This handbook applies to all students taking TR071 Science. It provides a guide to what is expected of you on this programme, and the academic and personal support available to you. Please retain for future reference.

The information provided in this handbook is accurate at time of preparation. Any necessary revisions will be notified to students via email and the Science Course Office website (http://www.tcd.ie/Science). Please note that, in the event of any conflict or inconsistency between the General Regulations published in the University Calendar and information contained in course handbooks, the provisions of the General Regulations will prevail.
Index

Introduction 1
Allocation of Places 1
Choice of subject form 3
Course Advisors 4
Moderatorships Pre-requisites & Quotas 5
Table of Pre-requisites 6
Changing Course 8
Field Courses 8
Non-Satisfactory Attendance and Course Work 8
Junior Sophister Examinations 9
Dates to Note 11

TR071  BIOCHEMISTRY 12
       CHEMISTRY 17
       ENVIRONMENTAL SCIENCE 22
       GENETICS 30
       GEOGRAPHY 38
       GEOLOGY 47
       IMMUNOLOGY 53
       MICROBIOLOGY 58
       MOLECULAR MEDICINE 65
       NEUROSCIENCE 70
       PHYSICS 75
       PHYSICS and ASTROPHYSICS 79
       PHYSIOLOGY 84
       PLANT SCIENCES 90
       ZOOLOGY 97

TR074  Chemistry with Molecular Modelling 103
TR073  Human Genetics 109
TR075  Medicinal Chemistry 118
TR076  Nanoscience, Physics and Chemistry of Advanced Materials 124
FOREWORD

The purpose of this booklet is to provide you with information on courses that will be available to you in the Sophister years (3rd and 4th) in Science. For those of you who entered the Science programme (TR071), you now have to make a choice as to which Moderatorship subject you wish to study. For some this will be very easy, because you have known from entry which programme you wish to follow, but I hope you have all remained open minded while getting a broad grounding in Science in your Fresh years. I would recommend that you read this booklet carefully before making your final decision. When you do this you will see that the Science courses can offer you an extremely wide range of choice, which take you to the leading edge of science, in all of the Moderatorship subjects. Please ask Course Advisers (listed on page 4) for further information on the subjects. Potential applicants are also welcome to visit the Science Course Office to discuss personal needs and any potential problems. We will all be very keen to provide you with the information you require to make an informed choice and invite you to the Moderatorship Fair on Friday 23rd of February 2017. There will be a presentation over lunchtime in the MacNeil Lecture Theatre followed by the Moderatorship Fair in the Hamilton Atrium (beside the Biology Laboratories).

An important feature of our Sophister Course Programme is the option to take Broad Curriculum subjects (www.tcd.ie/Broad_Curriculum/) from other programmes, particularly in the Junior Sophister year. Please take advantage of these to broaden your knowledge outside the confines of your chosen Moderatorship subject. Remember that prospective employers generally require you to have a broad range of skills as well as an in-depth knowledge in your area of specialisation. Take the opportunity to develop these broader skills, particularly in communication and presentation, because it is these that will eventually allow you to derive the greatest benefits from your particular choice of a Moderatorship subject.

I wish you well over the next two years, whatever choice you make, and I trust you will maintain the tradition we have of producing the very highest quality of Science graduates.

Professor Kevin Mitchell
Associate Dean of Undergraduate Science Education
Introduction

Sophister courses in Science are organised so that students follow a continuous programme of work over two years leading to a Moderatorship in a particular subject. Each module (whether lecture, tutorial, seminar or practical) has a specified credit value, which is an approximate measure of the workload associated with the module, and is in turn reflected in its proportional weighting in assessment. One credit is normally considered to represent a minimum of 20 hours of work on the part of a student. Students take modules to the value of 60 credits in each of the Sophister years.

The Sophister Course Booklet is intended as a detailed and comprehensive guide to all Moderatorship within Science. Full course descriptions and reading lists are available from individual schools/ departments and Course Advisers.

While every effort will be made to give due notice of major changes, the Science Course Office reserves the right to suspend, alter or initiate courses, timetables, examinations and regulations at any time.

Allocation of Places

The Science Course office coordinates and processes the applications for Junior Sophister places in the TR071 Science course. The procedures are documented below to show students that places are allocated in a fair, transparent and efficient manner.

The numbers of places available in each moderatorship subject is limited by quota. Admission is based on the overall mark obtained in the Senior Fresh examinations to include the prerequisite modules and the order of choice as expressed by the student. Decisions on places are made by the Science Course Office and students cannot be allocated a place by circumventing the Science Course Office and going to the disciplines directly. All enquiries with regard to the allocation of places made to the disciplines will be redirected to the Science Course Office.

Places will be allocated in the following way until quotas are reached:

1. All students passing their summer examinations will be ranked in merit order on the basis of their overall mark.

2. Places will be allocated in rank order, with preference given to students who have passed the prerequisite modules of the course.

3. Students failing the Annual examinations must reapply for the remaining unfilled places until quotas are reached. Second round choice of subject forms will be made available on-line following publication of the Annual examination results. http://www.tcd.ie/Science/current/sophister/js-moderatorship-form.php. The closing date for the online second round form is Friday 3rd August 2018.
4. In the event of two or more students having equal overall averages seeking one place, the choice will be made in favour of the student gaining the higher mark in the SF module that are pre-requisites for the moderatorship in question.

5. Examination results will be available on your personal portal at my.tcd.ie and on the Science Noticeboards.

6. Publication of the JS places will be available by student number on the science website https://www.tcd.ie/Science/local/, by the end of July 2018 and on the Science Course notice-boards. Places are listed anonymously and by student number.

7. Students are informed by email when the places are published and the procedures followed are clearly outlined in the email.

8. Students opting to go ‘off books’ rather than take up the place offered, will be treated as rising JS students in the following year. Places will not be reserved for such students. Students who apply for readmission will be considered for a place in the same way as the year in which they qualified (if a student did not qualify for a place in the first round, they will not be considered in the first round when they apply for readmission to the College).

9. Students wishing to change their mind over the summer vacation should email the Science Course office: science@tcd.ie - stating their new preference order. If a place is available, they will be offered it and their vacated place will be offered to the next person in the queue.

10. Students who fail their Junior Sophister examinations in a given discipline and who are entitled to repeat, or who gain that entitlement through appeal, will be treated ex-quota in relation to that discipline.

11. Students who are given permission by the Senior Lecturer to defer their Annual examinations until the Michaelmas examinations session can defer a place in their first preference only. Following publication of the Supplemental examinations, students who are sitting the annual examinations at the Supplemental session will be allocated a place based on the same criteria used in the summer allocation of places. If the student in this category does not qualify for the deferred place, the Science Course Administrator will offer that student a place in one of the subjects available in the second round and the deferred place will be offered to the next qualified student from the annual examinations list.

Special note: Students who have passed their Senior Fresh examinations may not repeat the SF year in order to improve their performance.
Choice of Subject Form

The choice of subject form is available online:
http://www.tcd.ie/Science/current/sophister/

The form may be submitted online or returned as a hardcopy to the Science Course Office. The closing date is 13th April 2018. Failure to meet this deadline will disadvantage you in relation to your choice of department.
<table>
<thead>
<tr>
<th>Course Advisers</th>
<th></th>
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</thead>
<tbody>
<tr>
<td><strong>Biochemistry</strong></td>
<td></td>
<td>Prof D. Nolan</td>
</tr>
<tr>
<td></td>
<td></td>
<td><a href="mailto:denolan@tcd.ie">denolan@tcd.ie</a></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Prof D Zisterer</td>
</tr>
<tr>
<td></td>
<td></td>
<td><a href="mailto:dzister@tcd.ie">dzister@tcd.ie</a></td>
</tr>
<tr>
<td><strong>Chemistry</strong></td>
<td></td>
<td>Prof M Southern</td>
</tr>
<tr>
<td></td>
<td></td>
<td><a href="mailto:southerj@tcd.ie">southerj@tcd.ie</a></td>
</tr>
<tr>
<td><strong>Chemistry with Molecular Modelling</strong></td>
<td></td>
<td>Prof G. Watson</td>
</tr>
<tr>
<td></td>
<td></td>
<td><a href="mailto:watsong@tcd.ie">watsong@tcd.ie</a></td>
</tr>
<tr>
<td><strong>Environmental Sciences</strong></td>
<td></td>
<td>Prof M. Saunders</td>
</tr>
<tr>
<td></td>
<td></td>
<td><a href="mailto:saundem@tcd.ie">saundem@tcd.ie</a></td>
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<tr>
<td><strong>Genetics</strong></td>
<td></td>
<td>Prof R. Bradley</td>
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<tr>
<td></td>
<td></td>
<td><a href="mailto:daniel.braden@tcd.ie">daniel.braden@tcd.ie</a></td>
</tr>
<tr>
<td><strong>Geography</strong></td>
<td></td>
<td>Prof R. Edwards</td>
</tr>
<tr>
<td></td>
<td></td>
<td><a href="mailto:robin.edwards@tcd.ie">robin.edwards@tcd.ie</a></td>
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<tr>
<td><strong>Geology</strong></td>
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<tr>
<td><strong>Immunology</strong></td>
<td></td>
<td>Prof C. Gardiner</td>
</tr>
<tr>
<td></td>
<td></td>
<td><a href="mailto:clair.gardiner@tcd.ie">clair.gardiner@tcd.ie</a></td>
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<tr>
<td></td>
<td></td>
<td>Prof F Sheedy</td>
</tr>
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<td></td>
<td></td>
<td><a href="mailto:fsheedy@tcd.ie">fsheedy@tcd.ie</a></td>
</tr>
<tr>
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<td></td>
<td>Prof J. Farrar</td>
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<tr>
<td></td>
<td></td>
<td><a href="mailto:gifarrar@tcd.ie">gifarrar@tcd.ie</a></td>
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<tr>
<td><strong>Medicinal Chemistry</strong></td>
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<td>Prof M. Senge</td>
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<tr>
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<td></td>
<td><a href="mailto:mathias.senge@tcd.ie">mathias.senge@tcd.ie</a></td>
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<tr>
<td><strong>Microbiology</strong></td>
<td></td>
<td>Prof J. Geoghegan</td>
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<tr>
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<td></td>
<td><a href="mailto:geoghegij@tcd.ie">geoghegij@tcd.ie</a></td>
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<tr>
<td><strong>Molecular Medicine</strong></td>
<td></td>
<td>Prof J. Murray</td>
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<tr>
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<td></td>
<td><a href="mailto:james.murray@tcd.ie">james.murray@tcd.ie</a></td>
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<tr>
<td></td>
<td></td>
<td>Prof A. Dunne</td>
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<tr>
<td><strong>Neuroscience</strong></td>
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<td><a href="mailto:aminogue@tcd.ie">aminogue@tcd.ie</a></td>
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<tr>
<td></td>
<td></td>
<td>Prof C Cunningham</td>
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</tr>
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<td><strong>Physics</strong></td>
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<td>Prof P. Eastham</td>
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<td><a href="mailto:easthamp@tcd.ie">easthamp@tcd.ie</a></td>
</tr>
<tr>
<td><strong>Physics and Astrophysics</strong></td>
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<td>Prof P. Eastham</td>
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<tr>
<td><strong>Nanoscience, Physics and Chemistry of Advanced Materials</strong></td>
<td></td>
<td>Prof H. Zhang</td>
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<td></td>
<td></td>
<td><a href="mailto:hozhang@tcd.ie">hozhang@tcd.ie</a></td>
</tr>
<tr>
<td><strong>Plant Sciences</strong></td>
<td></td>
<td>Prof. M Williams</td>
</tr>
<tr>
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<td><a href="mailto:willimsm@tcd.ie">willimsm@tcd.ie</a></td>
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<tr>
<td><strong>Zoology</strong></td>
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<td>Prof A. Jackson</td>
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<tr>
<td></td>
<td></td>
<td><a href="mailto:jacksoan@tcd.ie">jacksoan@tcd.ie</a></td>
</tr>
</tbody>
</table>
To be qualified for a moderatorship, students must have completed satisfactorily both Fresh years and must have taken the stated prerequisite modules (see page 7) for any moderatorship for which they wish to be considered. Students who have not completed the pre-requisites for a moderatorship may still be considered for that moderatorship subject to the following:

- Approval by the relevant School/Discipline.
- If places are still available in the School/Discipline.

While every effort will be made to give due notice of major changes in the quotas, the Science Course Office reserves the right to alter pre-requisites and quotas, if necessary.

<table>
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<tr>
<th>Moderatorship</th>
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1Junior Fresh Biology 1101 is advisable
2Junior Fresh Biology 1101 and 1102 are advisable
## Junior Fresh Modules 2016/17

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<td>BY1102</td>
<td>Evolution, Biodiversity &amp; the Environment</td>
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<td>CH1101</td>
<td>General and Physical Chemistry</td>
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<td>CH1102</td>
<td>Introduction to Systematic, Inorganic and Organic Chemistry</td>
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<td>Introduction to Geography I: Physical Geography and Earth System Science</td>
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## Senior Fresh Modules 2017/18

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<tr>
<td>BY2202</td>
<td>Vertebrate Form and Function</td>
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<tr>
<td>BY2203</td>
<td>Metabolism</td>
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<td>BY2204</td>
<td>Evolution</td>
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<tr>
<td>BY2205</td>
<td>Microbiology</td>
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<tr>
<td>BY2206</td>
<td>Ecosystem Biology and Global Change</td>
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<td>BY2207</td>
<td>Behaviour</td>
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<td>BY2208</td>
<td>Genetics</td>
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<td>BY2209</td>
<td>Infection and Immunity</td>
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<td>BY2210</td>
<td>Agriculture, Environment and Biotechnology</td>
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<td>Human Geography: Changing Worlds</td>
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<td>The Dynamic Earth 2: structure and microscopy</td>
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**Changing Course**

Once places have been allocated, if you wish to change your moderatorship subject, you should contact the Science Course Office immediately. Transfer applications will only be considered where places are still available and not after the end of the third week of Michaelmas term.

**Field Courses**

Students taking Environmental Sciences, Geography, Geology, Plant Sciences or Zoology may be required to attend field courses in any year. Those intending to proceed to moderatorship in Geology are encouraged to attend field courses during their Senior Fresh year.

The charges for field courses are in addition to the normal annual College fees and can vary from a few hundred to several thousand euros between the different disciplines. The charges vary from year to year between the different disciplines. Students intending to take a subject requiring attendance at field courses should consult the course adviser concerned, regarding the modules planned and the costs involved.

**Non-Satisfactory Attendance and Course Work**

All students must fulfil the requirements of the faculty, school or discipline, as appropriate, with regard to attendance and course work. Where specific attendance requirements are not stated, students are non-satisfactory if they miss more than a third of a required course in any term.

In order to rise with their class, students must obtain credit for the academic year by satisfactory attendance at lectures and tutorials, by carrying out the required course work, and by successful completion of examinations.

Please refer to your department/discipline handbook for moderatorship regulations.
Junior Sophister Examinations

Modules are assessed by in-course assessment and/or by examination. The Junior Sophister year carries a total of 60 credits. The scheme of distribution of marks between papers and practical work at the Sophister examinations will be published by individual schools or departments/disciplines.

Your attention is drawn to the Science examination regulations which prescribe the level of performance you must achieve in order to be permitted to proceed to the Senior Sophister year. A bare pass in the examination is not sufficient.

Junior Sophister examination regulations
To pass the Sophister years, students must achieve an overall credit-weighted average mark of 40%-III and accumulate 60 credits either by (a) passing all modules outright or (b) passing by compensation.

Junior Sophister Passing by Compensation
In single honor courses, in order to pass by compensation a student must:
a) Have an overall mark of at least 40%, and
b) Pass outright modules totalling at least 40 credits, and
c) Get a minimum mark of 35% in each failed module, up to a maximum of 10 credits

Please note that from 2018/19 exams will be semesterised.

Calculation of Moderatorship results
The final moderatorship results are calculated by aggregating the Junior and Senior Sophister examination results.

Junior Sophister 20%, Senior Sophister 80%:
Biochemistry, Environmental Sciences, Genetics, Geography, Geology, Immunology, Microbiology, Molecular Medicine, Neuroscience, Physiology, Plant Sciences, Earth Sciences, Human Genetics.

Junior Sophister 35%, Senior Sophister 65%:
Chemistry, Physics, Physics and Astrophysics, Chemistry with Molecular Modelling, Medicinal Chemistry, Nanoscience, Physics and Chemistry of Advanced Materials.
Reassessment and Repeat Regulations

What are the new reassessment regulations?
Reassessment will be available in all years.
The right to reassessment will be automatic for those students who achieve a fail grade in any of their modules.
Students may not present for reassessment in a module they have passed.
Capping of marks will not be applied for reassessment.
Special Examinations will not be available from the academic year 2018/19.

What are the new repeat year regulations?
Students will be allowed to repeat any academic year;
Students will not be allowed to repeat the same academic year more than once within a degree programme;
Students will not be allowed to repeat more than two different academic years within a degree programme;
Students will be required to repeat the year on a module-by-module basis;
There will no longer be an option to repeat a year on an ‘off-books’ basis.
## Dates to Note

<table>
<thead>
<tr>
<th>Day</th>
<th>Date</th>
<th>Event</th>
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<tbody>
<tr>
<td>Friday</td>
<td>23rd February 2018</td>
<td>Moderatorship Fair</td>
</tr>
<tr>
<td>Friday</td>
<td>6th April 2018</td>
<td>Semester 2 - Hilary Lecture Term ends</td>
</tr>
<tr>
<td>Friday</td>
<td>13th April 2018</td>
<td>Closing date – Submit choice of subject forms</td>
</tr>
<tr>
<td>Monday</td>
<td>30th April 2018</td>
<td>Annual Examinations begin</td>
</tr>
<tr>
<td>Friday</td>
<td>25th May 2018</td>
<td>Annual Examinations end</td>
</tr>
<tr>
<td>Friday</td>
<td>15th June 2018</td>
<td>Annual Examination Results Published</td>
</tr>
<tr>
<td></td>
<td>By end of July 2018</td>
<td>Notification of JS Moderatorship Subject</td>
</tr>
<tr>
<td>Friday</td>
<td>3rd August 2018</td>
<td>Closing date – 2nd Round Choice Subject Form</td>
</tr>
<tr>
<td>Saturday</td>
<td>18th August 2018</td>
<td>Supplemental Examinations begin</td>
</tr>
<tr>
<td>Saturday</td>
<td>25th August 2018</td>
<td>Supplemental Examinations end</td>
</tr>
<tr>
<td>Monday</td>
<td>3rd September 2018</td>
<td>Supplemental Examination Results Published</td>
</tr>
<tr>
<td>Monday</td>
<td>3rd September 2018</td>
<td>Notification of JS Moderatorship Subject (2nd Round)</td>
</tr>
<tr>
<td>Monday</td>
<td>10th September 2018</td>
<td>Semester 1 - Michaelmas Lecture Term begins</td>
</tr>
<tr>
<td>Friday</td>
<td>30th November 2018</td>
<td>Semester 1 - Michaelmas Lecture Term ends</td>
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</table>

**Semester 1 examinations will begin in December 2018. Timetables will be available closer to the time.**
Biochemistry is a moderatorship course run by the School of Biochemistry and Immunology. The focus is on understanding how living cells function at a molecular and cellular level. It encompasses a wide range of topics such as cancer biology, stem cell biology, immunology, neurobiology, developmental biology and drug discovery. Senior Sophister students spend a number of weeks in one of the research laboratories in the new Biomedical Sciences Institute where they conduct state-of-the-art research in areas such as cancer, obesity, ageing, neurobiology, nutrition, parasitology and biotechnology. Graduates in the discipline of biochemistry will be able to describe cellular function and regulation in terms of the molecules, proteins and structures involved, be trained in the application of appropriate technologies to investigate these processes and have a special insight into the nature of human pathological states and their treatment at a molecular level.

**Junior Sophisters (60 ECTS Credits):**

The JS year consists of a varied programme of lectures, practical’s, tutorials, a mini-review, data-handling and analytical skills sessions. The JS year is a 60 credit course composed of four 10 credit modules consisting of lectures and linked practical’s, a ten credit research skills module and a five credit module covering biochemical analysis. In addition, all JS students are obliged to take a Broad Curriculum option (5 credits).

**JS Assessment and Examination Procedures:**

The four core 10 credit lecture modules will be assessed by continuous assessment (30% weighting) and by an individual exam paper (70% weighting). There will be two such assessments at the end of each semester. The research skills, biochemical analysis and Broad Curriculum modules are entirely in-course assessed. The overall JS mark contributes to 20% of the final degree.
Senior Sophisters (60 ECTS Credits):
In the Senior Sophister year, students will carry out a capstone research project, complete a set of problems and assignments, and take specialised lecture courses in Biochemistry and Cell Biology.

SS Assessment and Examination Procedures:
The end of year final examinations is comprised of three 3-hour examinations papers. Each paper will contain four sections. The first two sections will examine the specialised SS lecture material. The remaining two sections are general in nature and examine core concepts in Biochemistry and Cell Biology. Each paper carries equal marks. The research skills module is examined entirely by in-course assessment during the first semester. Finally, a capstone research project will be carried out and contributes one third of the SS mark. The overall degree mark is comprised of 80% of SS mark and 20% of JS mark.
JUNIOR SOPHISTER MODULES  

BI3110 PROTEIN STRUCTURE (S1)  
This module introduces the concept of proteins as molecular nanomachines that act as the workhorses in living cells. The relationship between protein structure and function and how drugs can be exploited to target proteins to treat diseases will also be covered. As well as lectures the module includes a set of linked practical sessions.

BI3120 MEMBRANE AND CELL BIOLOGY (S1)  
This module covers the structure and function of biological membranes, the cytoskeleton, related signal transduction pathways and associated pathological conditions important in human health. As well as lectures the module includes a set of linked practical sessions.

BI3010 NUCLEIC ACIDS (S2)  
This module covers the structure and function of nucleic acids and the molecular basis of gene regulation including DNA replication and repair, transcription and translation. As well as lectures the module includes a set of linked practical sessions.

BI3140 BIOCHEMISTRY IN HEALTH AND DISEASE (S2)  
This module provides an introduction into how imbalances in metabolism result in disease states. It also covers the biochemical defense mechanisms against infection and aspects of the drug discovery process. As well as lectures the module includes a set of linked practical sessions.

BI3020 RESEARCH SKILLS (S1 & S2)  
This purpose of this module is to develop research, critical analysis and communication skills that are essential for a graduate biochemist. Students will be trained in data handling and statistical analysis of data as well as solving quantitative problems in biochemistry by a combination of lectures and tutorial sessions. In addition, students will undertake a major written review of a subject area of biochemical relevance under the supervision of a member of staff of the school

BI3115 BIOCHEMICAL ANALYSIS (S1)  
In this module students will be trained in basic biochemical laboratory skills, problem solving and evaluation of the scientific literature by a combination of practicals, lectures and tutorials.

BC BROAD CURRICULUM (S1 or S2)  

60 Credits
SENIOR SOPHISTER MODULES

60 Credits

RESEARCH PROJECT IN BIOCHEMISTRY (S1) 20 credits
The module comprises of an original research project in biochemistry and a research thesis.

ADVANCED RESEARCH SKILLS (S1) 10 credits
This purpose of this module is to further develop research, critical analysis and communication skills that are essential for a graduate biochemist. Students will be trained in data handling as well as solving quantitative problems in biochemistry. In addition, this module will introduce students to a wide array of cutting edge techniques and strategies used in biochemistry.

BIOCHEMISTRY IN HEALTH & DISEASE (S2) 10 credits
This module covers the structure, function and pharmacology of neurotransmitters, neuron-glial interactions, intraneuronal signalling and the neurobiology of behaviour and neurodegenerative disorders. This module also covers the biochemistry of genetic deficiency diseases and metabolic diseases.

IMMUNOLOGY & MICROBIOLOGY (S2) 10 credits
This module covers pathogen recognition by and signal transduction in immune cells. Bacterial pathogens of medical importance will also be covered in detail. It will provide an introduction to parasitic protozoa such as trypanosomes and helminths. Finally, the biochemical and genetic mechanisms by which bacteria, viruses and parasites evade the host immune responses will be covered.

CANCER BIOLOGY & CELL SIGNALLING (S2) 10 credits
This module covers the cellular and regulatory mechanisms that control the cell cycle. It also covers the molecular basis of a stem cell and its potential use in therapies. Furthermore it covers the molecular basis of cancer, the progression of the disease and the therapeutic treatment strategies.
Biochemistry Moderatorship Learning Outcomes:

On completion of this moderatorship students will be able to:

- Describe cell function and regulation in terms of the molecules, proteins and structures involved in these processes.

- Explain the biochemical basis of human diseased and pathological states and their treatment at a molecular level.

- Demonstrate a comprehensive understanding of biochemical techniques and approaches and their proper application.

- Design experiments, critically analyse and interpret resultant data, synthesise hypotheses from various information sources and write appropriate research reports.

- Demonstrate the ability to work effectively as an individual and in a team

- Use a full range of IT skills and display computer literacy

- Communicate effectively with the scientific community and with society at large and appreciate how the improved knowledge of Biochemistry impacts on society
All students graduate with a degree in Chemistry, which allows access to a wide range of careers in industry, academia and the professions. By choice of practical project and of lecture options in the final year, a student may specialise in Organic, Physical or Inorganic Chemistry.

**Junior Sophisters:**
In addition to the core modules (55 credits), you choose either a 5-ECTS medicinal chemistry or Broad Curriculum module.

**Mandatory Modules:** In order to reinforce and extend students’ laboratory skills in Chemistry, rising Junior Sophister students are required to attend a day-long workshop on Safety, which is held during Freshers’ Week (i.e. the week before lectures start). Attendance at all workshops is compulsory.

**Assessment and Examination Procedures:** Taught material in Chemistry will be examined in module examination papers. Practical work is assessed in-course. Further information relating to the assessed components and composition of written papers will be given in the Junior Sophister Chemistry Booklet issued to rising Junior Sophisters. The JS Chemistry mark will constitute 35% of the final degree mark.

**Senior Sophisters:**
In SS year, students attend a series of core modules (in Physical, Organic and Inorganic Chemistry), four specialised option topics of their choice and associated tutorials. In addition, students are required to attend research seminars and undertake a project in a research lab.

**Assessment and Examination Procedures:** Core and option taught modules will be examined in module examination papers. The Research Project is assessed in-course. Further information relating to the assessed components, composition of written papers and credit weightings will be given in the Senior Sophister Chemistry Booklet that will be issued to rising Senior Sophisters.
<table>
<thead>
<tr>
<th>Module</th>
<th>Credits</th>
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<tbody>
<tr>
<td><strong>Junior Sophister Modules</strong></td>
<td>60</td>
</tr>
<tr>
<td><strong>Inorganic Chemistry</strong></td>
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<tr>
<td>CH3103 Organometallics &amp; Coordination Chemistry (S1&amp;S2)</td>
<td>10</td>
</tr>
<tr>
<td>This module covers topics such as main group and transition metal</td>
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<tr>
<td>organometallics, transition metal compounds and complexes,</td>
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<tr>
<td>homogeneous catalysis and inorganic reaction mechanisms. <strong>NOTE:</strong></td>
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<tr>
<td>50% of the marks for this module are associated with laboratory</td>
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<tr>
<td>exercises.</td>
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<tr>
<td>CH3104 Solid State Materials (S2)</td>
<td>5</td>
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<tr>
<td>This module covers topics such as inorganic polymers, structural</td>
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<tr>
<td>inorganic chemistry, synthetic methodologies and characterisation</td>
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<tr>
<td>techniques of solid state materials.</td>
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<tr>
<td><strong>Organic Chemistry</strong></td>
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<tr>
<td>CH3203 Synthetic Organic Chemistry I (S1&amp;S2)</td>
<td>10</td>
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<tr>
<td>This module gives a basic grounding in the general methodology</td>
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<tr>
<td>employed in organic synthesis. Topics covered include organometallic</td>
<td></td>
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<tr>
<td>C-C couplings, pericyclic reactions, FMO theory and stereoelectronic</td>
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<tr>
<td>effects, and physical organic chemistry. <strong>NOTE:</strong> 50% of the marks</td>
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<tr>
<td>for this module are associated with laboratory exercises.</td>
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<tr>
<td>CH3204 Synthetic Organic Chemistry II (S2)</td>
<td>5</td>
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<tr>
<td>This module covers topics such as heterocyclic chemistry, organo-</td>
<td></td>
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<tr>
<td>heteroatom chemistry, and FGI and retrosynthesis.</td>
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<tr>
<td><strong>Physical Chemistry</strong></td>
<td></td>
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<tr>
<td>CH3303 Quantum Mechanical Concepts in Physical Chemistry (S1)</td>
<td>5</td>
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<tr>
<td>This module deals with quantum mechanics, spectroscopy and group</td>
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<tr>
<td>theory.</td>
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<tr>
<td>CH3304 Molecular Thermodynamics and Kinetics (S2)</td>
<td>10</td>
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<tr>
<td>This module deals with thermodynamics and statistical mechanics,</td>
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<tr>
<td>electrochemistry and kinetics. <strong>NOTE:</strong> 50% of the marks for this</td>
<td></td>
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<tr>
<td>module are associated with laboratory exercises.</td>
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<tr>
<td><strong>Interdisciplinary Modules</strong></td>
<td></td>
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<tr>
<td>CH3403 Analytical Method (S1)</td>
<td>5</td>
</tr>
<tr>
<td>This module deals with both the fundamental principles and</td>
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<tr>
<td>application of spectroscopic and other characterisation techniques.</td>
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<tr>
<td>Topics such as analytical chemistry, organic spectroscopy and</td>
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</tr>
<tr>
<td>structural methods in inorganic chemistry will be covered.</td>
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</tbody>
</table>
CH3404 Biomaterials and Soft Matter (S2)  5 credits
This module will cover bioorganic chemistry and natural products, bioinorganic chemistry, polymers, colloids and other soft matter systems.

Option Modules

CH3441 Medicinal Chemistry (S2)  5 credits
This module encompasses an introduction to medicinal chemistry, antiviral and anticancer chemistry and the computational method QSAR.

OR

BC Broad Curriculum  5 credits

*Note: Module codes given are indicative only as they may change as a result of changes to be introduced in compliance with the ‘Trinity Education Project’. Some of the modules indicated may change code or be switched from one semester to the other
Senior Sophister Modules  

CH4XXX Research Project (S1)  
This research-oriented module involves a research project and thesis, oral presentation of a research seminar and attendance at scheduled School research seminars.

CH4112 Advanced Organic Transformations I (S2)  
This module involves core lectures in organic and biological photochemistry and reactive intermediates.

CH4113 Advanced Organic Transformations 2 (S2)  
This module involves core lectures in asymmetric synthesis and retrosynthesis.

CH4104 Advanced Inorganic Chemistry I (S2)  
This module involves core lectures on advanced inorganic materials and characterisation techniques in bioinorganic chemistry.

CH4105 Advanced Inorganic Chemistry II (S2)  
This module involves core lectures in heavy transition metal chemistry and in advanced coordination chemistry.

CH4106-CH4107 Advanced Physical Chemistry (S2)  
This core module involves lectures in quantum chemistry and solid state chemistry.

Option Module (S1&S2)  
In this module students combine the development of problem-solving skills with taught material on broader and advanced option topics in chemistry. The problem-solving element is a self-directed component that concentrates on an integrative review and the attainment of a mature understanding of fundamental chemical concepts introduced over the entire period of the Moderatorship programme. The taught component consists of four advanced topics selected by the student from a list that includes, among others: advanced physical chemistry and quantum chemistry, supramolecular chemistry, structural chemistry, advanced organic synthesis and advanced organometallic chemistry. See Senior Sophister Course Booklet for further details.

*Note: Module codes given are indicative only as they may change as a result of changes to be introduced in compliance with the ‘Trinity Education Project’. Some of the modules indicated may change code or be switched from one semester to the other.
Chemistry Moderatorship Learning Outcomes

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

- Articulate in written and oral form a foundation level of knowledge and understanding of the biological, physical and quantitative sciences underpinning Chemistry.

- Apply key concepts in the major chemical sub-disciplines of Physical, Inorganic and Organic Chemistry.

- Design, perform, and analyse the results obtained from experiments in physical, inorganic and organic chemistry, using modern chemical experimental methodology and instrumentation.

- Demonstrate skills in problem solving, critical thinking and analytical reasoning, and be able to effectively communicate the results of their work to chemists and non-chemists, both verbally and in writing.

- Use modern library searching and retrieval methods to obtain information pertinent to the identification and solution of chemical problems and the exploration of new research areas.

- Work effectively and safely in a laboratory environment operating within the proper procedures and regulations for safe handling and use of chemicals.

- Update their knowledge and to undertake further study with a high degree of autonomy.
Environmental Science is by its nature a multidisciplinary research discipline – a study of the interactions between the biological, chemical and physical components of our environment. Environmental scientists have training that is similar to other physical or life scientists, but is specifically applied to the environment. Obtaining ample field experience is therefore a key component of the course. A broad scientific knowledge is required which may also involve an understanding of economics, law and the social sciences.

The undergraduate degree course offered by the School of Natural Sciences has been designed to provide for the needs of students with an interest in this rapidly developing academic and professional field. The Moderatorship programme comprises specially designed modules plus a wide range of suitable modules from contributing disciplines. There should be ample choice within the listed optional modules for a selection that reflects a particular student’s interests.

Field work is a core component of the course. In their Sophister years, Students may attend a number of residential field excursions both around Ireland as well as in the Canary Islands and Kenya.

The Environmental Science Moderatorship course consists of 60 European Credit Transfer Systems (Credits) for each year. Both Junior and Senior Sophisters take a total of 45 mandatory Credits and optional modules up to the value of 15 Credits. Some modules are examined entirely by in-course assessment, but most are assessed by a combination of in-course assessment and examination.
Junior Sophister Modules

(60 credits)

(The following module options may be subject to change)

MANDATORY MODULES

**ES3055 Introduction to Environmental Sciences (S1)**
5 credits
This module introduces students to the broad area of environmental sciences through fieldwork, tutorials and research seminars.

**ZO3010 Fundamentals of Ecology (S1)**
5 credits
The module examines the factors that affect the distribution, growth and survival of plant and animal populations. It describes how organisms may interact with their environment and the role that they have in ecosystem and community structure.

**ES3053 Freshwater Hydrobiology (S1)**
5 credits
This is an introductory module in freshwater hydrobiology. It examines the relationship between physico-chemical parameters and the biota of rivers and lakes, the effects of pollutants, community analysis, freshwater assessment and management, through a series of lectures, field and laboratory work in equal measure.

**GL3423 Hydrology and water quality (S2)**
5 credits
This course aims to provide students with an understanding of hydrological processes, following the different pathways of water through the terrestrial part of the hydrological cycle. It also aims to familiarise students with the factors affecting groundwater quality, and to develop an understanding of groundwater quality issues in the context of integrated catchment management.

**ZO3070 Experimental Design and Analysis (S2)**
5 credits
This module aims to put data collection and analysis in the context of research design and will be an important foundation for the Senior Sophister research project. The emphasis will be practical with a more 'hands on' approach rather than the theory of statistics. Initially students will be taught about experimental design, data collection and sampling and the use of spreadsheets for data entry. This will lead on to preliminary data exploration and issues of normality.

**GG3030 Environmental Governance 1 (S2)**
10 credits
This module focuses on the way in which environmental issues are governed by the state, the private sector, publics and civil society. The module will build on work developed in the previous three years of the Geography programme regarding human-environment interactions. In particular it will expand student’s knowledge of fundamental concepts of nature, culture and environment, and the politics of environmental valuation and protection.
BO3123 Soil Science (S2) 5 credits
Soils are important for plants as they provide the key resources required for growth and also essential structural support. This module will provide an overview of the fundamental concepts of soil formation and characterisation; how soil characteristics influence plant distribution and productivity through water and nutrient availability; how soil organisms (bacteria, fungi) interact with plants and how soils influence global biogeochemical cycles (carbon and nitrogen). Particular focus will be given to the role of soils in the production of food, fuel and fibre and how sustainable land management practices are required to ensure the long-term health and fertility of soil systems.

ZO3085 Terrestrial Field Ecology (Prof. John Rochford) (S2) 5 credits
This module, which will include a spring residential field course at the end of the Hilary Term, will be an introduction to field techniques used for the study of terrestrial ecosystems, with an emphasis on population assessment of mammals, insects and birds. Field visits will help with an understanding of contrasting habitats and conservation management.

OPTIONAL MODULES (students choose 15 credits from these modules)

BC Broad Curriculum 5 credits
Students are allowed to choose any Broad Curriculum course except for BC BOT.

BO3121 Field Skills in Plant and Environmental Science (Canary Islands) (S1 & S2) 5 credits
The lecture series explores the flora and ecology of a range of Mediterranean and tropical plant communities, with a focus on the Canary Islands. We start by analysing the climatic features that define these regions, and review some associated features of the environment and soils. We assess the impacts of climate change and deforestation. We assess the plant diversity of these regions and the importance of biodiversity conservation in both local and global contexts. We also focus on some characteristic plant groups of Mediterranean and tropical regions. The lecture series prepares for and culminates in the overseas field-course in Gran Canaria.

BO3120 Environmental Dynamics (S1) 5 credits
The last 2.5 million years of Earth history have witnessed dramatic climatic and environmental changes. This module provides an overview of these major environmental changes, their causes, and their significance for human development. It contrasts ‘glacial’ and ‘interglacial’ worlds, examines the nature of the transitions between them, explores some potential causes of change, and illustrates their environmental impacts. In the process, a range of key environmental records are considered, along with the “proxies” used to develop them.
B03122 Entomology (S2)  5 credits
There are more species of insects on Earth than any other group of organisms and they are of massive ecological and economic importance. This module will address behavioral, social, ecological and applied aspects of entomology, including their role in delivering ecosystem services (such as biocontrol and pollination), invasive species (such as fire ants and harlequin ladybirds) and conservation (both in Ireland and internationally). The practicals will provide students with the skills for sampling and identification of insects, which will be further enhanced through small group and individual projects.

B03124 Economic Botany (S2)  5 credits
This module represents a review of the economic importance of plants, ranging from the commercial use of algae in the food and biofuel industry, agriculturally important crops, plants as sources of pharmaceuticals to the use of non-food crops in industry. The module is entirely continually assessed. The continual assessment will be in the form of a desk-based study using FAO data on global food production, student talks on key economic crops from around the globe to practicals on brewing and tissue culture.

GL4422 Analysis in Geological, Earth and Environmental Research (S2)  5 credits
The module instructs students in geochemical and mineralogical analysis. It (1) introduces the key analytical instruments used for researching natural and man-made materials, before (2) providing a basic understanding of the operation of such instruments, and finally (3) developing the concepts of selecting the most appropriate techniques and limits of methodology.
Senior Sophister Modules 60 credits
(The following module options may be subject to change)

MANDATORY MODULES

FB4000 Research Project (S1 & S2) 15 credits
A research project is carried out by each Senior Sophister student under the supervision of a staff member. The project will be selected in consultation with the supervisor. It will be written up as a dissertation and submitted by a given deadline.

ES4052 General Environmental Sciences (S2) 10 credits
This module provides an opportunity for students to revise and study, in greater depth, topics from the Junior Sophister Environmental Sciences programme. Students are expected to integrate their approach to this earlier material with the perspectives and skills they develop during their final year. Assessment is by examination at the end of the year.

ZO4030 Data Handling (S1) 5 credits
This module will develop hypothesis testing with a revision of t-tests and explore general linear models, using ANOVA, product-moment correlation and regression. Experimental design will also be covered using ANOVA examples.

ZO4060 Research Comprehension (S1 & S2) 5 credits
This tutorial-based module will provide a broad overview of current advances in ecology, evolution and molecular & comparative physiology. Attendance at 10-15 research seminars delivered by invited speakers who are experts in their field that run throughout Semesters 1 and 2 is compulsory. These seminars will be followed by tutorials where the topics covered in the seminar and relevant publications from the speaker will be discussed. The process of conducting research, from initial concept through hypothesis formulation and testing will be discussed along with how to structure scientific presentations and research papers.

ZO4092 Environmental Impact Assessment (S2) 5 credits
This module involves an introduction to the principles and processes of Environmental Impact Assessment, particularly in relation to national and international requirements. All stages of the EIA process, from initial project screening to the final review, are covered, with the emphasis throughout on the role of the natural scientist. Strategic Environmental Assessment is also briefly covered. In addition to the lectures, students carry out a scoping exercise for a proposed development and conduct a quality review of an actual EIS.
BO4105 Global Environmental Change (S2)  
The global environment is changing more rapidly at present than at any time during the human occupancy of the planet. This module reviews the existence of the changing environment and the predictions for the future.

OPTIONAL MODULES (students choose modules to make up 15 credits)

BO4013 Plant Conservation and Biodiversity (S1)  
Loss of biodiversity is one of the major problems facing humanity. The theoretical background to the evolution of plant diversity is firstly developed, and the principles of conservation are then used to develop approaches to conserve plant diversity.

ES4020 Water Technology (S1)  
This module sets out to examine the practical aspects of managing the human water cycle from water treatment and supply through wastewater characteristics, treatment and disposal. As an introductory module it is limited in what it covers, but is primarily designed for those who are interested in a possible future in the water industry, environmental consultancy or who want to do postgraduate studies in a water-related topic.

ZO4013 Conservation & Wildlife Management (S1)  
This module looks at practical applications of wildlife biology to the conservation and management of animals, both in- and ex-situ, including the role of zoos in captive breeding programmes, and the design and management of conservation areas.

ZO4017 Tropical Ecology and Conservation (S1)  
This module takes place on a week-long residential field course in East Africa, focussing on the ecology and biodiversity of a range of ecosystems and habitats (including tropical montaine forest, aquatic ecosystems [freshwater rivers and lakes, wetlands and saline lakes] and grasslands) and the connectivities among them. Issues and problems to do with human impacts and the conservation and management of these diverse habitats will also comprise an important element of the module.

BO4107 Plant-Animal Interactions (S2)  
Plant-animal interactions have increasingly become recognized as drivers of evolutionary change and important components of ecological communities. This module will focus on herbivory (the consumption of plants by animals) and pollination (the transfer of pollen between male and female reproductive structures in flowers).
**ES4056 Environmental Governance II (S2)**
This module focuses on conflicts that arise from environmental problems and their management. It introduces students to the concept of governing environmental conflict through lectures, multimedia presentations, set readings and research activities, using examples from Ireland and overseas.

**ES4054 Spatial Analysis using GIS (S2)**
5 credits
This module introduces students to the framework and methods used in real-life problems related to the field of Spatial Analysis by applying the theoretical knowledge gathered during the module to live project work. The module seeks to impart the necessary skills and knowledge to enable graduates to engage as team members and leaders in the types of large and complex sustainable environment projects that are increasingly being planned across the world.
Environmental Science Moderatorship Learning Outcomes

On successful completion of this programme a student should be able to

- Identify and describe plant and animal communities and analyse their distribution. Know the principles of geochemical cycling in the global context with specific reference to environmental change.
- Know the principles of hydrology and its relationship with groundwater quality.
- Know the causes and effects of terrestrial, atmospheric and marine pollution and present day mitigation strategies.
- Show a good working knowledge of skills and tools, such as spatial data analysis and statistical techniques, which can be used selectively to address complex problems, or to conduct closely guided research.
- Identify, formulate, analyse and suggest reasoned solutions to current environmental problems.
- Design an Environmental Impact Assessment for a range of diverse habitats.
- Critically assess scientific literature.
- Work effectively as an individual, in teams and in multidisciplinary settings.
- Communicate effectively with both the scientific community and with society at large.
Genetics is a two-year moderatorship course run by the School of Genetics and Microbiology. It encompasses a wide range of topics such as medical genetics (including the genetics of cancer), stem cell biology, neurobiology, plant and microbial genetics, molecular evolution, developmental genetics, and genomics and systems biology. Senior Sophister students work part-time in a laboratory where they have the opportunity to acquire basic laboratory skills and conduct state-of-the-art research.

**Junior Sophisters:**
The JS year consists of a diverse programme of lectures, laboratory practicals, tutorials and research essays. In addition to core Genetics modules, students have the opportunity to select a Broad Curriculum option.

**Assessment and Examination Procedures**
Most JS modules are examined by six papers in annual examinations. Some modules and all practicals are examined by continuous assessment or by special tests. The Junior Sophister mark is carried over to year 4 and constitutes 20% of the total moderatorship mark.

**Senior Sophisters:**
In the Senior Sophister year, students attend a series of lectures that cover a wide range of topics (see below). Students also write a literature review and undertake a research project in a designated laboratory.

**Assessment and Examination Procedures**
The moderatorship exam at the end of the Senior Sophister year comprises a total of six papers. In four of these papers, the two lecture modules are assessed. In addition, there is an essay paper and a so-called problems paper, in which the ability of students to solve specific problems one often encounters in genetic research is tested.
## Junior Sophister Modules  60 credits

<table>
<thead>
<tr>
<th>Module Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>GE3M07</td>
<td>BACTERIAL GENETICS (S2)</td>
<td>5</td>
</tr>
<tr>
<td>GE3M09</td>
<td>EUKARYOTIC MOLECULAR GENETICS (S1)</td>
<td>5</td>
</tr>
<tr>
<td>GE3M11</td>
<td>GENOMICS (S1)</td>
<td>5</td>
</tr>
<tr>
<td>GE3M13</td>
<td>NEUROGENETICS AND DROSOPHILA (S2)</td>
<td>5</td>
</tr>
<tr>
<td>GE3M15</td>
<td>MEDICAL GENETICS (S2)</td>
<td>5</td>
</tr>
<tr>
<td>GE3M17</td>
<td>EVOLUTIONARY GENETICS (S1)</td>
<td>5</td>
</tr>
<tr>
<td>GE3M21</td>
<td>MOLECULAR GENETICS LABORATORY (S1)</td>
<td>5</td>
</tr>
<tr>
<td>GE3M23</td>
<td>ANALYTICAL GENETICS LABORATORY (S2)</td>
<td>5</td>
</tr>
<tr>
<td>GE3M25</td>
<td>DATA HANDLING (S1)</td>
<td>5</td>
</tr>
<tr>
<td>GE3M41</td>
<td>GENETICS TUTORIALS (S1 and 2)</td>
<td>5</td>
</tr>
<tr>
<td>GE3M31</td>
<td>REVIEW (GENETICS) (S1 and 2)</td>
<td>5</td>
</tr>
<tr>
<td>THE BROAD CURRICULUM</td>
<td></td>
<td>5</td>
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</tbody>
</table>

This module presents an evidence-based description of the basic cellular processes of transcription, translation and DNA replication in bacteria.

This module introduces the molecular biology and genetics of eukaryotic organisms, including core concepts such as the cell cycle and regulation of gene expression in eukaryotes.

This module provides an introduction to Genomics and Systems Biology, to Bioinformatics and to key techniques used in Molecular Biology.

The module will introduce the fundamentals of neuronal development architecture, neuronal excitability and synaptic function, sensory systems, circadian rhythms, perception and learning and their analysis by genetic methods in model organisms such as Drosophila.

The module introduces the genetics of human disease, from simple Mendelian traits to complex multigenic diseases and gene/drug interactions.

This module provides an introduction to genetic variation – its origins and its evolutionary consequences.

This practical class introduces students to standard methods of Molecular Genetics.

This practical class introduces students to standard methods of Analytical Genetics.

This module focuses on the handling and analysis of data. It includes teaching in bioinformatics, computer programming (*Perl* language) and statistics.

This module introduces students to core concepts of Genetics. In addition, students are trained in scientific writing and will acquire presentation skills.

Students write a literature review on a specific topic of genetics and present their work in a short talk.

Students can freely choose between available Broad Curriculum options.
Senior Sophister Modules  

<table>
<thead>
<tr>
<th>Module</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Literature Review (S1 and S2)</td>
<td>5</td>
</tr>
<tr>
<td>Research Project (S1 and S2)</td>
<td>15</td>
</tr>
<tr>
<td>Problems Paper (annual exam)</td>
<td>5</td>
</tr>
<tr>
<td>Essay Paper (annual exam)</td>
<td>5</td>
</tr>
</tbody>
</table>

Lecture Module: GE4017 Medical & Cellular Genetics  

GE4037 Transgenic Animals & Gene Therapy (Prof. Farrar) (S2)  
This module component explores current developments in the field of transgenic animals and gene therapy. The various methodologies employed to generate transgenic animal models will be outlined together with the use of such animals to explore the biological function of a gene and encoded protein in vivo, to simulate human disorders and to test novel therapeutics. Recent advances in the development of gene-based medicines for a variety of inherited disorders will be covered, as will developments in viral and non-viral technologies to optimise gene delivery to target tissues.

GE4049 Functions, Mechanisms and Prion-like proteins (Prof. Ramaswami) (S1)  
This module component explores the evidence that led to the Prion Hypothesis (1982), that a particular proteinaceous particle, a prion, which contains no detectable nucleic acid, can cause certain kinds of infectious neurological diseases, broadly called the spongiform encephalopathies (SE). The experiments have verified this hypothesis and shown that mutations in the prion gene cause inherited forms of SE, such as CJD. There is good evidence that the pathological form of the prion has a different 3 dimensional structure to the normal cellular form of prion. There is evidence that prion type proteins are found in yeast, and also may have important neurological functions in mammals.

GE4051 Programmed Cell Death (Prof. Martin) (S2)  
This module component examines the role of apoptosis in development, tissue homeostasis, immunity and disease. We will look at similarities and differences between the cell death ‘machinery’ in a simple nematode (C. elegans), the fruitfly (Drosophila) and mammals. The cell death machinery in mammals will be examined in detail how this is switched on by various stresses and forms of damage (including cancer chemotherapy) will be discussed. Finally, the role of apoptosis in disease and the potential for therapeutic manipulation is explored.
GE4061 Genetics and Immunology of Neural Diseases (Prof. Campbell) (S1)
With no neuron in the brain being more than 12 µm from a capillary, the vascular and nervous systems share common developmental pathways that allows for coordination of nutrients and information transfer. In addition, almost every neurological malignancy involves dysregulation of the blood vessels associated with neural tissues. This module component will provide an overview of the complexities of blood vessel development in the brain and retina. In addition, the module will focus on several common neurological conditions such as Alzheimer's disease, describing the underlying genetic causes of the condition and examining the current trends for future research and therapies. This module component will also explore the involvement of blood vessel and immune system dysfunction in conditions such as age-related macular degeneration (AMD) and neuropsychiatric disorders, with a focus on the genetic pre-disposition to such conditions.

GE4055 Genetics and Epigenetics of Cancer (Prof. Bracken) (S2)
The field of Epigenetics studies heritable changes in gene expression or cellular phenotype, caused by mechanisms other than changes in the underlying DNA sequence. This module component will provide an overview of our understanding of Epigenetics from the first studies on the structure of chromatin through to the discovery of the first histone and DNA modification enzymes and explore their mechanisms of action in gene expression control during development, stem cell differentiation and cellular reprogramming. The module component will also explore several exciting new advances, including the human "ENCODE project" and the advent of "Epigenetic drugs" which hold huge promise in medicine and in particular for the treatment of cancer.

Lecture Module: GE4018 Analytical & Developmental Genetics
10 credits

GE4056 Plant Developmental Genetics (Prof. Wellmer) (S1)
In this module component, key concepts of Plant Developmental Genetics will be discussed using the model plant Arabidopsis thaliana as an example. An emphasis lies on genetic mechanisms as well as on the methods that can be used to dissect the developmental processes underlying plant growth. Areas covered include plant embryogenesis; root and shoot development; the induction of flowering; and flower development.

GE4032 Developmental Genetics of Drosophila (Prof. Martin) (S2)
This module component discusses how the creation of simple gradients of relatively few transcription factors sets up the complex patterns of gene expression that create a cell fate ‘map’ within the developing fly embryo. We will look at sets of genes (called segmentation genes) whose expression switches on master regulatory genes (Hox genes) that dictate whether an individual fly segment will carry a wing, a bristle, or an antenna. This is a fascinating topic that discusses work leading to the award of the 1995 Nobel Prize in Medicine/Physiology to Christiane Nusslein-Volhard and Eric Weischaus.
GE4034  Human Evolutionary Genetics (Prof. Bradley) (S1)
Our concepts of human origins and migrations have been profoundly formed by human genetic analysis. The human genome is now the best studied genome for variation in both space and time. This module component follows how genetic insights help us understand: our relationships with the great apes and which are the important genetic changes on the human lineage; the origins of modern humans in Africa and the nature of the migration from there to the rest of the world; the different patterns between male and female lineage inheritance; the interaction between cultural and genetic inheritance patterns. Recent advances in ancient DNA sequencing and archaic human genomes are discussed in detail and a close look at European and even Irish genetic origins are included.

GE4053  Genetics of Neural Development (Prof. Labrador) (S2)
This module component is intended for Senior Sophisters with a neuroscience background. Students should have previously attended GE3006 (Neurogenetics) as a prerequisite. The module component covers different aspects of nervous system development from neural induction to early steps of circuitry assembly. There is a focus on different genetic experimental methods employed to identify central mechanisms of nervous system development. We will use different models to explain processes and provide examples of networks and concepts. The emphasis will be on the conservation of signaling pathways in development of very diverse organisms. This will include Drosophila melanogaster and vertebrates Xenopus laevis, Chick and Mouse.

GE4054  Behavioural Genetics (Prof. Mitchell) (S2)
This module component examines how genetic differences contribute to behavioural differences between individuals in a species. It considers examples from worms, flies, mice and humans. It will also explore how genetics can be used to dissect the biochemical and neural circuitry underlying specific behaviours.

TBD General and Molecular Genetics  10 Credits

GE4040 Principles of Genetics (Various) (S1)
This course introduces and reviews key concepts of genetics and hence conveys fundamental knowledge for all genetics students, including students of Human Genetics. The following topics will be covered: Population Genetics, Inheritance of Complex Traits, Evolution of Genes and Traits, Gene Interactions, Gene Isolation and Manipulation, Genome Structure, DNA replication, RNA: Transcription and Processing, Regulation of Gene Expression in Bacteria and Eukaryotes.
GE4029  Microbial Molecular Genetics (Prof. Devine) (S1)
This module component focuses on adaptation of bacteria to nutritional and environmental stresses using *Bacillus subtilis* as a model organism. The history of research in *B. subtilis* and the features that facilitated its emergence as a model organism are addressed. The use of integrating plasmids and transposons in the genetic analysis of adaptive processes in *B. subtilis* and their applicability to other bacteria are then discussed. We explore the genetic analysis of competence development at the onset of nutrient limitation in *B. subtilis* in detail, describing the signal transduction pathway by which the process is controlled and made responsive to cell density and nutrient availability. We discuss instances of bistable bacterial populations, detailing essential features of the genetic switches required to generate bistability and show how these conditions apply to the development of genetic competence. We discuss the structure of biofilms and how expression of their development is regulated. We also discuss the developmental process of sporulation in *B. subtilis*, showing how gene expression is spatially and temporally regulated during the 8-hour developmental cycle and how the separate sporangium and mother cell compartments communicate to ensure coordinate regulation of the developmental process. Finally we discuss the regulatory network that operates to decide on the response (ie. enzyme production, competence, development, biofilm construction or sporulation) most appropriate to the prevailing conditions.

GE4031  Plant Molecular Genetics II (Prof. Kavanagh) (S1)
Understanding how plants regulate gene expression in response to internal and external cues is of fundamental importance. This is explored in this module component via three thematic areas: (a) the regulation of seedling developmental programs by light (photomorphogenesis); (b) the perception, response pathway and role of the major environmental stress hormone abscisic acid (ABA); (c) the role and mechanisms of gene silencing in plants, including post-transcriptional gene silencing (equivalent to RNAi in animal systems), transcriptional gene silencing (TGS) with its dependence on RNA-directed methylation of DNA and chromatin, and the extraordinary trans-chromosomal silencing phenomenon known as Paramutation.

GE4276  Stem Cell Biology (Prof. Bracken) (S1)
Stem cells have the remarkable potential to develop into many different cell types in the body during early life and growth and therefore offer huge potential in regenerative medicine. This module component will provide an overview of the development of our understanding of stem cells, through the first isolation of embryonic stem cells and adult stem cells, to the discovery of cancer stem cells and Induced Pluripotent (iPS) stem cells. How our expanding knowledge of stem cells is now being used in the development of new and advanced methods of therapeutic intervention will also form an important part of this module.
We know much more now about the structure and evolution of genomes than we did just a few years ago. These lectures explore some of the findings that have come out of very recent research into genome evolution, based on the new area of comparative genomics. Topics include: Mechanisms by which new genes are formed and survive or go extinct; Evolution of gene regulation; the molecular basis of morphological evolution; Evolution of recombination hotspots; how chromosome structures and the order of genes along chromosomes evolve; Does having more genes make an organism more complex?
Genetics Moderatorship Learning Outcomes
Upon successful completion of this programme, students will be able to:

- Demonstrate in written and oral form a foundation level of knowledge and understanding of the biological, physical and quantitative sciences underpinning genetics.
- Demonstrate in written and oral form an advanced level of knowledge and understanding of the principles of genetics, and the evidence upon which they have been established, including
  - the nature of biological inheritance
  - the genetic basis of evolution and population variation
  - the molecular, cellular and physiological basis of genetics
  - the role of genetics in rare and common disease
  - the study of genetics in model organisms
  - the study of genetics in plants and animals
  - relevant mathematical, statistical and computational methods
- Demonstrate in written and oral form a detailed, critical knowledge and understanding, supported by the use of advanced textbooks, journal articles and data sets, of one or more specialist areas, some of it at the current boundaries of the field.
- Apply the knowledge and understanding gained to the critical analysis of experimental data, to sustaining evidence-based arguments on genetical hypotheses, to solving genetical problems and to designing and conducting genetical experiments.
- Pursue with a degree of independence an original genetics research project including project planning; identification, appraisal and safe application of the appropriate experimental techniques; accurate recording and presentation of data; identification of the limitations of and sources of error in experiments; analysis and interpretation of complex data; formulation of logical conclusions; and appraisal of the project outcome in the context of related, published work.
- Demonstrate proficiency in the application of computers to such problems as the searching of literature databases, analysis of biological sequence data and analysis of experimentally acquired data.
- Demonstrate recognition of the methods and value of scientific inquiry and an understanding of the ethical responsibilities of scientists.
- Demonstrate the capacity to apply international standards and practices within the discipline.
- Act effectively, under the guidance of senior scientists as necessary, as an individual, as part of a team, and/or in a multidisciplinary environment.
- Communicate information and ideas at a high level to both specialist and non-specialist audiences.
- Show that they have acquired the learning skills necessary to update their knowledge and to undertake further study with a high degree of autonomy.
Junior Sophister (Year 3)

All JS Geography Science students take two compulsory modules comprising a total of 10 Credits (GG3056 History & Philosophy of Geography and GG3028 Advanced Research Methods in Geography I)

Students select a further 50 Credits of optional modules from the Geography Core Programme (see below). You may substitute a minimum of 5 Credits up to a maximum of 20 Credits for elective modules outside of this core programme (including Broad Curriculum modules) during your sophister years.

**Compulsory Geography Modules**

**GG3056 History and Philosophy of Geography**

**Prerequisites:** None

**Outline:** This module, which is restricted to and compulsory for JS Geography students, presents an overview of the development of the discipline of Geography from classical Greece through to contemporary developments. Throughout, the focus is on how changes in the practice of geography are related to broader social, cultural and political contexts. A number of key topics are examined in detail.

**Module coordinator:** Prof Hennessy

**GG3028 Advanced Research Methods in Geography I**

**S2 5 credits**

**Prerequisites:** none

**Outline:** The objective of this module is to develop research skills to plan and carry out a dissertation investigation. The module focuses on approaches to solving geographic problems, although topics such as ethics, integrity, professionalism, philosophy, research project design, and presentation skills are also covered.

**Module coordinator:** TBC

**Optional Geography Modules**

Geography offers several optional modules that you may take providing you have the required prerequisites (where applicable). Modules commencing with GG34 include a mixed-year group of JS and SS students.

**GG3015: Globalisation**

**S2 5 credits**

**Prerequisites:** None

**Outline:** The module aims to introduce students to the forces underlying ‘globalisation’ and its impacts in both the developed and the Third Worlds. It adopts a critical perspective on the process of globalisation by examining social forces which drive it and how it is politically and economically constructed. It seeks to unpack the interaction between differently scaled social processes to interrogate the nature, meaning, construction, impacts, contradictions and resistances to contemporary neoliberal or corporate globalisation.

**Module coordinator:** Prof Carmody
GG3025 Advanced Research Methods in Geography II  S1  5 credits
Prerequisites: None
Outline: This module is focused on fieldwork. It provides students with practical experience in conducting primary research across a range of geographical themes. Students are required to complete a series of guided research tasks and to present the results of their work in evening seminars and as a field notebook. During the module, students are required to work individually and as part of a group, and to complete tasks within a limited timeframe.
Module coordinator: Prof Coxon

GG3030: Environmental Governance I  S2  10 credits
Prerequisites: None
Outline: This module focuses on the way in which environmental issues are governed by the state, the private sector, publics and civil society. The module will build on work developed in the previous two years of the Geography programme regarding human-environment interactions. In particular it will expand student’s knowledge of fundamental concepts of nature, culture and environment, and the politics of environmental valuation and protection.
Module Coordinator: Prof Bresnihan

GG3033 Geographical Information: Data and Tools  S2  5 credits
Prerequisites: None
Outline: This module explores how to identify, create and use geographic data and tools, such as GIS. The object of the module is to teach students about how data is constructed, used, found, and manipulated by geographic researchers. The module has a maximum quota of 30 student participants.
Module coordinator: Prof Lawton

GG3034 Practical Physical Geography  S1  5 credits
Prerequisites: SF Geography including GG2024
Outline: This module is aimed at students who are considering a physical geography dissertation project. The student numbers will be limited. A white laboratory coat is required for this module. Sharp pencils, calculator, ruler (metric) and a protractor are also required. Basic map work using OS 1:50,000 series maps and GSI geological maps. Fluvial geomorphology from maps, simple drainage basin analysis, analysing geological and climatic controls on fluvial landscapes. Orientation and altitude of corrie basins. Basic field and laboratory methods including sediment description, clast fabric, particle size analysis and loss of ignition measurements. Simple data handling using spreadsheets and graphics packages.
Module coordinator: Prof Coxon
GG3037 Urban Economic Structure & Regeneration  
**Pre-requisites:** None  
**Outline:** The study of cities is crucial to understanding contemporary society, given that we live now live in a majority urban world. This module introduces to some key themes, concepts, and debates in urban geography. The module first considers the historic development of urbanisation, the transition to urban-based economies, and the development of urban studies. It then focusses specifically on the urban impacts of globalisation, in particular how cities in the developed world have managed the shift from industrialism to post-industrialism.  
**Module coordinator:** Prof O’Callaghan

GG3039 Exploring the Sustainable City  
**Pre-requisites:** None  
**Outline:** What will the city of the future look like? To what extent are our models of city-making sustainable? Is the road that we are taking leading us towards an environmental utopia in which societies will grow in balance with nature, or are we paving the way for the collapse of our civilization? These are the key questions that will drive our exploration of the different ways through which, today, sustainable urban development is understood and practiced across the world.  
**Module Coordinator:** Prof Cugurullo

GG3054 Tropical Environments (*subject to availability)*  
**Prerequisites:** None  
**Outline:** This module examines the host of environmental challenges facing tropical regions, with a focus on understanding environmental change drivers and processes. Particular attention will be paid to several case study areas in the humid tropics. Topics covered include: tropical climates and ecosystems; long-term drivers of environmental change; the role of human-environment interactions; climate change predictions and impacts; current environmental management challenges.  
**Module coordinator:** Prof McGlynn

GG3055 Deserts of our Solar System  
**Prerequisites:** GG2024  
**Outline:** This module explores the landforms of our solar system. It focuses on the arid environments of Earth and Mars. Using the latest data from NASA and ESA we examine how landforms and geomorphic processes vary under different atmospheric, gravity and temperature regimes.  
**Module coordinator:** Prof Bourke

GG3475 Glacial Geomorphology (Unavailable 2018-19)  
**Prerequisites:** SF Geography including GG2024  
**Outline:** The module is an introduction to the landforms and processes of glaciation. It covers past and recent work on glacial geomorphology and concentrates on landforms and sediments and their production by glaciers. The topics covered include: history of glacial studies, physical properties of ice, ice motion, glacier systems, thermal regime, erosional processes and landforms, glacial deposition, mineral exploration in glacial terrain, engineering geology in glaciated areas, moraines and drumlins, meltwater deposition and
erosion (process and form). Examples are taken from Ireland where relevant and the module outlines the need for further work in many regions of the country. The module includes a fieldtrip and laboratory work.

**Module coordinator** Prof Coxon

**GG3477 Human Origins (Unavailable 2018-19)**

**Prerequisites:** GG1024; GG2024

**Outline:** This module provides a general introduction to the field of palaeoanthropology with particular focus on the contributions made by Earth Scientists to the study of the origins of our species. The module will examine how diverse lines of evidence from subjects such as archaeology, anatomy and genetics, can be combined to examine the changing relationships between humans and their environment. It will introduce the world of our ancestors and evaluate the science behind stories of popular interest such as Neanderthals, “hobbits”, and the rise and spread of our species, *Homo sapiens*.

**Module coordinator:** Prof Edwards

**GG3478 Periglacial Geomorphology (2018-19; not in 2019-20)**

**Prerequisites:** SF Geography including GG2024

**Outline:** This module covers the regions of the world that experience at present (or have experienced in the past) permanently frozen ground or processes associated with frost action. The processes producing a variety of landforms of all scales are looked at in detail and a pervading theme in the module is the identification and significance of fossil periglacial features in the landscape. Topics covered include: climatic zones, freeze-thaw cycles, permafrost, ground-ice, frost action, patterned ground, hardware modelling of processes, ice-mounds, thermokarst, man and periglacial regions, slopes, fluvial processes, fossil periglacial features in Europe, USA and Britain and Ireland.

**Module coordinator** Prof Coxon

**GG3479 Palaeoceanography & Palaeoclimate (2018-19; not in 2019-20)**

**Prerequisites:** GG1024; GG2024

**Outline:** The module will cover the role of oceans as both agents and archives of climate change during the last 2.6 million years of Earth history. It will include the following topics: Drivers of glacial-interglacial climate change; ice sheet – ocean interactions; Foraminifera as environmental proxies; sea-level change.

**Module coordinator:** Prof Edwards
**Senior Sophister (Year 4)**

All students must undertake an individual research project (20 Credits) that results in the production of a dissertation (see below). Students must also select a further 40 Credits of optional modules from the Geography Core Programme (see below). You may substitute a minimum of 5 Credits up to a maximum of 20 Credits for elective modules outside of this core programme (including Broad Curriculum modules) if you have not already done so in Year 3.

**GG4030 Geography Dissertation**  
*Type:* Compulsory  
*Outline:* The dissertation is an independent study in which field work or the study of original source material is expected to play an important role. Data can be collected in a variety of ways - such as through field sampling or survey, laboratory analysis, questionnaire surveys, interviews, content analysis, census material or archival work or some combination of these - depending on the topic chosen. The research topic is developed as part of GG3028 Advanced Research Methods in Geography I.  
*Module coordinator:* TBC

**Optional Geography Modules**

**GG3475 Glacial Geomorphology (Unavailable 2018-19)**  
*Type:* S1 10 credits  
*Prerequisites:* SF Geography including GG2024  
*Outline:* The module is an introduction to the landforms and processes of glaciation. It covers past and recent work on glacial geomorphology and concentrates on landforms and sediments and their production by glaciers. The topics covered include: history of glacial studies, physical properties of ice, ice motion, glacier systems, thermal regime, erosional processes and landforms, glacial deposition, mineral exploration in glacial terrain, engineering geology in glaciated areas, moraines and drumlins, meltwater deposition and erosion (process and form). Examples are taken from Ireland where relevant and the module outlines the need for further work in many regions of the country. The module includes a fieldtrip and laboratory work.  
*Module coordinator:* Prof Coxon

**GG3477 Human Origins (Unavailable 2018-19)**  
*Type:* S2 10 credits  
*Prerequisites:* GG1024; GG2024  
*Outline:* This module provides a general introduction to the field of palaeoanthropology with particular focus on the contributions made by Earth Scientists to the study of the origins of our species. The module will examine how diverse lines of evidence from subjects such as archaeology, anatomy and genetics, can be combined to examine the changing relationships between humans and their environment. It will introduce the world of our ancestors and evaluate the science behind stories of popular interest such as Neanderthals, “hobbits”, and the rise and spread of our species, *Homo sapiens*.  
*Module coordinator:* Prof Edwards
GG3478 Periglacial Geomorphology (2018-19; not in 2019-20)  S1  10 credits
Prerequisites: SF Geography including GG2024
Outline: This module covers the regions of the world that experience at present (or have experienced in the past) permanently frozen ground or processes associated with frost action. The processes producing a variety of landforms of all scales are looked at in detail and a pervading theme in the module is the identification and significance of fossil periglacial features in the landscape. Topics covered include: climatic zones, freeze-thaw cycles, permafrost, ground-ice, frost action, patterned ground, hardware modelling of processes, ice-mounds, thermokarst, man and periglacial regions, slopes, fluvial processes, fossil periglacial features in Europe, USA and Britain and Ireland.
Module coordinator: Prof Coxon

GG3479 Palaeoceanography & Palaeoclimate (2018-19; not in 2019-20)  S2  10 credits
Prerequisites: GG1024; GG2024
Outline: The module will cover the role of oceans as both agents and archives of climate change during the last 2.6 million years of Earth history. It will include the following topics: Drivers of glacial-interglacial climate change; ice sheet – ocean interactions; Foraminifera as environmental proxies; sea-level change.
Module coordinator: Prof Edwards

GG4026 Environmental Governance II  S2  10 credits
Pre-requisites: GG3030 Environmental Governance I
Outline: This module considers why conflicts arise through the process of environmental governance. The focus of the module will be on developing analytical frameworks for analysing conflicts and potential mechanisms for conflict resolution. It will introduce students to the concept of governing environmental conflict through lectures, multimedia presentations, set readings and independent research activities. Due to the nature of the assessment, this module will have a cap of 40 students.
Module Coordinator: Prof Bresnihan

GG4061 Understanding Environmental Change  S1  10 credits
Prerequisites: None
Outline: The global environment, including climate, is changing. This change has major economic, social and policy implications and will thus underpin living conditions for the whole of humanity going forward. The course will introduce the functional aspects of this change using an Earth Systems Science approach by providing the basis to understand how major components of the Earth System are linked and how these links change over time. Conceptual developments in this understanding, as well as the basic modern concepts in Environmental Change (both human-induced and natural) will be discussed as a basis to comprehend the utility of forecast tools used as a basis for societal response.
Module coordinator: Prof Rocha
GG4062 Spatial Analysis using GIS  S1  5 credits
**Prerequisite:** GG3055 or GG3033

Note: Places on this module are limited to 15. In the case of oversubscription, places will be allocated on the basis of student performance in GG3055 or GG3033.

**Outline:** The Introduction to Advanced Spatial Analysis using GIS module is designed to introduce the student to spatial analysis using a Geographic Information Systems (GIS) platform and guide her/him through the learning process of advanced ArcGIS extensions dedicated to network analysis, spatial data mining and environmental phenomena modelling.

**Module Co-ordinator:** Prof Harty

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GG4036 Globalisation and African Development  S2  5 credits
**Prerequisites:** None

**Outline:** This module explores the nature and impacts of globalisation in Africa. Particular attention is paid to the geography of HIV/AIDS, gender and development, China’s rising role in the continent, oil politics and the so called “resource curse”. Other topics covered included gender and the mobile phone revolution.

**Module coordinator:** Prof Carmody

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GG4066 Historical Geography I  S1  5 credits
**Prerequisites:** None

**Outline:** This module presents an overview of the historical geography of Ireland from the earliest human settlement in the Mesolithic through to c.1000 A.D. Throughout the module developments in Ireland are set within appropriate comparative and theoretical contexts. The principal topics explored are settlement, land use and agriculture, the changing environment (including human impacts), patterns of cultural variation and interaction and how these have come together to forge changing landscapes and regions.

**Module coordinator:** Prof Hennessy

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GG4067 Historical Geography II  S1  5 credits
**Prerequisites:** None

**Outline:** This module presents an overview of the historical geography of Ireland from c.1000 A.D. through to c.1900 A.D. Throughout the module developments in Ireland are set within appropriate comparative and theoretical contexts. The principal topics explored are settlement, land use and agriculture, the changing environment (including human impacts), patterns of cultural variation and interaction and how these have come together to forge changing landscapes and regions.

**Module coordinator:** Prof Hennessy
GG4069 Urban Geography: Cities, space and culture  
**S2 10 credits**

**Prerequisites:** None

**Outline:** This module introduces key debates and concepts in urban geography that shed light on what it means to live in an ‘urban society’. The first part of the module will outline how political economic processes, including the relationship between the supply of credit and the role of the property development sector and the role of entrepreneurial urbanism, produce urban space in highly uneven ways. The second part of the module will examine social and cultural geographies of cities, focusing on the role of identity and difference in shaping urban space and everyday life.

**Module Co-ordinator:** Prof O’Callaghan

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GG4070 Stormy Geomorphology  
**S1 5 credits**

**Prerequisites:** None

**Outline:** This module comprises a 5-day field residential course in Ireland. During this field trip students will examine the geomorphological evidence for extreme events. Sites will include a location where mega clasts (the size of cars) were thrown on top of cliffs 30 m high by waves. Students will receive field instruction on how to collect data using established and advanced technologies (e.g. drones) in order to build data sets on key environmental parameters.

**Module coordinator:** Prof Bourke
Geography Learning Outcomes

On successful completion of your Geography degree, you will be able to:

• Discuss Geographical theories, concepts, methods and processes;

• Demonstrate a detailed knowledge of one or more specialised areas in Geography by, for example, being able to identify, analyse and resolve problems. Some of this geographical knowledge will be at the current boundaries of research;

• Apply this knowledge and comprehension in a manner that indicates a thorough and informed approach to your work, and have competences typically demonstrated through devising and sustaining arguments, and formulating and solving problems;

• Use a number of specialised skills and tools, such as spatial data analysis and statistical techniques, which you can use selectively to address complex problems, or to conduct closely guided research;

• Devise data gathering experiments and to gather and interpret relevant data to inform independent judgements, which include reflection on relevant social, scientific or ethical issues;

• Communicate information, ideas, problems and solutions to both specialist and non-specialist audiences;

• To undertake further study with a high degree of autonomy.
The Geology Moderatorship aims to produce well-rounded graduates with a sound understanding of the geological processes that have acted on the Earth's surface and within the planet from the dawn of time to the present day. The programme also aims to provide each student with a broad set of both vocational and transferable skills.

Applicants to the Sophister course in Geology are strongly advised to have attended the residential field courses in the Senior Fresh year. The course structure of the Moderatorship in Geology is as follows:

**Junior Sophisters:**
The Junior Sophister programme is a prescribed course that consists of modules in the main branches of the geological sciences. A series of transferable as well as subject specific skills are developed during this year. Fieldwork is an important component and Junior Sophister students attend at least two major field classes away from Dublin.

**Senior Sophisters:**
In the Senior Sophister year, students take some core modules (M) that include an independent dissertation. In addition there is a range of optional (O) modules some of which are provided by other schools or departments. There is at least one long field course away from Dublin during the Senior Sophister year. Subject choice forms for the optional courses in the Senior Sophister year are normally completed at the start of the year.
Junior Sophister Modules 60 credits

GL3324 Geological field skills 1 CN (S1) 10 credits
This module deals with recognition of basic geological relationships in the field and the means by which they are recorded. It illustrates features such as stratigraphic contacts, intrusions, deformation fabrics, timing relationships and how they are represented on a geological map. The module is based at a suitable location outside of Dublin at the start of the junior sophister year.

GL3325 Geological field skills 2 DC (S2) 10 credits
This module takes place towards the end of the year. It integrates and illustrates important theoretical concepts covered in the class room and laboratory during the year. It reinforces geological field techniques, field note taking and mapping principles. The module takes place at a suitable location outside of Dublin in spring.

GL3326 Sedimentology MR (S1) 10 credits
This module aims to understand the key physical, chemical and biological processes that shape Earth’s surface. In particular, the module will study the generation, transport and preservation of sediment in response to these processes, and investigate sedimentary rocks and thin sections to interpret ancient depositional systems and environmental change.

GL3328 Structural Geology DC (S2) 5 credits
This module examines the geometries, kinematics and mechanics of rock deformation. It also deals practically with the representation of three dimensional structural data using maps, cross-sections and stereographic projections.

GL3334 Introduction to Geochemistry BK (S1) 5 credits
This module introduces students to the topic of geochemistry with an emphasis of the behaviour of major and trace elements in the most important rock forming and breakdown processes. These include: magmatic differentiation, metamorphic transformation, weathering and alteration. The module draws from insight provided by laboratory experiments as well as from empirical observations. Students will learn the most widely used tools of geochemistry and be prepared to appreciate the importance of geochemistry in reconstructing past events.

GL3335 Stratigraphy and the Geology of Ireland PNWJ (S2) 5 credits
This module introduces the concept of stratigraphy detailing its various disciplines, and the regulations underpinning the modern stratigraphic framework. It will outline techniques in biostratigraphic recording and analysis of biological data from fossils in the field, their taxonomic description, and their biostratigraphic and palaeoecological use. The Geology of Ireland lectures focus on integrating the diverse geological processes that have acted during its geological evolution from the Precambrian to present.
GL3336 Microscopy and Crystalline Rocks  ET (S1)  10 credits
This module introduces mineralogical principles, including crystallography, crystal growth and the origin, occurrence, classification, identification and uses of minerals. Emphasis is placed on the physics and chemistry that relates all minerals and mineral properties, and their expression under the petrologic microscope (both in the laboratory and on the virtual microscope). Mineral assemblages are then studied in the context of the main metamorphic rock series found in the crust and their relevance for reconstructing pressure-temperature and deformation histories. Metamorphic rocks will be studied in map context, using hand specimens and thin sections. The igneous rocks component then introduces the generation and crystallisation of magmas and the processes that lead to produce the wide variety of compositions and textures seen in igneous rocks. A range of intrusive and extrusive rocks are investigated at field and hand-specimen scale and in thin section.

GL3337 GIS and Mapping techniques  TBC / SMcC (S2)  5 credits
This module provides a practical introduction to the use of Geographical Information Systems (GIS) for geologists, and provides methodologies in geological map preparation and data recording. The GIS component covers the basic functionality of ArcMap and QGIS focussing on the acquisition, manipulation, and integration of Digital Elevation Models and satellite imagery to generate basemaps for geological fieldwork.
Senior Sophister Modules  

GL4401 Project (M)  
This involves a piece of geological research in which data are acquired and interpretations are presented in a logical and professional manner. Except in exceptional circumstances projects are field based.

GL4402 Fieldwork (M)  
An extended field course that integrates many of the specialist areas is held away from Dublin, usually in Hilary Term. Shorter courses may be scheduled during the year.

GL4404 Geological Literature (M)  
This module deals with critical analysis of research papers, an appreciation of early geological concepts and theories, and current topics of debate in the earth sciences.

GL4406 Global Igneous Petrology (O)  
This module discusses the production of magmas in the main tectonic settings and how these can be recognised. Discussion of magma generation is then followed by an introduction to magma storage and differentiation in the crust. This module will introduce students to some of the current controversies and problems in igneous petrology and has a strong focus on discussion and critical evaluation of geological evidence.

GL4412 Laboratory Project (O)  
The aim is to execute a piece of laboratory based geological research and present the acquired data and interpretations in a logical and professional manner.

GL4414 Petroleum Geology & Exploration (M)  
In this module the principal theoretical concepts of petroleum generation, migration and accumulation are introduced. These concepts are then illustrated by investigating the real-life example of ongoing oil exploration in the East African Rift System. Concepts will be further reinforced using other laboratory and field examples.

GL4416 Planet formation and the early Earth (O)  
This module retraces the history of the early Earth, from its formation to events that shaped the Earth until the oxygenation of the atmosphere. The module will introduce students to rocks that are unique to the early Earth with a focus on the most important events that have shaped the planet from the billion of year time perspective.

GL4419 Economic Geology (M)  
In this module, students will familiarise themselves with the most important types of ore deposits. Building onto the now familiar geotectonic and absolute time framework, the module introduces the various mineralisation types with case studies. Apart from understanding the anatomy, mineralogy and chemistry of ore deposits, students will also learn strategies for mineral exploration, including reconstructing alteration histories and manipulating lithogeochemical data.
GL4422 Analysis in geological, earth and environmental research (O) RG (S1) 5 credits
The module instructs students in geochemical and mineralogical analysis by following a series of environmental and geological samples from their collection, to obtaining data, to data processing and final interpretation. It introduces the key analytical instruments used for researching natural and man-made materials and develops the concepts of selecting the most appropriate techniques and the limits of each methodology.

GL4424 Micropalaeontology & Evolution (O) PNWJ (S1) 5 credits
This module introduces the subject of micropalaeontology, its scope, methods (including scanning electron microscopy) and potential, as well as the main groups of microfossils. It demonstrates the practical use of these fossils in biostratigraphy, palaeoenvironmental analysis, oceanography and thermal maturation studies. The module will also examine the evolution of life on our planet from earliest times.

GL4425 Applied Geophysics (O) CJB (S2) 5 credits
This module will introduce students to geophysics as a discipline, placing it in the broader Earth science context. The physical principles underlying a variety of geophysical techniques (seismology, gravity, magnetic, electrical, electromagnetic) will be explored through practice based field experiments and workshop format lectures in a week-long ‘field camp’ setting. Emphasis will be placed on team work in field data acquisition and in the processing, analysis and interpretation the student’s own data. The problem areas will be applied, with a focus on shallow geophysical applications.

GL4427 Isotope Geochemistry and Geochronology (O) QC (S1) 5 credits
This module deals with the theory and application of isotope geochemistry as tracers of geological processes. It will also demonstrate how radiogenic isotopes may be used for dating purposes, to either constrain thermal evolution or provide an absolute temporal framework to study the secular evolution of the solid Earth.

GL3423 Hydrology and water quality (O) CC (S2) 5 credits
This module aims to provide an understanding of hydrological processes, with a focus on hill slope systems, rivers and aquifers and on groundwater – surface water interactions. It also investigates contaminant transfer by different hydrological pathways, with an emphasis on contaminant hydrogeology including groundwater quality issues in rural and industrial settings and groundwater protection.
**Geology Moderatorship Learning Outcomes**

On successful completion of this programme a student should be able to:

- identify, formulate, analyse and suggest reasoned solutions to geological problems
- identify earth materials and interpret three and four dimensional distributions of these materials from incomplete data sets
- apply scientific procedure to solving problems
- critically assess previously produced geological data sets and interpretations
- work effectively as an individual, in teams and in multidisciplinary settings
- communicate effectively with both the geological community and with society at large
- Update their knowledge and undertake further study with a high degree of autonomy.
‘Immunology’ is a moderatorship course run by the School of Biochemistry and Immunology (http://www.tcd.ie/Biochemistry/). Immunology is the study of the molecules and cells of the body that are involved in recognising and fighting infection and disease. Furthermore, we aim to understand how we can exploit this information therapeutically. Much of the course content is shared with other degree programmes offered by the School (particularly in the areas of cell and molecular biology in JS), but there are specialised courses, assignments and practicals in Immunology in both Sophister years.

For all international visiting student queries please email Dr. Andrei Budanov at budanova@tcd.ie.

Junior Sophisters:
The JS year consists of a varied programme of lectures, tutorials, a literature review, data-handling and laboratory practicals. In addition to the core Immunology courses, students will also cover material in Biochemistry, Genetics and Microbiology, as indicated in the list below. JS students also take a Broad Curriculum option.

Assessment and Examination Procedures
There are four exam papers in the summer that contain questions on all the core Immunology and Biochemistry lectures as well as the related practicals. In addition to laboratory reports and assessments, assignments include a literature search and mini-review on an assigned immunology topic. Four quantitative problems will also be set and marked during the year. The Broad Curriculum options will be examined by in-course assessment during the year. JS marks contribute to 20% of the final degree.
Senior Sophisters:
In the Senior Sophister year, students will carry out a research project in Immunology, in a research laboratory (not a teaching laboratory). They will also complete a limited amount of problems and assignments, and take specialised lecture courses in Immunology.

SS Assessment and Examination Procedures:
The end of year final examinations are comprised of three 3-hour examinations papers. Each paper will contain four sections. The first two sections will examine the specialised SS lecture material. The remaining two sections are general in nature and examine core concepts in Immunology, biochemistry and cell biology. Each paper carries equal marks. The research skills module is examined entirely by in-course assessment during the first semester. Finally, a capstone research project will be carried out and contributes one third of the SS mark. The overall degree mark is comprised of 80% of SS mark and 20% of JS mark.
JUNIOR SOPHISTER MODULES 60 CREDITS

BI3220 CORE CONCEPTS IN IMMUNOLOGY (S1) 10 CREDITS
This module introduces fundamental processes and molecules associated with the immune system. The different immune responses to diverse pathogens will be covered. The role of the immune system in disease e.g. autoimmunity will also be addressed. There will be Immunology practicals associated with these lectures.

BI3240 MICROBIOLOGY AND IMMUNOLOGY (S2) 10 CREDITS
This module introduces some basic microbiology and the immune response to specific pathogens. Topics include virology and microbial pathogenicity. There are also practicals associated with this module.

BI3210 BIOCHEMISTRY (S1) 10 CREDITS
This module will cover protein structure and function as well as cell membrane structure and function. Some basic cell signalling will also be covered. There are some biochemistry practicals associated with this module.

BI3230 GENE REGULATION (S2) 10 CREDITS
Introduction to the basics of gene regulation including transcription, translation and replication in both prokaryotic and eukaryotic organisms. There are some molecular biology practicals associated with this module.

BI3215 ANALYTICAL SKILLS I (S1) 5 CREDITS
This module involves practicals and data handling project.

BI3020 RESEARCH SKILLS (S2) 10 CREDITS
This module involves a literature review and essay on an immunology topic and a presentation in addition to quantitative problem analysis.

BI3894 Broad Curriculum 5 credits
SENIOR SOPHISTTER MODULES

60 CREDITS

RESEARCH PROJECT IN IMMUNOLOGY (S1) 20 ECTS

ADVANCED RESEARCH SKILLS (S1) 10 ECTS

ADVANCED TOPICS IN IMMUNOLOGY I (S2) 10 ECTS
This module outlines the differentiation and roles of specific leukocyte populations in mediating innate and adaptive immune responses. It covers characteristic and distinctive features of immune responses at different anatomical sites. Signal transduction of various cell death pathway and cytokine receptors will be covered along with signalling and biochemical events associated with immunometabolism and regulation of immune responses.

ADVANCED TOPICS IN IMMUNOLOGY II (S2) 10 ECTS
This module covers innate and adaptive immune responses to viruses, bacteria and parasitic protozoa such as trypanosomes, plasmodium, and helminths. The biochemical and genetic mechanisms by which these microorganisms evade the host immune responses will be covered. This module will also cover vaccines, vaccine adjuvants and the danger theory.

ADVANCED TOPICS IN IMMUNOLOGY III (S2) 10 ECTS
This Immunotherapy based module covers basic and clinical aspects of autoinflammatory and autoimmune conditions, including rheumatoid arthritis, multiple sclerosis, obesity, immunodeficiency syndromes, as well as neuroinflammation and disease. The biochemical basis for cancer along with an understanding of the current role of immunotherapy for the treatment of cancer, and other diseases, will also be covered.

NOTE: Learning outcomes for each of the modules can be found on the School homepage: http://www.tcd.ie/Biochemistry/courses/senior_soph.php
Immunology Moderatorship Learning Outcomes

On completion of this programme it is expected that students will be able to:

- Discuss core and specialised areas of Immunology in depth and analyse
- Solve biochemical problems and demonstrate a comprehensive understanding of the theory behind techniques used in Immunology and a critical awareness of how these techniques can be applied to biological problems
- Design and implement a wide range of experimental procedures, critically analyse and interpret experimental data, synthesise hypotheses from various information sources and write a research thesis
- Demonstrate the ability to work effectively as an individual and in a team
- Use a full range of IT skills and display computer literacy
- Communicate effectively with the scientific community and with society at large and appreciate how the improved knowledge of Immunology impacts on society
Microbiology is a two-year moderatorship course run by the School of Genetics and Microbiology. It encompasses microbial & molecular genetics, microbial genomics, cellular & molecular biology, microbial pathogenesis, medical microbiology, immunology, virology, applied aspects of microbiology and biotechnology.

Senior Sophister students study in specialized areas of modern microbiology and carry out a full-time, nine-week research project. Microbiology graduates find employment in research labs, universities, industry, hospitals, the scientific civil service, police forensic labs, public health labs, quality control labs in the food, dairy and beverage industries, as well as in education, scientific publishing, technical sales and services, marketing and in management.

Junior Sophisters:

The JS year consists of a diverse programme of lectures, laboratory practicals, tutorials and a research essay. The JS year is a 60 credit course composed of five 10 credit modules consisting of lectures (5 credits) and associated practicals (5 credits), and a 5 credit research essay and transferable skills module. Students also have the opportunity to take an optional Microbiology module (5 credits), or can take a Broad Curriculum option (5 credits).

Assessment and Examination Procedures

Practical components (totalling 25 credits), Research Essay and Transferable Skills (5 credits) and the optional module (MI3M07, 5 credits) will be assessed in-course by laboratory practical report, practical test, written test or other assignments. Students are referred to the Microbiology Undergraduate Course Booklet for further details regarding the nature and timing of assessments.

The lecture components (totalling 25 credits) will be examined in one of five written papers taken during the university assessment periods. Further information relating to the number and composition of papers will be given in the Microbiology Undergraduate Course Booklet 2018/19 issued to rising Junior Sophisters.
Marks for Microbiology modules MI3M01-MI3M06 plus the Optional Course (MI3M07 or Broad Curriculum) will form the JS Microbiology mark that is carried forward to Moderatorship.

Senior Sophisters:

Assessment and Examination Procedures

Core lecture modules in Microbial & Molecular Cell Biology, Microbial Pathogenicity and Applied & Environmental Microbiology (MI4M02-MI4M04), associated data handling exercises and the specialized lecture modules (MI4M05) will be examined in five papers taken during the assessment periods.

Students are also required to submit a research essay on a chosen topic and have the opportunity to perform a full-time nine-week research project (MI4M01). The Research Essay and Research Project (MI4M01) are assessed in course. The JS Microbiology mark will constitute 20% of the final Moderatorship mark.

Further information relating to the assessed components, composition of written papers and weightings will be given in the Senior Sophister Microbiology Booklet issued to rising Senior Sophisters.
Junior Sophister Modules  

60 credits

MI3M01: Microbial Physiology, Prof A. Fleming (S1)  
10 credits
This module covers various aspects of microbial physiology including cell surface structure and function, cell membranes, nutrient uptake and metabolism, as well as mechanisms by which cells respond to nutrient depletion. Various biochemical, immunological and microscopy techniques for examining microbial cell surfaces are also described. In associated practicals, students gain a working knowledge of biochemical and immunological techniques relevant to the analysis of cell surfaces. The module also teaches data handling and interpretation, and includes a lecture and practical component.

MI3M02: Microbial Pathogenicity & Immunology, Prof K. Roberts (S2)  
10 credits
This module gives basic grounding in microbial pathogenicity and medical microbiology. It covers the molecular basis of bacterial pathogenesis, including adhesion to host cells and tissue, invasion of mammalian cells, survival within professional phagocytes, evasion of innate immune responses and damage of host tissue. Major bacterial protein toxins are also covered as are important bacterial pathogens, vaccines and laboratory techniques for the identification of bacterial pathogens. The module also includes a Viral Pathogenicity component which deals with the properties of viruses compared to other microorganisms, classification of viruses, virus structure, the molecular biology of virus multiplication and viruses of topical interest. The fundamentals of immunology are also covered in this module. The module encompasses both lectures and a practical class.

MI3M03: Research Essay & Transferable Skills, Prof J. Geoghegan (S1)  
5 credits
This module involves on-line tutorial teaching of a range of general transferable skills including the use of databases for literature searches, use of various illustration and graphics software packages, data interpretation, writing and presentation skills. Additionally, students gain experience of researching and writing an up-to-date mini-review on a topic of current research interest.

MI3M04: Bacterial Molecular Biology & Genetics, Prof C.J. Dorman (S2)  
10 credits
This module covers the major mechanisms by which bacteria regulate expression of genetic material as well as aspects of bacterial replication and recombination. In associated practicals, students gain a familiarity with modern molecular genetic techniques.

MI3M05: Eukaryotic Molecular Biology & Genetics, Prof U. Bond (S1)  
10 credits
This module covers eukaryotic molecular and cell biology. It also addresses how molecular biological techniques can be applied to current problems in Industry, Agriculture and Medicine as well as delivering practical exercises in yeast genetics. The lecture module also introduces students to Genomics including the use of bioinformatic databases and software, and their use in the analysis of genomes. The module encompasses lectures and a practical component.
MI3M06: Applied Microbiology, Prof C. Kroger, (S1, S2)  10 credits
This module addresses the scope of applied microbiology and includes the microbiology of 
food production and spoilage, preservation of perishable goods and food poisoning. 
Methods of sterilisation and disinfection will be described, as well as how biohazardous 
waste is treated. The module also covers the modes of action of, and mechanisms of 
resistance to, antimicrobial drugs. The associated practical includes a computer workshop 
which will introduce students to various microbial genome databases. Tutorials in statistics 
required for the analysis of data sets are also included in this module.

Optional Courses

Students can choose between either:

- Microbiology Past and present (MI3M07), Prof J. Geoghegan (S1 or S2)  5 credits

This module will look at the emergence and development of the discipline of Microbiology. 
A combination of lectures and tutorials will allow students to consider the influence of 
Microbiology and Microbiologists on, *inter alia*, mankind’s thinking about the origins of life 
and the nature of disease; the discovery of the varied natures and lifestyles of “germs”; the 
many and various approaches taken to combat microorganisms and their unwanted effects; 
the parts microbes have played in plagues, pestilences, conquests & colonisations and the 
roles of microorganisms as enemies and allies in warfare. Students will also consider some 
of the Microbiological challenges facing modern societies. The module also gives the 
student the opportunity to attend selected Microbiology seminars given by visiting 
academics, which will then be discussed.

OR

- A Broad Curriculum (BC) Cross Faculty Course  5 credits

Module managers, and the location of each module within semester 1 (S1) or semester 2 
(S2), are indicated in parenthesis. All modules are subject to change and availability of 
academic staff.
<table>
<thead>
<tr>
<th>Module Code</th>
<th>Module Title</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>MI4M01:</td>
<td>Research in Microbiology (S1-S2)</td>
<td>20</td>
</tr>
<tr>
<td>MI4M02:</td>
<td>Microbial Molecular &amp; Cellular Biology (S1-S2)</td>
<td>10</td>
</tr>
<tr>
<td>MI4M03:</td>
<td>Microbial Pathogenicity (S1-S2)</td>
<td>10</td>
</tr>
<tr>
<td>MI4M04:</td>
<td>Applied &amp; Environmental Microbiology (S1-S2)</td>
<td>10</td>
</tr>
<tr>
<td>MI4M05:</td>
<td>Advanced Topics in Microbiology (S1-S2)</td>
<td>10</td>
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</tbody>
</table>

**Senior Sophister Modules**  

60 credits

**MI4M01: Research in Microbiology (S1-S2)**  
This research oriented module involves a full-time **9-week research project** and thesis, the writing of a **research essay**, attendance at research seminars, and discussions of professional and ethical issues in Microbiology.

**MI4M02: Microbial Molecular & Cellular Biology (S1-S2)**  
This module involves core lectures and advanced data handling sessions in Microbial & Molecular Cell Biology.

**MI4M03: Microbial Pathogenicity (S1-S2)**  
This module involves core lectures and advanced data handling sessions in Microbial Pathogenicity.

**MI4M04: Applied & Environmental Microbiology (S1-S2)**  
This module involves core lectures and advanced data handling sessions in Applied & Environmental Microbiology.

**MI4M05: Advanced Topics in Microbiology (S1-S2)**  
In this module students select three **advanced optional modules** from a list which currently includes: Gram-Positive Bacterial Pathogens; Clinical Microbiology; Lessons from Yeasts - Applying Yeast Genetics to the Study of Human Disease; Regulation of Bacterial Gene Expression; Virology and Eukaryotic Genome Structure and Function.
Microbiology Moderatorship Learning Outcomes

Upon successful completion of this programme, students will be able to:

- Demonstrate in written and oral form a foundation level of knowledge and understanding of the biological, physical and quantitative sciences underpinning microbiology.
- Demonstrate in written and oral form an advanced level of knowledge and understanding of the principles of microbiology, including
  - the nature and diversity of microorganisms and the methods of studying them
  - the genetic, biochemical and physiological processes occurring in some of the best-characterised microorganisms
  - the interactions between some of the best-characterised pathogenic microorganisms and their hosts
  - the roles, uses and manipulation of microorganisms in health and disease, agriculture, biotechnology and the environment
  - the roles of microorganisms as model systems in related fields
  - the scientific method of investigation and testing of hypotheses and the distinction between scientific and unscientific arguments.
- 3. Demonstrate in written and oral form a detailed, critical knowledge and understanding, supported by the use of advanced textbooks, journal articles and data sets, of one or more specialist areas, some of it at the current boundaries of the field.
- 4. Apply the knowledge and understanding gained to the critical analysis of experimental data, to sustaining evidence-based arguments on microbiological hypotheses, to solving microbiological problems and to designing microbiological experiments.
- 5. Pursue with a degree of independence an original microbiological research project including project planning; identification, appraisal and safe application of the appropriate experimental techniques; accurate recording and presentation of data; identification of the limitations of and sources of error in experiments; analysis and interpretation of complex data; formulation of logical conclusions; and appraisal of the project outcome in the context of related, published work.
- 6. Demonstrate proficiency in the application of computers to such problems as the searching of literature databases, analysis of biological sequence data, visualisation of biological macromolecules and analysis of experimentally acquired data.
- 7. Demonstrate recognition of the value of scientific inquiry and an understanding of the ethical responsibilities of scientists.
- 8. Demonstrate the capacity to apply international standards and practices within the discipline.
- 9. Act effectively, under the guidance of senior scientists as necessary, as an individual, as part of a team, and/or in a multidisciplinary environment.
• 10. Communicate information and ideas at a high level to both specialist and non-specialist audiences.
• 11. Show that they have acquired the learning skills necessary to update their knowledge and to undertake further study with a high degree of autonomy.
Molecular Medicine is a moderatorship course offered jointly by the School of Biochemistry and Immunology and the School of Medicine, St. James’ Hospital. The emphasis of this course is on the study of fundamental life processes and how discoveries in basic science lead to new diagnostics and therapies for human disease.

For all international visiting student queries please email Prof Andrei Budanov at budanova@tcd.ie.

Junior Sophisters
The Junior Sophister year consists of a varied programme of lectures, practicals, tutorials and a mini-review of the literature on a chosen topic. Students will acquire a broad knowledge of various science disciplines, including biochemistry, cell biology, immunology, genetics, microbiology and topics central to the molecular medicine course such as clinical cancer, infection, stem cells, and drug discovery.

Assessment and Examination Procedures
Two exam papers are given per semester containing questions on the core lecture material and related practical’s. The Bioanalysis and Research Skills modules will be assessed by in-course assessments, including laboratory reports, quantitative problems, a literature search and mini-review on an assigned topic and a presentation. Broad curriculum options will be examined by in-course assessment during the year. JS marks contribute to 20% of the final degree.

Senior Sophisters
The Senior Sophister year will cover topics in neurobiology, oncology, haematology, immunology as well as autoimmune and auto-inflammatory diseases. Students will also complete a set of problems/assignments and carry out a capstone research project in the area of biochemistry, cell biology, immunology or clinical medicine. Students will have a choice to perform their project in the School of Biochemistry & Immunology, on the main College campus or in the Department of Clinical Medicine, St. James’s Hospital.
SS Assessment and Examination Procedures:
The end of year final examinations is comprised of three 3-hour examinations papers. Each paper will contain four sections. The first two sections will examine the specialised SS lecture material. The remaining two sections are general in nature and examine core concepts in Molecular Medicine. Each paper carries equal marks. The research skills module is examined entirely by in-course assessment during the first semester. Finally, a capstone research project will be carried out and contributes one third of the SS mark. The overall degree mark is comprised of 80% of SS mark and 20% of JS mark.
<table>
<thead>
<tr>
<th>Module Code</th>
<th>Course Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>BI3310</td>
<td>Proteins and drugs (Semester 1)</td>
<td>10</td>
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<tr>
<td></td>
<td>This module will cover protein structure and function, protein biochemistry, medicinal chemistry and associated practical skills.</td>
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<tr>
<td>BI3320</td>
<td>Cell Biology (Semester 1)</td>
<td>10</td>
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<tr>
<td></td>
<td>This module will cover the structure, function and organisation of biological membranes as well as providing an introduction to cell signalling events. Practical work will be linked to the lecture courses.</td>
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<tr>
<td>BI3330</td>
<td>Disease Mechanisms (Semester 2)</td>
<td>10</td>
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<td></td>
<td>This module will cover the molecular events involved in cancer as well as giving an overview of the immune system and metabolic diseases. Practical work will be linked to the lecture courses.</td>
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<tr>
<td>BI3010</td>
<td>Nucleic Acids (Semester 2)</td>
<td>10</td>
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<tr>
<td></td>
<td>This module will introduce the basics of gene regulation and protein expression, including transcription, translation and replication in eukaryotic organisms. Practical work will be linked to the lecture courses.</td>
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<tr>
<td>BI3020</td>
<td>Research Skills (Semester 1 &amp; 2)</td>
<td>10</td>
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<tr>
<td></td>
<td>The module will provide students with the skills to acquire and survey scientific literature. Students will then write a comprehensive review on a course relevant topic. Data analysis and interpretation skills will also be developed</td>
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<tr>
<td>BI3315</td>
<td>Bioanalysis (Semester 1 &amp; 2)</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>This module will develop data handling and acquisition skills.</td>
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<tr>
<td>BC</td>
<td>BROAD CURRICULUM</td>
<td>5</td>
</tr>
</tbody>
</table>
Neuroscience is a multidisciplinary area of study that makes use of a variety of methods and investigations from a range of disciplines. Consequently, the Neuroscience Moderatorship is an inter-faculty programme drawing on relevant courses contributed by various Schools in the different Faculties at Trinity College.

**Junior Sophisters:**
The JS year consists of a varied programme of lectures, laboratory practicals, workshops and seminars that cover different aspects of Neuroscience. In addition, throughout the Junior Sophister year, students take courses that will give them a broad based foundation in Data Handling and Statistics, Psychology, Physiology, Pharmacology and Cellular and Molecular Biology. Additionally, a broad curriculum course will have to be selected.

**Assessment and Examination Procedures**
Some courses are assessed by examination; however, some courses are assessed entirely by in-course assessment, and some are assessed by a combination of both. Junior Sophister Neuroscience results constitute 20% of the final Moderatorship result.

**Senior Sophisters:**
The Senior Sophister year is comprised of a variety of specialised courses in different areas of Neuroscience, distributed across the two semesters. Students will have a wide choice of potential capstone projects hosted by research groups within Trinity College Institute of Neuroscience and in most Schools and Departments that contribute to the Neuroscience degree. This project will begin in the Michaelmas term and continue in the Hilary term.

**Assessment and Examination Procedures**
Continual assessment based on written assignments, oral presentations and literature reviews take place mainly in the Michaelmas term. The research project is marked according to students’ performance in the lab. and their submitted dissertation. Examinations will take place at the end of Michaelmas term (2 exams) and at the end of the year (2 exams).
Junior Sophister Modules  

**Integrative Neuroscience* (S1)**  
5 credits  
Initiation in *systems neuroscience* and *behavioural neuroscience* and introduction to integrative frameworks for synthesizing neuroscience literature and approaching hypothesis driven research. Topics include: Functions of brain (behaviour & homeostasis), approaches to understanding behaviour (ethology & experimental psychology), integrative frameworks for explaining behaviour, neural circuit organization and function, technology & methods for integrative neuroscience, movement, sensory perception, motivational systems, emotional modulation, learning & memory, decision making, evolution of brain & behaviour.

**Cellular Physiology (S1)**  
5 credits  
Topics include: membrane structure, membrane proteins, membrane properties, receptors, neurotransmitters — definition and release. Neurotrophic factors, cytokines, Leptin, Stem cells, opiate peptides, nitric oxide, measuring molecules.

**Neuroanatomy (S2)**  
5 credits  
This module deals with the location, structure and function of the various components of the nervous system.

**Neurophysiology I (S1 & S2)**  
5 credits  
Topics include: ion channels, synaptic transmission, the somatosensory system, nociception, addiction and rewards, arousal and sleep, vision, motor control, plasticity, memory and learning, sensory physiology. Practicals consist of EEG recordings on humans.

**Basic Neurochemistry I (S2)**  
5 credits  
Cell-types in the brain and their functions, synaptic vesicles, aminergic neurotransmission, The fate of released neurotransmitters, synaptosomal bioenergetics, identification of neurotransmitters, some other transmitters, brain growth & development, stem cells.

**Research Skills (S1)**  
5 credits  
This module gives an introduction to experimental design, data handling and statistical analysis of data, data interpretation and presentation. Additionally, students will gain experience in the comprehension and critical analysis of research articles.

**Neurogenetics and Drosophila (S2)**  
5 credits  
The module will introduce the fundamentals of neuronal development architecture, neuronal excitability and synaptic function, sensory systems, circadian rhythms, perception and learning and their analysis by genetic methods in model organisms such as Drosophila.

**General Principles of Pharmacology (S1)**  
5 credits  
To introduce the student to the basic principles of pharmacology, drug development and experimental techniques used in pharmacology.

**Nucleic acids (S2)**  
5 credits  
This module covers the structure and function of nucleic acids and the molecular basis of gene regulation including DNA replication and repair, transcription and translation.
**BI3415 Biochemistry in Health and Disease (S2)**  
5 credits  
This module provides an introduction into how imbalances in metabolism result in disease states. It also covers the biochemical defense mechanisms against infection and aspects of the drug discovery process.

**BI3435 Basic Laboratory Skills for Neurobiology (S2)**  
5 credits  
In this practical module students will learn essential experimental techniques of modern cell biology involving experiments with proteins and nucleic acids.

**Broad Curriculum**  
5 credits  
A module of the broad curriculum has to be selected.

* Subject to approval
### Senior Sophister Modules

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BI444S Neurochemistry II (S1)</td>
<td>Advanced courses on brain biochemistry, CNS acting drugs, neurotransmission and neurodegenerative conditions such as Alzheimer’s disease, Parkinson’s disease and stroke.</td>
<td>5 credits</td>
</tr>
<tr>
<td>PG4460 Neurophysiology II (S1)</td>
<td>Seminars include: revision of membrane structure, receptors and signalling cascades, G-proteins, calcium as a messenger, transmitter release, ageing. Biophysical properties of excitability and synaptic transmission. The role of dendrites in synaptic integration and plasticity. Methodology and techniques in neurophysiology.</td>
<td>5 credits</td>
</tr>
<tr>
<td>BI4455 Neuroimmunology &amp; Neurodegeneration (S1)</td>
<td>This module will focus on bi-directional communication between the nervous and immune systems. Specific topics will include: An introduction to the immune system; Immune privilege, multiple Sclerosis, autonomic control of the immune system; stress hormones and immune function, sickness behaviour, microglial cells. Modelling neurodegenerative diseases (Alzheimer’s, Parkinson’s, Prion disease, Tauopathies, Motor Neuron disease)</td>
<td>5 credits</td>
</tr>
<tr>
<td>NS4PH2 Neuropharmacology (S1)</td>
<td>This course focuses on drug action within the central nervous system. Specifically the course will deal with the biological basis and drug treatment of depression, anxiety, insomnia, schizophrenia, pain, epilepsy, drug dependence, Parkinson’s disease, Alzheimer’s disease.</td>
<td>5 credits</td>
</tr>
<tr>
<td>BI4415 Research Literature Skills (Neuroscience) (S1)</td>
<td>Students will gain experience in the comprehension and critical analysis of research articles. They will be required to distil research papers into power point presentations and present to their class and lecturers. The Hilary term student research project will be preceded by a review of the literature pertaining to the project</td>
<td>15 credits</td>
</tr>
<tr>
<td>GE4060 Neurogenetics (S2)</td>
<td>This module will examine how genes influence behaviour through effects on cellular physiology and neuroanatomy and how a developmental programme encoded in the genome directs the assembly of the nervous system.</td>
<td>5 credits</td>
</tr>
<tr>
<td>PS4020 Neuropsychology and Systems Neuroscience (S2)</td>
<td>The students will learn about information processing in biological and theoretical networks, encoding and processing of the neuronal signal and its dependence on experience. Novel neuroscience methodologies will be discussed: massive parallel recording, isolation of single units with electrophysiological techniques and optogenetic techniques to manipulate of networks and behaviour.</td>
<td>5 credits</td>
</tr>
<tr>
<td>BI4495 Neuroscience Research Project (S2)</td>
<td>Students will conduct a research project in one of the Neuroscience laboratories across campus, including those contributing to Trinity College Institute of Neuroscience.</td>
<td>15 credits</td>
</tr>
</tbody>
</table>
Neuroscience Moderatorship Learning Outcomes.

On successful completion of this programme students will have a solid foundation in:

- Development of the nervous system
- Structure of the nervous system (Macro & micro)
- Function of the various cell types that make up the nervous system
- Genetics/Gene expression and its role in development and functioning of the nervous system
- Basic biochemistry: Membranes, Proteins, Enzymes
- Neurotransmission: Neurophysiology, Neurochemistry, Neurotransmitter substances, Receptors & classification, Signalling pathways
- Neurophysiology: Role of neurotransmitters/brain structures in normal Physiology
- Role of the nervous system in driving peripheral body functions
- Cognitive Neuroscience
- Neuropharmacology and Neuroimmunology
- Neurodegenerative diseases
- Experimental techniques: proficiency in the laboratory
- Experimental design, data handling, biostatistics
- Written and oral communication skills
The Physics moderatorship offers a broad course covering experiment, theory and computation across the spectrum of modern physics. It builds on the Physics modules taken in the Fresher years. There is particular emphasis on condensed matter physics, reflecting the School’s strength in research in this area.

Junior Sophisters:
The JS year consists of lectures, tutorials and practical delivered in modules, as listed below. Students receive training in communication skills within the practical module.

Mandatory Modules:
All lecture modules are mandatory with exceptions of PY3A03 and PY3C01. Students select only one of these two optional modules. Students also take a practical (lab) module. Note that those who take a Broad Curriculum module take a shorter practical (lab) module with reduced credits.

Assessment and Examination Procedures
Modules may be assessed by end-of-semester examination and/or continuous assessment. Further information relating to the assessed components and composition of written papers will be given in the Physics Undergraduate Handbook 2018-19.
Senior Sophisters:
The SS year consists of lectures, tutorials and an independent research project, which may be carried out at another university or research institute.

Mandatory Modules
All modules are mandatory. However, in the module PY4P07, Advanced Topics in Physics, students choose two of the five topics offered.

Assessment and Examination Procedures
Modules may be assessed by end-of-semester examination and/or continuous assessment. Further information relating to the assessed components and composition of written papers will be given in the Physics Undergraduate Handbook 2018-19. Assessment of the full-time research project will be by a report, poster and interview. Problem solving in physics will be examined at the end of Semester 1.
**Junior Sophister Modules**

**60 credits**

**PY3P01 Quantum Mechanics I (S1)**
This module covers solution of the Schrödinger Equation in specific topics, such as angular momentum and the hydrogen atom.

**PY3P02 Electromagnetic Interactions I (S2)**
This module covers the fundamentals of electromagnetic theory together with quantum optics and lasers.

**PY3P03 Condensed Matter I (S1)**
This module introduces condensed matter concepts such as crystal structure and thermal and electronic properties of matter.

**PY3P04 Condensed Matter II (S2)**
This module extends the discussion of condensed matter into the key areas of magnetic properties and the physics of semiconductors.

**PY3P05 Atomic & Nuclear Physics (S2)**
This module covers atomic and molecular spectroscopy together with nuclear structure and related effects.

**PY3P06 Dynamical Systems (S1)**
This module covers the mechanics of matter together with statistical thermodynamics.

**PY3P07 Experimental Techniques (S2)**
This module covers common device electronics together with the instrumentation used in physics research.

**PY3A03 Stellar and Galactic Structure (S1)**
This optional module covers the origin and evolution of the Sun and planets in our solar system and newly discovered extra-solar planetary systems from both observational and theoretical perspectives. Students take either this module or PY3C01 below.

**PY3C01 Computer Simulation I (S1)**
This optional module introduces the LINUX/UNIX environment and programming in Python, together with various numerical and statistical computer simulation techniques. Students take either this module or PY3A03 above.

**PY3PP1 Practical in Physics (S1 & S2)**
In this module students complete a number of advanced experiments in Physics. Minor components include training in communication skills, personal and career development and attendance at School Seminars. This module is not available to students who take a 5-credit ‘Broad Curriculum’ module.
PY3PP2 Practical in Physics with BC (S1 & S2) 15 credits

In this module students complete a reduced number of advanced experiments in Physics. Minor components include training in communication skills, personal and career development and attendance at School Seminars. This module is only available to students who take a 5-credit ‘Broad Curriculum’ module.

*Note
Module codes given are indicative only as they may change as a result of changes to be introduced in compliance with the ‘Trinity Education Project’. Some of the modules indicated may be merged to form larger modules.
Senior Sophister Modules* 60 credits

PY4P01 Quantum Mechanics II (S1 & S2) 5 credits
This module extends the discussion of quantum physics into the areas of multi-electron atoms, the time dependent Schrödinger Equation and perturbation theory.

PY4P02 High Energy Physics (S1 & S2) 5 credits
This module covers the theory and experimental investigation of fundamental particles, including the Standard Model.

PY4P03-PY4P04 Condensed Matter III and Nanoscience (S2) 10 credits
This module covers metal physics and superconductivity together with semiconductor devices, the modified properties of nanoscale matter, its fabrication and potential applications.

PY4P05 Electromagnetic Interactions II (S1 & S2) 5 credits
This module covers electromagnetic wave phenomena together with optical communications.

PY4P06 Modern Optics (S2) 5 credits
This module covers quantum optics and nonlinear optics.

PY4P07 Advanced Topics (S1 & S2) 5 credits
This module offers a number of specialist topics. Students select two topics to complete the module. The topics offered will be ‘Energy’; ‘Thin Films’; ‘Polymers’, ‘Diffraction, Imaging, and Spectroscopy of Nanostructure’ and ‘Green’s Functions in Physics’.

PY4PP2 Physics Research Project (S1) 20 credits
This independent physics research project is carried out in the first 9 weeks of Semester 1 in one of the School’s research groups or at another university or research institute.

PY4PP5 Problem Solving in Physics (S1) 5 credits
Techniques for using knowledge of physics to solve general problems will be developed. Students also attend School Seminars.

*Note
Module codes given are indicative only as they may change as a result of changes to be introduced in compliance with the ‘Trinity Education Project’. Some of the modules indicated may be merged to form larger modules.
Physics Moderatorship Learning Outcomes.

On the successful completion of this programme, a student should be able to:

- demonstrate in written and oral form a comprehensive level of knowledge of physics and the mathematics that underpins this knowledge, together with an awareness of its place within the broader science curriculum.

- apply the core concepts of Classical and Modern Physics across a wide spectrum of topics and applications, such as information technology and materials science.

- perform calculations to solve practical problems, including the use of numerical methods and computing.

- operate sophisticated spectrometers and similar test and evaluation apparatus across a wide spectrum of investigation.

- independently design and carry out an experiment and evaluate critically the data obtained, including appropriate error analysis.

- communicate the results of an experiment or project via dissertation, poster or oral presentation.

- employ literature search methods to obtain information relevant to research and development.

- act effectively as an individual or as a member of a team in professional, educational and industrial settings.

- update personal knowledge with a high degree of autonomy, whether in the workplace or in the context of further study.
Physics and Astrophysics combines the core of the moderatorship in Physics with specialist modules in astrophysics theory and practice. This moderatorship reflects the increasing interest in astronomy and space science.

**Junior Sophisters:**
The JS year consists of lectures, tutorials and practicals delivered in modules, as listed below. Students receive training in communication skills within the practical module.

**Mandatory Modules:**
All lecture modules are mandatory. Students also take a practical (lab) module. Note that those who take a Broad Curriculum module take a shorter practical (lab) module with reduced credits.

**Assessment and Examination Procedures**
Modules may be assessed by end-of-semester examination and/or continuous assessment. Further information relating to the assessed components and composition of written papers will be given in the Physics Undergraduate Handbook 2018-19.
Senior Sophisters:
The SS year consists of lectures, tutorials and an independent research project, which may be carried out at another university, observatory or research institute.

Mandatory Modules
All modules are mandatory.

Assessment and Examination Procedures
Modules may be assessed by end-of-semester examination and/or continuous assessment. Further information relating to the assessed components and composition of written papers will be given in the Physics Undergraduate Handbook 2018-19. Assessment of the full-time research project will be by a report, poster and interview. Problem solving in physics will be examined at the end of Semester 1.
Junior Sophister Modules*  

**PY3P01 Quantum Mechanics I (S1)**  
This module covers solution of the Schrödinger Equation in specific topics, such as angular momentum and the hydrogen atom.  

**PY3P02 Electromagnetic Interactions I (S2)**  
This module covers the fundamentals of electromagnetic theory together with quantum optics and lasers.  

**PY3P03 Condensed Matter I (S1)**  
This module introduces condensed matter concepts such as crystal structure and thermal and electronic properties of matter.  

**PY3P05 Atomic & Nuclear Physics (S2)**  
This module covers atomic and molecular spectroscopy together with nuclear structure and related effects.  

**PY3C01 Computer Simulation I (S1)**  
This module introduces the LINUX/UNIX environment and programming in Python, together with various numerical and statistical computer simulation techniques.  

**PY3A03 Stellar and Galactic Structure (S1)**  
This module covers the origin and evolution of the Sun and planets in our solar system and newly discovered extra-solar planetary systems from both observational and theoretical perspectives.  

**PY3A06 Statistical Thermodynamics & Astrophysical Spectroscopy (S1)**  
This module covers thermodynamics and statistical mechanics, together with the underlying physics required to interpret spectra from across the electromagnetic spectrum.  

**PY3A07 Experimental Techniques for Astrophysics (S2)**  
This module covers common device electronics and astronomical spectroscopy, astronomical instrumentation.  

**PY3AP1 Practical in Physics and Astrophysics (S1 & S2)**  
In this module students complete a number of advanced experiments in Physics together with an introduction to computer methods in Astrophysics. Minor components include training in communication skills, personal and career development and attendance at School Seminars. This module is not available to students who take a 5-credit ‘Broad Curriculum’ module.
PY3AP2 Practical in Physics and Astrophysics with BC (S1 & S2) 15 credits

In this module students complete a reduced number of advanced experiments in Physics together with an introduction to computer methods in Astrophysics. Minor components include training in communication skills, personal and career development and attendance at School Seminars. This module is only available to students who take a 5-credit ‘Broad Curriculum’ module.

*Note
Module codes given are indicative only as they may change as a result of changes to be introduced in compliance with the ‘Trinity Education Project’. Some of the modules indicated may be merged to form larger modules.
### Senior Sophister Modules*  
**60 credits**

<table>
<thead>
<tr>
<th>Module Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
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<tbody>
<tr>
<td>PY4P01</td>
<td>Quantum Mechanics II (S1 &amp; S2)</td>
<td>5</td>
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<tr>
<td></td>
<td>This module extends the discussion of quantum physics into the areas of multi-electron atoms, the time dependent Schrödinger Equation and perturbation theory.</td>
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<tr>
<td>PY4P02</td>
<td>High Energy Physics (S1 &amp; S2)</td>
<td>5</td>
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<tr>
<td></td>
<td>This module covers the theory and experimental investigation of fundamental particles, including the Standard Model.</td>
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<tr>
<td>PY4P05</td>
<td>Electromagnetic Interactions II (S1 &amp; S2)</td>
<td>5</td>
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<tr>
<td></td>
<td>This module covers electromagnetic wave phenomena together with optical communications.</td>
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<tr>
<td>PY4P06</td>
<td>Modern Optics (S2)</td>
<td>5</td>
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<tr>
<td></td>
<td>This module covers quantum optics and nonlinear optics.</td>
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<tr>
<td>PY4C01</td>
<td>Computer Simulation III (S2)</td>
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<td></td>
<td>This module provides an introduction to matrix computing and discrete Fourier transforms and partial differential equations through Python, and extends the toolkit of numerical and statistical computer simulation techniques.</td>
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<tr>
<td>PY4A03</td>
<td>Planetary and Space Science (S2)</td>
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<tr>
<td></td>
<td>This module covers advanced stellar structure and planetary systems</td>
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<tr>
<td>PY4A05</td>
<td>Cosmology (S1 &amp; S2)</td>
<td>5</td>
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<td></td>
<td>This module derives the basic equations of cosmology and uses these, together with observations, to examine the history and future of the Universe. Recent results concerning Dark Matter and Dark Energy, and possible future directions are also examined.</td>
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</tr>
<tr>
<td>PY4AP2</td>
<td>Physics/Astrophysics Research Project (S1 &amp; S2)</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>This independent research project in an area of physics or astrophysics is carried out in the first 9 weeks of Semester 1 in one of the School’s research groups or at another university, observatory or research institute.</td>
<td></td>
</tr>
<tr>
<td>PY4PP5</td>
<td>Problem Solving in Physics (S1)</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Techniques for using knowledge of physics to solve general problems will be developed. Students also attend School Seminars.</td>
<td></td>
</tr>
</tbody>
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*Note*

Module codes given are indicative only as they may change as a result of changes to be introduced in compliance with the ‘Trinity Education Project’. Some of the modules indicated may be merged to form larger modules.
Physics and Astrophysics Moderatorship Learning Outcomes.

On the successful completion of this programme, a student should be able to:

- demonstrate in written and oral form a comprehensive level of knowledge of physics and astrophysics and the mathematics that underpins this knowledge, together with an awareness of its place within the broader science curriculum

- apply the core concepts of classical and modern Physics across a wide spectrum of topics and applications, such as computer modelling of astrophysical phenomena.

- perform calculations to solve practical problems, including the use of numerical methods and computing

- understand the operation of modern astronomical instruments, such as electronic cameras and optical and radio telescopes

- independently design and carry out experiments and evaluate critically the data obtained, including appropriate error analysis

- communicate the results of an experiment or project via dissertation, poster or oral presentation

- employ literature search methods to obtain information relevant to research and development

- act effectively as an individual or as a member of a team in professional, educational and industrial settings

- update personal knowledge with a high degree of autonomy, whether in the workplace or in the context of further study
Botany is the study of plants which are the source of the food we eat, the oxygen we breathe, most of the medicines we use, and the timbers and fibre which shelter, warm and clothe us. Plants are the core to understanding one of the greatest issues of our time – global climate change. In Trinity we specialise in the study of the evolution, genetics, ecophysiology, vegetation structure, history and dynamics, sustainability and conservation of all forms of plant life.

**Junior Sophister**
The JS year consists of a diverse programme of lectures, laboratory practicals, field trips, tutorials and seminars, totalling 55 mandatory credits. In addition to core Botany modules, students also take either a Broad Curriculum module or choose an optional module (5 credits) from outside of the core Botany course. These modules are indicated in greater detail below.

**Field Courses**
There are two major field trips. The first is the Autumn Field trip which is based in and around Dublin with a residential stay in Wicklow. It takes place during the first week of Michaelmas Term and involves field and laboratory studies of woodlands, bogs and grasslands. The second field trip, based in an ecologically and biodiverse area of Europe (Canary Islands), is likely to take place during the study week in Hilary Term. Students also have the option of participating in a tropical field course.

**Seniors Sophisters**
In the Senior Sophister year, students attend a series of lectures, laboratory practicals, field work, seminars, tutorials and workshops. In addition, they are required to undertake a 20 credit research project which culminates in the submission of a dissertation. The year consists of a total of 55 mandatory credits and 5 optional credits for one of two modules taken from outside the Botany course. These modules are indicated in greater detail below.
Junior Sophister Modules 60 credits

Mandatory modules

BO3100 Plant Physiology (S1) 5 credits
This module covers major biochemical and physiological aspects of photosynthesis, respiration, resource capture and growth at both the cell and whole plant level. Supporting practicals are designed to examine both the light and stromal reactions of photosynthesis and to investigate the role of light in seed germination and plant development. Continual assessment will be through a programme of practicals, tutorials and student presentations.

ZO3010 Fundamentals of Ecology (S1) 5 credits
This module is run jointly with the Zoology Department. The module examines the factors that affect the distribution, growth and survival of plant and animal communities. It describes how organisms interact with their environment and the role that they have in ecosystem and community structure. There is an introduction to the concepts and models that help to explain and predict organism distributions and interactions.

BO3107 Plant Molecular Biology (S2) 5 credits
Plant Molecular Biology plays a major part in most fields of botanical research including ecology, systematics and physiology. The aim of this module is to cover the fundamentals of plant molecular biology and to explore applied aspects, including molecular systematics, molecular ecology, conservation genetics and genetic engineering.

BO3108 Plants and the Irish Environment (S1) 5 credits
This module combines an introduction to the Botany and Environmental Sciences moderatorships with a series of field-based activities including a residential field-trip during the first week of term. There will also be a lecture given during the field trip and three following it on specific aspects of the Irish flora.

BO3109 Seminars, Tutorials and Workshops (S1 & S2) 5 credits
The aim of the seminars is to introduce undergraduate students to current research topics on key issues related to the Plant Science curriculum. The aim of tutorials and workshops is to develop skills in communication and analysis of scientific information. The module is divided into a series of interactive tutorials and workshops with themes such as, essay writing, problem solving, graphics, thesis writing, and journal article analysis.
**BO3111 Angiosperm Diversity and Systematics (S2)**

By undertaking this module you will become acquainted with the most important group of plants on Earth – the Flowering Plants or Angiosperms. In it we discuss the origin of the Angiosperms, move on to various systems for their classification and discuss various large groups of Angiosperms: concentrating on those that occur in Europe.

**BO3120: Environmental Dynamics (S1)**

The last 2.6 million years of Earth history have witnessed dramatic climatic and environmental changes. This module provides an overview of these major environmental changes, their causes, and their significance for human development. It contrasts ‘glacial’ and ‘interglacial’ worlds, examines the nature of the transitions between them, explores some potential causes of change, and illustrates their environmental impacts. In the process, a range of key environmental records are considered, along with the “proxies” used to develop them.

**BO3121 Field Skills in Plant and Environmental Science (Canary Islands) (S2)**

This module combines a lecture series with a residential field trip to the Canary Islands. There are four main aims to this module: 1. To introduce a highly diverse subtropical island flora, with complex biogeographical composition; 2. To record the plant communities across a range of environments, differing in rainfall, altitude, degree of disturbance, etc. and to investigate the ecophysiology of the native flora over the range of habitats studied; 3. To assess the threat to biodiversity posed by human activities; and 4. To develop knowledge of field-based plant and animal identification, and how to conduct field research. The lecture series explores the geography, flora and fauna of the Canary Islands, as well as the history of the islands, and the impacts that humans have and continue to have on its ecosystems.

**BO3123 Soil Science (S1)**

Soils are important for plants as they provide the key resources required for growth and also essential structural support. This module will provide an overview of the fundamental concepts of soil formation and characterisation; how soil characteristics influence plant distribution and productivity through water and nutrient availability; how soil organisms (bacteria, fungi) interact with plants and how soils influence global biogeochemical cycles (carbon and nitrogen). Particular focus will be given to the role of soils in the production of food, fuel and fibre and how sustainable land management practices are required to ensure the long-term health and fertility of soil systems.
ZO3070 Experimental Design and Analysis (S2) 5 credits
This module, designed specifically for Environmental Scientists, Plant Scientists, Functional Biologists and Zoologists aims to put data collection and analysis in the context of research design and will be an important foundation for the Senior Sophister research project. The module consists of two parts. The emphasis will be practical with a more ‘hands on’ approach rather than the theory of statistics. Initially students will be taught about experimental design, data collection and sampling and the use of spreadsheets for data entry. This will lead on to preliminary data exploration and issues of normality.

BO3125 Diversity of Plant Morphology 5 credits
The Earth’s vegetation is replete with a diversity of plant forms from 40 meter high trees to aquatics to parasites and climbers. Different plant forms are adapted for different functions. This course aims to provide students with the basic tools necessary to understand, describe and appreciate a diversity of plant form and think critically about the likely functional role of different plant structures. Students will be introduced to the morphology of land plants (embryophytes) in the context of current understanding on plant phylogeny (based on molecular data), taxonomy and systematics. Major evolutionary trends in plant form, function and life cycles will be discussed.

Optional modules
BO3122 Entomology (S2) 5 credits
There are more species of insects on Earth than any other group of organisms and they are of massive ecological and economic importance. This module will address behavioral, social, ecological and applied aspects of entomology, including their role in delivering ecosystem services (such as biocontrol and pollination), invasive species (such as fire ants and harlequin ladybirds) and conservation (both in Ireland and internationally). The practicals will provide participants with the skills for sampling and identification of insects, which will be further enhanced through small group and individual teaching.

BO3124 Economic Botany (S1) 5 credits
This module represents a review of the economic importance of plants, ranging from the commercial use of algae in the food and biofuel industry, agriculturally important crops, plants as sources of pharmaceuticals to the use of non-food crops in industry. The module is entirely continually assessed. The continual assessment will be in the form of a desk-based study using FAO data on global food production, student talks on key economic crops from around the globe to practicals on brewing and tissue culture.

Broad Curriculum Modules 5 credits
Any of the offered BC modules may be taken as long as they can be accommodated in the timetable.
Senior Sophister Modules  

60 credits

Mandatory modules

FB4000 Research Project (S1 & S2)  
20 credits
A research project is carried out by each Senior Sophister student under the supervision of a staff member. The project will be selected in consultation with the supervisor. It will be written up as a dissertation and submitted by a given deadline.

BO4103 Plant Conservation and Biodiversity (S2)  
5 credits
Loss of biodiversity is one of the major problems facing humanity. The theoretical background to the evolution of plant diversity is firstly developed, and the principles of conservation are then used to develop approaches to conserve plant diversity.

BO4105: Global Environmental Change (S2)  
5 credits
The global environment is changing more rapidly at present than at any time during the human occupancy of the planet. This module reviews the existence of the changing environment and the predictions for the future.

BO4106 Seminars, Tutorials and Workshops (S1 & S2)  
5 credits
The aim of the seminars is to introduce undergraduate students to current research topics on key issues related to the Botany curriculum. The aim of tutorials and workshops is to develop skills in communication and analysis of scientific information. The module is divided into a series of interactive tutorials and workshops with themes such as, essay writing, problem solving, graphics, thesis writing, journal article analysis.

BO4108 Plant-Environment Interactions (S1)  
5 credits
Plant growth is significantly influenced by the surrounding physical, chemical and biological environment. This module will address the key inter-related concepts of carbon assimilation and sequestration, plant water relations and energy balance components across the soil-plant-atmosphere continuum. The physiological response of plants to respond to a broad range of environmental conditions including abiotic and biotic extreme events will be explored, and the implications for natural and production based systems will be assessed.

BO4109 Vegetation Description and Analysis (S1)  
5 credits
This module will describe how to sample, record and lead up to detailed multivariate analyses to help define vegetation communities. Though some theoretical and historical framework will be given in lectures, the emphasis will be on practical collection, analysis and interpretation of vegetation data. Various data sets will be utilised in computer-based sessions, and field work will be used to generate a novel data set, the analysis and interpretation of which will form part of the continuous assessment for this module.

BO4110: The Evolution of Plants and Plant-Atmosphere Interaction (S2)  
5 credits
We are currently experiencing major changes in our climatic and atmospheric environment. Conservative estimates project that the concentration of greenhouse gas carbon dioxide will double by the end of this century and global temperatures are expected to rise by 1 to 4
degrees C. A major issue facing the scientific and political community is understanding how these projected changes will influence natural ecosystems, plant and animal ecology and biodiversity. This module will explore the evolution of plants in the context of long-term changes in climate and atmospheric composition. Examples of plant-atmosphere and plant-climate interactions in the deep geological past will be examined in addition to modern experimental studies. The course will provide a framework for understanding the nature and scale of evolution, adaptation and ecophysiological responses of plants to their atmospheric and climatic environment over the past 500 million years of Earth history. Continual assessment will be through a programme of tutorials and student reviews of primary research papers linked to lectures.

**ZO4030: Data Handling (S1)**
5 credits
This module will develop hypothesis testing with a revision of t-tests and explore general linear models, using ANOVA, product-moment correlation and regression. Experimental design will also be covered using ANOVA examples. Equivalent non-parametric approaches will be described. The module will go on to cover chi-squared and goodness of fit, and end with a brief introduction to multivariate statistics with a focus on ordination and classification. The module will be delivered by lectures, demonstration and discussion sessions, and by hands on use of various software packages.

**Optional modules**

**BO4111 Restoration Ecology and Re-wilding**
5 credits
Restoration ecology, like conservation biology, is a ‘crisis’ discipline, having emerged as a scientific response to the ecological damage caused by human activities. Re-wilding and novel ecosystems are new, daring and controversial areas within restoration ecology. This module will introduce you to the challenges and opportunities, failings and fallacies of the complex world of restoration ecology and the work of restorationists. It will look at how re-wilding could be the best nature-based solution and how novel ecosystems could be the worst. As the discipline struggles to include social sciences, politics and economics, this module will draw on case studies of restoration globally to will challenge students to rethink ecology and ecosystems in the Anthropocene.

**ZO4017 Tropical Ecology (S1)**
5 credits
This module aims to provide students with a thorough understanding of the principles underpinning the ecology of tropical ecosystems. The module comprises a ten-day residential field course in East Africa that will run during the first two weeks of November. The module will focus on the ecology and biodiversity of a range of ecosystems and habitats (including tropical montaine forest and alpine communities, aquatic ecosystems [freshwater rivers and lakes, wetlands and saline lakes] and grasslands) and the connectivities among them. Issues and problems to do with human impacts and the conservation and management of these diverse habitats will also comprise an important element of the course.

**BO4107 Plant-Animal Interactions (S2)**
5 credits
Plant-animal interactions have increasingly become recognized as drivers of evolutionary change and important components of ecological communities. This module will focus on herbivory (the consumption of plants by animals) and pollination (the transfer of pollen
between male and female reproductive structures in flowers) and explore fundamental theories as well as applied issues surrounding conservation and management.

FB4060 Plant Breeding and Biotechnology (S2)  5 credits
The module covers the principles and practice of plant breeding and biotechnology. Lectures cover key topics such as the origins of agriculture, genetic resources, disease resistance, conventional breeding, modern breeding, genetic engineering, and case studies in breeding and biotechnology. Practicals cover crop diversity, polyploid estimation and at least one site visit to a Teagasc research centre (Oak Park, Carlow and/or Ashtown Dublin)
Botany Moderatorship Learning Outcomes:

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

- Demonstrate in written, oral and visual form a foundation level of knowledge and understanding of the biological, physical and quantitative sciences underpinning Botany.

- Demonstrate awareness, particularly in relation to the contributions that plant science makes to society, such as maintaining biodiversity, assessing the impacts of global change, reducing environmental pollution and ensuring sustainable food and energy production, taking into account scientific, social, political, moral and ethical considerations.

- Articulate the fundamental concepts in plant science.

- Discuss current research developments in plant science.

- Review and criticise published scientific information.

- Carry out research and develop technical competence in order to work accurately, efficiently and safely in the field and in a laboratory using modern research facilities.

- Demonstrate numerical competency and the ability to analyse quantitative data by appropriate statistical tests, using spreadsheets and other software.

- Collaborate effectively in teams and work independently.

- Communicate accurately, clearly, persuasively and imaginatively, in both oral and written form.
Zoology is a broad discipline, encompassing the study of living animals and their relationship with their environment. As the need for an understanding of complex biosystems increases, integration is required across all levels of biological organisation – from molecules to the biosphere – and the diversity of species – from single-celled to multicellular organism. Modern Zoology naturally provides this integration, and our programme offers courses that focus upon important themes of environmental and medical biology. The Zoology Moderatorship is designed, not only to provide specific knowledge about certain areas of animal biology, but also to encourage critical thinking and the development of numeracy and literacy, as well as the exploitation of sources of scientific data. The combination of scientific study with other skills provides an excellent background for a wide range of careers.

The current structure of the moderatorship in Zoology is as follows:

**Junior Sophister:**
The Junior Sophister Programme consists of a series of modules providing a basis in subject-specific and transferable skills. Core modules make up 55 credits, with a broad curriculum module making up the balance.

**Senior Sophister:**
In addition to prescribed modules, students will select areas of specialisation from the range of tutorial and other electives offered, attend research seminars and carry out a research project. The research project will include project planning, seminar and tutorial components, in addition to the final thesis.

**Environmental Science:** A selection of Zoology modules form part of an inter-disciplinary programme in Environmental Science. For further information, see Environmental Science.
Junior Sophister Modules  

<table>
<thead>
<tr>
<th>Core Modules</th>
<th>60 credits</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ZO3000 Marine Biology (Prof. Nessa O'Connor) (S1)</strong></td>
<td>5 credits</td>
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<tr>
<td>This team taught module, which includes a residential field course element in the first week of the Michaelmas Term, will introduce students to aspects of marine biology, together with invertebrate form and function, and provide foundational skills appropriate for the two year Sophister programme in Zoology.</td>
<td></td>
</tr>
</tbody>
</table>

| **ZO3003 Animal Diversity (Prof. Andrew Jackson) (S1)** | 10 credits |
| This team-taught module provides a detailed consideration of the evolution, and comparison of the structure, life cycles and general biology of invertebrate and vertebrate animals. The module is based on lectures, practicals and demonstrations from the Zoological collections. |

| **ZO3010 Fundamentals of Ecology (Prof. Ian Donohue) (S1)** | 5 credits |
| This module is run jointly with the Botany Discipline. The module examines the factors that affect the distribution, growth and survival of plant and animal populations. It describes how organisms may interact with their environment and the role that they have in ecosystem and community structure. |

| **ZO3020 Behavioural Ecology (Prof. Nicola Marples) (S1)** | 5 credits |
| Topics covered include how animals obtain food, avoid predators, breed and communicate. Practical work provides students with experience in studying behaviour in the field, laboratory and the Zoo and in data analysis. It includes work with live animals. |

| **ZO3030 Introduction to Parasitology (Prof. Celia Holland) (S2)** | 5 credits |
| This module covers host-parasite relationships, epidemiology, host behaviour, genetics and immunity. The concept of a parasite community at the infracommunity and component community level is developed. Parasites of human importance receive particular emphasis. |

| **ZO3050 Introduction to Developmental Biology (Prof. Rebecca Rolfe) (S2)** | 5 credits |
| This module emphasises a molecular approach to understanding developmental principles. Topics include developmental genetics, positional determination: how the body plan of the embryo is laid down including the role of homeo-box genes, and induction. |

| **ZO3070 Experimental Design and Analysis (Prof. Celia Holland) (S2)** | 5 credits |
| Students will be taught data collection and sampling and the use of spreadsheets for data entry, experimental design and statistical analysis. It will introduce a powerful and freeware statistics package R. A series of sessions will address the preparation for the Senior Sophister research project (FB4000) and the project proposal. |
ZO3085 Wildlife Biology and Terrestrial Field Ecology (Prof. John Rochford) (S2) 5 credits
This module offers an introduction to the field of Wildlife Biology and a short survey of the Irish Vertebrate Fauna. It will include a spring residential field course at the end of the Hilary Term, with an introduction to field techniques used for the study of terrestrial ecosystems, and an emphasis on population assessment of mammals, insects and birds. Field visits will help with an understanding of contrasting habitats and conservation management.

ZO3090 Desk Study: Zoology and Society (Prof. Pepijn Luijckx) (S2) 5 credits
Student will research, in the scientific literature, synthesise and write an extended essay (4,000 words) on a selected topic of current interest concerning Zoology and Society (sociological, ethical, medical or environmental). The finished product will conform to the general format of a scientific review article.

BO3122 Entomology (Prof. Jane Stout) (S2) 5 credits
There are more species of insects on Earth than any other group of organisms and they are of massive ecological and economic importance. This module will address behavioural, social, ecological and applied aspects of entomology, including their role in delivering ecosystem services (such as biocontrol and pollination), invasive species (such as fire ants and harlequin ladybirds) and conservation (both in Ireland and internationally). The practicals will provide students with the skills for sampling and identification of insects, which will be further enhanced through small group and individual projects.
### Senior Sophister Modules 60 credits

#### Core Modules 40 credits

**FB4000 Research Project (All staff) (S1 & S2)** 20 credits  
Each student will carry out a piece of independent research work under the supervision of an assigned staff member, and present the results in the form of a thesis. This module also includes informal tutorials, research seminars and practical instruction on working with animals.

**ZO4020 General Zoology (All staff) (S1 & S2)** 5 credits  
This module provides an opportunity for students to revise and study, in greater depth, selected topics from the Junior Sophister Zoology programme, including the practical components. Students are expected to integrate their approach to this earlier material with the perspectives and skills they develop during their final year.

**ZO4030 Data Handling (Prof. Andrew Jackson) (S1)** 5 credits  
This module will build on material from the JS Experimental Design and Analysis (ZO3070) module, introducing more advanced statistical methods suitable for direct application in the Research project.

**ZO4060 Research Comprehension (Prof. Andrew Jackson) (S1 & S2)** 5 credits  
This tutorial-based module will provide a broad overview of current advances in ecology, evolution and molecular & comparative physiology. Attendance at 15-20 research seminars delivered by invited speakers who are experts in their field that run throughout semesters 1 and 2 is compulsory. These seminars will be followed by tutorials where the topics covered in the seminar and relevant publications from the speaker will be discussed. The process of conducting research, from initial concept through hypothesis formulation and testing will be discussed along with how to structure scientific presentations and research papers.

### Elective Modules 25 credits

Students select 5 of the 5-credit tutorial modules on offer. Each module will include lectures and student participation in the form of presentations, debates or critiques as appropriate.

**ZO4012 Advances in Parasitology (Prof. Celia Holland) (S2)** 5 credits  
This elective explores the practical challenges of parasitological research on human subjects (e.g. growth, cognitive ability, immunocompetence) and the relative merits of using animal model systems as alternatives.

**ZO4013 Conservation and Wildlife Management (Prof. John Rochford) (S1)** 5 credits  
This module looks at practical applications of wildlife biology to the conservation and management of animals, both in- and ex-situ, including the role of zoos in captive breeding programmes, and the design and management of conservation areas.
ZO4015 Evolution (Prof. Nicola Marples) (S1) 5 credits
This module explores evolutionary concepts in greater detail giving insights into the processes underlying evolution. It covers different types of selection, co-evolution, sociality and altruism among other topics.

ZO4017 Tropical Ecology and Conservation (Prof. Ian Donohue) (S1) 5 credits
This module takes place on a week-long residential field course in East Africa, focussing on the ecology and biodiversity of a range of ecosystems and habitats (including tropical montaine forest, aquatic ecosystems [freshwater rivers and lakes, wetlands and saline lakes] and grasslands) and the connectivities among them. Issues and problems to do with human impacts and the conservation and management of these diverse habitats will also comprise an important element of the module.

ZO4018 Comparative Physiology (Prof. Colleen Farmer) (S1) 5 credits
This module provides a detailed consideration and comparison of the physiological basis for how diverse animals work. It takes a fundamental, biophysical approach to the study of structure and function in animals ranging from simple to complex. It emphasizes evolutionary changes in physiological systems, comparing the similarities and differences found in a range of animals that have adapted to different environments and different lifestyles.

ZO4092 Environmental Impact Assessment (Prof. John Rochford) (S2) 5 credits
This module involves an introduction to the principles and processes of Environmental Impact Assessment, particularly in relation to national and international requirements. All stages of the EIA process, from initial project screening to the final review, are covered, with the emphasis throughout on the role of the natural scientist. Strategic Environmental Assessment is also briefly covered. In addition to the lectures, students carry out a scoping exercise for a proposed development and conduct a quality review of an actual EIS.

BO4107 Plant-Animal Interactions (Prof. Jane Stout & Prof. Yvonne Buckley) (S2) 5 credits
Plant-animal interactions have increasingly become recognized as drivers of evolutionary change and important components of ecological communities. This module will focus on herbivory (the consumption of plants by animals) and pollination (the transfer of pollen between male and female reproductive structures in flowers).

BO4111 Restoration Ecology and Re-wilding (Prof. Marcus Collier) (S2) 5 credits
Restoration ecology, like conservation biology, is a ‘crisis’ discipline, having emerged as a scientific response to the ecological damage caused by human activities. Re-wilding and novel ecosystems are new, daring and controversial areas within restoration ecology. This module will introduce you to the challenges and opportunities, failings and fallacies of the complex world of restoration ecology and the work of restorationists. It will look at how re-wilding could be the best nature-based solution and how novel ecosystems could be the worst. As the discipline struggles to include social sciences, politics and economics, this module will draw on case studies of restoration globally to challenge students to rethink ecology and ecosystems in the Anthropocene.
Zoology Moderatorship Learning Outcomes.

On successful completion of the two-year Sophister programme in Zoology, students will be able to:

- set out the important basic concepts and current research developments in animal biology
- structure the diversity and evolution of the animal kingdom
- appreciate the basis of good experimental design
- demonstrate technical competence in the handling of modern research facilities and operate safely in a laboratory environment, both individually and as a team member
- design sampling programmes and carry out fieldwork using standard procedures
- communicate effectively both orally and in writing
- use word processing, graphical and analytical computer programmes
- critically analyse experimental results (including those obtained personally) and utilize appropriate statistical and other quantitative procedures for data handling
- proficiently search and critically assess scientific literature and databases
- apply a scientific approach to problem solving
- articulate the contribution, including the ethical dimension, made by Zoology to society, in the realms of the environment, agriculture, human behaviour and health.
All students graduate with a degree in Chemistry with Molecular Modelling, which allows access to a wide range of careers in industry, academia and the professions.

**Junior Sophister:**
In the JS year students attend a series of lectures in Physical, Organic, and Inorganic Chemistry, and in Molecular Modelling.

**Mandatory Safety Course:** In order to reinforce and extend the laboratory skills in Chemistry, rising Junior Sophister students are required to attend a day-long workshop on Safety, which is held in Freshers' Week (i.e. the week before lectures start) of Michaelmas Term 2017. Attendance at all workshops is compulsory.

**Assessment and Examination Procedures:**
The lecture material will be examined in module examination papers taken during the Annual examination period. Practical work is assessed in course. Further information relating to the assessed components, composition of written papers and credit weightings will be given in the Junior Sophister Chemistry Booklet (all chemistry courses) issued to rising Junior Sophisters. The JS Chemistry mark will constitute 35% of the final degree mark.
Senior Sophisters:
In SS year, students attend a series of core modules in Physical, Organic and Inorganic Chemistry and Molecular Modelling, four specialised advanced topics, of which two are compulsory, and associated problem-solving sessions/tutorials. In addition, students are required to attend research seminars and undertake a semester long project in a research lab (see below for further details).

Assessment and Examination Procedures:
Core modules and option topics in Inorganic, Organic and Physical Chemistry and Molecular Modelling will be examined during the annual examination period. The Research Project is assessed in course. All modules are weighted according to their respective credit rating. The JS Chemistry mark will constitute 35% of the final Moderatorship mark. Further information relating to the assessed components, composition of written papers and credit weightings will be given in the Senior Sophister Chemistry Booklet (all chemistry courses) issued to rising Senior Sophisters.
Junior Sophister Modules 60 credits

Inorganic Chemistry

CH3103 Organometallics & Coordination Chemistry (S1&S2) 10 credits
This module covers topics such as main group and transition metal organometallics, transition metal compounds and complexes, homogeneous catalysis and inorganic reaction mechanisms. **NOTE:** 50% of the marks for this module are associated with laboratory exercises.

CH3104 Solid State Materials (S2) 5 credits
This module covers topics such as inorganic polymers, structural inorganic chemistry, synthetic methodologies and characterisation techniques of solid state materials.

Organic Chemistry

CH3203 Synthetic Organic Chemistry I (S1&S2) 10 credits
This module gives a basic grounding in the general methodology employed in organic synthesis. Topics covered include organometallic C-C couplings, pericyclic reactions, FMO theory and stereoelectronic effects, and physical organic chemistry. **NOTE:** 50% of the marks for this module are associated with laboratory exercises.

CH3204 Synthetic Organic Chemistry II (S2) 5 credits
This module covers topics such as heterocyclic chemistry, organoheteroatom chemistry, and FGI and retrosynthesis.

Physical Chemistry

CH3303 Quantum Mechanical Concepts (S1) 5 credits
This module deals with quantum mechanics, spectroscopy and group theory.

CH3304 Molecular Thermodynamics and Kinetics (S2) 10 credits
This module deals with thermodynamics and statistical mechanics, electrochemistry and kinetics. **NOTE:** 50% of the marks for this module are associated with laboratory exercises.

Interdisciplinary Modules

CH3403 Analytical Methods (S1) 5 credits
This module deals with both the fundamental principles and application of spectroscopic and other characterisation techniques. Topics such as analytical chemistry, organic spectroscopy and structural methods in inorganic chemistry will be covered.
Molecular Modelling

**CH3601-CH3602 Computational Chemistry (S1 & S2)**  10 credits
This module covers a range of topics in computational molecular quantum chemistry, forcefield-based methods, molecular dynamics and numerical optimization methods, programming and related skills.

*Note: Module codes given are indicative only as they may change as a result of changes to be introduced in compliance with the ‘Trinity Education Project’. Some of the modules indicated may change code or be switched from one semester to the other.*
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CH4XXX Research Project (S1)</td>
<td>This research-oriented module involves a research project and thesis, oral presentation of a research seminar and attendance at scheduled School research seminars.</td>
<td>20</td>
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<tr>
<td>CH4112 Advanced Organic Transformations I (S2)</td>
<td>This module involves core lectures in organic and biological photochemistry and reactive intermediates.</td>
<td>5</td>
</tr>
<tr>
<td>CH4105 Advanced Inorganic Chemistry II (S2)</td>
<td>This module covers core topics in heavy transition metal chemistry and advanced coordination chemistry.</td>
<td>5</td>
</tr>
<tr>
<td>CH4106 Advanced Physical Chemistry I (S2)</td>
<td>This module involves covers core topics in photochemistry, redox active nanostructured materials and systems, and advanced reaction dynamics.</td>
<td>5</td>
</tr>
<tr>
<td>CH4107 Advanced Physical Chemistry II (S2)</td>
<td>This core module involves lectures in quantum chemistry and solid state chemistry</td>
<td>5</td>
</tr>
<tr>
<td>CH4701 Advanced Molecular Modelling I (S1&amp;S2)</td>
<td>In this module students combine self-directed learning with taught material on advanced topics in molecular-modelling in chemistry. The self-directed component concentrates on an integrative review and the attainment of a mature understanding of fundamental topics introduced over the entire period of the Moderatorship programme. The taught component consists of two compulsory topics in quantum chemistry and statistical thermodynamics along with two self-selected advanced topics from the available options (see Senior Sophister course booklet for further details).</td>
<td>10</td>
</tr>
<tr>
<td>CH4702-CH4703 Advanced Molecular Modelling II (S2)</td>
<td>This module covers aspects of computational drug design and more advanced lectures in molecular quantum chemistry, High Performance Computing and advanced molecular dynamics</td>
<td>10</td>
</tr>
</tbody>
</table>

*Note: Module codes given are indicative only as they may change as a result of changes to be introduced in compliance with the ‘Trinity Education Project’. Some of the modules indicated may change code or be switched from one semester to the other.
Chemistry with Molecular Modelling Moderatorship Learning Outcomes

On successful completion of this programme, a student should be able to

- Articulate in written and oral form a foundation level of knowledge and understanding of the biological, physical and quantitative sciences underpinning Chemistry.

- Apply key concepts in the major chemical sub-disciplines of Physical, Inorganic and Organic Chemistry.

- Design, perform, and analyse the results obtained from, experiments in physical, inorganic and organic chemistry, using modern chemical experimental methodology and instrumentation.

- Demonstrate skills in problem solving, critical thinking and analytical reasoning, and be able to effectively communicate the results of their work to chemists and non-chemists both verbally and in writing.

- Use modern library searching and retrieval methods to obtain information pertinent to the identification and solution of chemical problems and the exploration of new research areas.

- Work effectively and safely in a laboratory environment operating within the proper procedures and regulations for safe handling and use of chemicals.

- Demonstrate knowledge of molecular modelling techniques and their implementation.

- Design and perform appropriate theoretical calculations to solve chemical problems and analyse the results.

- Update their knowledge and to undertake further study with a high degree of autonomy.
Human Genetics is a four-year moderatorship degree run by the School of Genetics and Microbiology and located in the Smurfit Institute of Genetics. The degree course encompasses diverse aspects of human genetics including cancer genetics, gene therapy, stem cell biology, neurogenetics, pharmacogenomics (interaction of genetic background on drug response), epigenetics, molecular evolution and developmental genetics. Senior Sophister students undertake a laboratory-based research project providing an opportunity to acquire basic laboratory skills and conduct state-of-the-art research.

**Junior Sophisters:**

The JS year consists of a diverse programme of lectures, laboratory practicals, tutorials and research essays. Additionally, students have an opportunity to select a Broad Curriculum option.

**Assessment and Examination Procedures:**

Most JS modules are examined by six papers in the annual examinations. Some modules, and all practicals, are examined by continuous assessment or by special tests. The Junior Sophister mark is carried over to year 4 and constitutes 20% of the total moderatorship mark.

**Senior Sophisters:**

Human Genetics Senior Sophister students have a choice of a diverse range of lecture modules covering many areas of Human Genetics (see below). Students also write a literature review and undertake a research project in a designated laboratory.

**Assessment and Examination Procedures:**

The moderatorship examination at end of the Senior Sophister year comprises five papers. In three of these papers, the lecture modules are assessed. Additionally there is a problems paper in which the ability of students to solve specific problems one often encounters in genetic research is tested and an essay paper.
Junior Sophister Modules 60 credits

GE3M07 BACTERIAL MOLECULAR BIOLOGY AND GENETICS (S2) 5 credits
This module presents an evidence-based description of the basic cellular processes of transcription, translation and DNA replication in bacteria.

GE3M09 EUKARYOTIC MOLECULAR BIOLOGY & GENETICS (S1) 5 credits
This module introduces the molecular biology and genetics of eukaryotic organisms, including core concepts such as the cell cycle and regulation of gene expression in eukaryotes.

GE3M11 GENOMICS (S1) 5 credits
This module provides an introduction to Genomics and Systems Biology, to Bioinformatics and to key techniques used in Molecular Biology.

GE3M13 NEUROGENETICS AND DROSOPHILA GENETICS (S2) 5 credits
The module will introduce the fundamentals of neuronal development architecture, neuronal excitability and synaptic function, sensory systems, circadian rhythms, perception and learning and their analysis by genetic methods in model organisms such as Drosophila.

GE3M15 MEDICAL GENETICS (S2) 5 credits
The module introduces the genetics of human disease, from simple Mendelian traits to complex multigenic diseases and gene/drug interactions.

GE3M17 EVOLUTION., MUTATION & VARIATION (S1) 5 credits
This module provides an introduction to genetic variation – its origins and its evolutionary consequences.

GE3M21 MOLECULAR GENETICS LABORATORY (S1) 5 credits
This practical class introduces students to standard methods of Molecular Genetics.

GE3M23 ANALYTICAL GENETICS LABORATORY (S2) 5 credits
This practical class introduces students to standard methods of Analytical Genetics.

GE3M25 DATA HANDLING (S1) 5 credits
This module focuses on the handling and analysis of data and includes bioinformatics, computer programming (Perl language) and statistics.

GE3M43 TUTORIAL (HUMAN GENETICS; S1 & S2) 5 credits
This module introduces students to core concepts of Human Genetics. In addition, students are trained in scientific writing and will acquire presentation skills.

GE3M33 REVIEW (HUMAN GENETICS; S1 & S2) 5 credits
Students write a literature review on a specific topic of human genetics and present their work in a short talk.

THE BROAD CURRICULUM 5 credits
Students can freely choose between available Broad Curriculum options
<table>
<thead>
<tr>
<th>Module Title and Courses</th>
<th>Course Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module 1: Human Genetics Core Curriculum I</td>
<td>GE4210</td>
</tr>
<tr>
<td>Genetics &amp; Epigenetics of Cancer</td>
<td>GE4055</td>
</tr>
<tr>
<td>Transgenic Animals and Gene Therapy</td>
<td>GE4037</td>
</tr>
<tr>
<td>Stem Cell Biology</td>
<td>GE4276</td>
</tr>
<tr>
<td>Genetics &amp; Immunology of Neural Diseases</td>
<td>GE4038</td>
</tr>
<tr>
<td>Functions, Mechanisms and Genetics of Prion-Domain Proteins</td>
<td>GE4049</td>
</tr>
<tr>
<td>Module 2: Human Genetics Core Curriculum II</td>
<td>GE4220</td>
</tr>
<tr>
<td>Principles of Genetics</td>
<td>GE4040</td>
</tr>
<tr>
<td>Human Evolutionary Genetics</td>
<td>GE4034</td>
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<tr>
<td>Genetics of Neural Development</td>
<td>GE4053</td>
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<tr>
<td>Behavioural Genetics</td>
<td>GE4054</td>
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<tr>
<td>Molecular Evolution II</td>
<td>GE4025</td>
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<tr>
<td>Module 3: Principles of Human Genetics and General Genetics</td>
<td>GE4230</td>
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<tr>
<td>Principles of Human Genetics</td>
<td>GE4280</td>
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<tr>
<td>Programmed Cell Death</td>
<td>GE4051</td>
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<tr>
<td>Developmental Genetics of Drosophila</td>
<td>GE4032</td>
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<tr>
<td>Microbial Molecular Genetics</td>
<td>GE4029</td>
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</tbody>
</table>

**GE4280** **Principles of Human Genetics (Profs Campbell, Mitchell, Farrar, McLysaght, Bracken, Kavanagh; S1)**

Many underlying principles relating to Human Genetics will be addressed during this module including human population history, mutation and selection, the genetics underlying the inheritance of Mendelian disorders (single gene disorders), the effects of genetic background on phenotype, the inheritance of complex disorders and various methodologies that can be employed to elucidate the genetic pathogenesis of such disorders, the fields of clinical genetics and pharmacogenomics, imprinting and X- chromosome inactivation, the mitochondrial genome, inheritance and mutation, amongst other topics. This comprehensive module component will provide students with an overview of the field and knowledge of many of the fundamental principles of Human Genetics.
GE4040  **Principles of Genetics (Profs Wellmer, Kavanagh, Devine; S1)**
This course introduces and reviews key concepts of genetics and hence conveys fundamental knowledge for all genetics students, including students of Human Genetics. The following topics will be covered: Population Genetics, Inheritance of Complex Traits, Evolution of Genes and Traits, Gene Interactions, Gene Isolation and Manipulation, Genome Structure, DNA replication, RNA transcription and processing, Regulation of gene expression in bacteria and eukaryotes.

GE4055  **Genetic and Epigenetics of Cancer (Prof Bracken; S2)**
The field of Epigenetics studies heritable changes in gene expression or cellular phenotype, caused by mechanisms other than changes in the underlying DNA sequence. This module component will provide an overview of our understanding of Epigenetics from the first studies on the structure of chromatin through to the discovery of the first histone and DNA modification enzymes and explore their mechanisms of action in gene expression control during development, stem cell differentiation and cellular reprogramming. The module component will also explore several exciting new advances, including the human "ENCODE project" and the advent of "Epigenetic drugs" which hold huge promise in medicine and in particular for the treatment of cancer.

GE4037  **Transgenic Animals & Gene Therapy (Prof Farrar; S1)**
The module component explores current developments in the field of transgenic animals and gene therapy. The various methodologies employed to generate transgenic animal models will be outlined together with the use of such animals to explore the biological function of a gene and encoded protein *in vivo*, to simulate human disorders and to test novel therapeutics. Recent advances in the development of gene-based medicines for a variety of inherited disorders will be covered, as will developments in viral and non-viral technologies to optimise gene delivery to target tissues.

GE4276  **Stem Cell Biology (Prof Bracken; S1)**
Stem cells have the remarkable potential to develop into many different cell types in the body during early life and growth and therefore offer huge potential in regenerative medicine. This module component will provide an overview of the development of our understanding of stem cells, through the first isolation of embryonic stem cells and adult stem cells, to the discovery of cancer stem cells and Induced Pluripotent (iPS) stem cells. How our expanding knowledge of stem cells is now being used in the development of new and advanced methods of therapeutic intervention will also form an important part of this module component.
**GE4061  Genetics and Immunology of Neural Diseases (Prof Campbell; S1)**

With no neuron in the brain being more than 12 µm from a capillary, the vascular and nervous systems share common developmental pathways that allows for coordination of nutrients and information transfer. In addition, almost every neurological malignancy involves dysregulation of the blood vessels associated with neural tissues. This module component will provide an overview of the complexities of blood vessel development in the brain and retina. In addition, the module component will focus on several common neurological conditions such as Alzheimer’s disease, describing the underlying genetic causes of the condition and examining the current trends for future research and therapies. The module component will also explore the involvement of blood vessel and immune system dysfunction in conditions such as age-related macular degeneration (AMD) and neuropsychiatric disorders, with a focus on the genetic pre-disposition to such conditions.

**GE4049  Functions, Mechanisms and Genetics of Prion-Domain Proteins (Prof Ramaswami; S1)**

The module component explores the evidence that led to the Prion Hypothesis (1982), that a particular proteinaceous particle, a prion, which contains no detectable nucleic acid, can cause certain kinds of infectious neurological diseases, broadly called the spongiform encephalopathies (SE). The experiments have verified this hypothesis and shown that mutations in the prion gene cause inherited forms of SE, such as CJD. There is good evidence that the pathological form of the prion has a different 3 dimensional structure to the normal cellular form of prion. There is evidence that prion type proteins are found in yeast, and also may have important neurological functions in mammals.

**GE4034  Human Evolutionary Genetics (Prof Bradley; S1)**

Our concepts of human origins and migrations have been profoundly formed by human genetic analysis. The human genome is now the best studied genome for variation in both space and time. The module component follows how genetic insights help us understand: our relationships with the great apes and which are the important genetic changes on the human lineage; the origins of modern humans in Africa and the nature of the migration from there to the rest of the world; the different patterns between male and female lineage inheritance; the interaction between cultural and genetic inheritance patterns. Recent advances in ancient DNA sequencing and archaic human genomes are discussed in detail and a close look at European and even Irish genetic origins are included.

**GE4053  Genetics of Neural Development (Prof Labrador; S2)**

This module is intended for Senior Sophisters with a neuroscience background. Students should have previously attended GE3006 (Neurogenetics) as a prerequisite. The module component covers different aspects of nervous system development from neural induction to early steps of circuitry assembly. There is a focus on different genetic experimental methods employed to identify central mechanisms of nervous system development. We will use different models to explain processes and provide examples of networks and concepts. The emphasis will be on the conservation of signaling pathways in development of very diverse organisms. This will include Drosophila melanogaster and vertebrates Xenopus laevis, Chick and Mouse.
GE4054  Behavioural Genetics (Prof Mitchell; S2)
This module component examines how genetic differences contribute to behavioural differences between individuals in a species. It considers examples from worms, flies, mice and humans. It will also explore how genetics can be used to dissect the biochemical and neural circuitry underlying specific behaviours.

GE4025  Molecular Evolution II (Prof McLysaght; S1)
We know much more now about the structure and evolution of genomes than we did just a few years ago. These lectures explore some of the findings that have come out of very recent research into genome evolution, based on the new area of comparative genomics. Topics include: Mechanisms by which new genes are formed and survive or go extinct; Evolution of gene regulation; the molecular basis of morphological evolution; Evolution of recombination hotspots; how chromosome structures and the order of genes along chromosomes evolve; Does having more genes make an organism more complex?

GE4051  Programmed Cell Death (Prof Martin; S2)
This module component examines the role of apoptosis in development, tissue homeostasis, immunity and disease. We will look at similarities and differences between the cell death ‘machinery’ in a simple nematode (C. elegans), the fruitfly (Drosophila) and mammals. The cell death machinery in mammals will be examined in detail how this is switched on by various stresses and forms of damage (including cancer chemotherapy) will be discussed. Finally, the role of apoptosis in disease and the potential for therapeutic manipulation is explored.

GE4029  Microbial Molecular Genetics (Prof Devine; S1)
This module component focuses on adaptation of bacteria to nutritional and environmental stresses using Bacillus subtilis as a model organism. The history of research in B. subtilis and the features that facilitated its emergence as a model organism are addressed. The use of integrating plasmids and transposons in the genetic analysis of adaptative processes in B. subtilis and their applicability to other bacteria are then discussed. We explore the genetic analysis of competence development at the onset of nutrient limitation in B. subtilis in detail, describing the signal transduction pathway by which the process is controlled and made responsive to cell density and nutrient availability. We discuss instances of bistable bacterial populations, detailing essential features of the genetic switches required to generate bistability and show how these conditions apply to the development of genetic competence. We discuss the structure of biofilms and how expression of their development is regulated. We also discuss the developmental process of sporulation in B. subtilis, showing how gene expression is spatially and temporally regulated during the 8-hour developmental cycle and how the separate sporangium and mother cell compartments communicate to ensure coordinate regulation of the developmental process. Finally we discuss the regulatory network that operates to decide on the response (ie. enzyme production, competence, development, biofilm construction or sporulation) most appropriate to the prevailing conditions.
This module component discusses how the creation of simple gradients of relatively few transcription factors sets up the complex patterns of gene expression that create a cell fate ‘map’ within the developing fly embryo. We will look at sets of genes (called segmentation genes) whose expression switches on master regulatory genes (Hox genes) that dictate whether an individual fly segment will carry a wing, a bristle, or an antenna. This is a fascinating topic that discusses work leading to the award of the 1995 Nobel Prize in Medicine/Physiology to Christiane Nusslein-Volhard and Eric Weischaus.
Human Genetics Moderatorship Learning Outcomes

Upon successful completion of this programme, students will be able to:

• Demonstrate in written and oral form a foundation level of knowledge and understanding of the biological, physical and quantitative sciences underpinning human genetics.

• Demonstrate in written and oral form an advanced level of knowledge and understanding of the principles of human genetics, and the evidence upon which they have been established, including
  o The nature of biological inheritance
  o The genetic basis of evolution and population variation
  o The molecular, cellular and physiological basis of human genetics
  o The role of genetics in rare and common disease
  o The study of genetics in model organisms
  o Relevant mathematical, statistical and computational methods

• Demonstrate in written and oral form a detailed, critical knowledge and understanding, supported by the use of advanced textbooks, journal articles and data sets, of one or more specialist areas, some of it at the current boundaries of the field.

• Apply the knowledge and understanding gained to the critical analysis of experimental data, to sustaining evidence-based arguments on genetic hypotheses, to solving genetic problems and to designing and conducting genetic experiments.

• Pursue with a degree of independence an original genetics research project including project planning; identification, appraisal and safe application of the appropriate experimental techniques; accurate recording and presentation of data; identification of the limitations of and sources of error in experiments; analysis and interpretation of complex data; formulation of logical conclusions; and appraisal of the project outcome in the context of related, published work.
o Demonstrate proficiency in the application of computers to such problems as the searching of literature databases, analysis of biological sequence data and analysis of experimentally acquired data.

o Demonstrate recognition of the methods and value of scientific inquiry and an understanding of the ethical responsibilities of scientists.

o Demonstrate the capacity to apply international standards and practices within the discipline.

o Act effectively, under the guidance of senior scientists as necessary, as an individual, as part of a team, and/or in a multidisciplinary environment.

o Communicate information and ideas at a high level to both specialist and non-specialist audiences.

o Show that they have acquired the learning skills necessary to update their knowledge and to undertake further study with a high degree of autonomy.
Medicinal Chemistry is the area of chemistry that bridges chemistry, pharmacy and medicine and specialises in drug discovery, development and translational chemistry. The specialisation really begins in the Sophister years, building upon the fundamental principles covered in the Fresher years. From a chemistry perspective the main focus is on both Organic and Medicinal Chemistry, however, courses are also presented by colleagues from Schools such as Biochemistry, Pharmacy and Microbiology. Graduates will receive a degree in Medicinal Chemistry, which allows access to a wide range of careers in industry, academia and the professions.

**Junior Sophisters:**
The JS year consists of 60 credits.
The modules and practical classes are indicated in greater detail below.

**Mandatory Modules:** In order to reinforce and extend the student’s laboratory skills in Chemistry, rising Junior Sophister students are required to attend a day-long workshop on safety to be held in Freshers' Week (i.e. the week before lectures start) of Michaelmas Term. Attendance at all workshops is compulsory.

**Assessment and Examination Procedures:** The lecture material in Medicinal Chemistry will be examined by written exam. Practical work is assessed in-course. Further information relating to the assessed components, organisation of written papers and credit weightings will be given in the Junior Sophister Chemistry Booklet issued to rising Junior Sophisters.

**Senior Sophisters:**
The SS year consists of 60 credits. In addition to the core modules, students are required to attend research seminars and undertake a semester-long project in a research lab (see below for further details).

**Assessment and Examination Procedures:** The lecture modules will be examined by written exam and the Research Project will be assessed in course. The SS Medicinal Chemistry mark will constitute 65% of the final Moderatorship mark. Further information relating to the
assessed components, composition of written papers and credit weightings will be given in the Senior Sophister Chemistry Booklet issued to rising Senior Sophisters.
Junior Sophister Modules

Organic Chemistry

CH3203 Synthetic Organic Chemistry I (S1&S2) 10 credits
This module gives a basic grounding in the general methodology employed in organic synthesis. Topics covered include organometallic C-C couplings, pericyclic reactions, FMO theory & stereoelectronic effects and physical organic chemistry. **NOTE:** 50% of the marks for this module are associated with laboratory exercises.

CH3204 Synthetic Organic Chemistry II (S2) 5 credits
This module covers topics such as heterocyclic chemistry, organoheteroatom chemistry and FGI & retrosynthesis.

Medicinal Chemistry

CH3441 Medicinal Chemistry (S2) 5 credits
This module includes an introduction to medicinal chemistry, anti-viral and anti-cancer chemistry and the computational method QSAR.

CH3446 Microbiology and Medicinal Chemistry (S2) 5 credits
This module covers antimicrobial agents, anti-infective agents, antimalarial chemistry and aspects of industrial chemistry.

CH3447 Biochemistry and Pharmacology (S1) 5 credits
This module covers protein structure and chemistry, steroid drugs, receptor pharmacology and the autonomic nervous system.

Inorganic Chemistry

CH3103 Organometallics & Coordination Chemistry (S1&S2) 10 credits
This module covers topics such as main group and transition metal organometallics, transition metal compounds and complexes, homogeneous catalysis and inorganic reaction mechanisms. **NOTE:** 50% of the marks for this module are associated with laboratory exercises.

Physical Chemistry

CH3304 Molecular Thermodynamics and Kinetics (S2) 10 credits
This module deals with thermodynamics and statistical mechanics, electrochemistry and kinetics. **NOTE:** 50% of the marks for this module are associated with laboratory exercises.

Interdisciplinary Modules

CH3403 Analytical Methods (S1) 5 credits
This module deals with both the fundamental principles and application of spectroscopic and other characterization techniques. Topics such as analytical chemistry, organic spectroscopy and structural methods in inorganic chemistry will be covered.

CH3404 Biomaterials and Macromolecules (S2) 5 credits
This module will cover bioorganic chemistry and natural products, bioinorganic chemistry, colloids and other soft-matter systems.
*Note: Module codes given are indicative only as they may change as a result of changes to be introduced in compliance with the ‘Trinity Education Project’. Some of the modules indicated may change code or be switched from one semester to the other.
Senior Sophister Courses

CH4XXX Research Project (S1)  
This research-oriented module involves a semester-long research project and thesis (either in TCD or with one of our collaborating universities), oral presentation and viva of the research project and attendance at scheduled School and TRI research seminars.

CH4112 Advanced Organic Chemistry I (S2)  
This module involves core lectures in asymmetric synthesis and retrosynthesis.

CH4113 Advanced Organic Chemistry II (S2)  
This module involves core lectures in organic and biological photochemistry and reactive intermediates.

CH4401-02 Advanced Medicinal Chemistry (S2)  
This module involves the chemistry, biochemistry and drugs associated with the central nervous system, computational medicinal chemistry and analytical methods.

CH4403-04 Advanced Medicinal Chemistry (S2)  
This module involves site-specific drug delivery and combinatorial chemistry, biochemistry and drugs associated with the cardiovascular system, and specialised case studies.

CH4405 Advanced Medicinal Chemistry (S1 & S2)  
In this module students combine self-directed learning with taught material on advanced topics in medicinal chemistry. The self-directed component concentrates on an integrative review and the attainment of a mature understanding of fundamental chemical topics introduced over the entire period of the Moderatorship programme. The taught component consists of advanced synthetic organic chemistry, chemical biology, supramolecular chemistry and the chemistry of DNA–drug interactions. See Senior Sophister Course Booklet for further details.

*Note: Module codes given are indicative only as they may change as a result of changes to be introduced in compliance with the ‘Trinity Education Project’. Some of the modules indicated may change code or be switched from one semester to the other.
Medicinal Chemistry Moderatorship Learning Outcomes

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

- Articulate in written and oral form a foundation level of knowledge and understanding of the medicinal, biological, physical and quantitative sciences underpinning Medicinal Chemistry.

- Apply key concepts in the major chemical sub-disciplines of Physical, Inorganic and Organic Chemistry with particular reference to Medicinal Chemistry.

- Design, perform, and analyse the results obtained from experiments in physical, inorganic and organic chemistry, using modern chemical experimental methodology and instrumentation.

- Demonstrate skills in problem solving, critical thinking and analytical reasoning, and be able to effectively communicate the results of their work to chemists, biologists and others both verbally and in writing.

- Use modern library searching and retrieval methods to obtain information pertinent to the identification and solution of chemical problems and the exploration of new research areas.

- Work effectively and safely in a laboratory environment operating within the proper procedures and regulations for safe handling and use of chemicals and instrumentation.

- Demonstrate knowledge of medicinal chemistry techniques and their implementation.

- Combine accrued knowledge to design and prepare drugs.

- Update their knowledge and to undertake further study with a high degree of autonomy.
Nanoscience, Physics & Chemistry of Advanced Materials is a moderatorship taught jointly by the Schools of Physics and Chemistry. Building on the foundation courses taken in the Fresher years, students follow in-depth courses across the spectrum of modern physics, physical chemistry, materials science and nanoscience.

**Junior Sophister:**
The JS year consists of lectures, tutorials and practicals delivered in modules, as listed below. Students receive training in communication skills within the practical module.

**Safety:** To reinforce and extend laboratory skills rising Junior Sophister students are required to attend a day-long workshop on Chemical and Laboratory Safety to be held in Freshers' Week (i.e. the week before lectures start) of Michaelmas Term. Attendance at this workshop is compulsory.

**Mandatory Modules:** All modules specified below are mandatory.

**Assessment and Examination Procedures:** Modules may be assessed by end-of-semester examination and/or continuous assessment. Further information relating to the assessed components and composition of written papers will be given in the Junior Sophister NPCAM Booklets issued to rising Junior Sophisters. JS marks contribute 35% of the final degree Moderatorship mark.
**Senior Sophisters:**
The SS year consists of lectures, tutorials and a research project delivered in modules, as listed below. The independent research project is pursed during the first semester in an internationally recognised laboratory that specialises in aspects of nanoscience, physics, chemistry or advanced materials, which may be a facility off-campus. Projects external to Trinity College are either hosted by cognate universities or research institutes. Projects are also hosted by the Schools of Chemistry and Physics and by CRANN.

**Mandatory Modules:** All modules are mandatory.

**Assessment and Examination Procedures:**
Modules may be assessed by end-of-semester examination and/or continuous assessment. Further information relating to the assessed components and composition of written papers will be given in the Senior Sophister NPCAM Booklets issued to rising Senior Sophisters. Assessment of the full-time research project will be performed in Semester 2. Problem Solving in Nanoscience will be examined at the end of Semester 1. SS marks contribute 65% of the final degree Moderatorship mark.
## Junior Sophister Modules*  
60 credits

<table>
<thead>
<tr>
<th>Module Code</th>
<th>Module Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>PY3P01</td>
<td>Quantum Mechanics I (S1)</td>
<td>5 credits</td>
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<tr>
<td></td>
<td>This module covers solution of the Schrödinger Equation in specific topics, such as angular momentum and the hydrogen atom.</td>
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<tr>
<td>PY3P02</td>
<td>Electromagnetic Interactions I (S2)</td>
<td>5 credits</td>
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<tr>
<td></td>
<td>This module covers the fundamentals of electromagnetic theory together with quantum optics and lasers.</td>
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<tr>
<td>PY3P03</td>
<td>Condensed Matter I (S1)</td>
<td>5 credits</td>
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<tr>
<td></td>
<td>This module introduces condensed matter concepts such as crystal structure and thermal and electronic properties of matter.</td>
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<tr>
<td>PY3P04</td>
<td>Condensed Matter II (S2)</td>
<td>5 credits</td>
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<tr>
<td></td>
<td>This module extends the discussion of condensed matter into the key areas of magnetic properties and the physics of semiconductors.</td>
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<tr>
<td>CH3104</td>
<td>Solid State Materials (S2)</td>
<td>5 credits</td>
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<tr>
<td></td>
<td>This module covers topics such as inorganic polymers, structural inorganic chemistry, synthetic methodologies and characterisation techniques of solid state materials.</td>
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<tr>
<td>CH3303</td>
<td>Quantum Mechanical Concepts in Physical Chemistry (S1)</td>
<td>5 credits</td>
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<tr>
<td></td>
<td>This module deals with quantum mechanics, spectroscopy and group theory.</td>
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<tr>
<td>CH3305</td>
<td>Molecular Thermodynamics and Kinetics (S2)</td>
<td>5 credits</td>
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<tr>
<td></td>
<td>This module deals with thermodynamics and statistical mechanics, electrochemistry and kinetics.</td>
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<tr>
<td>CH3403</td>
<td>Analytical Methods (S1)</td>
<td>5 credits</td>
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<tr>
<td></td>
<td>This module deals with both the fundamental principles and application of spectroscopic and other characterisation techniques. Topics such as analytical chemistry, organic spectroscopy and structural methods in inorganic chemistry will be covered.</td>
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<tr>
<td>CH3093</td>
<td>Practical in Advanced Materials (S1 &amp; S2)</td>
<td>20 credits</td>
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<tr>
<td></td>
<td>In this module students complete a number of advanced experiments in Physics, Chemistry and Materials Science. Minor components include training in communication skills, personal and career development and attendance at School Seminars.</td>
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</tr>
</tbody>
</table>

*Note  
Module codes given are indicative only as they may change as a result of changes to be introduced in compliance with the ‘Trinity Education Project’. Some of the modules indicated may be merged to form larger modules.
Senior Sophister Modules*  60 credits

PY4P03-4P04 Condensed Matter III and Nanoscience (S2)  10 credits
This module covers metal physics and superconductivity together with semiconductor devices, the modified properties of nanoscale matter, its fabrication and potential applications.

PY4P06 Modern Optics (S2)  5 credits
This module covers optical properties of materials and nonlinear optics.

PY4N07 Advanced Topics for Nanoscience (S2)  5 credits
This module consists of specialist courses in polymer physics, thin films, and diffraction, imaging, and spectroscopy of nanostructure.

CH4106-4107 Advanced Physical Chemistry (S2)  10 credits
This core module involves lectures in quantum chemistry and solid state chemistry. It encompasses units on quantum chemistry and solid state.

CH4601 Materials Chemistry 1 (S2)  5 credits
This module involves courses in matter transfer and computational techniques. It encompasses units on Matter Transport in Solids and an introduction to static and dynamic atomistic simulation.

PY4NP2 Nanoscience Research Project (S1)  20 credits
This module consists of a 9-week independent research project. The project is pursued in an internationally recognised laboratory that specialises in aspects of nanoscience, advanced materials or semiconductor processing.

PY4NP5 Problem Solving in Nanoscience (S1)  5 credits
This module involves general problem-solving and scientific comprehension in nanoscience, advanced materials or semiconductor processing. Students also attend a selection of seminars in both the Schools of Chemistry and Physics.

*Note
Module codes given are indicative only as they may change as a result of changes to be introduced in compliance with the ‘Trinity Education Project’. Some of the modules indicated may be merged to form larger modules.
Nanoscience, Physics & Chemistry of Advanced Materials Moderatorship

Learning Outcomes

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

• Articulate in written and oral form a foundation level of knowledge and understanding of Physics, Chemistry and Mathematics.

• Apply key concepts in Physics and Chemistry and key concepts in the Physics and Chemistry of Materials.

• Design, perform, and analyse the results obtained from experiments in materials physics and chemistry, using modern physical and chemical experimental methodologies and instrumentation, with particular reference to materials.

• Demonstrate skills in problem-solving, critical thinking and analytical reasoning, and be able to effectively communicate the results of their work to chemists, physicists, material scientists and others, both verbally and in writing.

• Use modern library searching and retrieval methods to obtain information pertinent to the identification and solution of problems in the physics and chemistry of materials, and the exploration of new research areas.

• Work effectively and safely in a laboratory environment operating within the proper procedures and regulations for safe handling and use of chemicals and instruments.

• Design and perform appropriate experiments to address materials physics and chemistry problems, and analyse the results.

• Update their knowledge and be able to undertake further study with a high degree of autonomy.
This handbook applies to all students taking TR071 Science. It provides a guide to what is expected of you on this programme, and the academic and personal support available to you. Please retain for future reference.

The information provided in this handbook is accurate at time of preparation. Any necessary revisions will be notified to students via email and the Science Course Office website (http://www.tcd.ie/Science). Please note that, in the event of any conflict or inconsistency between the General Regulations published in the University Calendar and information contained in course handbooks, the provisions of the General Regulations will prevail.

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