation and carbon gain.

GENE 4001 Eukaryotic Genome

For details of unit see under Genetics.

BOTN 4008 Plant – Pathogen Interactions

Disease and disease resistance in plants; the ways in which pathogens gain entry and colonise host tissues; toxins, cell-wall-degrading enzymes, growth de-regulators; the constitutive and induced defensive responses of plants; mechanical and biochemical resistance, including hypersensitive response, phytoalexins and PR proteins.

BOTN 4009 In vitro Techniques

Regulatory aspects of growth and metabolism of plant cells in culture. Growth and production kinetics of cultured plant cells; screening for chemical variants; cloning, clonal analysis and stability of isolates;

possible origins of cellular heterogeneity; selection by amino acid analogue resistance.

BOTN 4010 Organogenesis

Molecular and cellular controls of cell shape, cell division planes, and organ formation. Generation of primordia at stem apex.

BOTN 4011 Critiques of Scientific Papers

Essential skills in the analysis and writing of scientific papers: titles, abstracts, presentation of materials and methods, data presentation and analysis, validity of conclusions. This tutorial course is designed to provide critical reading and writing skills.

BOTN 4012 Ecological Significance of Different Photosynthetic Pathways

Fundamental characteristics of carbon assimilation in terrestrial C₃, C₄, C₃-C₄ and CAM plants. Photosynthetic mechanisms in aquatic plants. Plant distribution and photosynthetic pathway. Examination of the effects of irradiance, temperature, CO₂, water and nutrients on carbon assimilation. Predicting the response of plants and vegetation to global changes in climate.

BOTN 4013 Science and Society

Social creation of scientific knowledge: theories of Merton, Kuhn, Feyerabend. Role of science in society: reliability, use and abuse of scientific knowledge; should science be planned to meet social needs?; the public understanding of science. Limits of science: does science have conceptual or ethical limits? Emergence of anti-science culture.

BOTN 4014 Developmental Plant Genetics

Developmental and environmental control of plant gene expression and pattern formation. Embryogenesis, root, shoot and leaf development, formation of reproductive structures. Formation of the photosynthetic apparatus.

BOTN 4015 Plants in Changing Environments

Underlying causes of differences in relative growth (RGR). Ecological and evolutionary significance of differences in RGR. Using RGR and related traits to explain and predict vegetation dynamics. Plant functional types and “scaling-up” in ecology.

BOTN 4020 Programmed Cell Death in Higher Plants

Introduction to programmed cell death and examination of its role in a number of different organisms; molecular and biochemical mechanisms that control the cell death process in different organisms including plants; the role of cell death in plant development and disease resistance.

BOTN 4021 Burren Field Course

This five-day residential field course takes place after the Third Science summer examinations each year. It is compulsory for students pursuing (a) a single honours degree in Botany or (b) taking Botany as a core element in the Environmental Biology programme. The course is also available to other students who have completed BOTN 3007: *Vegetation Ecology and Biogeography*. The course covers field methods in vegetation ecology, including species identification, habitat description, vegetation description and vegetation classification. A variety of habitat types are examined, including coastal systems (cliff tops, rocky shores, salt marshes, shingle beaches, sand beaches and sand-dune systems); lake and lake shore systems (acid lakes and Burren turloughs); limestone pavement systems; mountain vegetation (arctic alpine species, species changes with increasing altitude); peatlands (raised bogs, blanket bogs and fens); river and wetland systems; and woodland systems (Corylo-Fraxinetum woodlands, Blechno-Quercetum woodlands, hazel scrub, yew/juniper scrub, pine woodland). Discussion of conservation of habitats and rare plant species take place during field excursions. Evening sessions involve confirmation of field identifications, analysis of species distributions and habitat report writing.

BOTN 4022 Cell Signalling in Plants

Plant growth and development are controlled by interactions between the plant, environmental conditions and intrinsic developmental programs directed by plant hormones. This series of lectures will give an insight into current advances in signal transduction processes in plants and appropriate examples from animals, yeast and bacteria will be used to illustrate both conservation and divergence of signalling mechanisms between different organisms.

Project

Each student will carry out a research project, to be presented as a thesis and seminar for part of the Degree examination assessment.

Cell and Molecular Biology – CELB 4000

Each student must attend ten of the following courses and undertake a Research Project. The Project is to be presented as a seminar and submitted as a thesis. Selection of courses and project are subject to the approval of the Programme Director.

CELB 4001 Animal and Plant Cell Tissue Culture

Introduction to techniques of animal and plant tissue culture, factors influencing proliferation and differentiation of cells in vitro. Applications of: a) animal cell culture techniques to topics such as intracellular protein targeting, antigen processing and presentation, signal transduction and gene expression in development; b) plant cell culture techniques to plant improvement programs; plant regeneration, variation, selection.

CELB 4002 Immunobiology

Basic concepts in immunobiology. Antigen recognition by B and T cells. T cell development and T cell mediated immunity. Host defence mechanisms. Control and manipulation of the immune response.

CELB 4003 Neurobiology

Molecular mechanisms underlying memory and learning. Neurodegenerative states: Alzheimer's disease. Psychotic states: schizophrenia and depression. Molecular mechanisms involved in processing and storing information derived from the internal condition and the external environment.

GENE 4002 Human Genetic Diseases

For details of unit see under Genetics.

CELB 4005 Complex Modes of Gene Regulation

Investigation of aspects of regulation of gene expression: DNA topology and nucleosome structure; interaction of transcription factors with chromatin; identification of nuclear localisation signals; regulated nuclear localisation of transcription factors; nuclear gradients in *Drosophila* development; comparison of immune response pathways in *Drosophila* and mammals; effect of phosphorylation on nuclear transport.

CELB 4006 Cell Extension and Locomotion

Cytoskeleton-plasma membrane interactions, F-actin assembly and force generation, role of calcium and calmodulin, amoeboid locomotion, nerve growth cones, fibroblast locomotion.

BOTN 4014 Developmental Plant Genetics

For details of this unit see under Botany.

BOTN 4011 Critiques of Scientific Papers

For details of this unit see under Botany.

BOTN 4020 Programmed Cell Death in Higher Plants

For details of this unit see under Botany.

GENE 4001 Eukaryotic Genome

For details of this unit see under Genetics.

ZOOL 4014 Prion Diseases

For details of this unit see under Zoology.

ZOOL 4018 Genomic Imprinting, Chromatin and Epigenetics

For details of this unit see under Zoology.

ZOOL 4020 Human Evolution

Biology and diversity of the order Primates. Assessment of rate, timing and sequence of evolution of humans through genetic analyses, fossil record and paleogeography. Current controversies in evolutionary psychology will be discussed.

<i>Chemistry – CHEM 4000</i>

Core Courses

Organic Chemistry

Structure and reactivity, pericyclic reactions, reaction co-ordinate diagrams; rearrangements; acid-base and enzymatic catalysis; asymmetric synthesis; biosynthesis; catalysis in chemistry and biology; retrosynthetic analysis.

Inorganic Chemistry

Organometallic and related chemistry; structural methods in inorganic chemistry; bonding and electronic spectroscopy of coordination compounds; inorganic solid-solution chemistry; boranes, carboranes and their complexes; transition metal-catalyzed polymerizations.

Physical Chemistry

Reaction dynamics, electrochemistry, nanochemistry, spectroscopy, thermodynamics, phase behaviour of solutions, statistical mechanics, colloids, biopolymers.

Optional Courses

In addition to the core courses students will choose from a selection of optional courses, examples of which are given below.

Bioelectrochemistry/Neurochemistry; solution chemistry; supramolecular chemistry; atmospheric chemistry; nucleic acids and their functioning in biological systems; biomaterials; organo-main-group chemistry; organometallics reagents in organic synthesis; reactive intermediates; transition metal complexes in catalysis; synthesis and properties of polymer materials; solution-phase NMR techniques applied to structural determination; computational chemistry; biomacromolecular chemistry; bioinorganic chemistry; bioorganic and medicinal chemistry; heterocyclic and combinatorial chemistry; environmental applications of heterogeneous catalysis; solvent effects and chemistry in water; statistical mechanics of phase transitions and kinetics.

Experimental Research Projects

Projects are carried out in the research laboratories under the direction of members of staff.

<i>Computer Science – COMP 4000</i>
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Students will be required to take a total of eight units. Not all of the following units will be offered in a given year and certain restrictions may also apply.

Students are also required to undertake a significant project, details of which will be provided by the department.

COMP 4001 Computability

Effective procedures; the spectrum of computability, from simple problems to undecidable ones; what is and is not computable; models of computability; Turing machines, partial recursive functions; Markov algorithms; what is and is not tractable; complexity classes, P, NP, co-NP and NPC; coping with NP problems; problem restriction, approximation algorithms.

COMP 4002 Information Systems II

Databases: recovery; concurrency; security; integrity; distributed databases; extended relational data model; object oriented data model.

Prerequisite: COMP 3005

COMP 4003 Systems Design & Development II

Systems development life cycle (issues/problems); Tools and techniques for analysis and design; implementation approaches; soft methodologies; CASE tools: analysis, design, code generation; distributed system issues; evaluation; usability; quality assurance; security; project management tools and techniques.

Prerequisite: COMP 3004

COMP 4004 Interactive Computer Graphics

The rendering pipeline; visible surface determination; local illumination and shading models; curve and curved surface generation; solid modelling; texture mapping; global illumination: ray tracing, radiosity and Monte Carlo methods; computer animation; scientific visualization.

COMP 4005 Introduction to Digital Image Processing and Linear System Theory

Digital Image Processing System; Human Vision System; Image Representation; Histogram and algebraic operations; Linear system theory; Convolution; Image transforms (DFT, wavelets...); Filter Design; Colour Image Processing; Segmentation; Applications: – Loss less Compression; – Still image compression standards; – Digital image watermarking; – Video Coding and Compression Standards.

COMP 4006 Programme Design and Verification II

Calculating programs; advanced derivational techniques; refinement calculus; reifying abstract data types; the use of simple algebras in program construction.

COMP 4007 Systems & Specification

The nature of systems and basic concepts of systems theory; types of systems and their characteristic properties; formal description of systems; needs and uses; principles and practice of system specification; examples and case studies.

COMP 4008 Topics in Object-Oriented Design

Object-oriented methods in the software development cycle; practical design techniques using e.g. Unified Modelling Language technique;

alternative approaches to object-oriented design; frameworks and design patterns.

Prerequisite: COMP 3011

COMP 4009 Design Patterns

Introduction to Patterns. Use of patterns in the design process. Documentation of new patterns. Creational patterns. Structural patterns. Behavioural patterns. Introduction to Frameworks. Data-driven and architecture-driven approaches. Synergy between patterns and frameworks. Case studies.

Prerequisite: COMP 3011

COMP 4010 Concurrent Programming

Nature of concurrent programming shared memory; message passing; interference; synchronisation; mutual exclusion; semaphores; deadlock; fairness; high level constructs for concurrency; communicating sequential processes; applications to operating systems; formal verification.

COMP 4011 Formal Specifications

Need for formal specifications; specification methods e.g. VDM, algebraic specifications; techniques for specifying complex systems; developing systems for specifications; case studies.

COMP 4012 Operating Systems II

Language mechanisms for concurrency. Security and Protection – formal models (access matrix, BLP, lattice, take grant models). Scheduling Algorithms. Distributed Operating Systems – design and implementation, Synchronisation in Distributed OS, Distributed Process Scheduling, Distributed Concurrency control (deadlock and recovery), Distributed File Systems, Distributed Shared Memory, Distributed Computer Security. Case Studies: CHORUS, MACH, AMOEBA.

Prerequisite: COMP 3002

COMP 4013 Language Engineering

Fundamentals of natural language processing; formal models and corpus-based methods in speech and language; resources, standards and evaluation methodology; applications of human language technology.

Prerequisite: COMP 3009

COMP 4014 Distributed Systems

Distributed systems processing and interconnection architectural/reference models and concepts; open and closed systems; distributed operating system kernels, decomposition and consequences of distribution; security and management of distributed systems; transparency, remote operations, coordination replication, shared transactions, concurrency control, recovery and fault tolerance.

Prerequisite: COMP 3008

COMP 4015 Exploring Computer Science

Special topics related to current research and state of art applications not covered in other units.

COMP 4016 The Intelligent Internet

Applications of Artificial Intelligence techniques to the Internet; information integration, information extraction, information retrieval, clustering, recommender systems and semi-structured information.

Prerequisite: COMP 3009

COMP 4017 Foundations of Artificial Intelligence

The importance of representation, First Order Logic, Predicate Calculus, Normalised FOPL forms, Skolemisation, Conversion to Clausal Form, Resolution, Logic Programming, Prolog, Extra Logical features of Prolog, Semantic Networks, Frames, The Frame Problem.

Prerequisite: COMP 3009

COMP 4018 Connectionist Computing

Basic neurobiology; cortical and sub-cortical structure and function. History of connectionism: the McCulloch and Pitts neuron, Hebbian learning, the Perceptron. Modern connectionist learning: simple associators, the Boltzmann machine, Hopfield networks, Kohonen networks, error backpropagation. Connectionist natural language processing. Connectionist visual processing.

Prerequisite: COMP 3009

COMP 4019 Multi-Agent Systems (MAS)

Definition of Distributed Artificial Intelligence (DAI). Motivations for MAS, Strong versus weak notions of agency. Intentional agent systems. Agent communication. Speech act theory. Collaboration, planning, belief desire intention (BDI) architectures. Agent oriented design, agent

oriented programming and languages (Agent0, Agentalk), Multi-agent systems prototyping environment, industrial and commercial applications.

Prerequisite: COMP 3009

COMP 4021 Parallel Algorithms: Design & Analysis

Performance and Scalability of Parallel Systems, Metrics, Sources of Parallel Overhead; Arrays and Trees – Elementary Sorting and Counting, Matrix Algorithms, Graph Algorithms; Meshes and Trees – 2-Dimensional Mesh of Trees, Elementary $O(\log N)$ -Step Algorithms, Higher-Dimensional Meshes of Trees; Hyper-cubes and Related Networks – Hypercube, Butterfly Cube-Connected-Cycles and Benes Network, Shuffle-Exchange, Packet Routing Algorithms, Sorting, FFT, Other Hypercube Networks; Parallel Systolic Algorithms – Mapping 1-D and 2-D Systolic Arrays onto Parallel Computers.

Prerequisite: COMP 3001

COMP 4023 Hardware-Software Codesign

Models and Architectures; Hardware languages; Target architectures; Compilation techniques and tools for embedded systems; Design specification; Prototyping and Emulation.

Prerequisite: COMP 3001

COMP 4024 Parallel Programming Systems

Vector and superscalar processors: architecture and programming model, optimising compilers (dependency analysis and code generation), array libraries (BLAS) parallel languages (Fortran 90, C[]). Shared-memory multi-processors: architecture and programming models, optimising compilers, thread libraries (Pthreads), parallel languages (Fortran 95, OpenMP). Distributed-memory multi-processors: architecture and programming model, performance models, message-passing libraries (MPI), parallel languages (HPF). Heterogeneous networks of computers: architecture and programming models, programming challenges, performance models, parallel programming languages (mpC), message-passing libraries (FT-MPI, HMPI).

COMP 4025 Spatial Information Systems

Databases issues in information systems storing and handling spatial data: representation and manipulation of spatial data; models; relations; indexing methods for spatial data; geometric problems and algorithms;

query processing in spatial databases; geographic applications; emerging research directions.

Prerequisite: COMP 2006/2606

COMP 4026 Knowledge Based Computation

Knowledge-based methods for artificial intelligence systems. Knowledge representation, organization, application and maintenance. Principles of memory organization, indexing and retrieval. Memory-based, analogical and case-based reasoning. Applications to understanding, explanation, planning, and advisory systems.

Prerequisite: COMP 3009

Computer Science (Denominated Entry)

Students follow Third Year courses as directed by the Department of Computer Science.

Environmental Biology – ENVB 4000

The Fourth Year Programme comprises nine lecture courses.

Compulsory Courses

ENVB 4001 Environmental Regulation: Policy and Practice

Environmental regulation in Ireland and the EU: policy, administrative and legislative framework with regard to species/habitat conservation, pollution, and resource management in terrestrial, freshwater and marine environments.

ENVB 4002 Environmental Impact Assessment

Development, philosophy and structure of the EIA framework in Ireland and other countries. Practicalities of EIA, including a mock scoping exercise and lectures from environmental consultants. Biological sampling and coastal examples will be emphasised.

BOTN 4011 Critiques of Scientific Papers

For details of this unit see under Botany

Optional courses

Students select six optional courses, with three from each of the two main subject areas contributing to their degree programme (i.e. Botany, Industrial Microbiology, Zoology). Course selection will depend on the student's subject background and must be agreed by the Programme Directors and the relevant Heads of Departments. Please note course descriptions may be found under the relevant subject.

Courses in Botany

BOTN 4001	Peatland Ecology and Conservation
BOTN 4002	Ecotoxicology
BOTN 4003	Evolution in Plant Populations
BOTN 4004	Mycorrhizal Symbiosis
BOTN 4012	Ecological Significance of Different Photosynthetic Pathways

Courses in Industrial Microbiology

INDM 4013	Current Topics in Fungi
INDM 4015	Advances in Environmental Microbiology II
INDM 4016	Advances in Environmental Microbiology III

Courses in Zoology

ZOOL 4001	Biodiversity
ZOOL 4005	Ecology of Tropical Rainforests
ZOOL 4016	Marine Community Ecology
ZOOL 4019	Bioassessment of Freshwaters

Project

A project in an environmental topic is carried out in Botany, Industrial Microbiology or Zoology. Project selection may be restricted by the availability of space in laboratories. The project is a significant component of the final year course and is presented in thesis form as part of the final degree examination assessment.

Written Assignments

A library-based written assignment on an environmental topic forms part of the final degree examination assessment.

Environmental Geochemistry – ENGC 4000

Students take the following eight units in Fourth Year.

Core Units

Chemistry

Students choose 3 core Chemistry units, to be decided in agreement with the Course Director.

GEOL 3006 Sedimentology and Volcanology

For details of this unit see under Geology

GEOL 3008 Igneous, Metamorphic Petrology

For details of this unit see under Geology

GEOL 4011 Isotope Geochemistry I

Radiogenic isotopes as geochronometers and tracers. Quaternary geology and short-lived nuclides. Actinide geochemistry. $^{230}\text{Th}/^{234}\text{U}$, $^{234}\text{U}/^{238}\text{U}$, $^{231}\text{Pa}/^{235}\text{U}$ and ^{210}Pb dating methods. U-series mobilisation and surface hydrology. Groundwater dating and tracing. Applications to radioactive waste disposal studies. Pb isotopes as environmental tracers. Cosmogenic isotopes. Radiocarbon dating.

GEOL 4012 Isotope Geochemistry II

The carbon cycle. Organic compounds in mineral inclusions, humic acids, lipids, kerogen. The organic geochemistry of peat, coal, crude petroleum and recent sediments. Extraction techniques and analytical methods. Compound specific stable isotope analysis. Stable isotope fractionation processes and temperature effects.

All Fourth Year students are required to complete a field, laboratory or combined field laboratory project(s) during the course of the year. In the case of field projects, the data are collected in the Summer before the start of the Fourth Year. This will be presented in thesis form as part of the final degree examination assessment. The Fourth Year course involves geological field classes.

<i>Experimental Physics – EXPH 4000</i>
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Students taking an Honours Degree in Experimental Physics will be required to take units EXPH 4001 to EXPH 4006 inclusive plus any two of units EXPH 4007 to EXPH 4014. It should be noted that not all of the optional units will necessarily be offered each year.

Advanced Laboratory II

Students are required to complete an appropriate number of mini practical projects. These projects are designed to provide an opportunity to explore a range of areas of physics independently in a supportive environment. In addition to laboratory projects, students will generally undertake a computational and a collaborative electronics project. Students will also be required to present two short seminars on some aspect of physics.

EXPH 4001 Quantum Mechanics

Dirac general transformation theory. Schrödinger and Heisenberg representations as special cases. Time development of quantum systems. Definition of Hamiltonian in quantum theory. Symmetry in quantum theory. Conservation laws. Introduction to relativistic quantum mechanics. Dirac equation and its solution for free electron. "Quantum reality". Einstein Podolski Rosen paradox. Bell inequality. Aspect experiments.

EXPH 4002 Quantum and Nuclear Physics

Quantum theory for Bosons and Fermions. Theory of the deuteron. Scattering theory; including partial wave analysis, scattering length and effective range concepts, proton-neutron scattering, the Born approximation and resonant scattering. Nuclear fusion including solar fusion and the solar neutrino flux. Single-particle shell model of the nucleus. Neutron physics including neutron detectors.

EXPH 4003 Applied Electromagnetism and Plasma Physics

Fields due to an oscillating dipole. Rate of radiation from an oscillating charge. Scattering including Thompson scattering and Rayleigh scattering. Fields due to a moving charge. The invariance of Maxwell's equations. The current-potential four vectors. Fundamental atomic processes. Diffusion, electrical conduction and mobility. Einstein's equation. Debye length. Highly conducting plasmas. Waves in plasmas. Plasma diagnostics.

EXPH 4004 Atomic and Molecular Physics

Hydrogen atom in a magnetic field. Approximation methods: Non-degenerate and degenerate perturbation theory, variation principle. Stark effect. Helium atom: spin and exchange in two-electron systems, energy level structure and spectrum. Many-electron atoms. Central field theory. Coupling schemes. Autoionisation. Time-dependent perturbation

theory. Transition probabilities. The covalent bond. Properties of simple diatomic molecules.

EXPH 4005 High Energy Particle Physics

Fundamental particles and interactions. Quantum numbers and conservation laws. Resonant states and quark model of hadrons. The Standard Model of particle physics: Quarks and leptons. Gauge and Higgs bosons. Feynman diagrams. Strong interactions. Electroweak unification. C, P and CP violation. Mixing and oscillation. Modern experiments at colliders. Physics of charm, beauty and top-quarks. Searches for the Higgs boson and new phenomena. Neutrino physics.

EXPH 4006 Solid State Physics and Lasers

Reciprocal space. Crystalline structure. Brillouin zones. Landau levels. Measurement of the Fermi surface. Location of the Fermi level in intrinsic and extrinsic semiconductors. Low dimensional systems. Quantum Hall effect. Einstein's theory of radiation. Resonant cavities and modes. Threshold value of population inversion. Optical pumping. Types of laser. Laser output. Semiconductor lasers.

EXPH 4007 Applied Optics

Polarisation and birefringence. Acousto-optic, electro-optic and magneto-optic effects. Modulators, deflectors and displays. Liquid crystals. Non-linear optics. Harmonic generation. Parametric oscillation. Phase conjugation. Memory devices. Detectors: PMT, photoconductive and junction, CCD. Planar dielectric waveguides. Optical fibres: step and graded-index, attenuation and dispersion. Optical communications. Fibre optic sensors.

EXPH 4008 Topics in Environmental Physics

Radiation dosimetry. The natural radiation environment, radon and cosmic radiation doses. Properties of aerosols. Lung dosimetry of alpha emitters. Radioecology and radioecological modelling. Radioanalytical techniques, including low-level measurement techniques. Radioisotope dating. Remote sensing of environmental and surface features: including a review of remote sensing technology, and application to water quality and land productivity estimation.

EXPH 4009 Perspectives in Modern Astrophysics

The Sun, stellar evolution, gravitational potential energy, temperature pressure, luminosity and fusion reactions galaxy formation, dark matter and large scale structure of the galaxy. Neutrino flux. Supernovae, pulsars, primordial black holes, supermassive black holes and active galactic nuclei. High energy processes and radiation mechanisms.

EXPH 4010 Atomic Structure and Spectra

Single particle and many body models. Hartree and Hartree-Fock methods. Slater F and G integrals. Energy level structure in complex systems. Configuration interaction. Series perturbations. Selection rules and quantum mechanical treatment of transition probabilities. Autoionization, inner shell photoionization and non-radiative decay. Unresolved arrays and statistical methods. Modern developments in atomic physics.

EXPH 4011 Physics of Ionised Gases

States of matter. Collective model – some general characteristics – plasma oscillations. Debye length. Classical Collision Theory. Processes leading to the creation of an ionised gas. Derivation of Boltzmann equation. Derivation of macroscopic hydromagnetic equations. Conservation laws. Motion of particles in electric and magnetic fields. Plasma diagnostics. Waves in plasmas.

EXPH 4013 Low Temperature and Condensed Matter Physics

Type-I and type-II superconductors. Meissner effect. Thermodynamics and electrodynamics of superconductor equations. London penetration depth. Coherence length. Phenomenological theories. BCS theory. Energy gap. Josephson effects. SQUIDs and SLUGs. High- T_c superconductors. Superfluidity in liquid helium. First and second sound. Rotons. Vortex states. Laser cooling and trapping. Bose-Einstein condensates Co-operative magnetic phenomena.

EXPH 4014 Medical Physics

Photon interactions in matter. X-ray spectra and filtration. Charged particle interactions. Production of medical radiation beams. Charged particle equilibrium. Kerma and dose. Bragg and Gray cavity theory. Absolute dosimetry. Detection of ionising radiation. Radiation Protection. Medical uses of ionising radiation, external teletherapy, brachytherapy. Nuclear Medicine and diagnostic imaging.

Genetics

GENE 4001 The Eukaryotic Genome

cDNA and genomic libraries, subtractive cDNA techniques. Identification of novel genes through transposon tagging. The control of gene expression in animals and plants with reference to the use of transgenics. DNase sensitivity and heat-shock proteins, gene activation by steroids and homeotic genes and the homeobox.

GENE 4002 Human Genetic Diseases

This course offers students an overview of genetic disorders and the application of molecular techniques to identify disease causing genes. Topics covered include: the inheritance pattern, molecular basis and clinical consequences of inherited genetic defects: the relevance of chromosomal abnormalities and gene-environment interaction to human disease and the techniques used in identifying disease causing genes.

PHAR 4014 Developmental Biology

Details available from the Department of Pharmacology

BIOC 4014 Bioinformatics

For details of unit see under Biochemistry

Geology – GEOL 4000

The Fourth Year course builds on the background of the main branches of Geology with additional material on petroleum and ore geology, geotectonics, micropalaeontology, invertebrate palaeontology and isotope geology. Students carry out an independent mapping project in the Summer before the Fourth Year to be presented as a thesis and a seminar. In addition students attend regular research seminars.

GEOL 4001 Palaeontology

Fossil Taxonomy and Micropalaeontology; study of foraminifera, conodonts and calcareous algae; Faunal Provinces; evolution of reefs and their biota; Precambrian fossils and evolution of the biosphere.

GEOL 4002 Stratigraphy

Upper Palaeozoic Stratigraphy and Sedimentology of NW Europe. North Sea Basin case study: structural control and evolution of sedimentation and hydrocarbon prospectivity in rocks of Devonian to Palaeogene age.

Lower Palaeozoic stratigraphy, sedimentology and volcanology of the British Isles and its relationship to tectonics.

GEOL 4003 Sedimentology

Sediment yield and erosion rates. Sea level change. Principles and applications of sequence stratigraphy in alluvial, paralic, carbonate and deep-water settings. Carbonate petrography. Compaction and diagenetic modelling. Reservoir architecture. Subsidence and basin analysis. Extensional, foreland and strike-slip basin fills.

GEOL 4004 Metamorphic petrology and Precambrian geology

Crustal evolution and tectonics of Laurentia-Baltica from Archaean to Neoproterozoic; tectonics and metamorphism of the Dalradian; geochronology of metamorphic processes; thermobarometry and relative thermobarometry; mixed fluid equilibria; eclogites; granulites and thermal aureoles.

GEOL 4005 Geological mapwork and orogenic belts

Crustal evolution based on integrated analysis of orogenic belts using published geological maps and problem maps and structural, petrological, geochemical and geophysical (including palaeomagnetic) data. Examples include the Lapland-Kola orogen; Caledonian orogen in Ireland, Scotland and Norway; Sveconorwegian orogen in Sweden and Norway.

GEOL 4006 Igneous Petrology

Magmatism at constructive and destructive intra-plate margins and intra-plate settings. Evolution of magmatism through geological time. The origin of komatiites and massif anorthosite and their implications for Precambrian earth evolution. The origin and evolution of carbonatitic magmas. Igneous rocks as tracers of the composition and evolution of the mantle.

GEOL 4007 Ore Geology

The mineralogy, geological setting and origin of metallic mineralisation illustrated by examples of globally important ore deposit types.

GEOL 4008 Petroleum Geology

The principles and application of wireline logging, seismic and sequence stratigraphy and drill stem testing. Basin analysis and petroleum play synthesis with special emphasis on the basins of the Middle East and the Irish offshore.

GEOL 4009 Structural Geology

Derivation of kinematics from structural features. Geometry and growth of normal fault systems. Models for thrusting and gravity sliding. The effects of faults and fractures on fluid flow.

GEOL 4010 Tectonics

Tectonic development and deep crustal structure of the Caledonides and the Variscides. Origin and superimposition of non-plane strains in orogenic belts. Salt and inversion tectonics. Models for extensional basin evolution.

Field Work in Geology

Field work is an important part of geological training. In addition to field classes referred to under the First and Second Science courses, Third Year honours students and those taking the single subject BSc (General) degree programme are required to attend an 8 day field class in southern UK, southern Spain, Cyprus or Greece during the Spring vacation, two weekend field classes in Ireland and occasional one day field classes. Fourth Year Geology students attend an 8 day field class in southern Spain, Cyprus or Greece in the Spring vacation, a 7 day mapping course in Ireland following the Summer examinations, and occasional weekend and one day field classes in Ireland. Honours students carry out an independent mapping project before the start of the Fourth Year. The costs of field classes in Second, Third and Fourth Years are subsidised by the Department but students are required to make a financial contribution to the field classes.

Geophysical Science

Students take the three core units in Experimental Physics and Geology and either of GEOL 3010 or GEOL 4013, whichever has not been taken in Third Year.

Core Units

GEOL 3004 Applied Geology

For details of this unit see under Geology

GEOL 3006 Sedimentology and Volcanology

For details of this unit see under Geology

GEOL 3007 Structural, Petroleum Geology

For details of this unit see under Geology

GEOL 4014 Topics in Geophysics

Topics related to current research and state-of-the-art ideas not covered in other units.

EXPH 3006 Thermodynamics and Statistical Physics

For details of this unit see under Experimental Physics

EXPH 3009 Optics

For details of this unit see under Experimental Physics.

EXPH 4008 Environmental Radiation and Radioecology

For details of this unit see under Experimental Physics.

and either

GEOL 3010 Seismology, Global Geophysics

or

GEOL 4013 Data Processing and the Crust

Time series analysis. Seismic reflection and refraction data processing. Forward modelling techniques and synthetic seismograms. Synthetic random media. Ray tracing. Vertical seismic profiles. P and S-wave studies of the crust. Reflection seismic data interpretation. Sequence stratigraphy. Petrophysics. Potential field data processing and analysis.

In addition, all fourth year students are required to complete a geophysical field or laboratory project during the course of the year. In the case of field projects, the data is collected in the summer before the start of the Fourth Year. This will be presented in thesis form as part of the final degree examination assessment.

These courses are available to Third Year students in other departments provided they have an adequate background in Experimental Physics and/or Geology.

<i>Industrial Microbiology – INDM 4000</i>

Courses are selected, in consultation with the Head of Department, from the topics listed below. All students are required to undertake a substantial laboratory-based research project. Successful students may opt to undertake a project in a research laboratory in industry or a research institute. On completion of the project it is presented in the form of a thesis, which forms part of the degree examination. An oral presentation is also required for assessment. Attendance of students at Department seminars is obligatory.

INDM 4001	Topics in Bacteria and Fungi
INDM 4002	Enzyme Technology
INDM 4003	Applied Microbial Genetics
INDM 4004	Food Science
INDM 4005	Fermentation Science
INDM 4006	Advances in Environmental Microbiology I
INDM 4007	Medical Microbiology
INDM 4008	Process Microbiology
INDM 4009	Developments in Biotechnology
INDM 4010	Bio-separation Techniques
INDM 4011	Advances in Food Microbiology
INDM 4012	Current Topics in Bacteria
INDM 4013	Current Topics in Fungi
INDM 4014	Microbial Genetics
INDM 4015	Advances in Environmental Microbiology II
INDM 4016	Advances in Environmental Microbiology III
INDM 4017	Food Microbiology

Mathematical Physics

Students taking the BSc (Single Honours) Degree must take seven courses and students taking the BSc (Joint Honours) Degree must take four courses. Subject to the approval of the Head of Department, appropriate Honours courses in Mathematics or Experimental Physics may be taken in place of some of these courses.

MAPH 4110 Nonlinear Waves and Solitons

Nonlinear model wave equations: Korteweg-deVries equation, nonlinear Klein-Gordon equation, nonlinear Schrödinger Equation, Burgers equation, Ginzburg-Landau equation. Multiple scale perturbation techniques.

Instabilities: Linear and nonlinear instability.

Hyperbolic waves and shocks: Method of characteristics, wave distortion, shock jump conditions.

Solitons: KdV equation, nonlinear dispersive phenomena, conservation laws, Backlund transformations, inverse scattering theory.

MAPH 4120 Differential Geometry

An Introduction to Differential Geometry for General Relativity:

Tensor algebra. Differentiable manifolds. Affine connections. Torsion tensor. Curvature tensor of a connection. Pseudo-Riemannian manifolds. Riemann curvature tensor. Bianchi identities, Ricci identities.

MAPH 4130 Mathematical Foundations of Quantum Mechanics

Hilbert spaces. Bounded and unbounded operators. Adjoints of operators. Self-adjoint extensions. Spectral theory. The Spectral Theorem for bounded and unbounded self-adjoint operators. Perturbations of self-adjoint operators. Quadratic forms. Free Quantum Fields. The basic principles of scattering in Hilbert space.

MAPH 4141 Quantum Mechanics

Periodic potential, energy bands. Approximation methods of bound states, Helium atom. Zeeman effect. Angular momentum, Clebsch-Gordan coefficients, Wigner-Eckart theorem. Non-relativistic hydrogen atom with spinning electron. Relativistic theory of the electron. Scattering theory.

MAPH 4151 Statistical Mechanics

Classical Statistical Mechanics:

The microcanonical ensemble, time averages, ergodicity. The canonical and grand-canonical ensemble, equivalence of ensembles, the thermodynamic limit and phase transitions. Lattice gases and magnetic systems.

Quantum Statistical Mechanics:

Trace class operators, density matrices, Fock space, ideal Bose and Fermi gases, Bose-Einstein condensation, lattice models, the Mermin-Wagner argument.

MAPH 4161 Computational Physics (from session 2002/2003)

Parabolic equations in one space variable (Schrödinger equation, Diffusion equation). Parabolic equations in two and three dimensions – ADI methods. Hyperbolic equations – Lax Wendroff scheme, flux-limiter methods (fluid dynamics, wave equation). Consistency, convergence and stability. Elliptic equations (Poisson's equation). Finite element method. Metropolis Algorithm (Ising Model), Quantum Monte Carlo (Molecular dynamics).

MAPH 4171 General Relativity

Einstein's field equations. Physical interpretations of the energy-momentum-stress tensor. Newtonian approximation. The Schwarzschild solution. The Kruskal extension of the Schwarzschild manifold. Experimental tests. Interior Schwarzschild solution. Kinematics of a continuous medium. The Robertson-Walker cosmos. The equation of geodesic deviation. Plane gravitational waves and their interaction with clusters of test particles.

(This course requires MAPH 4181, or MAPH 3141 and MAPH 3151, and MAPH 4120 as pre/corequisites.)

MAPH 4181 Electromagnetic Theory

Electrostatics: electrostatic potential; Gauss's law; Poisson's equation; dielectrics; electrostatic energy. Magnetic fields due to steady currents: vector potential; Ampère's circuital law; magnetic materials. Maxwell's equations. Energy and momentum: Poynting vector. Plane waves in non-conducting and conducting media. Wave guides. Radiation from bounded sources. Liénard-Wiechert potentials. Relativistic formulation of electromagnetic theory.

This course may only be taken in conjunction with MAPH 4141 or MAPH 4171. Students who have taken modules MAPH 3141 and MAPH 3151 cannot take module MAPH 4181).

MAPH 4190 Theoretical Astrophysics

The universe observed.

Stellar Physics: Star formation, heat transfer, nucleosynthesis. Equations of stellar structure. White Dwarfs, Neutron stars.

Astrophysical Hydrodynamics: Basic equations, accretion, shock waves, jump conditions, similarity solutions, supernova remnants. Jets.

Astrophysical Plasmas: Debye length, plasma frequency, dispersion measure, pulsars. Faraday rotation. Magnetohydrodynamics, Magnetic virial theorem. Alfvén waves.

MAPH 4211 Numerical Analysis*

Berstein polynomials. Weierstrass approximation theorem. Lagrange and Hermite interpolation polynomials. Cubic splines. Functional iteration.

* This course is given jointly with the Mathematics Department.

Second order functional iteration. Newton's method. Method of false position. Aitken's method.

Integration. Ordinary differential equations. Introduction to partial differential equations and Poisson's equation in two dimensions. Linear algebraic equations. Iterative methods. Matrix eigenvalues.

MAPH 4192 Special Topics in Mathematical Physics 1

Quantum Computing. Introduction to the basics of classical computing. Universality and a proof of Deutsch's theorem. Quantum parallelism and quantum algorithms. Deutsch's problem and the Deutsch-Jozsa promise problem; Simon's XOR problem; Grover's search algorithm. Introduction to factorisation of numbers and Shor's algorithm.

MAPH 4193 Special Topics in Mathematical Physics II

Further details available from the Mathematical Physics Department.

<p style="text-align: center;"><i>Mathematical Science</i> <i>(SCBDF0014)</i></p>

Students take the equivalent of 12 units chosen from the courses listed below. The courses in Mathematics and Mathematical Physics are equivalent to 1.5 units and the courses in Statistics are equivalent to one unit. The combination of courses must be approved by the Course Director.

Mathematics

MATH 4101	Ring Theory
MATH 4102	Group Theory
MATH 4103	Combinatorics
MATH 4104	Measure Theory
MATH 4105	Differential Geometry
MATH 4106	Functional Analysis
MATH 4107	Numerical Analysis
MATH 4108	Financial Mathematics
MATH 4109	Topology
MATH 4110	Commutative Algebra
MATH 4111	Several Complex Variables
MATH 4112	Special Topics

Mathematical Physics

MAPH 4110	Nonlinear Waves and Solitons
MAPH 4120	Differential Geometry
MAPH 4130	Mathematical Foundations of Quantum Mechanics
MAPH 4141	Quantum Mechanics
MAPH 4151	Statistical Mechanics
MAPH 4161	Computational Physics
MAPH 4171	General Relativity
MAPH 4181	Electromagnetic Theory
MAPH 4190	Theoretical Astrophysics
MAPH 4192	Special Topics in Mathematical Physics I
MAPH 4193	Special Topics in Mathematical Physics II

Statistics

STAT 4211	Data Analysis I
STAT 4212	Applied Statistics I
STAT 4213	Applied Statistics II
STAT 4214	Time Series Analysis
STAT 4215	Multivariate Analysis
STAT 4216	Actuarial Statistics I
STAT 4217	Actuarial Statistics II
STAT 4222	Stochastic Processes I
STAT 4223	Official Statistics
STAT 4231	Linear Models with Complex Structure
STAT 4232	Topics in Biostatistics
STAT 4233	Nonparametric Statistics
STAT 4235	Survival Analysis
STAT 4237	Stochastic Processes II
STAT 4238	Data Analysis II
STAT 4239	Stochastic Processes II

<i>Mathematics</i>

Eight units must be chosen. A student's choice of units is subject to the approval of the Head of the Mathematics Department.

MATH 4101 Ring Theory

Rings and modules. Noetherian rings. Hilbert's Nullstellensatz. Simple rings and semisimple rings. Artin-Wedderburn theorem. Burnside's theorem.

MATH 4102 Group Theory

Sylow theorems. Advanced topics in the theory of groups: finite p -groups, local analysis, p -nilpotence, the transfer.

MATH 4103 Combinatorics

Recurrence relations and generating functions. Principle of inclusion and exclusion. Ramsey theory. Latin squares. Designs. Finite geometries.

MATH 4104 Measure Theory

Measure spaces and measurable functions. Integrability. Dominated convergence theorem. Product measures. Radon-Nikodym theorem.

MATH 4105 Differential Geometry

Differentiable atlases. Manifolds and submanifolds. Tangent bundles and vector fields. Riemannian manifolds. Curvature and torsion. Dynamical systems.

MATH 4106 Functional Analysis

Topological vector spaces and linear mappings. Hahn-Banach theorem. Banach-Steinhaus theorem. Hilbert spaces. Riesz-Fischer theorem. Geometry of Banach spaces.

MATH 4107 Numerical Analysis

Weierstrass approximation theorem. Cubic splines. Functional iteration. Newton's method. Aitken's method. Ordinary differential equations. Partial differential equations and Poisson's equation in two dimensions.

MATH 4108 Financial Mathematics

Rates of interest. Annuities, discount, capital redemption policies. Consumer credit, immunization, stochastic interest rate, mortality.

MATH 4109 Topology

Topological spaces and continuous maps. Compactness, connectedness. Separation axioms. Compactification. Quotient spaces.

MATH 4110 Commutative Algebra

Polynomial algebras and affine varieties. Dimension theory of commutative rings. Localization and completion. Projective varieties and graded algebras. Spectra of rings.

MATH 4111 Several Complex Variables

MATH 4112 Special Topics

Fourth Year Honours students may, with the consent of the Head of Department, substitute an appropriate course or courses in Mathematical Physics for one or more of their Mathematics courses.

<p style="text-align: center;"><i>Pharmacology – PHAR 4100</i></p>

Advanced courses (10 lectures/tutorials per course) are given in specialised areas of pharmacology. These include:

PHAR 4001	Disorders of Haemostasis
PHAR 4002	Neuropharmacology
PHAR 4003	Cancer studies
PHAR 4004	CNS Dopamine Receptors/Drug Development
PHAR 4005	Nitric Oxide, Vascular Injury and Angiogenesis
PHAR 4006	Cytokine Receptors/Muscle Pharmacology
GENE 4001	Eukaryotic Genome (For details of unit see under Genetics).
PHAR 4009	Molecular Biology of Steroid Hormone Receptors
PHAR 4014	Developmental biology/pharmacology
PHAR 4011	Renal Pharmacology and Toxicology
STAT 4230	Statistics – Laboratory Assays

A research project is carried out under the direction of individual academic staff members and the completed project is presented in thesis form for the degree examination. Oral presentations of research work are also required.

Students are required to attend at departmental research seminars and small-group discussion sessions.

Physiology – PHYS 4001

The following courses are offered in a range of topics reflecting the specialised interests of the staff in the department. Each student must attend all of the courses offered.

Local Control of Vascular Resistance

Assessment of arterial myogenic (pressure-dependent) activity. Ionic conductance, membrane potential, intracellular calcium changes and lipid second messenger contributions to the myogenic response.

Renal Physiology and Electrolyte Homeostasis

Tubular functions. Renal circulation and metabolism. Transport mechanisms. Endocrine and neural control of electrolyte homeostasis.

Gastrointestinal Physiology

Recent advances in gastrointestinal physiology. Physiological barriers to gastro-oesophageal reflux. Regulation of vomiting. Neuroanatomy and electrophysiology of the enteric nervous system. Gastric proton pump.

Circuitry and Plasticity in the CNS

Chemical transmission in the central nervous system. The synapse. The neuron. The microcircuit, intrinsic circuits and the neural network. Principles of chemical neurotransmission. Principles of microdialysis. The motor circuit. Parallel and serial processing in the basal ganglia. The limbic circuit and schizophrenia, Synaptic plasticity. Long term potentiation and long term depression.

Neuromodulation of Respiratory Motor Outputs

Voltage-gated ion channels. Ligand-gated ion channels. Passive membrane properties. Integration of neuronal activity. Pathologies associated with ion channel dysfunction.

Pulmonary Circulation

Details available from the Department.

Central Cardiorespiratory Control

Details available from the Department.

Each student is required to carry out a supervised laboratory-based research project, which has to be presented orally and submitted in minor thesis form as part of the Degree examination assessment. In addition, students are required to attend departmental research seminars and discussion groups and carry out the continuous assessments set.

Plant Genetic Engineering – BOTN 4100

Each student must attend ten of the following courses and undertake a Research Project in consultation with the Course Director.

BOTN 4003 Evolution in Plant Populations

For details of this unit see under Botany.

BOTN 4006 Eukaryotic Genome

For details of this unit see under Botany.

BOTN 4007 Organelle Biogenesis

For details of this unit see under Botany.

BOTN 4008 Plant – Pathogen Interactions

For details of this unit see under Botany.

BOTN 4009 In Vitro Techniques

For details of this unit see under Botany.

BOTN 4011 Critiques of Scientific Papers

For details of this unit see under Botany.

BOTN 4013 Science and Society

For details of this unit see under Botany.

BOTN 4014 Developmental Plant Genetics

For details of this unit see under Botany.

BOTN 4016 Plant Transformation

Agrobacteria-mediated transformation, direct gene transfer, selection, screening, use of transgenics in modifying plant metabolism and development. Co-suppression and anti-sense strategies.

BOTN 4017 Plant Food Safety

Testing procedures for dietary compatibility of modified plant proteins, lectins, haemagglutinins. Consequences of alteration of enzyme activities in metabolic cassettes.

BOTN 4018 GMOs in the Environment

The release of GMOs and their consequences. Regulatory procedures.

BOTN 4019 Molecular Biology and Plant Breeding

RFLP, RAPD, microsatellite and repeated sequences in genotyping and haplotyping, varietal identification and pathogen detection. Transformation and genetic engineering in plant breeding. Identification of differentially expressed genes.

CELB 4002 Immunobiology

For details of this unit see under Cell and Molecular Biology.

<p><i>Psychology</i></p>

(Available only to those students taking Honours Psychology. All Honours students take PSY 4201 – PSY 4215 inclusive and select two Optional Units from PSY 4216 – PSY 4224.)

Core Units:

PSY 4201	Neuropsychology
PSY 4202	Advanced Cognitive Psychology
PSY 4203	Social: Social Cognition
PSY 4204	Social: Group Theory and Processes
PSY 4205	Social: Constructivism and Gender
PSY 4206	Aspects of Self and Identity
PSY 4207	Applied Psychology & Work
PSY 4208	Language: Symbols to Societies
PSY 4209	Perspectives on Development
PSY 4210	Applied Developmental
PSY 4211	Intelligence
PSY 4212	Current Debates in Psychology
PSY 4213	Philosophical Psychology
PSY 4214	Advanced Stats/Computer Analysis
PSY 4215	Research Project

Honours Psychology students are required to undertake a research project and to write a minor thesis under the direction of individual academic staff members for the degree examination. In addition, students are required to attend departmental research seminars and discussion groups.

Optional Units:

PSY 4216	History and Psychology
PSY 4217	Behavioural Paediatrics
PSY 4218	Counselling and Psychotherapy
PSY 4219	Psychology and Education
PSY 4220	Reading
PSY 4221	Comparative Psychology
PSY 4222	Attachment Theory
PSY 4223	Emotions and Mind
PSY 4224	Organisational Psychology

Notes for Final Year Students:

- Students are required to attend tutorials and departmental seminars, and to submit essays.
- Practical work may also be required in certain courses.
- Up to 25% of the marks allocated to any unit may be awarded for practical work.
- Some courses may not be offered in a particular year.

<i>Statistics</i>

STAT 4211 Data Analysis I

STAT 4212 Applied Statistics I

Design and Analysis of Experiments. Complete Block Designs (Randomized Block and Latin Square Designs). Incomplete Block Designs. Factorial Designs. Confounding and Fractional Factorial Designs. Statistical Software.

STAT 4213 Applied Statistics II

Introduction to Sample Surveys. Contingency Table Analysis. Logistic Regression. Log-linear Models. Statistical Computing.

STAT 4214 Time Series Analysis

Characteristics of time series. Autocorrelation and cross-correlation function. Stationary time series. Autoregressive and moving average processes. Nonstationary time series. Model specification and estimation. Model diagnostics. Forecasting. Special topics.

STAT 4215 Multivariate Analysis

Random vectors. Multivariate Normal Distribution, Correlation and Regression. Hotelling's T^2 Statistic. Discriminant Analysis. Canonical Correlation. Principal Components Analysis. Multivariate Analysis of Variance.

STAT 4216 Actuarial Statistics I

Economics of Uncertainty. Risk Theory and Utility. Jensen's Inequality. Sums of Random Variables and Convolutions. Loss Distributions. Reinsurance. Risk Models. Mixtures of Random Variables and Mixtures of Distributions.

This unit is not available to students who have taken STAT 3216.

STAT 4217 Actuarial Statistics II

Ruin theory. Lundberg's Inequality. Credibility Theory. No Claims Discounting. Applications in Insurance.

This unit is not available to students who have taken STAT 3217.

STAT 4222 Stochastic Processes I

An introduction to the classification and simulation of stochastic processes. Discrete and continuous time models. Stochastic calculus.

STAT 4223 Official Statistics

Collection of official statistics including macro-economics, business, demographic and social statistics. Accessing official statistics and their applications. Estimation, imputation and seasonal adjustment.

STAT 4230 Statistics – Laboratory Assays

STAT 4231 Linear Models with Complex Structure

Analysis of unbalanced data from surveys and experiments. Partitions of data in orthogonal designs. Means model. Estimation of variance components in unbalanced mixed and random effect models. Methods for the analysis of repeated measures data.

STAT 4232 Topics in Biostatistics

This course covers specialised applications of statistics in biology. Topics include the following: Pharmaceutical statistics, ecological statistics, medical and epidemiological statistics.

STAT 4233 Nonparametric Statistics

Distribution-free statistics; statistics utilizing counting and ranking; Wilcoxon statistics; Kruskal-Wallis statistic. Friedman statistic; Spearman's statistics; Permutation procedures; Power functions and asymptotic distribution. Nonparametric regression.

STAT 4234 Regression Theory

Simple and Multiple Linear Regression. Weighted Least Squares. Lack of Fit. F tests. Residuals and Influence. Model Building.

STAT 4235 Survival Analysis

Censoring. Life tables. Kaplan Meier estimate. Mantel-Haenzel statistics. Parametric methods. Cox's proportional hazards model. Goodness-of-Fit.

STAT 4236 Statistical Computing

Fixed point and floating point arithmetics. A review of programming style. Random number generators. Monte Carlo applications. A review of maximum likelihood. Unconstrained nonlinear optimizations. Accessing Fortran libraries.

STAT 4237 Stochastic Processes II

General principles of stochastic processes. Markov chains. Markov processes. Special topics in time series models.

STAT 4238 Data Analysis II

STAT 4239 Stochastic Processes III

Gauss Wiener processes and levy processes. Monte Carlo simulation of stochastic processes. Stochastic actuarial modelling.

STAT 4240 Data Mining

<i>Theoretical Physics</i>

Students take the equivalent of 12 units. These are chosen from the courses listed below. The courses in Group A are equivalent to 1.5 units and the courses in Group B are equivalent to one unit.

Group A

MAPH 4110	Nonlinear Waves and Solitons
MAPH 4120	Differential Geometry
MAPH 4130	Mathematical Foundations of Quantum Mechanics
MAPH 4151	Statistical Mechanics
MAPH 4161	Computational Physics
MAPH 4171	General Relativity
MAPH 4191	Theoretical Astrophysics
MAPH 4192	Special Topics in Mathematical Physics I
MAPH 4193	Special Topics in Mathematical Physics II

Group B

EXPH 4002	Quantum Mechanics and Nuclear Physics
EXPH 4004	Atomic and Molecular Physics
EXPH 4005	High Energy Particle Physics
EXPH 4009	Perspectives in Modern Astrophysics
EXPH 4010	Atomic Structures and Spectra
EXPH 4011	Physics of Ionized Gases
EXPH 4013	Condensed Matter Physics
EXPH 4015	Data reduction, Modelling and Error Analysis
EXPH 4016	Interdisciplinary Computational Physics
EXPH 4017	Experimental Laboratory Option

Also, at most 1.5 units may be in a more advanced topic, which will normally be in one of the following areas.

- Quantum Field Theory
- Quantum Gravity
- Advanced Mathematical Statistical Mechanics
- Advanced General Relativity
- Non-linear Waves
- Advanced Theoretical Astrophysics

Zoology – ZOOL 4000

Students must choose and attend seven units. Units will only be offered if sufficient students choose to take them. Each student undertakes a research project which is written and presented as a thesis. Each student must give an oral presentation based on their research project. In addition, students are required to write a literature review and an essay on an assigned topic. Attendance at Research Seminars is obligatory.

ZOOL 4001 Biodiversity

Evolution and maintenance of biodiversity within systems. Equilibrial and nonequilibrial models of community organisation. Global patterns of species diversity. Functional redundancy. The Irish fauna.

ZOOL 4005 Ecology of Tropical Rainforests

The paradox of tropical luxuriance: climate, soil, vegetation and nutrient cycling. Biodiversity in tropical forests. Rainforests as a vanishing resource with emphasis on ethnopharmacology. Accounts of expeditions to West Central Africa and Amazonia. Models for sustainable use.

ZOOL 4009 Parasitology

Deals with classical aspects of parasitology. The biology, pathology, diagnosis and treatment of a number of parasitic infections, in humans and other animals are described. The parasites include protozoan and helminth endoparasites and ectoparasites.

ENVB 4002 Environmental Impact Assessment

For details on this unit, see under Environmental Biology.

ZOOL 4012 General Zoology

This is the coding for the examination paper on general zoology in the final examination.

ZOOL 4014 Prion Diseases

This course examines the current research into the agents responsible for the animal and human Transmissible Spongiform Encephalopathies. It includes the nature of the agent, its genetics, cell biology and epidemiology.

ZOOL 4015 Marine Ecology

Oceanography via remote sensing. The ecology of corals and fishes on coral reefs. The unusual biology and ecology of deep-sea animals. The unexpected impacts of humans in the marine environment. The ecology of polar environments.

ZOOL 4016 Marine Community Ecology

Patterns of community structure in benthic marine habitats, such as rocky shores, sandy beaches and kelp forests. Apatial and temporal scales of variation. Interactions between physical factors and biological processes such as recruitment, competition and predation. Detecting and reducing human impacts in a variable world.

ZOOL 4018 Genomic imprinting, chromatin and epigenetics

Parent of origin-dependent gene expression in mammals: molecular mechanisms, evolution and implications for embryonic development, cancer and animal cloning.

ZOOL 4019 Bioassessment of Freshwaters

Contemporary bioassessment approaches using fish, invertebrates and plants, ecosystem integrity, stress factors, reference conditions, typologies, biological indicators, analyses and interpretation of data, biotic metrics and indices, predictive models.

Part Time Degree Programme

***BSc Degree in Occupational Safety and Health Management
(SCBDF0012)***

1. Applicants to this part time BSc degree course must have completed and achieved a high standard in the NUID Diploma in Safety, Health and Welfare at Work or equivalent. Applicants should also have at least two years' relevant work experience.
2. A limited number of places are available on the course. Applications should be made in writing to: Centre for Safety and Health at Work, NovaUCD, University College Dublin, Belfield, Dublin 4. Closing date for receipt of applications is 30 April each year.
3. The degree course is a part time course and will normally be completed in two years.
4. The foundation unit, SHWW 3201 Research Methods, Data Processing and Analysis, is offered each year. This unit is compulsory for students in the first year of the programme. Thereafter each core and elective unit is offered once every second year to both first and second year students who attend lectures together.
5. Project work is based on individual work placements in industry (which may be in the student's own workplace), which takes place over both first and second years of the degree programme.
6. Examinations will be held each year in Summer with repeat examinations in Autumn.

Core Units

SHWW 3201 Research Methods, Data Processing and Analysis

Introduction to programme, its objectives and knowledge and skills needed to carry out workplace placement and research project. Builds on and adds to Epidemiology and Statistics in the Diploma course. Use of software packages for data analysis, and report/thesis writing skills.

SHWW 3202 Risk Management

Advanced risk management techniques relating to management of safety and health in the workplace, including cost benefit analysis, claims investigation and analysis, practical legal issues that relate to risk management and stages of litigation process.

SHWW 3203 Applied Management for Occupational Safety and Health

Practical management skills, communication skills, strategic planning and project management. Relevant industrial relations and human resource issues relating to occupational safety and health in organisations. Builds on Ergonomics and Behavioural Science and Safety and Health Legislation in the Diploma course.

SHWW 3204 Occupational Safety and Health and Environmental Management

Legislative and practical links between management of occupational safety and health and management of workplace environmental issues. Addresses needs of occupational safety and health professionals whose brief includes environmental issues. Explores roles of organisations involved in managing health and safety and the environment.

SHWW 3205 Safety Management and Quality Auditing

Quality Auditing and Standard Setting: how these principles can be applied to Occupational Safety and Health Management. Existing standards, contemporary trends and legislative requirements. Safety Management Systems are addressed in detail.

SHWW 3209 Industrial Placement

SHWW 3210 Project

Elective Units

Students must choose one of the following units:

SHWW 3206 Occupational Hygiene – the Working Environment

Occupational Hygiene practice, including personal and environmental monitoring in workplace. Builds on Occupational Hygiene in the Diploma course.

SHWW 3207 Occupational Health

Issues that relate to occupational health practice; skills required to run an occupational health department; legislation; the occupational health professional as part of multidisciplinary team; models of occupational health and occupational health nursing; and contemporary issues in occupational health practice.

SHWW 3208 Ergonomics

Ergonomic issues in contemporary work setting: the person, the environment, the equipment and the job. Legislation; the ergonomist as part of multidisciplinary team; ergonomic assessment; job and task analysis; analytical tools; and contemporary issues in workplace ergonomics.

PHAR 3004 Toxicology

For details of this unit see under Pharmacology.

***BSc Honours Degree in Medical Subjects for Medical Students
or Graduates (SCBDF0010)***

The Degree of BSc with Honours in Medical subjects may be conferred in any one of the following subjects: (a) Anatomy, (b) Biochemistry, (c) Medical Microbiology, (d) Pathology, (e) Pharmacology, (f) Physiology.

1. Students who have passed the appropriate University examination in Medicine in the corresponding subjects at a standard of at least Second Class Honours are eligible to take the BSc Degree in that subject. To be eligible to pursue the Degree of BSc in Anatomy or Biochemistry, students must have passed the University Examination of the Second Year of Medicine with Honours and must also have passed the University Examination of the Third Year of Medicine.
2. Candidates who hold the Degrees of MB, BCh and BAO may be recommended by the Faculty of Science for admittance to the Honours Degree courses in any one of the subjects (a) to (f).
3. For admission to the Honours Degree Examination in subjects (a) to (f), candidates must have attended the prescribed courses for at least one academic year.
4. Particulars of the prescribed courses are given in the booklet for the Faculty of Medicine. At the discretion of the Professors concerned, special instruction in related subjects may be arranged.

Postgraduate Programmes

The following postgraduate programmes are offered in the Faculty of Science:

Degree of Doctor of Philosophy (PhD)

- by research and thesis

Degree of Master of Science (MSc)

- by Mode I (research and thesis)
- by Mode II (course and examination)

Degree of Master of Applied Science (MApplSc)

- By Course And Examination

Higher Diploma

Diploma

Certificate

Admission and Entry Requirements for PhD Degree

Candidates are required to have reached a high Honours standard at the examination for the primary degree or equivalent before they can be allowed to enter a course of study and research for the Degree of PhD.

Candidates for this degree are required to be admitted by the Faculty on the recommendation of the Professor; their admission must then be confirmed by the Academic Council.

The degree is normally (except in Science) to be taken six terms after the Master's Degree, but in special cases candidates may be permitted to take it six terms after the primary degree. In the Faculty of Science, six terms after the BSc Degree is the minimum period.

This degree will not be awarded unless the examiners report that the work is worthy of publication as a whole or in part.

Candidates for PhD Degrees will be allowed six years from the date of registration in which to complete their degree. If they have not done so within that period, they must re-apply to Faculty for registration.

Admission and Entry Requirements for Msc and MAppSc Degrees

1. Application for admission to the MSc Degree programmes should be made to the Head of the relevant department.
2. Application for admission to the MAppSc Degree programmes should be made to the Director of the relevant programme.
3. Candidates for the MSc Degree and MAppSc Degree must have the permission of the Faculty and the Department concerned to enter a course. Except by permission of the Faculty, they cannot at the same time engage in any other course.
4. Only those candidates who have obtained at least a Second Class Honours primary degree, or equivalent, will be permitted to proceed directly to an MSc Degree Mode I. Entry requirements for the MSc Mode II or an MAppSc are determined by individual Departments.
5. Candidates who hold a Third Class Honours primary degree, the BSc General Degree with Distinction, or the BSc General Degree followed by two years' approved postgraduate experience, may be admitted to the MSc on the recommendation of the Faculty and the Department concerned. Such candidates would normally be required to pass a qualifying examination during their first year and attend the College for at least six terms.
6. The MSc Degree (Mode I) by thesis is an Honours degree. Candidates must attend for at least three terms and carry out research, under the direction of the Professor or Lecturer, in the subject concerned. The thesis presented by the candidate is to embody the results of this research. Candidates may be required to pass an examination in the subject-matter of the thesis if the Examiners so decide. Three copies of the thesis must be lodged with the Supervisor of Examinations, University College Dublin, on or before the date fixed by the University.
7. The Degree of Master of Science (MSc) may be awarded in any one of the following subjects: Anatomy, Biochemistry, Botany, Chemistry, Computer Science, Experimental Physics, Geology, Industrial Microbiology, Mathematical Physics, Mathematical Science, Mathematics, Medical Microbiology, Pathology, Pharmacology, Physiology, Psychology, Statistics, Zoology.

8. Students who pass the Higher Diploma in Mathematical Science with distinction may be admitted to the MSc Degree course in Mathematical Physics or Mathematics.
9. Students who pass the Diploma in Statistics (see Arts Faculty regulations) with distinction may be admitted to the MSc Degree in Statistics.
10. The MSc Degree (Mode II) by examination and the MAppSc Degree may be awarded with First or Second Class Honours. (The regulations governing these examinations are contained in Marks and Standards, available for consultation in the Library or on the web: <http://www.ucd.ie/~exams/>).
11. Candidates must attend a postgraduate course for three terms. An examination will be held in the subject-matter of the course selected. Candidates may be required to submit a dissertation on a project undertaken as part of their course and this dissertation will be taken into account by the Examiners in making their recommendations.

Courses leading to the MSc Degree are offered in the Departments of Botany, Computer Science, Mathematics, Mathematical Physics, Psychology and Statistics.

12. Candidates for the MSc Degree (Mode I Research) will be allowed a maximum of four years from the date of registration in which to complete their degree. If they have not done so within that period, they must reapply to Faculty for registration.
13. Candidates for the MSc Degrees (Mode II Examination) and MAppSc will be allowed a maximum of three years from the date of registration in which to complete their degree. If they have not done so within that time period, they must reapply to Faculty for registration.

Course Details for Taught MSc Degrees (Mode II)

Degree of Master of Science in Cognitive Science (SCMXF0011)

This interdisciplinary programme provides a one year (12 month) taught course in Cognitive Science. Students entering the course bring a background in one of the component disciplines (Computer Science, Linguistics, Psychology or Philosophy) and are encouraged to broaden their knowledge base in the other disciplines. After a year, they are well prepared to pursue postgraduate level research in Cognitive Science. The programme offers 2 semesters of taught courses which provide a solid foundation in Cognitive Psychology, Philosophy of Mind, Linguistics and Computational Modelling, as well as an in-depth study of selected research topics. Students also complete a substantial research project which is supervised by staff with active research interests. The project culminates in a minor dissertation.

***Degree of Master of Science in Computational Science
(SCMXF0025)***

Computational Science is a new rapidly emerging field involving the collaboration of applied mathematicians, computer scientists and researchers from many areas of applied science. Computational Science uses the techniques of Applied Mathematics and Computer Science for the development of problem solving methodologies and robust application tools. The techniques are used in many application areas, including science, engineering and finance/economics. The MSc in Computational Science is a twelve-month programme, which involves taught courses and a substantial dissertation written during the summer. All students are initially registered for the HDip in Computational Science and allocation to the MSc will be on the basis of performance in examinations and course-assessed work prior to the summer term.

***Degree of Master of Science in Mathematical Physics
(SCMXF0007)***

This is a one-year full-time taught Masters course open to those who have attained at least a 2nd Class Honours primary degree or equivalent in Mathematical Physics or a cognate subject. Candidates are required to attend postgraduate lectures on branches of Mathematical Physics approved by the department of Mathematical

Physics and to submit a dissertation which will be taken into account by the examiners.

***Degree of Master of Science on Mathematical Science
(SCMXF0010)***

This is a one-year full-time taught Masters course open to those who have attained at least a 2nd Class Honours primary degree or equivalent in Mathematical Science, Mathematics, Mathematical Physics or a cognate subject. Candidates are required to attend postgraduate lectures on branches of Mathematical Science approved by the departments of Mathematics and Mathematical Physics and to submit a dissertation which will be taken into account by the examiners. The courses offered will vary from year to year, and examinations in any given year will normally only be offered on courses given in that year.

***Degree of Master of Science in Plant Molecular Biology
(SCMXF0002)***

Advanced theoretical and practical training in a wide range of modern techniques in molecular biology as applied to Plant Science is provided in a one-year full-time course. There is a strong emphasis on laboratory-based training to complement the theoretical aspects of molecular biology. A practical research project forms an essential part of the year's programme.

Candidates should possess an honours degree in a biological subject, a BSc General with Distinction or equivalent by practical experience. An Examination will be held in the subject matter of the course; marks will also be awarded for the year's practical and for the research project. Candidates must pass separately the written papers, the year's practical work and the minor thesis.

***Degree of Master of Science in Radiological Sciences
(SCMXF0003)***

Advanced academic, practical and radiological training in all branches of diagnostic imaging is provided by a one year, full-time course in collaboration with the Institute of Radiological Sciences at the Mater Misericordiae Hospital and the Diagnostic Imaging and Nuclear Medicine Departments at St. Vincent's Hospital.

Candidates should be graduates in Medicine who have passed their fellowship examination in Radiology or equivalent (i.e. MD in Radiology) and actively engaged in diagnostic radiology.

Degree of Master of Science in Statistics (SCMXF0008)

This is a one-year, full-time taught Master's course open to those who have attained at least a Second Class Honours degree in Statistics or in a cognate subject or who have achieved a distinction in the Higher Diploma in Statistics. Candidates for entry must satisfy the Department of Statistics that they possess a reasonable knowledge of the basics of statistics. The purpose of the programme is to educate the student at postgraduate level in theoretical and applied statistics. The course will consist of lectures in eight topics in theoretical and applied statistics and students will also undertake a substantial project to be submitted as a minor thesis.

Course Details for MAppSc Degrees

Courses leading to the Degree of Master of Applied Science are offered in the following areas:

Computer Science (SCMXF0015)

This is a one year, full-time taught Master's course open to those who have achieved a good Second Class Honours in the Higher Diploma in Computer Science or equivalent and to suitably qualified Science graduates. The course has been designed with a specific emphasis on practical applications of relevance to the internet and e-commerce sector. The course will comprise six modules as prescribed by the Department of Computer Science. Students will be required to undertake a substantial project to be written up as a thesis to be submitted by the end of the academic year.

Environmental Science (SCMXF0014)

A one-year, full-time course open to graduates in Science, Engineering and Architecture.

Food Science (SCMXP0012)

A two-year, part-time course open to graduates in Science, Agriculture, Engineering, Veterinary Medicine, Commerce and Medicine.

Safety, Health and Welfare at Work (SCMXP0017)

The course is open to graduates who achieve a high standard in the Diploma in Safety, Health and Welfare at Work. It can be taken on a one year, full-time basis or on a two year, part-time basis.

The entry requirements for Science graduates will be the same as for the MSc. Suitably qualified graduates of other faculties and universities will be admitted on the recommendation of the Faculty. Candidates must attend the prescribed course of lectures and practicals. An examination will be held in the subject-matter of the course selected. Candidates may be required to submit a dissertation on a project undertaken as part of their course and this dissertation will be taken into account by the Examiners in making their recommendation.

Course Details for Higher Diplomas, Diplomas and College Certificates

Candidates for the Higher Diploma in the Faculty of Science will be allowed a maximum of two years from the date of registration in which to complete their diploma. If they have not done so within that period, they must reapply to Faculty for registration.

HDip/MSc in Advanced Software Engineering.

This HDip/MSc in Advanced Software Engineering offers students with a software engineering background an opportunity to develop their foundational skills in the area of agile processes and related disciplines.

Students who obtain an honours standard in the written examinations will be invited to complete, and achieve a passing grade in, a substantial dissertation in order to obtain the MSc qualification. Students who obtain a pass standard in the examinations will obtain the Higher Diploma qualification.

Higher Diploma in Computer Science (SCHDF0018)

The diploma course is full-time for one year and the course content consists of subject matter from the honours degree course in Computer Science. Admission will normally be restricted to graduates of disciplines other than Computer Science. The course is designed to give graduates of other disciplines a sound theoretical foundation and practical exposure to Computer Science.

HDip/MSc in Computational Science

Computational Science is a new rapidly emerging field involving the collaboration of applied mathematicians, computer scientists and researchers from many areas of applied science. Computational Science uses the techniques of Applied Mathematics and Computer Science for the development of problem solving methodologies and robust application tools. The techniques are used in many application areas, including science, engineering and finance/economics.

The HDip in Computational Science is a taught post-graduate programme, which runs for nine months from September each year. The MSc in Computational Science is a twelve-month programme, which involves additional taught courses and a substantial dissertation written during the summer. All students are initially

registered for the HDip and allocation to the MSc will be on the basis of performance in examinations and course-assessed work prior to the summer term.

The HDip in Computational Science may also be taken on a modular basis over a longer period of time. In particular it may be taken concurrently with a PhD in a cognate subject with the agreement of the supervisor concerned.

<i>Higher Diploma in Mathematical Science (SCHDF0020)</i>
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The diploma course is full-time for one year and the course content consists of subject matter from the honours degree course in either Mathematics or Mathematical Physics. There will be a Mathematics stream and a Mathematical Physics stream.

Entry to the course is restricted to graduates who obtain the permission of the Head of the Department of Mathematics or of Mathematical Physics, as appropriate. Permission will normally be given to university graduates who have attained a sufficiently high standard in Mathematics or Mathematical Physics.

The examination may be taken once only and must be taken in the academic year of registration. (Exceptions to this rule may be granted by the Faculty but only for grave reasons). Students who pass with distinction will qualify for admission to the MSc course in Mathematical Science, Mathematics or Mathematical Physics.

A student's choice of options must be approved by the departments concerned.

Mathematics Stream

- | | |
|---------|------------------------------|
| Part I | 1. Algebra |
| | 2. Analysis |
| Part II | 3. Algebra |
| | 4. Real and Complex Analysis |

Mathematical Physics Stream

Part I Students take four courses from MAPH 3111, MAPH 3120, MAPH 3130, MAPH 3161 and MAPH 3171.

Part II Students take four courses from the Fourth Year courses in Mathematical Physics.

Higher Diploma in Statistics (SCHDF0021)

This is a full-time one-year course open to graduates who have attained a sufficiently high standard in a subject area that is cognate to Statistics. The course content consists of subject matter from the degree courses in Statistics and gives a grounding in theoretical and applied statistics. Students who pass the Higher Diploma in Statistics with distinction may be admitted to the MSc programme in Statistics. Candidates must be approved by the Head of Department.

Diploma in Safety, Health and Welfare at Work

This is a two-year, part-time course intended for persons with a professional interest in safety and health in the workplace. It comprises the following units:

- Safety and Health Legislation
- Health and Safety Management
- Occupational Health
- Occupational Hygiene
- Chemical Safety and Toxicology
- Human and Organisational Behaviour at Work
- Safety Technology
- Statistics in Health and Safety
- Projects
- Industrial Placements

Admission to the course is not restricted to graduates. Preference is given to applicants with relevant experience.

Certificate in Safety and Health at Work (IFCTP0004)

This one-year, part-time course provides an introduction to all aspects of occupational safety and health; theoretical and scientific aspects are introduced as well as practical applications of risk management and hazard control. The course is designed as an extra-mural course which can be offered at UCD and/or other centres throughout Ireland. Candidates would normally be required to have Leaving Certificate or equivalent. Further information may be obtained from the Centre for Safety and Health at Work, NovaUCD, University College Dublin, Belfield, Dublin 4. (Telephone No. 01-716 3500).

HDip/MSc Ubiquitous and Multimedia Systems

Computing as a discipline is in the midst of a radical shift from the traditional desktop metaphor to the palmtop and ultimately wearable devices. This course will provide a small, highly skilled cohort of students with a range of skills and competencies that are ultimately needed within the context of this evolving mobile, ubiquitous, multimedia computing paradigm.

Students who obtain an honours standard in their summer examination will be invited to complete, and achieve a passing grade in, a substantial dissertation over the summer months in order to obtain the MSc qualification. Students who obtain a pass standard in the examinations will obtain the Higher Diploma qualification.

Degree of Doctor of Science (DSc) on Published Work*

A candidate shall be deemed eligible to present for the Degree of Doctor by submitting published work to the National University of Ireland, which must embody the results of original research and a common theme sufficient to indicate that the candidate has achieved a special competence in this aspect of the subject. The work submitted must be of a high standard and contain original contributions to the advancement of knowledge and learning which has given the candidate international distinction in the field of study. Fifteen terms must elapse from the date of obtaining the Degree of Bachelor of Science. Further information may be obtained from the National University of Ireland, 49, Merrion Square, Dublin 2.

* *See Calendar of the National University of Ireland.*

European Credit Transfer System (ECTS)

**Credit Scheme for the Undergraduate Degree Programme in Science for Visiting
Students from European Universities**

Year	Subjects	Unit Courses	Credits	Total Per Year
First Science	4	-	15 per subject	60 credits
Second Science	3	12	5 per unit	60 credits
Third Science	*	10	6 per unit	60 credits
Fourth Science	*	-	60 per year	60 credits

* See regulations for Single Honours, Joint Honours, Topical, One-Subject General and Two-Subject General Degrees for number of subjects involved.

List of Staff

Where degrees have been awarded to academic staff by the National University of Ireland, the awarding university is omitted. In every other case the awarding university is listed in brackets.

Faculty of Science Office

<i>Telephone No. 716 2355</i>	<i>Room 128, Science Lecture Building</i>
<i>Email: Sue.Philpott@ucd.ie</i>	<i>Fax No. 716 2439</i>
	<i>Web: http://www.ucd.ie/~science/</i>
Dean of the Faculty:	Professor Michael J. Kennedy
Associate Dean (First Science):	Dr Bret Danilowicz
Associate Dean (Undergraduate):	Mr Hubert Fuller
Associate Dean (Postgraduate):	Professor Ciaran Regan
Associate Dean (Research & Development):	Professor Mark Keane
Senior Faculty Administrator:	Ms Gillian Goodbody
Faculty Administrator:	Ms Sue Philpott
Senior Executive Assistant	Mr Kieran Moloney
Student Advisers:	Rev. Tony Coote (Chaplain) Ms Aoife FitzGerald

Applied and Computational Mathematics

<i>Telephone No. 7168265</i>	<i>Fax No. 7161196</i>
<i>Email: Breda.McMahon@ucd.ie</i>	<i>Web: http://mathsa.ucd.ie/</i>
Programme Director:	Professor David Lewis, BSc, PhD, DSc

Biochemistry

Telephone No. 7161547	Fax No. 2837211
Email: Annette.Forde@ucd.ie	Web: http://www.ucd.ie/~biochem/
Head of Department	Professor J. Paul G. Malthouse
Professor of Biochemistry	Paul C. Engel, BA (Oxon), DPhil (Oxon)
Associate Professor (Redox Biochemistry)	Stephen G. Mayhew, BSc (Sheffield), PhD (Sheffield), MRIA
Associate Professor of Biochemistry (Biochemical NMR and Enzymology)	J. Paul G. Malthouse, BSc (Lond), PhD (Lond)
Senior Lecturer	B. Therese Kinsella, BSc, PhD Bartholomew Masterson, BSc, PhD Geraldine Butler, BA (Dub), PhD (Dub) Philip Newsholme, BSc (B'ham), DPhil (Oxon)
Lecturer	Jana Haase, Diplom (Leipzig), PhD (Free University of Berlin) Bronagh Hayden, BSc, PhD (Temporary Appointment) Gethin McBean, BA (Dub), PhD (Southampton) Margaret Worrall, BA (Dub), PhD (Cantab)
Research Associate	Brenda Brankin, BSc (QUB), PhD(QUB)
Administrator:	Annette Forde

Botany

Telephone No. 7162253	Fax No. 7161153
Email: Jane.Flaherty@ucd.ie	Web: http://www.ucd.ie/~botany/Botany.htm
Acting Head of Department	Professor Gerard Doyle
Professor of Botany	Martin W. Steer, BSc (Bristol), PhD (QUB), DSc (Bristol), MRIA, FRMS, MIBiolI, PresMSI

Associate Professor of Botany
(Vegetation Science)

Gerard Doyle, BSc, PhD, MIBiolI

Senior Lecturer

Hubert Fuller, BSc
Thomas F. Gallagher, BSc, PhD
Derek T. Mitchell, BSc (*Sheffield*), PhD
(*Sheffield*)
Bruce A. Osborne, BA (*Stirling*), PhD
(*Nottingham*)
Marinus L. Otte, MSc (*Vrije*), PhD (*Vrije*)
James White, BSc, MSc (*Wales*), DSc
Graham Wilson, BSc (*Lond*), PhD (*B'ham*)

Lecturer

Paul F. McCabe, BSc, (*NUI, Maynooth*),
MSc (*NUI, Maynooth*), PhD (*NUI,*
Maynooth)
Carl Khee-Yew Ng, BSc (*Singapore*), MSc
(*Singapore*), PhD (*Lancaster*)

Administrative Assistant:

Jane Flaherty

Cell and Molecular Biology

Telephone No. 7162265

Fax No. 7161152

Email: Mark.Rogers@ucd.ie

Web: <http://www.ucd.ie/~botany/Botany.htm>

Course Director

Dr Mark Rogers, BA (*Dub*), PhD (*Glasgow*)

Chemistry

Telephone No. 7162165

Fax No. 7162127

Email: Kathy.L.Murphy@ucd.ie

Web: <http://chemistry.ucd.ie/>

Head of Department

Professor Michael J. McGlinchey

Professor of Inorganic Chemistry

Michael J. McGlinchey, BSc, PhD (*UMIST*)

Professor of Organic Chemistry

A. Francis Hegarty, PhD, DSc, FRSC,
MRIA

Professor of Physical Chemistry

Kenneth A. Dawson, MSc (*QUB*), DPhil
(*Oxon*), MRIA

Associate Professor of Chemistry
(Nanotechnology)

Donald Fitzmaurice, BSc, PhD

Associate Professor of Inorganic
Chemistry (Organometallic Chemistry)

Anthony R. Manning, PhD (*Manchester*)

Associate Professor of Chemistry
(Physical Organic Chemistry)

Rory A. More O'Ferrall, PhD (*Lond*)

Associate Professor of Chemistry
(Electrochemistry)

Robert O'Neill, BSc, PhD

Associate Professor of Chemistry
(Atmospheric Chemistry)

Howard W. Sidebottom, PhD (*St. Andrew's*)

Senior Lecturer

Raphael D. Darcy, PhD, FICI
Noel J. Fitzpatrick, PhD, FICI
Declan G. Gilheany, BSc (*QUB*), PhD
(*QUB*)
Patrick J. Guiry, BSc, PhD
Earle W. Waghorne, PhD (*ANU*)

Lecturer

Vitaly Buckin, MSc (*Moscow*), PhD
(*Acad.Sci. USSR*)
Michael Casey, BSc, PhD (*Lond*), DIC
Grace Morgan, BSc (*QUB*), PGCE (*QUB*),
PhD (*OU*)
Paul V. Murphy, BSc, PhD
Donal O'Shea, BSc, PhD
Wilhelm Risse, Vordiplom (*Marburg*),
Diplom (*Marburg*), PhD (*Bristol*)
Matthias Tacke, Diplom (*Münster*), PhD
(*Münster*)
Edward G. Timoshenko, MSc (*Moscow*),
PhD (*Moscow*)

Administrator:

Kathy Murphy

Computer Science

Telephone No. 7162469	Fax No. 2697262
Email: Patricia.Geoghegan@ucd.ie	Web: http://www.cs.ucd.ie/contents.htm
Head of Department	Mr Gregory O'Hare (Acting Head of Department)
Professor of Computer Science	Mark T. Keane, BA, MA (Dub), PhD (Dub)
Digital Professor of Computer Science	Barry Smyth, BSc, PhD (Dub)
Senior Lecturer in Computer Science	Joseph Carthy, BSc, PhD Liam Murphy, BE, MSc, PhD Gregory O'Hare, MSc (Ulster) Ahmed Patel, MSc (Dub), PhD (Dub)
Lecturer	Julie Berndsen, MA (Dub), DPhil (Bielefeld) Michela Bertolotto, BSc (Genova), PhD (Genova) Arthur W.S. Cater, BA (Cantab), PhD (Cantab) Fintan Costello, BSc, PhD (Dub) Fred Cummins, BA (Dub), MA (Indiana), PhD, (Indiana) Damian Dalton, BSc, DipCompSc John Dunnion, MSc Franz H. Geiselbrechtinger, Diplom Mathematiker (Tech. Univ. Munich), Drrernat (Munich) Neil Hurley, MSc, PhD (Dub) M-Tahar Kechadi, BEng (Algeria), DEA (Lille), MSc (Lille), PhD (Lille) Nicholas Kushmerick, BSc (Washington), MS, (Washington), PhD (Washington) Alexei Lastovetsky, MSc (Moscow Aviation Inst), PhD (Moscow Aviation Inst),, DrSci (Russian Academy of Sciences) Eleni Mangina, MSc (Edin)

Henry B. McLoughlin, BSc
Mel Ó Cinneide, MSc
Guenole Silvestre, Ingénieur (*ISEP, Paris*),
PhD (Dub)
David Wilson, BA (*Rockford*), MA
(*Indiana*), PhD (*Indiana*)
Tony Veale, PhD (*Dub*)

Administrator:

Patricia Geoghegan
Clare Comerford
Angela Logue

Environmental Biology

Telephone No. 7162330

Fax No. 7161152

Email: Tom.Bolger@ucd.ie

Web: <http://www.ucd.ie/zoology>

Programme Director:

Dr Thomas Bolger

Botany

Dr Bruce Osborne, BSc, PhD
Telephone No. 7162249

Industrial Microbiology

Dr Evelyn M. Doyle, BSc, PhD
Telephone No. 7161300

Zoology

Dr Tasman Crowe, BSc, PhD
Telephone No. 7162194

Environmental Geochemistry

Telephone No. 716 2327

Fax No. 2837733

Email: Sarah.Procter@ucd.ie

Web: <http://www.ucd.ie/~geology/home.html>

Programme Director:

Dr J. Stephen Daly, BA (Dub), PhD
(Keele) PGeo, FGS

Experimental Physics

Telephone No. 7162210

Fax No. 2837275

Email: Marian.Hanson@ucd.ie

Web: <http://www.ucd.ie/~physics/main.html>

Head of Department

Professor Gerard O'Sullivan

Professor of Experimental Physics (Experimental Particle Physics)	Martin W. Grünewald, Vordiplom (<i>Aachen</i>), Diplom (<i>Aachen</i>), MS (<i>CalTech</i>), PhD (<i>CalTech</i>)
Associate Professor of Experimental Physics	David J. Fegan, MSc, PhD, MRIA Brian P. McBreen, BSc, PhD, MRIA Peter I. Mitchell, BSc, PhD, CPhys, FInstP Gerard O'Sullivan, BSc, PhD, CPhys, MInstP
Senior Lecturer	Ann C. Breslin, MSc (<i>Lond</i>), PhD, CPhys, MInstP Padraig Dunne, BSc, PhD, CPhys, MInstP James P. McLaughlin, MSc PhD, CPhys, MInstP Eón Ó Mongáin, MSc, PhD John A. Scott, MSc, PhD, CPhys, FInstP
Lecturer	Lorraine Hanlon, MSc, PhD, CPhys, MInstP Michael J. Hoey, BSc, PhD (<i>QUB</i>) Luis León-Vintró, BSc (<i>Barcelona</i>), PhD John Quinn, BSc, PhD Emma Sokell, BA (<i>Oxon</i>), PhD (<i>Manchester</i>), CPhys, MInstP
Assistant Lecturer	Donal Gallagher, BSc, MSc (Temporary appointment)
Administrator:	Marian Hanson

<i>Genetics</i>

Programme Director:	Dr Geraldine Butler, BA (<i>Dub</i>), PhD (<i>Dub</i>)
Biological Subject Co-ordinators:	
Biochemistry	Geraldine Butler <i>Telephone No. 7161583</i>
Botany	Thomas Gallagher <i>Telephone No. 7162342</i>

Industrial Microbiology	Patrick Caffrey <i>Telephone No. 7161396</i>
Pharmacology	Finian Martin <i>Telephone No. 7162808</i>
Zoology	Catherine Nolan <i>Telephone No. 7162112</i>

Geology

<i>Telephone No. 716 2331</i>	<i>Fax No. 2837733</i>
<i>Email: Sarah.Procter@ucd.ie</i>	<i>Web: http://www.ucd.ie/~geology/home.html</i>
Head of Department	Professor Patrick M. Shannon
Professor of Geology	Michael J. Kennedy, MA (<i>Dub</i>), PhD (<i>Dub</i>), FGS, EURGeol
Associate Professor of Geology (Petroleum Geology)	Patrick M. Shannon, BSc, PhD, FinstPet, PGeo, MRIA
Senior Lecturer in Geology	Christopher J. Bean, BA, MSc, PhD (<i>Dub</i>) J. Stephen Daly, BA (<i>Dub</i>), PhD (<i>Keele</i>), PGeo, FGS P. Frank McDermott, PhD (<i>Open</i> <i>University</i>), PGeo Ian D. Somerville, BSc (<i>QUB</i>), PhD (<i>QUB</i>), PGeo FGS John J. Walsh BSc (<i>UCD</i>), PhD (<i>NUIG</i>), PGeo
Lecturer	Peter Houghton, BA (<i>Dub</i>), PhD (<i>Glasgow</i>) Julian F. Menuge, BSc (<i>Leicester</i>), PhD (<i>Cantab</i>), PGeo
Administrative Assistant:	Sarah Procter

Geophysical Science

Telephone No. 716 2140

Fax No. 2837733

Email: Sarah.Procter@ucd.ie

Web: <http://www.ucd.ie/~geology/home.html>

Programme Director:

Dr Christopher J. Bean, BA, MSc, PhD
(Dub)

Industrial Microbiology

Telephone No. 7161512

Fax No. 7161183

Email: Geraldine.Neylan@ucd.ie

Web: <http://www.ucd.ie/~indmicro/>

Acting Head of Department

Professor Catherine T. Kelly

Professor of Industrial Microbiology

–

Associate Professor of Industrial
Microbiology

Catherine T. Kelly, BSc, PhD

Senior Lecturer, Industrial Microbiology

Caroline Hussey, BSc, PhD (Dub)
Nicholas J.W. Clipson, BSc (Newcastle),
DPhil (Sussex)
Evelyn M. Doyle, BSc, PhD
Aiden J. McLoughlin, BSc, PhD
Wim Meijer, MSc (Groningen), PhD
(Groningen)

Lecturer

John P. Caffrey, BA (Dub), PhD (Dub)
James B. Gillespie, BA (Oxon), PhD (UWO)
Hilary E.M. McMahon, BSc, PhD
Cormac D. Murphy (Temporary
Appointment)
Kevin E. O'Connor, BSc, PhD
Mary E. Upton, MSc, PhD

Administrative Assistant:

Geraldine Neylan

Mathematical Physics

Telephone No. 7168266	Fax No. 7161172
Email: mathematical.physics@ucd.ie	Web: http://www.ucd.ie/~math-phy/
Head of Department	Professor Adrian Ottewill
Professor of Mathematical Physics	Adrian C. Ottewill, BA (<i>Oxon</i>), DPhil (<i>Oxon</i>), DSc (<i>Oxon</i>), MRIA
Associate Professor of Relativity Theory	Peter Hogan, MSc, PhD
Associate Professor of Theoretical Physics	
Associate Professor of Mathematical Physics	Joseph V. Pulé, BSc (<i>Malta</i>), DPhil (<i>Oxon</i>), DSc (<i>Oxon</i>), MRIA
Senior Lecturer	Daniel A. Birmingham, BA (<i>Dub</i>), PhD (<i>Dub</i>) Edward A. Cox, BSc (<i>QUB</i>), MSc, PhD Peter Duffy, BA (<i>Dub</i>), PhD (<i>Dub</i>)
Administrative Assistant:	Veronica Barker

Mathematical Science

Telephone No. 7168373	Fax No. 7161172
Email: mathematical.physics@ucd.ie	Web: http://www.ucd.ie/~mathsci/
Programme Director:	Professor David Lewis, BSc, PhD, DSc

Mathematics

Telephone No. 7168265	Fax No. 7161196
Email: Breda.McMahon@ucd.ie	Web: http://mathsa.ucd.ie/
Head of Department (1999-2002)	Professor David Lewis
Professor of Mathematics II	Sean Dineen, DSc, PhD (<i>Maryland</i>)
Professor of Mathematics	Stephen J. Gardiner, MSc (<i>QUB</i>), PhD (<i>QUB</i>), DSc (<i>QUB</i>)
Associate Professor of Mathematics (Algebra)	Thomas J. Laffey, MSc, DPhil (<i>Sussex</i>), MRIA

Associate Professor of Mathematics	Roderick I.S. Gow, BA (<i>Cantab</i>), PhD (<i>Liverpool</i>) David Lewis, BSc, PhD, DSc
Senior Lecturer	Wayne G. Sullivan, BS (<i>Georgia InstTech</i>), DPhil (<i>Oxon</i>) Russell J. Higgs, BA (<i>Liverpool</i>), PhD (<i>Liverpool</i>) Pauline Mellon, MSc, PhD Mícheál S.A. Ó Searcóid, BSc (<i>Lond</i>), HDip in Ed (<i>Dub</i>), MSc, PhD
Lecturer	Christopher Boyd, BA (<i>Dub</i>), MSc (<i>Dub</i>), PhD Kevin Hutchinson, MA, PhD (<i>Cornell</i>) Maria Meehan, Msc, PhD J.B. Quigley, MSc, PhD (<i>Indiana</i>) David A. Tipple, MSc, PhD (<i>Manchester</i>)
Assistant Lecturer	Michael Mackey, MSc, PhD Thomas Ungar, Lic.Wisk (<i>Ghent</i>), PhD
Administrative Assistant:	Breda McMahon

<i>Occupational Safety and Health</i>
--

Telephone No. 7163500

Fax No. -

Email: cshw@ucd.ie

Web: <http://www.ucd.ie/~science/~cshw>

Joint Academic Director:	Anne Drummond, RGN, RM, DipSHWW, MSc (Occupational Health), (<i>Surrey</i>), <i>FIOSH</i>
Joint Academic Director:	Peter Start, MA, MSc, FICI, FRSC, FIOSH, RSP
Assistant to the Academic Directors:	Justine McGrane, RGN, RM, BSc in OSH Management
Administrative Staff:	
Senior Centre Assistant	Aileen Ward
Centre Assistant	Sinead Broughal

Centre Assistant

Amanda Kay

Pharmacology

Telephone No. 7161557

Fax No. 2692749

Web: <http://www.ucd.ie/~pharmacol/pharhome.htm>

Head of Department

Professor Michael P. Ryan

Professor of Pharmacology

Michael P. Ryan, BSc, PhD

Associate Professor of Pharmacology

Ciaran M. Regan, BSc, PhD, DSc
Finian M. Martin, BSc, PhD

Senior Lecturer in Pharmacology

Alan K. Keenan, BSc, PhD
Paul Moynagh, BA (*Dub*), PhD
Kathy O'Boyle, BSc, PhD

Lecturer

William Gallagher, PhD
Carmel Hensey, BSc, PhD

Administrative Assistant:

Eileen Gibbins

Physiology

Telephone No. 7167310

Fax No. 7167417

Email: Geraldine.Duggan@ucd.ie

Web: <http://www.ucd.ie/~physiol/index.html>

Professor of Physiology and Histology

Ronan G. O'Regan, MD, BCh, BAO, BSc,
PhD, MRIA

Associate Professor of Physiology

Paul McLoughlin, MB, BCh, BAO, BSc,
PhD (*Lond*), MRCPI

Senior Lecturer in Physiology

John B. Moynihan, BSc, PhD
Philip Nolan, MB, BCh, BAO, BSc
John O'Connor, BA (*Dub*), PhD (*Dub*)

Lecturer	Stuart Bund, BSc (<i>Leicester</i>), PhD (<i>Leicester</i>) Helen Harty, BSc (<i>Sheffield</i>), PhD (<i>QUB</i>) Caroline Herron, BSc (Southampton), PhD (Southampton) James F.X. Jones, MB, BCh, BAO, BSc, PhD William O'Connor, BSc (<i>NUIG</i>), PhD (<i>NUIG</i>) Ken D. O'Halloran, BSc, PhD
Administrative Assistant:	Geraldine Duggan

Plant Genetic Engineering

Telephone No. 7162342	Fax No. 7161153
Email: Jane.Flaherty@ucd.ie	Web: http://www.ucd.ie/~botany/Botany.htm
Programme Director	Dr Thomas F. Gallagher, BSc, PhD

Statistics

Telephone No. 7167152	Fax No. 7161186
Email: Marie.Doyle@ucd.ie	Web: http://www.ucd.ie/~statdept/
Head of Department:	Dr John Connolly
Professor of Statistics	Philip J. Boland, BSc (<i>Le Moyne</i>), MA (<i>Rochester</i>), PhD (<i>Rochester</i>), DSc
Senior Lecturer	John F.M. Connolly, BSc, HDip in Ed, MSc (<i>Reading</i>), PhD (<i>Dub</i>) Adrian Dunne, BSc (<i>Lond</i>), PhD (<i>Dub</i>) Gabrielle E. Kelly, MSc, PhD (<i>Stanford</i>) David H. Williams, BA, MSc, PhD (<i>Manchester</i>)
Lecturer	Gareth Colgan, FIA
Administrative Assistant:	Marie Doyle

Theoretical Physics

Telephone No. 7168266

Fax No. 7161172

Email: mathematical.physics@ucd.ie

Web: <http://www.ucd.ie/~math-phy/theor/thph-home.html>

Programme Directors:

Experimental Physics

Professor Gerry O'Sullivan
Telephone No. 716 2210

Mathematical Physics

Dr Peter Duffy
Telephone No. 716 8224

Zoology

Telephone No. 716 2265

Fax No. 716 1152

Email: Dorothy.Allen@ucd.ie

Web: <http://www.ucd.ie/~zoology/zoology.html>

Head of Department

Dr Mark Rogers

Professor of Zoology

-

Senior Lecturer in Zoology

Thomas M. Bolger, BSc, PhD
Bret S. Danilowicz, BSc (*Syracuse*), PhD
(*Duke*)
Thomas J. Hayden, BSc, PhD
Patrick Joyce, BSc, PhD
Declan Murray, BSc, PhD
Mark Rogers, BA (*Dub*), PhD (*Glasgow*)
Michael F. Ryan, BSc, PhD (*Lond*)

Lecturer

Gareth J. Dyke, BSc (*Bristol*), PhD (*Bristol*)
Mary Kelly Quinn, BSc, PhD
Catherine M. Nolan, BSc, PhD
Thomas L. Wilkinson, BSc (*Wales*), DPhil
(*Oxon*)

Administrative Assistant:

Dorothy Allen

Timetables

First Science Timetable (2003-2004)

(Lectures and Practicals)

Denominated Entry Programmes please contact their departments for timetables

	Monday			Tuesday			Wednesday			Thursday			Friday		
	Lectures	Loc.	Practicals	Lectures	Loc.	Practicals	Lectures	Loc.	Practicals	Lectures	Loc.	Practicals	Lectures	Loc.	Practicals
09.00	Chemistry	Th A	Geology	Maths (Pass) Maths(Hons)	Th B/D Th E		Chemistry	Th A		Maths (Pass) Maths (Hons)	Th B/D Th F		Chemistry	Th A	
10.00	Exp. Physics	Th A		COMP 1001	Th A		Exp.Phys.	Th A		COMP 1002 Geology	ID Th D		ExpPhysics	Th A	
11.00	MathPhys	Th E		Biology MathsPhys	Th A Th E		Maths (Pass)	Th A/B		Biology MathPhysics	Th A Th E		COMP 1002 Geology	ID Th D	
12.00	Maths(Pass) Maths (Hons)	Th B/C Th D		COMP 1002 Geology	ID Th D		COMP 1001	Th A		COMP 1001	Th A		Biology MathPhysics	Th A Th E	
13.00											Geology	Maths (Hons)	Th E		
14.00			CompSc ExpPhys Geology			Comp Sc ExpPhys			Biology Comp Sc			Biology Comp Sc			CompSc COMP 1002 (2pm- 4pm))
14.30			Chem			Chem			Chem			Chem			Chem
1500												Geology			
16.00			Geology			ExpPhys			Comp Sc			Comp Sc			
17.00												Geology			

NOTE: Practical classes are held in the relevant Department. ID=Lecture held in relevant Department. Allocation of students to practical classes and tutorials will be made by individual Departments.

Second Science Timetable (2003-2004) – First Semester

(Lectures and Practicals)

Time	Monday			Tuesday			Wednesday			Thursday			Friday				
	Lectures	Loc.	Practicals	Lectures	Loc.	Practicals	Lectures	Loc.	Practicals	Lectures	Loc.	Practicals	Lectures	Loc.	Practicals		
09.00	MATH 2201	Th E		CHEM 2101	Th C		Ind.Micro. PHYS 2004/6	Th D Th F		CHEM 2102	Th C		Ind. Micro EXPH 2003	Th D ID			
10.00	BOTN 2005	Th D	Botany (11-1 pm) Chemistry (10-1 pm) Pharmacol (10-1 pm)	CHEM 2102	Th E		EXPH 2001 ZOOLOGY 2006	ID Th E	Biochem. (10-1 pm) Chem. (10-1 pm) Zool 2006 (11-1 pm)	EXPH 2003 ZOOLOGY 2006	ID Th E	Biochem. (10-1 pm) Zool 2006 (11-1 pm)	COMP 2002 PHYS 2004/6 STAT 2221	Th C Th F Th D			
11.00	STAT 2201/2	Th A		BIOC 2001/2 GEOL 2002	Th D ID		STAT 2201/2 STAT 2221	Th E Th F			MATH 2201		Th D		BOTN 2005 MAPH.2010 MAPH 2121 PHAR 2001/2	Th F L104 Th C Th E	
12.00	EXPH 2001	ID		BOTN 2001 MAPH 2121 PHAR 2001/2	Th B Th E Th F		MATH 2101	Arts			COMP 2002 PHAR 2001/2		Th E Th D		GEOL 2001 BIOC 2001/2	ThD Th B	
13.00	STAT 2201/2 BIOC 2001/2	Th A Th B		MAPH 2010 MAPH 2121 ZOOLOGY 2005	L104 EP128 Th E		STAT 2201/2	Th E		MATH 2202 MATH 2103	Th B Arts		MATH 2202 MATH 2103	Th D Arts			
14.00	MAPH 2111 ZOOLOGY 2005	EP128 Th E		GEOL 2002 Ind. Micro.	ID Th E		BIOC 2001/2 GEOL 2001	Th D ID		Ind. Micro.	Th E		CHEM 2101 STAT 2205/6	Th C Arts			
14.30										PHYS 2004/6	ET						
15.00	COMP 2001	ID	Chemistry (3-6 pm) C.Science (3-5 pm) Physiology (3-5.30 pm) Zool 2005 (4-6 pm)	STAT 2205/6	Arts	C.Science (3-5 pm) Geology (3-5 pm) Ind.Micro. (3-5.30 pm) Pharmacol. (3-6 pm)	STAT 2205/6	Arts	Biochem. (3-6 pm) Chemistry (3-6 pm) C.Science (3-5 pm) Exp.Phys. (3-6 pm) Geology (3-5 pm) Pharmacol. (3-6 pm)	MATH 2101	Arts	Biochem. (3-6 pm) Chemistry (3-6 pm) Ind. Micro. (3-5.30 pm) Physiology (3.30-5.30 pm)	BOTN 2001	Th D	Botany (4-6 pm) Chemistry (3-6 pm) Exp.Phys. (2.30-5.30 pm) Pharmacol. (3-6 pm)		
16.00				STAT 2205/6	Arts		COMP 2001	ID									

NOTE: Practical classes are held in the relevant Department; ID = Lecture held in relevant Department; ET = Lecture held in Earlsfort Terrace; Arts = Lecture held in Arts Building. Allocation of students to practical classes will be made by the relevant Department.

Second Science Timetable (2003-2004) – Second Semester

(Lectures and Practicals)

Time	Monday			Tuesday			Wednesday			Thursday			Friday		
	Lectures	Loc.	Practicals	Lectures	Loc.	Practicals	Lectures	Loc.	Practicals	Lectures	Loc.	Practicals	Lectures	Loc.	Practicals
09.00	MATH 2203	Th B		CHEM 2103	Th C		Ind.Micro. PHYS 2005/7	Th D Th F		CHEM 2104	Th C		Ind. Micro EXPH 2004	Th D ID	
10.00	BOTN 2003	Th D	Botany (11-1 pm)	CHEM 2104	Th E		EXPH 2004 ZOOZ 2008	ID Th E	Biochem. (10-1 pm)	EXPH 2002 ZOOZ 2008	ID Th E	Biochem. (10-1 pm)	PHYS 2005/7	Th F	
11.00	STAT 2203/4	Th A	Chemistry (10-1 pm) Pharmacol. (10-1 pm)	BIOC 2003/4 GEOL 2004	Th D ID		STAT 2203/4	Th E	Chemistry (10-1 pm) Zool 2008 (11-1 pm)	MATH 2203	Th D	Zool 2008 (11-1 pm)	BOTN 2004 MAPH 2141 PHAR 2003/4	Th B Th F Th E	
12.00	EXPH 2002	ID		BOTN 2003 MAPH 2130 PHAR 2003/4	Th C Th E Th F		MATH 2102	Arts		PHAR 2003/4	Th D		BIOC 2003/4 GEOL 2003	Th B Th D	
13.00	STAT 2203/4 BIOC 2003/4	Th A Th B		MAPH 2141 ZOOZ 2007	EP 231 Th E		STAT 2203/4	Th E		MATH 2204 MATH 2104	Th B Arts		MATH 2204 MATH 2104	Th D Arts	
14.00	MAPH 2130 ZOOZ 2007	EP 128 Th E		GEOL 2003 Ind. Micro.	ID Th E		BIOC 2003/4 GEOL 2004	Th D Th E		Ind. Micro.	Th E		CHEM 2103 STAT 2206/7	Th C Arts	
14.30										PHYS 2005/7	ET				
15.00 16.00	COMP 2003	ID	Chemistry (3-6 pm) C.Science (3-5 pm) Physiology (3-5.30 pm) Zool 2007 (4-6 pm)	STAT 2206/7	Arts	C.Science (3-5 pm) Geology (3-5 pm) Ind.Micro. (3-5.30 pm) Pharmacol. (3-6 pm)	STAT 2206/7	Arts	Biochem. (3-6 pm) Chemistry (3-6 pm) C.Science (3-5 pm) Exp.Phys. (3-6 pm) Geology (3-5 pm) Pharmacol (3-6 pm)	COMP 2003 MATH 2102	ID Arts	Biochem. (3-6 pm) Chemistry (3-6 pm) Ind. Micro. (3-5.30 pm) Physiology (3.30-5.30 pm)	BOTN 2004	Th D	Chemistry (3-6 pm) Exp.Phys. (2.30-5.30 pm) Pharmacol. (3-6 pm) Botany (4-6 pm)
17.00				COMP 2011	ID					COMP 2011	ID				

NOTE: Practical classes are held in the relevant Department; ID = Lecture held in relevant Department; ET = Lecture held in Earlsfort Terrace; Arts = Lecture held in Arts Building. Allocation of students to practical classes will be made by the relevant Department.

Third Science Timetable (2003-2004) – First Semester

Time	Monday			Tuesday			Wednesday			Thursday			Friday		
	Lectures	Loc.	Practicals	Lectures	Loc.	Practicals	Lectures	Loc.	Practicals	Lectures	Loc.	Practicals	Lectures	Loc.	Practicals
09.00	BIOC 3004 CHEM 3102 COMP 3008 GEOL 3006 STAT 3208	Th F ID ID ID Arts	BOTN 3002 (9-12 noon) GEOL 3006 (10-12 noon)	MAPH 3021 PHYS 3002/3 CHEM 3104	L104 ET ID	BIOC 3004 (9-12 noon) GENE 3001 (9-12 noon) GEOL 3005 (10-12 noon) INDM 3001	BOTN 3003 CHEM 3101 COMP 3007 GEOL 3006 PHAR 3002 STAT 3208	ID ID Th E ID G01 Arts		CHEM 3101 COMP 3001 MAPH 3021 PHYS 3002/3	ID Th E L104 ET	BIOC 3001 (9-12 noon) BOTN 3009 (9-11 am) GEOL 3002 (9-11 am) INDM 3002 (9-12 noon) PHAR 3005-6 (10-1 pm) BOTN 3009 (11-1 pm)	CHEM 3103 COMP 3009 INDM 3001 MAPH 3011 STAT 3210 PSY 3207	ID Th F ID L104 DB Arts	Chemistry (2-5 pm) BIOC 3008 (3-6 pm) GENE 3001 (3-6 pm) GEOL 3001 (3-5 pm) INDM 3005/7 (3-6 pm) Physiology (3-5.30 pm)
10.00	CHEM 3103 COMP 3008 PSY 3207 ZOOZ 3009	ID ID Arts L101		EXPH 3016	ID	(9-12 noon) ZOOZ 3010 (10-12 noon)	BOTN 3009 MATH 3203 ZOOZ 3014	ID EP 128 Th D		CHEM 3104 MATH 3203	ID EP 128		CHEM 3102 PSY 3207 STAT 3221	ID Arts Th D	
11.00	CHEM 3108 INDM 3007/5 MAPH 3011 MATH 3203 PSY 3204 ZOOZ 3010	ID ID L104 ID Arts ThF		EXPH 3001 PHAR 3005	ID Th F		COMP 3017 GEOL 3005 PSY 3204 STAT 3221 CHEM 3109	ID ID Arts Th F ID		CHEM 3109 GEOL 3005 MATH 3208 PHAR 3005 PHYS 3009	ID ID Th B Th F ET		CHEM 3108 COMP 3017 INDM 3007 PSY 3206 ZOOZ 3010	ID ID ID Arts L101	
12.00	BOTN 3002 EXPH 3001 MATH 3208 PHAR 3001	ID ID Th F Th E		GENE 3001 MAPH 3071	Th C L 104		BIOC 3001 GEOL 3001 INDM 3005 INDM 3007 MATH 3202 MATH 3204	Th B ID ID ID EP 129 L104		BOTN 3010 COMP 3003 INDM 3005 MATH 3202 MATH 3204 ZOOZ 3014	ID ID ID L104 EP 129 Th B		BOTN 3001 COMP 3003 EXPH 3016 PHAR 3002	ID ID ID Th F	
13.00	MATH 3202 MATH 3204 MAPH 3071 ZOOZ 3016	EP 128 EP 231 L104 Th E		PHIL 3901	ThA		GENE 3001 MATH 3208	Th A Th D		BIOC 3001 COMP 3009 ZOOZ 3016	Th E Th D Th F		PHIL 3901	ThA	
14.00	BIOC 3006 INDM 3002 PHY 3002/3 PSY 3201	Th C ID ET Arts	Chemistry (2-5 pm) PHAR 3001-4 (2.30-5.30 pm)	BIOC 3004 COMP 3007	Th D Th B	BOTN 3003 (2-5 pm) Chemistry (2-5 pm) PHAR 3001-4 2.30-5.30 pm BIOC 3004 (3-6 pm) ExpPhysics (3-5 pm) PHAR 3005-6 (3-6 pm) ZOOZ 3009 (4-6 pm) CompScience Psychology	INDM3011 PSY 3201 BIOC 3008	ID Arts Th E	BOTN 3009 (2-4 pm) ZOOZ 3014 (2-4 pm) Chemistry (3-6 pm)	GEOL 3002 STAT 3218	ID ID	BIOC 3001 (2-5 pm) BOTN 3010 (2-5 pm) Chemistry (2-5 pm) PHAR 3001-4 (2.30-5.30 pm) PHAR 3005-6 (2.30-5.30 pm) ExpPhysics (3-5 pm) ZOOZ 3016 (3-5 pm) Psychology	BIOC 3008 GEOL 3001 PHYS 3009 PSY 3206 STAT 3205/6	L104 ID ET Arts Arts	
15.00	PSY 3208 STAT 3218	Arts ID	BIOC 3006 (3-6 pm) BOTN 3001 (3-6 pm) INDM 3005/7 (3-6 pm)	ZOOZ 3009	Th D		BIOC 3006 GEOL 3002 INDM3011 PHAR 3001 STAT 3205/6	Th E ID ID Th D Arts							
16.00			PHAR 3005-6 (3-6 pm) Physiology (3-5.30 pm)	STAT 3205/6	Arts		COMP 3001 INDM3011	Th F ID							

NOTE: Practical classes are held in the relevant Department; ID = Lecture held in relevant Department; ET = Lecture held in Earlsfort Terrace. Arts Building, DB = Daedalus Building, Eng = Engineering Building, G01 = Geology Building.

Third Science Timetable 2003-2004 – Second Semester

Time	Monday			Tuesday			Wednesday			Thursday			Friday			
	Lectures	Loc	Practicals	Lectures	Loc	Practicals	Lectures	Loc	Practicals	Lectures	Loc	Practicals	Lectures	Loc	Practicals	
09:00	BIOC 3003 CHEM 3105 COMP 3004 GEOL 3009 STAT 3209	ThD ID Th E ID Arts	BIOC 3009 (3-6 pm) BOTN 3007 (3-6 pm) Chemistry (2-5 pm) GEOL 3008 (3-5 pm) INDM 3006/8 (3-6 pm) PHAR 3001-4 (2.30-5.30 pm)	GEOL 3013 MAPH 3041 PHYS 3004/5	ID L104 ET	BIOC 3003 (9-12 noon) INDM 3004 (9-12 noon) GEOL 3013 (10-12 noon)	CHEM 3106 EXPH 3003 MAPH 3081 STAT 3209	ID ID L10 Arts	GENE 3002/3 (9-12 noon) GEOL 3010 (9-11 am)	CHEM 3106 COMP 3002 PHYS 3004/5	ID ID ET	BIOC 3002 (9-12 noon) BOTN 3008 (9-12 noon) CELB 3001 (10-12 noon)	CHEM 3107 COMP 3006 INDM 3004 MAPH 3041 PSY 3207 STAT 3210	ID Th F ID L104 Arts DB	GEOL 3009 (9-11 am)	
10:00	CHEM 3107 EXPH 3006 GEOL 3009 INDM 3008/6 MAPH 3081 ZOOZ 3011	ID ID ID ID L104 Th F		COMP 3013 GEOL 3010 PHAR 3004 PHYS 3006/7	ID ID Th D ET	BOTN 3007 GEOL 3013 PHAR 3006/7 MATH 3207	ID ID Th D L 104	EXPH MATH 3207 PHYS 3006/7	ID L 104 ET	GEOL 3003 (9-11 am) INDM 3003 (9-12 noon) PHAR 3005-6 (9-12 noon) ZOOZ 3017 (9-11 am)	CHEM 3111 COMP 3013 GEOL 3008 MATH 3201	ID ID ID L 104	CHEM 3107 BOTN 3006 CHEM 3105 MATH 3207 PHAR 3008 PSY 3207 ZOOZ 3013	Th E ID ID Th D EP 129 Arts L101		
11:00	BOTN 3008 CELB 3001 CHEM 3111 COMP 3011 GEOL 3008 PSY 3205	ID ID ID ID ID Arts		EXPH 3006	ID	CHEM 3110 EXPH 3008 PSY 3205 STAT 3224	Th F ID Arts ID	CHEM 3111 COMP 3013 GEOL 3008 MATH 3201	ID ID ID L 104	CHEM 3110 COMP 3013 GEOL 3008 MATH 3201	ID ID ID L 104		CHEM 3110 GENE 3002 GEOL 3010 MAPH 3031 PSY 3203	Th A L101 ID L104 Arts		
12:00	BIOC 3002 EXPH 3012 GEOL 3003 MAPH 3031	Th E ID ID L104		COMP 3011 GEOL 3004 MAPH 3081 ZOOZ 3017	ID ID L 104 L 101	BIOC 3005 COMP 3005 GEOL 3004 INDM 3008/6 ZOOZ 3017	Th B Th ID ID L	EXPH 3005 INDM 3008/6 PHAR 3003 STAT 3224	ID ID Th C ID		BIOC 3002 EXPH PHAR 3008	Th D ID Th E	BIOC 3002 (2-5 pm) BOTN 3004 (3-6 pm) Chemistry (2-5 pm) ExpPhys (3-5 pm) GEOL 3007 (3-5 pm) PHAR3001-4 (2.30-5.30 pm)	BOTN 3004 EXPH 3005 MAPH 3081 PHAR 3003	ID ID L104 Th F	
13:00	COMP 3006 GENE 3003 STAT 3220 ZOOZ 3013	ThD EP 129 Th F Th E		BOTN 3008 COMP 3005 MATH 3201 PHAR 3006	ID Th C EP 128 Th F	BIOC 3003 (3-6 pm) Chemistry (2-5 pm) CompSc ExpPhys (3-5 pm) GEOL 3004 (3-5 pm) PHAR 3001-4 (2.30-5.30 pm) PHAR 3005-6 (2.30-5.30 pm)	EXPH 3017 PHAR 3004 ZOOZ 3015	ID Th F Th	COMP 3002 GENE 3002 PSY 3202	ID EP 129 Arts	GENE 3002/3 (3-6 pm) INDM 3006/8 (3-6 pm) ZOOZ 3011 (4-6 pm)	GEOL 3007	ID	COMP 3004 GENE 3003 MATH 3201	Th C EP 129 Th F	
14:00	BIOC 3009 MATH 3205 PHYS 3004/5 PSY 3208 STAT 3220 ZOOZ 3012	Th A L 104 ET Arts ThF ThC		BIOC 3003 GEOL 3007 ZOOZ 3015	Th F ID Th C	COMP 3002 GENE 3002 PSY 3202	ID EP 129 Arts	EXPH 3005 PSY 3202 STAT 3206/07 ZOOZ 3011	ID Arts Arts Th E		MATH 3205	EP 128	PHAR3001-4 (2.30-5.30 pm)	BIOC 3005 GEOL 3003 INDM 3003 PHYS 3006/7 PSY 3203 STAT 3206/07	ThD ID ID ET Arts Arts	BIOC 3005 (3-6 pm) Chemistry (3-6 pm) ExpPhys (2-5 pm) Physiology (3-5.30 pm) ZOOZ 3013 (3-5 pm)
15:00	PSY 3208	Arts		MATH 3207 ZOOZ 3012	Th B Th E	EXPH 3005 PSY 3202 STAT 3206/07 ZOOZ 3011	ID Arts Arts Th E	MATH 3205	EP 128				PHAR 3005-6 (2.30-5.30 pm)			
16:00				STAT 3206/07	Arts											

Locations : Lecture theatres and class rooms are in the Science Lecture Block unless otherwise specified. ID = in the subject department. Arts = Arts Building, ET =Earlsfort Tce, DB = Daedalus Building.