FACULTY OF ENGINEERING, MATHEMATICS & SCIENCE

Science
Sophister Course Programme

2019/2020

Science Course Office
www.tcd.ie/science
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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Trinity College Dublin,
the University of Dublin
Tel: +353 1 896 1970/896 2022
Web Address: http://www.tcd.ie/Science/

Edited by: Anne O’Reilly and Agnes Gogan
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
Trinity Electives 8
Changing Courses 8
Non-Satisfactory Attendance and Course Work 8
Junior Sophister Examinations 9
Dates to Note 10

TR071
BIOCHEMISTRY 11
BOTANY 16
CHEMISTRY 24
ENVIRONMENTAL SCIENCE 29
GENETICS 38
GEOGRAPHY 46
GEOLOGY 53
IMMUNOLOGY 59
MICROBIOLOGY 64
MOLECULAR MEDICINE 71
NEUROSCIENCE 76
PHYSICS 81
PHYSICS and ASTROPHYSICS 86
PHYSIOLOGY 91
ZOOLOGY 97

TR074 Chemistry with Molecular Modelling 103
TR073 Human Genetics 109
TR075 Medicinal Chemistry 117
TR076 Nanoscience, Physics and Chemistry of Advanced Materials 123
Graduate Attributes 128

Appendix I General Information 129
The purpose of this booklet is to provide you with information on courses that will be available to you in the Sophister (3rd and 4th) years in Science. For those of you who entered the Science programme (TR071), you now have to decide 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 Freshman years. I recommend that you read this booklet carefully before making your final decision. When you do this, you will see that the Science course offers you a very broad choice, allowing you to become an expert in one of a wide range of Moderatorship subjects. Please ask Course Advisers (listed on page 4) for further information on subjects that interest you.

Potential applicants are welcome to visit the Science Course Office to discuss personal needs and any potential problems. We are keen to provide you with all the information you require to make an informed choice and, to help you with this, we invite you to the Moderatorship Fair on Friday 29th March 2019. 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) where you will have a chance to find out more about the different Moderatorships by speaking to Course Advisers.

An important feature of our Sophister Course Programme is the option to take a Trinity Elective. Trinity Electives are stand-alone, College-wide modules that give you an opportunity to broaden your knowledge outside of your chosen Moderatorship subject. There is a wide range of choice available to you and a list of the modules can be found at this link (https://www.tcd.ie/TEP/trinity_electives.php). 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 Áine Kelly
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 Moderatorships 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 Freshman 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 science@tcd.ie.

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

1. All students passing their Senior Freshman semester one and semester two 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 Senior Freshman examinations must reapply for the remaining unfilled places until quotas are reached. Second round choice of subject forms will be made available on-line (http://www.tcd.ie/Science/current/sophister/js-moderatorship-form.php) following publication of the Senior Freshman examination results.
4. The closing date for the online second round form is Friday 2\textsuperscript{nd} August 2019.

5. 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.

6. Examination results will be available on your personal portal at my.tcd.ie.

7. Publication of the JS places will be available through my.tcd.ie portal by the beginning of July 2019.

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

9. 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).

10. 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.

11. Students who fail their Junior Sophister examinations will be treated ex-quota in relation to that discipline.

12. Students who are given permission by the Senior Lecturer to defer their examinations until the reassessment examination session can defer a place in their first preference only. Following publication of the reassessment examinations, students who passed Senior Freshman examinations at the reassessment 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 first-round allocation.

\textbf{Special note: Students who have passed their Senior Freshman examinations may not repeat the SF year in order to improve their performance.}
The choice of subject form is available online: https://www.tcd.ie/Science/TR071-Direct-Entries/sophister/js-moderatorship-form.php. The closing date is 12th April 2019. Failure to meet this deadline will disadvantage you in relation to your choice of department.
<table>
<thead>
<tr>
<th>Course Advisers</th>
<th>Name</th>
<th>Email</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biochemistry</td>
<td>Prof D. Nolan</td>
<td><a href="mailto:denolan@tcd.ie">denolan@tcd.ie</a></td>
</tr>
<tr>
<td></td>
<td>Prof D Zisterer</td>
<td><a href="mailto:dzisterer@tcd.ie">dzisterer@tcd.ie</a></td>
</tr>
<tr>
<td>Botany</td>
<td>Prof. M Williams</td>
<td><a href="mailto:willimsm@tcd.ie">willimsm@tcd.ie</a></td>
</tr>
<tr>
<td>Chemistry</td>
<td>Prof M Southern</td>
<td><a href="mailto:southerj@tcd.ie">southerj@tcd.ie</a></td>
</tr>
<tr>
<td>Chemistry with Molecular Modelling</td>
<td>Prof G. Watson</td>
<td><a href="mailto:watsong@tcd.ie">watsong@tcd.ie</a></td>
</tr>
<tr>
<td>Environmental Sciences</td>
<td>Prof M. Saunders</td>
<td><a href="mailto:saundem@tcd.ie">saundem@tcd.ie</a></td>
</tr>
<tr>
<td>Genetics</td>
<td>Prof T. Kavanagh</td>
<td><a href="mailto:TKVANAGH@tcd.ie">TKVANAGH@tcd.ie</a></td>
</tr>
<tr>
<td>Geography</td>
<td>Prof R. Edwards</td>
<td><a href="mailto:robin.edwards@tcd.ie">robin.edwards@tcd.ie</a></td>
</tr>
<tr>
<td>Geology</td>
<td>Prof R. Edwards</td>
<td><a href="mailto:robin.edwards@tcd.ie">robin.edwards@tcd.ie</a></td>
</tr>
<tr>
<td>Immunology</td>
<td>Prof C. Gardiner</td>
<td><a href="mailto:clair.gardiner@tcd.ie">clair.gardiner@tcd.ie</a></td>
</tr>
<tr>
<td></td>
<td>Prof F Sheedy</td>
<td><a href="mailto:fsheedy@tcd.ie">fsheedy@tcd.ie</a></td>
</tr>
<tr>
<td>Human Genetics</td>
<td>Prof J. Farrar</td>
<td><a href="mailto:gjfarrar@tcd.ie">gjfarrar@tcd.ie</a></td>
</tr>
<tr>
<td>Medicinal Chemistry</td>
<td>Prof M. Senge</td>
<td><a href="mailto:mathias.senge@tcd.ie">mathias.senge@tcd.ie</a></td>
</tr>
<tr>
<td>Microbiology</td>
<td>Prof J. Geoghegan</td>
<td><a href="mailto:geoghegj@tcd.ie">geoghegj@tcd.ie</a></td>
</tr>
<tr>
<td>Molecular Medicine</td>
<td>Prof J. Murray</td>
<td><a href="mailto:james.murray@tcd.ie">james.murray@tcd.ie</a></td>
</tr>
<tr>
<td></td>
<td>Prof A. Dunne</td>
<td><a href="mailto:aidunne@tcd.ie">aidunne@tcd.ie</a></td>
</tr>
<tr>
<td>Neuroscience</td>
<td>Eva Jimenez-Mateos</td>
<td><a href="mailto:JIMENEZE@tcd.ie">JIMENEZE@tcd.ie</a></td>
</tr>
<tr>
<td></td>
<td>Prof C Cunningham</td>
<td><a href="mailto:cunninco@tcd.ie">cunninco@tcd.ie</a></td>
</tr>
<tr>
<td>Physics</td>
<td>Prof P. Eastham</td>
<td><a href="mailto:easthamp@tcd.ie">easthamp@tcd.ie</a></td>
</tr>
<tr>
<td>Physics and Astrophysics</td>
<td>Prof J. Groh</td>
<td><a href="mailto:grohj@tcd.ie">grohj@tcd.ie</a></td>
</tr>
<tr>
<td>Nanoscience, Physics and Chemistry of Advanced Materials</td>
<td>Prof H. Zhang</td>
<td><a href="mailto:hozhang@tcd.ie">hozhang@tcd.ie</a></td>
</tr>
<tr>
<td>Physiology</td>
<td>Prof A. Witney</td>
<td><a href="mailto:awitney@tcd.ie">awitney@tcd.ie</a></td>
</tr>
<tr>
<td>Zoology</td>
<td>Prof A. Jackson</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 Freshman years and must have taken the stated prerequisite modules (see page 6) 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:

1. Approval by the relevant School/Discipline.
2. 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>
<thead>
<tr>
<th>Moderatorship</th>
<th>Quotas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biochemistry</td>
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<tr>
<td>Botany</td>
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<tr>
<td>Chemistry</td>
<td>28</td>
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<tr>
<td>Environmental Sciences</td>
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<td>Genetics</td>
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<td>Geography</td>
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<td>Geology</td>
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<td>Immunology</td>
<td>20</td>
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<td>Microbiology</td>
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<td>Molecular Medicine</td>
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<td>Neuroscience</td>
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<td>Physics</td>
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<tr>
<td>Physics and Astrophysics</td>
<td>20</td>
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<tr>
<td>Physiology</td>
<td>18</td>
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<tr>
<td>Zoology</td>
<td>36</td>
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## Table of Prerequisites for Moderatorship 2019

<table>
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<tr>
<th>Moderatorship</th>
<th>Senior Freshman</th>
<th>Junior Freshman</th>
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<tbody>
<tr>
<td>Biochemistry¹</td>
<td>BYU22001, BYU22003, BYU22005, BYU22008</td>
<td>CH1101, CH1102, &amp; MA1S11 or MA1M01</td>
</tr>
<tr>
<td>Botany</td>
<td>4 of the following: BYU22001, BYU22002, BYU22003, BYU22004, BYU22005, BYU22006, BYU22007, BYU22008, BYU22009, BYU22010</td>
<td>BY1101 or BY1102</td>
</tr>
<tr>
<td>Chemistry</td>
<td>CHU22201, CHU22202</td>
<td>CH1101, CH1102, &amp; MA1S11 or MA1M01</td>
</tr>
<tr>
<td>Environmental Sciences</td>
<td>4 of the following: BYU22001, BYU22002, BYU22003, BYU22004, BYU22005, BYU22006, BYU22007, BYU22008, BYU22009, BYU22010</td>
<td>BY1101, BY1102</td>
</tr>
<tr>
<td>Genetics</td>
<td>BYU22001, BYU22003, BYU22005, BYU22008</td>
<td>BY1101, CH1101, CH1102, &amp; MA1S11 or MA1M01</td>
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<tr>
<td>Geography</td>
<td>GGU22924, GGU22925</td>
<td>GG1024 and/or GG1025</td>
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<tr>
<td>Geology</td>
<td>GLU22905, GLU22906</td>
<td>GL1101</td>
</tr>
<tr>
<td>Immunology¹</td>
<td>BYU22001, BYU22003, BYU22005, BYU22008</td>
<td>CH1101, CH1102, &amp; MA1S11 or MA1M01</td>
</tr>
<tr>
<td>Microbiology</td>
<td>BYU22001, BYU22003, BYU22005, BYU22008</td>
<td>BY1101, CH1101, CH1102, &amp; MA1S11 or MA1M01</td>
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<tr>
<td>Molecular Medicine¹</td>
<td>BYU22001, BYU22003, BYU22005, BYU22008</td>
<td>CH1101, CH1102, &amp; MA1S11 or MA1M01</td>
</tr>
<tr>
<td>Neuroscience¹</td>
<td>BYU22001, BYU22002, BYU22003, BYU22008</td>
<td>CH1101, CH1102, &amp; MA1S11 or MA1M01</td>
</tr>
<tr>
<td>Physics</td>
<td>PYU2P10, PYU2P20, MAU22S01, MAU22S02, MAU22S03, MAU22S04</td>
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<tr>
<td>Physics and Astrophysics</td>
<td>PYU2P10, PYU2P20, MAU22S01, MAU22S02, MAU22S03, MAU22S04</td>
<td>PY1P10, PY1P20, MA1S11, MA1S12</td>
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<tr>
<td>Physiology²</td>
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<td>MA1S11 or MA1M01</td>
</tr>
<tr>
<td>Zoology</td>
<td>BYU22001, BYU22002, BYU22003, BYU22008</td>
<td>BY1101, BY1102, &amp; MA1S11 or MA1M01</td>
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¹Junior Freshman Biology 1101 is advisable
²Junior Freshman Biology 1101 and 1102 are advisable
### Junior Freshman Modules 2017/18

<table>
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<th>Module</th>
<th>Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>BY1101</td>
<td>Molecular and Cellular Biology</td>
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<tr>
<td>BY1102</td>
<td>Evolution, Biodiversity &amp; the Environment</td>
<td>10</td>
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<tr>
<td>CH1101</td>
<td>General and Physical Chemistry</td>
<td>10</td>
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<tr>
<td>CH1102</td>
<td>Introduction to Systematic, Inorganic and Organic Chemistry</td>
<td>10</td>
</tr>
<tr>
<td>GG1024</td>
<td>Introduction to Geography I: Physical Geography and Earth System Science</td>
<td>10</td>
</tr>
<tr>
<td>GG1025</td>
<td>Introduction to Geography II: Environmental Geography</td>
<td>10</td>
</tr>
<tr>
<td>GL1101</td>
<td>Geology</td>
<td>10</td>
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<tr>
<td>MA1S11</td>
<td>Mathematics – Semester 1</td>
<td>10</td>
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<tr>
<td>MA1S12</td>
<td>Mathematics – Semester 2</td>
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<tr>
<td>MA1M01</td>
<td>Mathematical Methods</td>
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</tr>
<tr>
<td>PY1P10</td>
<td>Physics – Semester 1</td>
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<tr>
<td>PY1P20</td>
<td>Physics – Semester 2</td>
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<tr>
<td>PY1F01</td>
<td>Foundation Physics for Life and Earth Sciences</td>
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### Senior Freshman Modules 2018/19

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<tbody>
<tr>
<td>BYU2201</td>
<td>Cell Structure and Function</td>
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<tr>
<td>BYU2202</td>
<td>Vertebrate Form and Function</td>
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</tr>
<tr>
<td>BYU2203</td>
<td>Metabolism</td>
<td>5</td>
</tr>
<tr>
<td>BYU2204</td>
<td>Evolution</td>
<td>5</td>
</tr>
<tr>
<td>BYU2205</td>
<td>Microbiology</td>
<td>5</td>
</tr>
<tr>
<td>BYU2206</td>
<td>Ecosystem Biology and Global Change</td>
<td>5</td>
</tr>
<tr>
<td>BYU2207</td>
<td>Behaviour</td>
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</tr>
<tr>
<td>BYU2208</td>
<td>Genetics</td>
<td>5</td>
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<tr>
<td>BYU2209</td>
<td>Infection and Immunity</td>
<td>5</td>
</tr>
<tr>
<td>BYU2210</td>
<td>Agriculture, Environment and Biotechnology</td>
<td>5</td>
</tr>
<tr>
<td>CHU2201</td>
<td>Chemistry 1</td>
<td>10</td>
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<tr>
<td>CHU2202</td>
<td>Chemistry 2</td>
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<tr>
<td>GGU2294</td>
<td>Physical Geography: Changing Environments</td>
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<td>GGU2295</td>
<td>Human Geography: Changing Worlds</td>
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<tr>
<td>GLU22905</td>
<td>The Dynamic Earth 1: rocks and evolution</td>
<td>10</td>
</tr>
<tr>
<td>GLU22906</td>
<td>The Dynamic Earth 2: structure and microscopy</td>
<td>10</td>
</tr>
<tr>
<td>MAU22S01</td>
<td>Multivariable calculus for Science</td>
<td>5</td>
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<td>MAU22S02</td>
<td>Vector calculus for Science</td>
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<tr>
<td>MAU22S03</td>
<td>Fourier analysis for Science</td>
<td>5</td>
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<td>MAU22S04</td>
<td>Mechanics</td>
<td>5</td>
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<tr>
<td>MAU22S06</td>
<td>Numerical and data analysis techniques</td>
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<td>PYU22P10</td>
<td>Classical Physics</td>
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<tr>
<td>PYU22P20</td>
<td>Modern Physics</td>
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</tbody>
</table>
Trinity Electives

Trinity Electives are stand alone, College-wide 5ECTS modules. They cover a broad range of topics in the arts, humanities, social sciences, sciences and technology. They are designed to allow students to study topics outside of their core discipline and thus to develop breadth within their education. TR071 students have the opportunity to take one Trinity Elective in Junior Sophister year. Choice is student driven and the selection will be made through online enrolment which will open in early April 2019.

The Trinity Electives website provides full details of each of the Trinity Electives. A list of the Trinity Electives that will be available can be found at https://www.tcd.ie/TEP/trinity_electives.php.

Changing Course

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

Repetition of the Junior Sophister year in 2020/2021

Science TR071 students please note that in event of failure at 2019/20 examinations, students who are permitted to repeat the Junior Sophister year in full will be required to repeat in one of the four new science streams as appropriate:
 TR060: Biological & Biomedical Sciences - https://www.tcd.ie/Science/Study-Science/TR060/
 TR061: Chemical Sciences https://www.tcd.ie/Science/streams/TR061/
 TR062: Geography and Geosciences: https://www.tcd.ie/Science/streams/TR062/
 TR063: Physical Sciences https://www.tcd.ie/Science/streams/TR063/

Non-Satisfactory Attendance and Course Work

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

At the end of the teaching term, students who have not satisfied the school or department requirements, may be reported as non-satisfactory for that term. Students reported as non-satisfactory for the Michaelmas and Hilary terms of a given year may be refused permission to take their semester two assessment/examinations and may be required by the Senior Lecturer to repeat their year (https://www.tcd.ie/undergraduate-studies/academic-progress/attendance-course-work.php.
Please refer to your department/discipline handbook for moderatorship regulations.
Junior Sophister Examinations

Modules are assessed by continuous 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.

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.

What are the new repeat year regulations?
Students who fail to satisfy the requirements of their year at the Reassessment session are required to repeat the year in full (i.e. all modules and all assessment components).
Students are permitted to repeat any year of an undergraduate programme subject to not repeating the same year more than once and not repeating more than two academic years within a degree course, except by special permission of the University Council (see calendar https://www.tcd.ie/calendar/undergraduate-studies/general-regulations-and-information.pdf page 41 section 72-73).
The option to repeat a year on an ‘off-books’ basis will be at the discretion of the Senior Lecturer (see Calendar https://www.tcd.ie/calendar/undergraduate-studies/general-regulations-and-information.pdf page 41-42, section 78-79).
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<tr>
<th>Day</th>
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<tr>
<td>Friday</td>
<td>29th March 2019</td>
<td>Moderatorship Fair</td>
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<tr>
<td>Friday</td>
<td>12th April 2019</td>
<td>Semester 2 - Hilary Lecture Term ends</td>
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<tr>
<td>Friday</td>
<td>12th April 2019</td>
<td>Closing date – Submit choice of Moderatorship forms</td>
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<tr>
<td>Tuesday</td>
<td>23rd April 2019</td>
<td>Semester 2 Examinations begin</td>
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<td>Saturday</td>
<td>27th April 2019*</td>
<td>Semester 2 Examination ends</td>
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<tr>
<td>Friday</td>
<td>24th May 2019</td>
<td>Official Examination Results Published</td>
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<td>Beginning July</td>
<td>Notification of JS Moderatorship places</td>
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<tr>
<td>Friday</td>
<td>2nd August 2019</td>
<td>Closing date – 2nd Round Choice Moderatorship Form</td>
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<tr>
<td>Monday</td>
<td>26th August 2019</td>
<td>Reassessment Examinations begin</td>
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<tr>
<td>Saturday</td>
<td>31st August 2019</td>
<td>Reassessment Examinations end</td>
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<tr>
<td>Monday</td>
<td>9th September 2019</td>
<td>Semester 1 - Michaelmas Lecture Term begins</td>
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<td>Friday</td>
<td>29th November 2019</td>
<td>Semester 1 - Michaelmas Lecture Term ends</td>
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<td>Monday</td>
<td>9th December 2019</td>
<td>Semester 1 Examinations begin</td>
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<td>Friday</td>
<td>13th December 2019</td>
<td>Semester 1 Examinations ends</td>
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*Semester 2 assessment maybe held on Tuesday 30th April and Thursday 2nd May 2019 of Trinity week if required.*
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, practicals, 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 practicals, a ten-credit research skills module and a five-credit module covering biochemical analysis. In addition, all JS students are obliged to take a Trinity Elective (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 in the summer (70% weighting). The research skills, biochemical analysis and Trinity Elective modules are entirely in-course assessed. Overall the assessment is approximately 50:50 continuous assessment: exam. 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 research project and write a thesis, complete a set of problems and assignments, give a number of presentations and take specialised lecture courses in Biochemistry and Cell Biology.

SS Assessment and Examination Procedures:
There are three annual exam papers at the end of the SS year as follows: Paper 1 (BIU44110) Biochemistry in Health & Disease II; Paper 2 (BIU44120) Immunology & Microbiology and Paper 3 (BIU44130) Cancer Biology & Cell Signalling. Each paper carries equal marks and contributes a total of 50% to the final SS mark. The Advanced Research Skills (BIU44010) module covers quantitative biochemical problems, bioinformatics (sequence analysis), comparative medicine and a series of group presentations by students on various biochemical techniques. A series of lectures will also introduce students to a wide array of cutting-edge techniques and strategies used in biochemistry. Marks for this module are awarded through in course assessment and contribute 16.6% to the final mark. Finally, an 11-week Research Project (BIU44190) will be carried out in semester 1 which contributes 33.4% to the SS mark. The overall degree mark is comprised of 80% of SS mark and 20% of JS mark.
JUNIOR SOPHISTER MODULES                      60 Credits

BIU33110 PROTEIN STRUCTURE (S1)     10 credits
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.

BIU33120 MEMBRANE AND CELL BIOLOGY (S1)     10 credits
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.

BIU33010 NUCLEIC ACIDS (S2)     10 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. As well as lectures the module includes a set of linked practical sessions.

BIU33140 BIOCHEMISTRY IN HEALTH AND DISEASE (S2)     10 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. As well as lectures the module includes a set of linked practical sessions.

BIU33020 RESEARCH SKILLS (S1 & S2)     10 credits
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. Students will also give a short oral presentation of their review.

BIU33030 BIOCHEMICAL ANALYSIS (S1)     5 credits
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.

Trinity Electives (S1 or S2) https://www.tcd.ie/TEP/trinity_electives.php.     5 credits
SENIOR SOPHISTER MODULES

BIU44190  RESEARCH PROJECT IN BIOCHEMISTRY (S1)  20 credits
The module comprises of an original research project in biochemistry and a research thesis.

BIU44010  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.

BIU44110  BIOCHEMISTRY IN HEALTH & DISEASE II (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.

BIU44120  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.

BIU44130  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.
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 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 Trinity Elective 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 and includes 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 will be based in an ecologically important area of Europe (Canary Islands). It takes place during the study week in the Hilary Term.

**Seniors Sophisters**
In the Senior Sophister year, students attend a series of lectures, laboratory practical’s, field work, seminars, tutorials and workshops. In addition, they are required to undertake a 20-credit research project in the second semester which culminates in the submission of a dissertation. The year consists of a total of 50 mandatory credits and 10 optional credits. These modules are indicated in greater detail below.
Junior Sophister Modules 60 credits

Mandatory modules

BOU33100 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.

ZOU33010 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.

BOU33107 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.

BOU33108 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.

BOU33109 General Botanical Science (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.
BOU33111 Angiosperm Diversity and Systematics (S2)  5 credits
This stand-alone module follows on from Lower Plant Diversity and Evolution (BO3110) which deals with lower plants. 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.

BOU33120: Environmental Dynamics (S1)  5 credits
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.

BOU33121 Field Skills in Plant and Environmental Science (Canary Islands) (S2)  5 credits
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.

BOU33123 Soil Science (S1)  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.

BOU33125 Diversity of Plant Morphology (S2)  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.
ZOU33070 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.

Optional modules
BOU33122 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 practical’s will provide students with the skills for sampling and identification of insects, which will be further enhanced through small group and individual

Trinity Electives https://www.tcd.ie/TEP/trinity_electives.php.  5 credits
Senior Sophister Modules                60 credits

Mandatory modules

FBU44000 Research Project (S2)       20 credits
The project provides an important opportunity for students to plan and carry out a detailed and original piece of scientific research and communicate the results. It culminates in the production of a thesis and communication of the results through a poster presentation at an undergraduate research conference. Students will be assigned to a member of staff who will support an appropriate topic and will supervise the work. For the project, students will be expected to outline clearly a scientific problem, review the associated literature, design and execute an appropriate research programme, analyse and present the results and draw clear conclusions.

BOU44106 Tutorials in Botany (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.

BOU44103 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.

BOU44108 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.

BOU44109 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.
BOU4110 Evolution of Plants and Plant Atmosphere Interactions (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.

ZOU44030 Data Handling (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.

Optional modules
ZOU44017 Tropical Ecology Field Trip (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.

BOU44105: Global Environmental Change (S1) 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.

BOU44107 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).
FBU44060 Plant Breeding and Biotechnology (S1) 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. Practical’s cover crop diversity, polyploid estimation and at least one site visit to a Teagasc research centre (Oak Park, Carlow and/or Ashtown Dublin).

BOU44111 Restoration Ecology and Re-Wilding (S1) 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. Restoration ecology has many positive outcomes but has also a lot of controversy. Re-wilding and novel ecosystems are new, daring and controversial areas within restoration ecology making it difficult to know how and when to intervene. This module will introduce you to the challenges and opportunities, failings and fallacies of the complex world of restoration ecology and the work of restoration ecologists. 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. Students will also visit an abandoned industrial landscape and look at the after-use and restoration processes.
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.
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 may choose an optional module or a Trinity Elective module for your remaining 5 credits.

**Mandatory Courses:** 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. Attendance at all workshops is compulsory.

**Assessment and Examination Procedures:** The lecture material in Chemistry 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 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 attend research seminars and undertake a project in a research lab.

**Assessment and Examination Procedures:** Core and option lecture modules detailing advanced topics in Organic, Inorganic and Physical Chemistry will be examined during the Annual Examination periods. The Research Project is assessed in-course. All modules are weighted according to their respective credit rating. 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.
Junior Sophister Modules  

**60 credits**

**Inorganic Chemistry**

**CHU33103 Organometallics & Coordination Chemistry (Inorganic Chemistry I) (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 the Inorganic component of the laboratory exercises.

**CHU33104 Solid State Materials (Inorganic Chemistry II) (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**

**CHU33203 Synthetic Organic Chemistry I (S1)**  
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 stereo electronic effects, and physical organic chemistry. **NOTE:** 50% of the marks for this module are associated with the Organic component of the laboratory exercises.

**CHU33204 Synthetic Organic Chemistry II (S2)**  
5 credits  
This module covers topics such as heterocyclic chemistry, organoheteroatom chemistry, and FGI and retrosynthesis.

**Physical Chemistry**

**CHU33303 Quantum Mechanical Concepts in Physical Chemistry (Physical Chemistry I) (S1)**  
5 credits  
This module deals with quantum mechanics, spectroscopy and group theory.

**CHU33304 Molecular Thermodynamics and Kinetics (Physical Chemistry II) (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 the Physical component of the laboratory exercises.

**Interdisciplinary Modules**

**CHU33403 Analytical Methods (Interdisciplinary Module I) (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.
CHU33404 Biomaterials and Soft Matter (Interdisciplinary Module II) (S2) 5 credits
This module will cover bioorganic chemistry and natural products, bioinorganic chemistry, polymers, colloids and other soft matter systems.

Optional Modules

CHU33441 Medicinal Chemistry (S2) 5 credits
This module encompasses an introduction to medicinal chemistry, antiviral and anticancer chemistry and the computational method QSAR.

OR

Trinity Electives https://www.tcd.ie/TEP/trinity_electives.php. 5 credits
Senior Sophister Modules 60 credits

CHU44112 Advanced Organic Transformations I (S2) 5 credits
This module involves core lectures in organic and biological photochemistry and reactive intermediates.

CHU44113 Advanced Organic Transformations 2 (S2) 5 credits
This module involves core lectures in asymmetric synthesis and retrosynthesis.

CHU44104 Advanced Inorganic Chemistry I (S2) 5 credits
This module involves core lectures on advanced inorganic materials and characterisation techniques in Bioinorganic Chemistry.

CHU44105 Advanced Inorganic Chemistry II (S2) 5 credits
This module involves core lectures in heavy transition metal chemistry and in advanced coordination chemistry.

CHU44106 Advanced Physical Chemistry I (S2) 5 credits
This module involves core lectures in photochemistry, redox active nanostructured materials and systems and advanced reaction dynamics.

CHU44107 Advanced Physical Chemistry II (S2) 5 credits
This core module involves lectures in quantum chemistry and solid-state chemistry.

CHU44108 Advanced Topics and Problem Solving (S1 and S2) 5 credits
In this module students select four advanced option topics from a list that currently includes: Molecular Dynamics, Matter Transport in Solids, Quantum Chemistry, Heterogeneous Catalysis, Supramolecular Chemistry, Topics in Structural Chemistry, Statistical Thermodynamics, Organic Synthetic Methods II, Advanced Organometallic Chemistry, Special topics in Organic Chemistry, DNA Structure and Drug-DNA Complexes, Bio-Organic Chemistry, Electrochemical Biosensors, and Material Synthesis using Chemical Vapour Deposition. Note that not all option topics may be offered in any given year. See Senior Sophister Course Booklet for further details.

In addition, students will be given self-directed learning and undertake a series on problems both during the first semester and under exam conditions in the second semester.

CHU44120 CMM Capstone project 20 credits
This module is a research project undertaken in a research lab in Trinity in other universities around the world which can be arranged in the JS year through the Schools international coordinator. Assessment is via production of a thesis, oral presentation of a research seminar and viva voce examination.
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 Sciences is by its nature a multidisciplinary academic field, comprising a study of the frequently complex interactions between the biological, chemical and physical components of our environment. The environmental science discipline has evolved over the last numbers of decades as key environmental problems such as climate change, pollution, sustainable development, deforestation and desertification to name a few, have become the focus of scientists, policy makers and the general public. Environmental scientists have training that is similar to other physical or life scientists but is specifically applied to the environment. A broad scientific knowledge is required which involves a fundamental understanding of the physical and life sciences in addition to 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 programme comprises specially designed modules plus suitable modules from contributing disciplines. Field study and laboratory skills represent a core component of the programme consisting of a number of residential field excursions both around Ireland as well as in the Canary Islands and Kenya, and these are blended with the theoretical content to provide our graduates with the training required to become highly successful practitioners in this field.

The Environmental Science Moderatorship course consists of 60 European Credit Transfer Systems (Credits) for each year. Junior Sophisters take a total of 40 mandatory Credits and optional modules up to the value of 20 Credits, while 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**

**BOU33108 Plants and the Irish Environment (Prof. Fraser Mitchell) (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.

**BOU33123 Soil Science (Prof. Matthew Saunders) (S1)**  
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.

**ZOU33010 Fundamentals of Ecology (Prof. Ian Donohue) (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.

**ESU33040 Environmental Monitoring (Prof. Jeremy J. Piggott) (S1)**  
5 credits  
This module covers the tools and sampling approaches used to characterize and monitor the quality of the environment. Techniques encompass the collection and analysis of chemical and biological samples and their application to environmental quality indices. Students will have the opportunity to apply the techniques to a range of sample types, such as those collected from sediments and waters. Techniques include both traditional and novel methods being applied in environmental monitoring programs across Europe, with a particular focus on those associated with the Water Framework Directive Monitoring Programme.

**ZOU33070 Experimental Design and Analysis (Prof. Celia Holland) (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. 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 (FBU44000) and the project proposal.
Since the 1960s, concern for the environment has grown as our understanding of major issues like climate change, biodiversity loss, and pollution have improved. Despite this, most indicators suggest that environmental problems like climate change and biodiversity loss are getting worse, not better. This module investigates why this is the case and how we might contribute to more responsible and effective forms of environmentalism. The module critically examines the major cultural, scientific, and economic understandings of nature that have shaped mainstream responses to environmental problems. It also looks at more radical forms of environmentalism that foreground questions of power and justice in the pursuit of sustainable development.

ZOU33085 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 20 credits from these modules)

Trinity Electives https://www.tcd.ie/TEP/trinity_electives.php. 5 credits

BOU33121 Field Skills in Plant and Environmental Science (Prof. Jane Stout) (Canary Islands) (S2) 5 credits
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.

BOU33120 Environmental Dynamics (Prof. Fraser Mitchell) (S1) 5 credits
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.
GLU34923 Hydrology and water quality (Prof. Catherine Coxon) (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.

B0U33122 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 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 practical sessions will provide students with the skills for sampling and identification of insects, which will be further enhanced through small group and individual projects.

BOU33125 Diversity of plant morphology (Prof. Jennifer McElwain) (S2) 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.
Senior Sophister Modules                                                                   60 credits
(The following module options may be subject to change)

MANDATORY MODULES

FBU44000 Research Project (All staff) (S2)                                                20 credits
The project provides an important opportunity for students to plan and carry out a detailed and original piece of scientific research and communicate the results. It culminates in the production of a thesis and communication of the results through a poster presentation at an undergraduate research conference. Students will be assigned to a member of staff who will support an appropriate topic and will supervise the work. For the project, students will be expected to outline clearly a scientific problem, review the associated literature, design and execute an appropriate research programme, analyse and present the results and draw clear conclusions.

ESU44052 General Environmental Sciences (Prof. Matthew Saunders) (S1 & S2)                 5 credits
This module provides an opportunity for students to build on the content covered throughout the Sophister Environmental Sciences programme, and to explore in greater detail the key challenges facing Environmental Scientists today. Guest lectures also form a core part of this module and will be given by practitioners in the environmental sciences field. Students are expected to integrate their approach to this material with the perspectives and skills they develop during their Sophister years.

ZOU44030 Data Handling (Prof. Andrew Jackson) (S1)                                       5 credits
This module will build on material from the JS Experimental Design and Analysis (ZOU33070) module, introducing more advanced statistical methods suitable for direct application in the Research project.

ZOU44060 Research Comprehension (Prof. Pepijn Luijckx) (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. Assessment for this module will take place in S2 only.
ZOU44092 Environmental Impact Assessment (Prof. John Rochford) 5 credits (S1)
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.

BOU44105 Global Environmental Change (Prof. Mike Williams) (S1) 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.

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

BOU44013 Plant Conservation and Biodiversity (Prof. Stephen Waldren) (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.

BOU44109 Vegetation description and analysis (Prof Stephen Waldren) (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.

ZOU44013 Conservation and Wildlife Management (Prof. John Rochford) (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.
BOU44110 Evolution of plants and plant-atmosphere interactions (5 credits)  
(Prof. Jennifer McElwain) (S2)

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.

ZOU44017 Tropical Ecology (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 montane 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.

BOU44111 Restoration ecology and re-wilding (Prof. Marcus Collier) (S1)  
(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. Restoration ecology has many positive outcomes but has also a lot of controversy. Re-wilding and novel ecosystems are new, daring and controversial areas within restoration ecology making it difficult to know how and when to intervene. This module will introduce you to the challenges and opportunities, failings and fallacies of the complex world of restoration ecology and the work of restoration ecologists. 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. Students will also visit an abandoned industrial landscape and look at the after-use and restoration processes.
BOU44107 Plant-Animal Interactions (Prof. Jane Stout) (S1) 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).

ES4056 Environmental Governance 2 (Prof. Patrick Bresnihan) (S2) 10 Credits
This module introduces students to the interdisciplinary field of political ecology; political ecology seeks to better understand the complex drivers and uneven consequences of socio-environmental change. The module will provide students with the conceptual and methodological tools to carry out critical, independent research on an environment-related topic. The objective of the course is for students to come away with a critical “toolkit” for thinking, writing, and acting on complex social and ecological problems in Ireland and elsewhere. It is also hoped that the research carried out by the students will provide valuable and critical insights for a wider audience interested in environmental issues in Ireland.

ESU44054 Spatial Analysis using GIS (Prof. Niamh Hartey) (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. It aims to help fill a major and increasingly obvious skills gap. A unique feature of this module is the use of Dublin and Ireland as a learning laboratory, where the students will take responsibility of a project. The Spatial Analysis using GIS Module is designed to introduce the student to spatial analysis using the Geographic Information Systems (GIS) platform ArcGIS.
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;
• demonstrate the principles of geochemical cycling in the global context with specific reference to environmental change;
• describe how soils are formed and discuss how they are influenced by both natural and anthropogenic processes.
• discuss 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; and
• 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 Trinity Elective option.

**Assessment and Examination Procedures**
Most JS modules are examined in end-of-Semester 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 5 papers. In 3 of these papers, the 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

GEU33002 EUKARYOTIC MOLECULAR 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.

GEU33003 GENOMICS (S1)  5 credits
This module provides an introduction to Genomics and Systems Biology, to Bioinformatics and to key techniques used in Molecular Biology.

GEU33006 EVOLUTIONARY GENETICS (S1)  5 credits
This module provides an introduction to genetic variation – its origins and its evolutionary consequences.

GEU33007 MOLECULAR GENETICS LABORATORY (S1)  5 credits
This practical class introduces students to standard methods of Molecular Genetics.

GEU33009 DATA HANDLING (S1)  5 credits
This module focuses on the handling and analysis of data. It includes teaching in bioinformatics, computer programming (Perl language) and statistics.

GEU33001 BACTERIAL GENETICS (S2)  5 credits
This module presents an evidence-based description of the basic cellular processes of transcription, translation and DNA replication in bacteria.

GEU33004 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.

GEU33005 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.

GEU33008 ANALYTICAL GENETICS LABORATORY (S2)  5 credits
This practical class introduces students to standard methods of Analytical Genetics.

GEU33011 GENETICS TUTORIALS (S1 and 2)  5 credits
This module introduces students to core concepts of Genetics. In addition, students are trained in scientific writing and will acquire presentation skills.

GEU33010 REVIEW (GENETICS) (S1 and 2)  5 credits
Students write a literature review on a specific topic of genetics and present their work in a short talk.

Trinity Electives  https://www.tcd.ie/TEP/trinity_electives.php.  5 credits
Senior Sophister Modules 60 credits

Research Project (S1 and S2) 20 credits

Literature Review (S1) 5 credits

Problem-solving in Genetics (CA) 5 credits

Lecture Module GEU44002: Medical & Cellular Genetics 10 credits

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.

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.

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.
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.

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 GEU44003: Analytical & Developmental Genetics 10 credits
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.

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.
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.

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.

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.

Lecture module GEU44004: General and Molecular Genetics              10 credits

Principles of Genetics (Various) (S1)
These lectures introduce and review key concepts of genetics and hence convey 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.
**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 (i.e., enzyme production, competence, development, biofilm construction or sporulation) most appropriate to the prevailing conditions.

**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.

**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.
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?
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 (GG33956 History & Philosophy of Geography and GGU33928 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 Trinity Electives) during your sophister years.

Compulsory Geography Modules

GGU33928 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

GGU33956 History and Philosophy of Geography  S1  5 credits
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

Optional Geography Modules
Geography offers several optional modules that you may take providing you have the required prerequisites (where applicable).

GGU33915: Globalisation & Geopolitics  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
GGU33925 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 Cugurullo

GGU33930: Environmental Governance I S2 10 credits

Prerequisites: None

Outline: Since the 1960s, concern for the environment has grown as our understanding of major issues like climate change, biodiversity loss, and pollution have improved. Despite this, most indicators suggest that environmental problems like climate change and biodiversity loss are getting worse, not better. This module investigates why this is the case and how we might contribute to more responsible and effective forms of environmentalism. The module critically examines the major cultural, scientific, and economic understandings of nature that have shaped mainstream responses to environmental problems. It also looks at more radical forms of environmentalism that foreground questions of power and justice in the pursuit of sustainable development.

Module Coordinator: Prof Bresnihan

GGU33933 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

GGU33934 Practical Physical Geography S1 5 credits

Prerequisites: SF Geography including GGU22924

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
GGU33937 Urban Economic Structure and Regeneration  

**Prerequisites:** None

**Outline:** This module introduces you to some key themes, concepts, and debates in urban geography. In particular it will focus on the concept of urban regeneration. The module first considers the historic development of urbanisation, the transition to urban-based economies, and the development of urban studies. It then focuses specifically on the urban impacts of globalisation, in particular how cities in the developed world have managed the shift from industrialism to post-industrialism. Finally, the module examines regeneration from a number of perspectives. Particular attention will be given to the circular nature of processes of urban growth and decline and how regeneration efforts include and exclude particular social groups and identities.

**Module coordinator:** Prof. O’Callaghan

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GGU33939 Exploring the Sustainable City  

**Prerequisites:** 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? In this highly interdisciplinary module, we are going to use the tools of geography to examine the most critical socio-environmental issues faced by cities (climate change, consumption, happiness, environmental degradation, etc.), and discuss both the theory and practice of urban sustainability. This module is more than a review of how urban sustainability is understood and practiced, and you will be asked to design, present and discuss practical plans of action to sustain urban living in the 21st century and beyond.

**Module coordinator:** Prof Cugurullo

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GGU33953 Deserts of our Solar System  

**Prerequisites:** GGU22924

**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

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GGU34977 Human Origins  

**Module coordinator:** Prof Edwards  

**Prerequisites:** GG1024; GGU22924

**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.
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).

GGU44930 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

GGU449626 Environmental Governance II
Pre-requisites: GGU33930 Environmental Governance I
Outline: This module introduces students to the interdisciplinary field of political ecology; political ecology seeks to better understand the complex drivers and uneven consequences of socio-environmental change. The module will provide students with the conceptual and methodological tools to carry out critical, independent research on an environment-related topic. The objective of the course is for students to come away with a critical “toolkit” for thinking, writing, and acting on complex social and ecological problems in Ireland and elsewhere. It is also hoped that the research carried out by the students will provide valuable and critical insights for a wider audience interested in environmental issues in Ireland.
Module Coordinator: Prof Bresnihan
GGU44961 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

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GGU44962 Spatial Analysis using GIS  S1  5 credits

**Prerequisite:** GGU33933

**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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GG4064 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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GGU44969 Urban Geography: Cities, Space and Culture  S1  10 credits

**Prerequisites:** None

**Outline:** This module will introduce students to 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. The module will also use Dublin as a key case study and research laboratory to explore how these processes are shaping that city. Focussing on contemporary events, it will bring together rich and varied scholarship from leading researchers in Dublin and the experiential analysis of policy makers, community activists, and a range of other urban actors.

**Module coordinator:** Prof. O’Callaghan
GGU44XXX Historical Geography S1  
**Prerequisites:** None

**Outline:** This module presents an overview of the historical geography of Ireland from the earliest human settlement in the Mesolithic through to the Nineteenth century. 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

GGU44971 Stormy Geomorphology  
**Prerequisites:** None

**Outline:** There is no doubt that the severity of extreme climate events has become increasingly evident. However, separation of global & regional trends from local effects is complex. Geomorphology is a critical discipline in disentangling climate change impacts from other controlling factors. During this field trip you will examine the geomorphological evidence for extreme events. You will receive field instruction on how to collect data using established and advanced technologies in order to build data sets on key environmental parameters.

BOU44111: Restoration Ecology and Re-wilding S2  
**There is a cap of 15 places for geography students**

Restoration ecology, like conservation biology, is a ‘crisis’ discipline, having emerged as a scientific response to the ecological damage caused by human activities. Restoration ecology has many positive outcomes but has also a lot of controversy. Re-wilding and novel ecosystems are new, daring and controversial areas within restoration ecology making it difficult to know how and when to intervene. This module will introduce you to the challenges and opportunities, failings and fallacies of the complex world of restoration ecology and the work of restoration ecologists. 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. Students will also visit an abandoned industrial landscape and look at the after-use and restoration processes.

**Module coordinator:** Prof Collier
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 Freshman 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

GLU33924 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.

GLU33925 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 classroom 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.

GLU33926 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.

GLU33928 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.

GLU33934 Introduction to Geochemistry  
**JD R-B (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.

GLU33935 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.
GLU33936 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.

GLU33937 GIS and Mapping techniques  CA (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 focusing on the acquisition, manipulation, and integration of Digital Elevation Models and satellite imagery to generate base maps for geological fieldwork.
Senior Sophister Modules

GLU44901 Project (M)  
CN (S1) 15 credits 
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.

GLU44902 Fieldwork (M)  
QC (S2) 5 credits 
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.

GLU44904 Geological Literature (M)  
PNWJ (S1) 5 credits 
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.

GLU44906 Global Igneous Petrology (O)  
ET (S1) 5 credits 
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.

GLU44912 Laboratory Project (O)  
JD R-B (S1) 5 credits 
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.

GLU44914 Petroleum Geology & Exploration (M)  
CN (S1) 10 credits 
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.

GLU44919 Economic Geology (M)  
SMcC (S2) 5 credits 
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.
GLU44922 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.

GLU44924 Micropalaeontology  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, paleoenvironmental analysis, oceanography and thermal maturation studies. The module will also examine the evolution of life on our planet from earliest times.

GLU44925 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.

GLU44927 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.

GLU34923 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.

https://www.tcd.ie/Geology/undergraduate/modules/
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. 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 Prof 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 Trinity Elective.

**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 Trinity Elective 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 Biochemistry and Immunology.

SS Assessment and Examination Procedures (60 ECTS)

There are three final exam papers in the summer. Each paper covers a separate module (10 ECTS) and consists of long questions, short questions and integrative type questions. Each paper carries equal marks and together contributes a total of 50% to the final SS mark. The Advanced Research Skills module (10 ECTS) covers quantitative biochemical problems, bioinformatics molecular modelling and research techniques. This module is examined by in-course assessment during the year. Finally, an 11-week research project will be carried out and contributes one third of the marks for SS year. The overall degree mark is comprised of 80% of SS mark and 20% of JS mark.
Junior Sophister Modules

Credits: 60

BIU33220  Core Concepts in Immunology (S1)  10 credits
This module introduces fundamental processes and molecules associated with the immune system. The role of the immune system in disease e.g. autoimmunity will also be addressed. There will be Immunology practicals associated with these lectures.

BIU33240  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.

BIU33210  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.

BIU33230  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.

BIU33030  Laboratory Methods (S1)  5 credits
This module involves practicals and data handling project.

BIU33020  Research skills (S1-2)  10 credits
This module involves a literature review and essay on an immunology topic and a presentation in addition to quantitative problem analysis.

Trinity Electives (S1 or S2)  https://www.tcd.ie/TEP/trinity_electives.php.  5 credits
SENIOR SOPHISTER MODULES \hspace{1cm} 60 Credits

BIU44290 \hspace{0.5cm} Research Project in Immunology (S1) \hspace{0.5cm} 20 credits

The module comprises of an original research project in Immunology and a research thesis.

BIU44010 \hspace{0.5cm} Advanced Research Skills (S1) \hspace{0.5cm} 10 credits

This purpose of this module is to further develop research, critical analysis and communication skills that are essential for a graduate scientist. Students will be trained in data handling as well as solving quantitative problems in Immunology. In addition, this module will introduce students to a wide array of cutting-edge techniques and strategies used in scientific research.

BIU44210 \hspace{0.5cm} General Immunology (S2) \hspace{0.5cm} 10 credits

This module covers key aspects of systemic and mucosal Immunology including NK cells, B cells and also organ specific Immunology: reproductive, liver, GI and Immunology. There is also a series of lectures on Immune signalling which includes cell death pathways, cytokine signalling, cytokine processing and immunometabolism.

BIU44220 \hspace{0.5cm} Infection and Immunity (S2) \hspace{0.5cm} 10 credits

This module focuses on specific aspects of the immune response against a range of pathogens including viruses, bacteria (extracellular and intracellular), helminths and trypanosomes. Biochemical and genetic mechanisms by which bacteria, viruses and parasites evade the host immune responses will be covered. Finally, there is a series of advanced lectures on vaccines and adjuvants.

BIU44230 \hspace{0.5cm} Immunological Diseases and Immunotherapy (S2) \hspace{0.5cm} 10 credits

This module covers diseases in which the immune system is known to play a role, either in pathology of disease or in potential treatment of the disease. Diseases covered include rheumatoid arthritis, autoinflammatory diseases and obesity. Lectures also cover some neuroimmunology and associated diseases e.g. multiple sclerosis. Finally, given the importance of the immune system in cancer, there are a series of lectures on cancer initiation, progression and conventional treatment along with key immunological aspects including the immune response to cancer, cancer immune evasion and the exploitation of the immune system in a range of cancer immunotherapies.

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, antimicrobial chemotherapy 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, beverage and pharmaceutical industries, as well as in education, scientific publishing, technical sales and services, marketing and in management.

Junior Sophisters:

The Junior Sophister (JS) year consists of a diverse programme of lectures, laboratory practical’s, tutorials and a research essay. The JS year is a 60-credit course composed of five 10 credit modules consisting of lectures and associated practicals and a 5-credit research essay and transferable skills module. Students also take a Trinity Elective (5 credits).

Assessment and Examination Procedures

Practical components, Research Essay and Transferable Skills will be assessed in-course by laboratory practical report, practical test, written test or other assignments. Students are referred to the Microbiology Junior Sophister Course Booklet 2019/20 for further details regarding the nature and timing of assessments.

The lecture components 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 2019/20 issued to rising Junior Sophisters.

Marks for Microbiology modules MIU33001-MIU33006 plus the Trinity Elective will form the JS Microbiology mark that is carried forward to Moderatorship.
Senior Sophisters:

Assessment and Examination Procedures

Modules in Microbial & Molecular Cell Biology and Microbial Pathogenicity (MIU44002 & MIU44003), the specialized topic modules (MIU44004) and data handling module (MIU44005) and will be examined in four 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. The Research Essay and Research Project (MIU44001) 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

MIU33001: 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. Biosynthesis, post-translational modification and secretion of protein and polysaccharide structures in microbes are described. 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.

MIU33002: 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 practical classes.

MIU33003: Research Essay & Transferable Skills, Prof J. Geoghegan (S2)  
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.

MIU33004: 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 practical’s, students gain a familiarity with modern molecular genetic techniques.

MIU33005: 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 molecular biology and yeast genetics. The lecture component 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.
MIU33006: Applied Microbiology and Antimicrobial agents, Prof C. Kroger, (S1, S2)
10 credits

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.

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.
Senior Sophister Modules

MIU44001: Research in Microbiology (S1, S2) 20 credits
This research-oriented module involves a full-time 9-week research project and thesis, the writing of a research essay and discussions of professional and ethical issues in Microbiology.

MIU44002: Microbial Molecular & Cellular Biology (S1, S2) 10 credits
This module involves core lectures, attendance at research seminars and self-directed study guided by reading material in Microbial & Molecular & Cellular Biology.

MIU44003: Microbial Pathogenicity (S1, S2) 10 credits
This module involves core lectures and self-directed study, attendance at research seminars and self-directed study guided by reading material in Microbial Pathogenicity.

MIU44004: Advanced Topics in Microbiology (S1, S2) 10 credits
In this module students select three advanced topics from a list which currently includes: cell biology of intracellular pathogens, viral pathogenesis, small RNA-mediated gene regulation, regulation of bacterial gene expression, antimicrobial resistance, immune evasion by bacterial pathogens, lessons from yeast and chromatin, epigenetics and disease. Students are required to carry out self-guided study on primary literature sources in preparation for class participation and presentations.

MIU44005: Data Handling (S2) 10 credits
Students receive tutorials in data handling, data interpretation and problem solving to complement the lectures in the core themes.
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.
- 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 microbiological hypotheses, to solving microbiological problems and to designing microbiological experiments.
- 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.
- 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.
- Demonstrate recognition of the 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.
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
Four exam papers are given in the summer, 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. Trinity Elective 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 carryout 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.
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.
Junior Sophister                                                    60 credits

BIU33310 Proteins and drugs (Semester 1)                                  10 credits
This module will cover protein structure and function, protein biochemistry, medicinal chemistry and associated practical skills.

BIU33320 Cell Biology (Semester 1)                     10 credits
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.

BIU33330 Disease Mechanisms (Semester 2)                                                      10 credits
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.

BIU33010 Nucleic Acids (Semester 2)                                                          10 credits
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.

BIU33020 Research Skills (Semester 1 & 2)                                                      10 credits
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

BIU33030 Laboratory Methods (Semester 1 & 2)                                 5 credits
This module will develop data handling and acquisition skills.

Trinity Electives (S1 or S2) https://www.tcd.ie/TEP/trinity_electives.php.       5 credits
Senior Sophister (60 ECTS)

BIU44390 RESEARCH PROJECT IN MOLECULAR MEDICINE (Semester 1) 20 credits

The module comprises of an original research project in biochemistry, cell biology, immunology or clinical medicine.

BIU44010 ADVANCED RESEARCH SKILLS (Semester 1) 10 credits

This purpose of this module is to further develop research, critical analysis and communication skills that are essential for a graduate Molecular Medicine student. Students will be trained in data handling as well as solving quantitative problems in biochemistry and immunology. In addition, this module will introduce students to a wide array of cutting-edge techniques and strategies used in biochemistry, immunology and molecular medicine.

BIU44310 NEUROBIOLOGY & IMMUNOLOGY (Semester 2) 10 credits

This module covers the structure, function and pharmacology of neurotransmitters, neuron-glia interactions, intraneuronal signalling and the neurobiology of behaviour and neurodegenerative disorders. This module also covers regional immunology (e.g. gastrointestinal immunology, respiratory immunology etc), cell death mechanisms and immunometabolism.

BIU44320 MICROBIAL DISEASES AND IMMUNE SYSTEM DISORDERS (Semester 2) 10 credits

The first part of this module will focus on microbial diseases. Bacterial pathogens of medical importance will be covered in detail. Parasitic protozoa such as trypanosomes and helminths will be introduced. Finally, the biochemical and genetic mechanisms by which bacteria, viruses and parasites evade the host immune responses will be explored. This module will also cover the basic and clinical aspects of auto-inflammatory and autoimmune conditions, including rheumatoid arthritis, multiple sclerosis and immunodeficiency syndromes.

BIU44330 CELL CYCLE, CANCER BIOLOGY AND THERAPEUTICS (SEMESTER 2) 10 credits

This module will provide an in-depth analysis of cancers of the blood, lung, prostate and oesophagus. It will focus on the progression of disease and current therapeutic interventions. This module will also provide a detailed overview of the meiotic and mitotic cell cycle and its regulation and the molecular biology of cancer.
Molecular Medicine Moderatorship Learning outcomes:

On 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, phascail and quantitative sciences underpinning Molecular Medicine

• Discuss core and specialised areas of Molecular Medicine in depth and analyse and solve biochemical problems

• Demonstrate a comprehensive understanding of the theory behind techniques used in Molecular Medicine and show 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 a wide range of information sources, critically evaluate research literature and write a research dissertation

• Work effectively as an individual and in a team

• Display computer literacy and use advanced computer skills to aid in conducting scientific research

• Communicate effectively with the scientific community and with society at large, and articulate how the improved knowledge of the underlying basis of disease and their treatment impacts on society
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 practical’s, 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 Trinity Elective module 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 in-course assessment and examination. 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 that run mainly in Michaelmas term. Hilary term is primarily devoted to a major research project that is conducted in one of the several research groups within Trinity College Institute of Neuroscience.

**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 the student performance in the lab and their write-ups. The end of year final examinations is comprised of four 3-hour examination papers.
**Junior Sophister Modules**

**PGU33003 Cellular Physiology (S1)**
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.

**AN3MNA Neuroanatomy (S2)**
This module deals with the location, structure and function of the various components of the nervous system.

**PGU33009 Neurophysiology I (S1 & S2)**
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. Practical’s consist of EEG recordings on humans.

**BIU33445 Basic Neurochemistry I (S2)**

**BIU33455 Integrative Neuroscience**
This course will provide students with a firm grounding in systems neuroscience, cognitive neuroscience, and behavioral neuroscience and will, secondly, introduce students to integrative frameworks for synthesizing existing neuroscience literature from different fields and for orientating to hypothesis driven and explanatory research.

**BIU33455 Research Skills (S1)**
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.

**GEU33004 Neurogenetics and Drosophila (S2)**
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.

**NSU33PH1 General Principles of Pharmacology (S1)**
To introduce the student to the basic principles of pharmacology, drug development and experimental techniques used in pharmacology.

**BIU33425 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.
BIU33415 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.

BIU33435 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.

Trinity Elective https://www.tcd.ie/TEP/trinity_electives.php. 5 credits
Senior Sophister Modules

**PGU44004 Neurophysiology II (S1)**
5 credits
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.

**NSU44PH2 Neuropharmacology (S1)**
5 credits
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.

**PS4020 Neuropsychology (S1)**
5 credits
The students will learn about perception and cognitive processes from a psychology-led perspective but one that integrates physiological, behavioural and neuropsychological research, also relying on the interpretation of modern non-invasive tools in human neuroscience including EEG and fMRI.

**BIU44415 Research Literature Skills (Neuroscience) (S1,2)**
10 credits
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. A journal comprehension examination paper will conclude this module.

**BIU4495 Neuroscience Research Project (S1,2)**
20 credits
Students will conduct a research project in one of the Neuroscience laboratories across campus, including those contributing to Trinity College Institute of Neuroscience. This will be preceded by a comprehensive literature review on the topic of the project.

**BIU44445 Neurochemistry II (S2)**
5 credits
This module includes advanced courses on brain biochemistry, CNS acting drugs, neurotransmission and neurodegenerative conditions such as Alzheimer’s disease, Parkinson’s disease and stroke.

**BIU44455 Neuroimmunology & Neurodegeneration (S2)**
5 credits
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)

**GEU44500 Neurogenetics (S2)**
5 credits
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.
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
- Integration of molecular, synaptic, cellular, circuit and behavioural function
- Neurodegenerative diseases
- Experimental techniques: proficiency in the laboratory
- Experimental design, data handling, biostatistics
- Written and oral communication skills
The Physics moderatorship covers a range of topics across the spectrum of modern physics, and the experimental, theoretical, and computational techniques used to explore them. It builds on the Physics modules taken in the Fresher years. There is a particular emphasis on condensed matter physics and nanoscience, reflecting the importance of these fields and the School’s research areas.

**Junior Sophisters:**
The JS year consists of lectures, tutorials and practical delivered in modules, as listed below. Students receive training in communication skills as part of the practical module, worth 20 credits. Students may choose one Trinity Elective during the year, in which case they take an alternative practical module worth 15 credits. Students choose either PYU33A03 Stellar and Galactic Structure or PYU33C01 Computer Simulation I. All other modules are mandatory.

**Assessment and Examination Procedures**
Each 5-credit lecture module will be examined separately by a 2-hour exam in the relevant end-of-semester examination period, with the exception of PYU33C01 which is assessed entirely by continuous assessment. Examined modules may include continuous assessment components. Continuous assessment of the practical module (PYU33PP1) contributes 20 credits. For full details of assessments and modules please see the School of Physics Handbook, [https://www.tcd.ie/Physics/study/current/undergraduate/handbook/](https://www.tcd.ie/Physics/study/current/undergraduate/handbook/)

**Senior Sophisters:**
The SS year consists of lectures, tutorials and practical physics delivered in modules, as listed below. A major component of the year is an independent research project, which is carried out during the first 9 weeks of Michaelmas term. There are no lectures during this period. All modules are mandatory, but students choose two of the five topics offered as part of PYU44P07 Advanced Topics.
Assessment and Examination Procedures

Each 5-credit lecture module will be examined separately in the relevant end-of-semester examination period. The 10-credit lecture modules PYU44P01 and PYU44P03 are examined in the semester 2 examination period. Examined modules may include continuous assessment components. The research project PYU44PP2 is assessed during semester 2. For full details of assessments and modules please see the School of Physics Handbook, https://www.tcd.ie/Physics/study/current/undergraduate/handbook/
Junior Sophister Modules 60 credits

PYU33P01 Quantum Mechanics (S1) 5 credits
This module covers solution of the Schrödinger Equation in specific topics, such as angular momentum and the hydrogen atom.

PYU33P02 Electromagnetic Interactions I (S2) 5 credits
This module covers the fundamentals of electromagnetic theory together with quantum optics and lasers.

PYU33P03 Condensed Matter I (S1) 5 credits
This module introduces condensed matter concepts such as crystal structure and thermal and electronic properties of matter.

PYU33P04 Condensed Matter II (S2) 5 credits
This module extends the discussion of condensed matter into the key areas of magnetic properties and the physics of semiconductors.

PYU33P05 Atomic & Nuclear Physics (S2) 5 credits
This module covers atomic and molecular spectroscopy together with nuclear structure and related effects.

PYU33P06 Dynamical Systems (S1) 5 credits
This module covers the mechanics of matter together with statistical thermodynamics.

PYU33P07 Experimental Techniques (S2) 5 credits
This module covers common device electronics together with the instrumentation used in physics research.

PYU33A03 Stellar and Galactic Structure (S1) 5 credits
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.

or

PYU33C01 Computer Simulation I (S1) 5 credits
This module provides an introduction to numerical and computational techniques and how they may be used to solve problems in Physics.

PYU33PP1 Practical in Physics (S1 & S2) 20 credits
or PYU33PP2 Practical in Physics with a Trinity Elective (S1 & S2) 15 credits

In these modules’ students complete a number of advanced experiments in Physics. They also include components involving training in communication skills, personal and career development, and attendance at School Seminars. Students may take a Trinity Elective in their Junior Sophister year, in which case they take the 15-credit practical module and complete a smaller number of experiments.
Senior Sophister Modules 60 credits

PYU44P01 Quantum Mechanics and High Energy Physics (S1 & S2) 10 credits
The quantum mechanics component of this module extends the discussion of quantum physics into the areas of multi-electron atoms, the time dependent Schrödinger Equation and perturbation theory. The high-energy physics component covers the theory and experimental investigation of fundamental particles, including the Standard Model.

PYU44P03 Condensed Matter and Nanoscience (S1 & S2) 10 credits
The condensed matter part of this module covers metal physics and superconductivity together with semiconductor devices. The nanoscience component covers the modified properties of nanoscale matter, its fabrication and potential applications.

PYU44P05 Electromagnetic Interactions II (S2) 5 credits
This module covers electromagnetic wave phenomena together with optical communications.

PYU44P06 Modern Optics (S2) 5 credits
This module covers the optical properties of materials and nonlinear optics.

PYU44P07 Advanced Topics (S2) 5 credits
This module offers a number of specialist topics; students select two topics to complete the module. The topics offered are Energy, Thin Films, Polymers, Diffraction, Imaging, and Spectroscopy of Nanostructures, and Green’s Functions in Physics.

PYU44PP1 Physics Research Project (S1 & S2) 20 credits
This module comprises a 9-week full-time research project in experimental, theoretical, or computational physics, undertaken at the beginning of semester 1. The project may be undertaken in Trinity, or in another University or Research Institute in Ireland or abroad.

PYU44PP5 Problem Solving in Physics (S1) 5 credits
This module develops techniques and approaches for solving problems in physics.
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 modules from 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 practical delivered in modules, as listed below. Students receive training in communication skills as part of the practical module, worth 20 credits. Students may choose a Trinity Elective, in which case they take an alternative practical module worth 15 credits. All modules are mandatory.

**Assessment and Examination Procedures**

Each 5-credit lecture module will be examined separately by a 2-hour exam in the relevant end-of-semester examination period, with the exception of PYU33C01 which is assessed entirely by continuous assessment. Examined modules may include continuous assessment components. Continuous assessment of the practical module (PYU33PP1) contributes 20 credits. For full details of assessments and modules please see the School of Physics Handbook, [https://www.tcd.ie/Physics/study/current/undergraduate/handbook/](https://www.tcd.ie/Physics/study/current/undergraduate/handbook/)
**Senior Sophisters:**

The SS year consists of lectures, tutorials and practical physics delivered in modules, as listed below. A major component of the year is an independent research project, which is carried out during the first 9 weeks of Michaelmas term. There are no lectures during this period. All modules are mandatory.

**Assessment and Examination Procedures**

Each 5-credit lecture module will be examined separately in the relevant end-of-semester examination period. The 10-credit lecture modules PYU44P01 and PYU44A01 are examined in the semester 2 examination period. Examined modules may include continuous assessment components. The research project PYU44PP2 is assessed during semester 2. For full details of assessments and modules please see the School of Physics Handbook: https://www.tcd.ie/Physics/study/current/undergraduate/handbook/
### Junior Sophister Modules 60 credits

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<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
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<tr>
<td>PYU33P01</td>
<td>Quantum Mechanics (S1)</td>
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<td>This module covers solution of the Schrödinger</td>
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<td>Equation in specific topics, such as angular</td>
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<td>momentum and the hydrogen atom.</td>
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<td>PYU33P02</td>
<td>Electromagnetic Interactions I (S2)</td>
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<td>This module covers the fundamentals of</td>
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<td>electromagnetic theory together with quantum</td>
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<td>optics and lasers.</td>
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<td>PYU33P03</td>
<td>Condensed Matter I (S1)</td>
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<td>concepts such as crystal structure and thermal</td>
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<td>and electronic properties of matter.</td>
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<td>PYU33P05</td>
<td>Atomic &amp; Nuclear Physics (S2)</td>
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<td>This module covers atomic and molecular</td>
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<td>spectroscopy together with nuclear structure</td>
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<td>and related effects.</td>
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<td>PYU33A03</td>
<td>Stellar and Galactic Structure (S1)</td>
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<td>PYU33A06</td>
<td>Statistical Thermodynamics and Astrophysical</td>
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<td>Spectroscopy(S1)</td>
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<td>This module covers thermodynamics and statistical</td>
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<td>mechanics, together with the underlying physics</td>
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<td>electromagnetic spectrum.</td>
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<td>PYU33P07</td>
<td>Experimental Techniques for Astrophysics (S2)</td>
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<td>This module covers common device electronics</td>
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<td>PYU33C01</td>
<td>Computer Simulation I (S1)</td>
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<td>they may be used to solve problems in Physics.</td>
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<tr>
<td>PYU33AP1</td>
<td>Practical in Physics and Astrophysics (S1 &amp; S2)</td>
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<td>or PYU33AP2</td>
<td>Practical in Physics and Astrophysics with a 5</td>
<td>15</td>
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<td>credit Trinity Elective (S1 &amp; S2)</td>
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In these modules students complete a number of advanced experiments in Physics together with an introduction to computer methods in Astrophysics. They also include components involving training in communication skills, personal and career development, and attendance at School Seminars. Students may take a Trinity Elective in their Junior Sophister year, in which case they take the 15-credit practical module and complete a smaller number of experiments.
## Senior Sophister Modules 60 credits

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<tr>
<th>Course Code</th>
<th>Course Title</th>
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<tr>
<td>PYU44P01</td>
<td>Quantum Mechanics and High Energy Physics (S1 &amp; S2)</td>
<td>10</td>
</tr>
<tr>
<td>PYU44P05</td>
<td>Electromagnetic Interactions II (S2)</td>
<td>5</td>
</tr>
<tr>
<td>PYU44P06</td>
<td>Modern Optics (S2)</td>
<td>5</td>
</tr>
<tr>
<td>PYU44A03</td>
<td>Planetary and Space Science and Cosmology (S1 &amp; S2)</td>
<td>10</td>
</tr>
<tr>
<td>PYU44C01</td>
<td>Computer Simulation III (S2)</td>
<td>5</td>
</tr>
<tr>
<td>PYU44PP1</td>
<td>Physics Research Project (S1 &amp; S2)</td>
<td>20</td>
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<tr>
<td>PYU44PP5</td>
<td>Problem Solving in Physics (S1)</td>
<td>5</td>
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</tbody>
</table>

**PYU44P01 Quantum Mechanics and High Energy Physics (S1 & S2) 10 credits**
The quantum mechanics component of this module extends the discussion of quantum physics into the areas of multi-electron atoms, the time dependent Schrödinger Equation and perturbation theory. The high-energy physics component covers the theory and experimental investigation of fundamental particles, including the Standard Model.

**PYU44P05 Electromagnetic Interactions II (S2) 5 credits**
This module covers electromagnetic wave phenomena together with optical communications.

**PYU44P06 Modern Optics (S2) 5 credits**
This module covers the optical properties of materials and nonlinear optics.

**PYU44A03 Planetary and Space Science and Cosmology (S1 & S2) 10 credits**
This module covers advanced stellar structure and planetary systems. This is combined with a treatment of cosmology, in which the basic equations of cosmology are derived and used 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.

**PYU44C01 Computer Simulation III (S2) 5 credits**
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.

**PYU44PP1 Physics Research Project (S1 & S2) 20 credits**
This module comprises a 9-week full-time research project in astrophysics or physics, undertaken at the beginning of semester 1. The project may be undertaken in Trinity, or in another University or Research Institute in Ireland or abroad.

**PYU44PP5 Problem Solving in Physics (S1) 5 credits**
This module develops techniques and approaches for solving problems in physics.
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
The Physiology Moderatorship provides students with a thorough grounding in the mechanisms underlying the function of the body, from the cellular to the whole-body level. All physiological systems are studied in-depth with the focus on the physiology and pathophysiology of the human body.

In the senior sophister year, students undertake advanced physiology modules and research that reflect the current research interests of the academic staff of the Department. This includes students conducting a full-time individual laboratory-based research project. Projects range from cellular and molecular physiology through to human clinical and exercise physiology.

Students develop a number of key transferable skills including problem solving, critical thinking, IT and numeracy skills. We place an emphasis on developing students’ communication skills, with each student giving multiple oral presentations and writing many reports throughout their two years in the Department.

The Course structure of the Moderatorship in Physiology is as follows:

**Junior Sophister:**
- **Modules:** 55 Physiology credits + 5 credits in another JS Science module (often Comparative Physiology from the Zoology Department) or Trinity Elective, making a total of 60 credits.
- **Assessment:** Some modules are assessed in-course, in whole or in part. Annual Examination - Three three-hour papers.

**Senior Sophister:**
- **Modules:** 60 Physiology credits. This includes a major individual research project [PGU44005] and a comprehensive literature review and preparatory research skills [PGU44003].
- **Assessment:** All modules are partly assessed in-course. Annual examination – Three three-hour papers and a *viva voce* examination.
Junior Sophister 60 credits

PGU33001 Research skills (S1 & S2) 5 credits
This module aims to develop the research skills necessary for successful completion of the moderatorship in Physiology. It incorporates a personal development programme, run in association with the careers advisory service, instruction in data handling, statistics and laboratory skills, and lectures in core concepts of Physics and Chemistry that relate to Physiology.

PGU33008 Physiology of brain, nerve and muscle (S1) 5 credits
This module covers the function of the central and peripheral nervous systems, with in-depth lectures on muscle function, sensory physiology and the neurophysiology of the brain. The muscle function component covers the neural control of muscle contraction, muscle fibre types and the effect of exercise. The lectures in sensory physiology cover basic properties of sensory processing with details on the physiological properties of the somatosensory system, vision, hearing, smell and taste.

PGU33014 Cell physiology (S1) 5 credits
This module covers advanced topics in the cell membrane, neurotransmitters and receptors. The module comprises lectures and student-led seminars.

PGU33006 Nerve, muscle and sensation (S1) 5 credits
This laboratory-based module complements the lecture material covered in PGU33008 and examines aspects of nerve-muscle function and sensory physiology. First, basic principles of nerve conduction are examined through computer simulations of the amphibian nerve. Laboratory and tutorial work cover human nerve-muscle function, and the recording of muscle activity through electromyography (EMG). Finally, small group experiments are conducted on a sensory system (including touch, pain, audition, smell and taste).

PGU33005 Cell and tissue structure (S1) 5 credits
The lectures cover basic tissue structure and function. The laboratory classes teach recognition of tissues and a broader understanding of the relationship of structure to function. Students consider changes in tissue structure in relation to physiological, pathophysiological and developmental states.

PGU33013 Journal club (S2) 5 credits
This module consists of seminars that give an opportunity to study recent scientific articles and to acquire the necessary skills for evaluating them. The journal articles selected complement material learned by students in taught modules, with a focus on exercise and neurophysiology.

PGU33011 Gut, metabolism and hormones (S2) 5 credits
This module includes lectures on the endocrine regulation of physiological function, renal and GIT function, growth, metabolism and reproductive function. Lectures are shared with the first Medical year.
PGU33007 Fluids, heat and metabolism (S2) 5 credits
This module deals with the regulation of temperature, metabolism and fluids, and particularly how this occurs during thermal stress and exercise. It includes lectures, tutorials and laboratory experiments, as well the delivery of visual and written presentations of a topic of interest to the student.

PGU33010 Cardiovascular physiology (S2) 5 credits
This module covers the function and regulation of the cardiovascular system and includes lectures, laboratory classes, workshops and group projects. The lectures examine the functioning and regulation of the circulatory system, using the themes of adaptive responses to exercise and environmental change.

PGU33012 Respiratory physiology (S2) 5 credits
This module covers the function and regulation of the respiratory system and includes lectures, laboratory classes, workshops and group projects. Topics include respiratory mechanics, lung compliance and airway resistance, transport of oxygen and carbon dioxide, the role of respiration in acid-base homeostasis and respiration in altered environments.

PGU33015 Physiological pharmacology (S2) 5 credits
Key concepts of drug action and drug development including drug toxicity are explored. Gene-based therapy, immunotherapy and neuropharmacology are discussed.

Trinity Elective https://www.tcd.ie/TEP/trinity_electives.php. 5 credits
Senior Sophister                                       60 credits

PGU44001 Synaptic properties (S1+S2)                                 5 credits
This advanced module covers mechanisms of synaptic communication. Topics include: voltage-gated ion channels, chemically-gated ion channels, neuronal circuitry in the brain, synaptic plasticity. Electrophysiological techniques for recording of potentials and currents from brain cells including whole cell currents and single channel currents are described.

PGU46006 Biomechanics and neural control of movement (S1+S2)                 5 credits
This lecture and laboratory module cover the basic laws of mechanics as they apply to the movement of living organisms, especially man, and the role of muscle and environmental forces in aiding equilibrium and controlling movement. The underlying neural control of movement is examined through experiments recording muscle activity during everyday actions, use of 3D motion capture, neural stimulation and considering patient case studies.

PGU44007 Glial physiology (S1+S2)                                              5 credits
This lecture-based module is designed to explore the neurobiology of glia and assess the impact of glia on nervous system function. The first part of the module is designed to provide an understanding of microglial plasticity and appreciate their ability to adopt different phenotypes. The diverse roles of microglia will be considered. Special focus will be placed on their phagocytic role and the changes that occur in microglia to facilitate phagocytosis. The importance of cytoskeletal proteins in enabling phagocytosis will be explored.

PGU44009 Techniques in cellular physiology (S1+S2)                                            5 credits
This module aims to provide theoretical knowledge and practical experience of modern techniques used in cell physiology research. Topics include: cell culture, molecular biology, gene silencing, the use of ratiometric dyes, gel electrophoresis and western immunoblotting, biochemical protein analysis, confocal microscopy, suction electrode recording and preparation of solutions, bench work. A practical demonstration will accompany most of the lecture topics where students will gain ‘hands on’ experience.

PGU44002 Journal club (S1+S2)                                 5 credits
This module consists of student-led discussions of original, recently-published, journal articles in various aspects of physiological research, in particular cellular and molecular approaches.

PGU44003 Advanced research skills (S1)                                              5 credits
This module covers data handling and laboratory skills as well as production of an extensive review of the literature relevant to the student’s research project. Seminars are also included to enhance students’ general understanding of the biomedical sciences and the ethical issues involved in physiological research and in the translation of physiological findings to a clinical setting.
PGU44005 Research project (S2) 15 credits
Each student engages in a laboratory-based, full-time, original research project during Hilary term. During their research project students typically participate in weekly laboratory meetings led by their project supervisor. Students are required to deliver oral presentations of their research plans and research results to the Department of Physiology. Students write a final project report in the style of the *Journal of Physiology*.

PGU44008 Integrative physiology (S1+S2) 15 credits
This interactive workshop-based module is intended to develop students’ understanding of physiology as a whole-body science and to reinforce core concepts in systems physiology. The teaching is based on student-led discussions of a set discussion topic in Physiology, including presentation of relevant material from recent journal articles.
**Physiology Moderatorship Learning Outcomes**

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

- Studied all systems of the human body, including the nervous, musculoskeletal, gastrointestinal, immune, endocrine, reproductive, cardiovascular and respiratory systems, in both lecture and practical laboratory settings.

- Developed key practical laboratory skills in molecular and cellular physiology, human neurophysiology and exercise physiology.

- Developed general research skills including data handling, statistical analysis of data and critical analysis of published journal articles.

- Applied their knowledge of physiology to discuss clinical case studies and topical issues and problems in physiology in an integrated manner.

- Completed a full-time, individual original research project in an aspect of physiology, have written-up this project according to the standards of the *Journal of Physiology* and presented the results to their peers and academic staff in oral 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. Mandatory core modules make up 55 credits with 5 credits of Trinity Electives making up the balance.

**Senior Sophister:**

In addition to prescribed modules, students will select five areas of specialisation from the range of electives offered (25 credits total), attend research seminars and carry out a research project (20 credits). 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 60 credits

Semester 1 and 2 are indicated by S1 and S2.

Core Modules 55 credits

ZOU33000 Marine Biology (Prof. Nessa O’Connor) (S1) 5 credits
This team-taught module, which includes a residential field course element in the first week of the Semester 1, 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.

ZOU33003 / ZOU33004 Animal Diversity Parts 1 & 2 (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 (ZOU33003) and vertebrate (ZOU33004) animals. The module is based on lectures, practical’s and demonstrations from the Zoological museum collection.

ZOU330XX Evolution (Prof Nicola Marples) (S1) 5 credits
This module explores evolutionary concepts in greater detail giving insights into the processes underlying evolution with a focus on whole organism evolution and zoology. It covers different types of selection, co-evolution, sociality and altruism among other topics. [module code to be confirmed]

ZOU33030 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 infra-community and component community level is developed. Parasites of human importance receive particular emphasis.

ZOU33050 Introduction to Developmental Biology (Prof. Paula Murphy) (S1) 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.

ZOU33070 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 (FBU44000) and the project proposal.
ZOU33085 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.

ZOU33010 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.

BOU33122 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 practical's will provide students with the skills for sampling and identification of insects, which will be further enhanced through small group and individual projects.

Optional Modules

Trinity Electives (S1 or S2) https://www.tcd.ie/TEP/trinity_electives.php. 5 credits
Senior Sophister Modules 60 credits

Semester 1 and 2 are indicated by S1 and S2.

Core Mandatory Modules 35 credits

FBU44000 Research Project (All staff) (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.

ZOU44020 General Zoology (All staff) (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. Appropriate literature relating to the Junior Sophister mandatory modules will be recommended for detailed study.

ZOU44030 Data Handling (Prof. Andrew Jackson) (S1) 5 credits
This module will build on material from the 3rd year Experimental Design and Analysis (ZO3070) module, introducing more advanced statistical methods suitable for direct application in the Research project. The focus is on the framework of Generalised Linear Modelling using the R statistical software introduced in year 3.

ZOU44060 Research Comprehension (Prof. Pepijn Luijckx) (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. Assessment for this module will take place in S2 only.

Optional Modules 25 credits
Students select 5 of the 5 ECTS tutorial modules on offer. Each module will include lectures and student participation in the form of presentations, debates or critiques as appropriate.

ZOU44012 Advances in Parasitology (Prof. Celia Holland) (S1) 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.
ZOU44013 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.

ZOU44017 Tropical Ecology (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 montane 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.

ZOU44092 Environmental Impact Assessment (Prof. John Rochford) (S1) 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.

ZOU440XX 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. [module code to be confirmed]

BOU44107 Plant-Animal Interactions (Prof. Jane Stout) (S1) 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).

BOU44111 Restoration Ecology and Re-wilding (Prof. Marcus Collier) (S1)

Restoration ecology, like conservation biology, is a ‘crisis’ discipline, having emerged as a scientific response to the ecological damage caused by human activities. Restoration ecology has many positive outcomes but has also a lot of controversy. Re-wilding and novel ecosystems are new, daring and controversial areas within restoration ecology making it difficult to know how and when to intervene. This module will introduce you to the challenges and opportunities, failings and fallacies of the complex world of restoration ecology and the work of restoration ecologists. It will look at how re-wilding could be the best nature-based solution and how novel ecosystems could be the worst.
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 analysis
- 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 2020. Attendance at all workshops is compulsory.

**Assessment and Examination Procedures:**

The lecture material will be examined in module examination papers taken during the examination periods. 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 lecture courses 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 and option lecture courses 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

CHU33103 Organometallics & Coordination Chemistry (Inorganic Chemistry I) (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 the Inorganic component of the laboratory exercises.

CHU33104 Solid State Materials (Inorganic Chemistry II) (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

CHU33203 Synthetic Organic Chemistry I (S1) 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 stereo electronic effects, physical organic chemistry. **NOTE:** 50% of the marks for this module are associated with the Organic component of the laboratory exercises.

CHU33204 Synthetic Organic Chemistry II (S2) 5 credits
This module covers topics such as heterocyclic chemistry, organoheteroatom chemistry, and FGI and retrosynthesis.

Physical Chemistry

CHU33303 Quantum Mechanical Concepts (Physical Chemistry I) (S1) 5 credits
This module deals with quantum mechanics, spectroscopy and group theory.

CHU33304 Molecular Thermodynamics and Kinetics (Physical Chemistry II) (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 the Physical component of the laboratory exercises.

Interdisciplinary Modules

CHU33403 Analytical Methods (Interdisciplinary Module I) (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

CHU33701 Computational Chemistry I (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. The module also covers programming and related skills, with courses on Unix and Fortran 90(+). The programming elements are assessed during the year through practicals and assignments (50%) with the remaining 50% assessed by examination.
## Senior Sophister Modules

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<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>CHU44720</td>
<td>Research in Chemistry (S1)</td>
<td>20</td>
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<tr>
<td>CHU44112</td>
<td>Advanced Organic Transformations I (S2)</td>
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<tr>
<td>CHU44105</td>
<td>Advanced Inorganic Chemistry II (S2)</td>
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<td>CHU44167</td>
<td>Advanced Physical Chemistry I (S2)</td>
<td>10</td>
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<tr>
<td>CHU444708</td>
<td>Advanced topics and problem solving (CMM) (S1 &amp; S2)</td>
<td>10</td>
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<tr>
<td>CHU44701</td>
<td>Advanced Molecular Modelling II (S2)</td>
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### CHU44720 Research in Chemistry (S1) 20 Credits
This module is a research project undertaken in a research lab in Trinity in other universities around the world which can be arranged in the JS year through the Schools international coordinator. Assessment is via production of a thesis, oral presentation of a research seminar and *viva voce* examination.

### CHU44112 Advanced Organic Transformations I (S2) 5 credits
This module involves core lectures in organic and biological photochemistry and reactive intermediates.

### CHU44105 Advanced Inorganic Chemistry II (S2) 5 credits
This module involves core courses in heavy transition metal chemistry and in advanced coordination chemistry.

### CHU44167 Advanced Physical Chemistry I (S2) 10 credits
This module involves core courses in quantum chemistry, solid state chemistry, photochemistry and electrochemical devices.

### CHU444708 Advanced topics and problem solving (CMM) (S1 & S2) 10 credits
In this module students take two compulsory courses in quantum chemistry and statistical thermodynamics and select two advanced options courses from a list which currently includes: Matter Transport in Solids, Heterogeneous Catalysis, Supramolecular Chemistry, Topics in Structural Chemistry, Organic Synthetic Methods II, Aspects of Inorganic Chemistry, Special topics in Organic Chemistry, DNA Structure and Drug-DNA Complexes, Bio-Organic Chemistry, Electrochemical Biosensors, Material Synthesis using Chemical Vapour Deposition. Note that not all option courses may be offered in any given year. See Senior Sophister Course Booklet for further details.
In addition, students will be given self-directed learning and undertake a series on problems both during the first semester and under exam conditions in the second semester.

### CHU44701 Advanced Molecular Modelling II (S2) 10 credits
Courses in high performance computing, advanced molecular dynamics, computational drug design and more advanced lectures in molecular quantum chemistry.
Chemistry with Molecular Modelling Moderatorship Learning Outcomes

On the 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 are 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 practical’s, tutorials and research essays. Additionally, students have an opportunity to select a Trinity Elective.

**Assessment and Examination Procedures:**

Most JS modules are examined by five papers in end of semester examinations. Some modules, and all practical’s, 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 examinations at end of the Senior Sophister year comprises three papers. In these three papers, the lecture modules are assessed. Additionally, there is a problems assessment during the first semester in which the ability of students to solve specific problems one often encounters in genetic research is tested.

**Trinity Electives:** Students can freely choose between available Trinity Electives  5 credits
Junior Sophister Modules

GEU33002 EUKARYOTIC MOLECULAR 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.

GEU33003 GENOMICS (S1) 5 credits
This module provides an introduction to Genomics and Systems Biology, to Bioinformatics and to key techniques used in Molecular Biology.

GEU33006 EVOLUTIONARY GENETICS (S1) 5 credits
This module provides an introduction to genetic variation – its origins and its evolutionary consequences.

GEU33007 MOLECULAR GENETICS LABORATORY (S1) 5 credits
This practical class introduces students to standard methods of Molecular Genetics.

GEU33009 DATA HANDLING (S1) 5 credits
This module focuses on the handling and analysis of data and includes bioinformatics, computer programming (Perl language) and statistics.

GEU33001 BACTERIAL GENETICS (S2) 5 credits
This module presents an evidence-based description of the basic cellular processes of transcription, translation and DNA replication in bacteria.

GEU33004 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.

GEU33005 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.

GEU33008 ANALYTICAL GENETICS LABORATORY (S2) 5 credits
This practical class introduces students to standard methods of Analytical Genetics.

GEU33202 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.

GEU33201 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.
Senior Sophister Modules  

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
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<tr>
<td>Research Project (S1 and S2)</td>
<td>20</td>
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<tr>
<td>Literature Review (S1)</td>
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<tr>
<td>Problem-solving in Genetics (CA)</td>
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Lecture Module GEU44202: Human Genetics Core Curriculum I  

<table>
<thead>
<tr>
<th>Course</th>
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<tr>
<td>Genetic and Epigenetics of Cancer (Prof Bracken; S2)</td>
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</table>

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.

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.

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.
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.

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.

Lecture Module GEU44203: Human Genetics Core Curriculum II 10 credits

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.

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.
**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.

**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.

**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?

**Lecture Module GEU44204: Principles of Human Genetics and General Genetics 10 credits**

**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 popuation 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.
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.

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 Weischau.

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.
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.
• 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.
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 wide range of careers in industry, academia and the professions.

**Junior Sophisters:**

The JS year consists of 60 credits.

The courses and practical classes are indicated in greater detail below.

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

**Assessment and Examination Procedures:** The lecture material in Medicinal Chemistry will be examined in five examination papers taken in the semester examination periods. All examined modules are weighted according to their respective credit rating. 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 term long project in a research lab (see below for further details).

Assessment and Examination Procedures: The lecture courses will be examined in five papers taken in the semester examination periods. The Research Project is assessed in course. The SS year has a total of 60 ECTS, broken down as follows:

Project mark: 20 credits 33.33%
Problem-solving viva 1 credit 1.67%
Examinations: 39 credits 65%

The final degree mark will comprise 35% from your JS mark and 65% from your SS mark. There will be a 1.5-hour moderatorship examination for 5-ECTS modules that are assessed by examination and a 3-hour examination for 10-ECTS modules, with each 5-ECTS paper being worth 8.3% of the overall mark for the SS year (16.67% for 10-ECTS modules/exams). The mark from the problem-solving viva question will contribute 10% to the mark for CHU44408. Further information relating to the assessed components, organisation 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

CHU33203 Synthetic Organic Chemistry I (S1) 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 & stereo electronic effects and physical organic chemistry. A laboratory part of this module is aimed at broadening the student’s knowledge in Organic Chemistry. Organic chemistry lab marks (5 ECST) from labs will be included in the mark for this module.

CHU33204 Synthetic Organic Chemistry II (S2) 5 credits
This module covers topics such as heterocyclic chemistry, organoheteroatom chemistry and FGI & retrosynthetic.

Medicinal Chemistry

CHU33441 Medicinal Chemistry (S2) 5 credits
This module includes an introduction to medicinal chemistry, anti-viral and anti-cancer chemistry and the computational method QSAR.

CHU33446 Microbiology and Pharmacology (S2) 5 credits
This module covers antimicrobial agents, steroids and antimalarial chemistry.

CHU33447 Biochemistry and Pharmaceutical Chemistry (S1) 5 credits
This module covers protein structure and chemistry, steroid drugs, receptor pharmacology and the autonomic nervous system.

Inorganic Chemistry

CHU33103 Organometallics & Coordination Chemistry (S1) 10 credits
This module covers topics such main group and transition metal organometallics, transition metal compounds and complexes, homogeneous catalysis and inorganic reactions mechanism. A laboratory part of this module is aimed at broadening the student’s knowledge in Inorganic Chemistry. Inorganic chemistry lab marks (5 ECST) from labs will be included in the mark for this module.

Physical Chemistry

CHU33304 Molecular Thermodynamics and Kinetics (S2) 10 credits
This module deals with thermodynamics and statistical mechanics, electrochemistry and kinetics. A laboratory part of this module is aimed at broadening the student’s knowledge in Physical Chemistry. Physical chemistry lab marks (5 ECST) from labs will be included in the mark for this module.

Inter-Disciplinary Modules

CHU33403 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.
CHU33404 Biomaterials and Macromolecules (S2) 5 credits
This module will cover bioorganic chemistry and natural products, bioinorganic chemistry, colloids and other soft matter systems.
Senior Sophister Courses  

**CHU44420 Research Project (S1)**  
20 credits  
This research-oriented module involves a term 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 research seminars.

**CHU4113 Advanced Organic Transformations (S2)**  
10 credits  
This module involves core lectures in organic and biological photochemistry, reactive intermediates and asymmetric synthesis and retrosynthesis.

**CHU44401 Advanced MedChem I (S2)**  
10 credits  
This module involves a) the chemistry, biochemistry and drugs associated with the central nervous system and b) computational medicinal chemistry and analytical methods.

**CHU44402 Advanced MedChem II (S2)**  
10 credits  
This module involves site-specific drug delivery, combinatorial chemistry and screening methods and the chemistry, biochemistry and drugs associated with the cardiovascular system and specialised case studies.

**CHU44408 MedChem Advanced Topics and Problem-Solving (S2)**  
10 credits  
This module involves Supramolecular Chemistry (CHU44025), Organic Synthetic Methods II (CHU44031), DNA Structure and Drug-DNA Complexes (CHU44034), Chemical Biology (CHU44036) and Problem-solving (self-directed and online learning); for further details see SS handbook.
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 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 pursued during the first nine weeks of 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**

**PYU33P01 Quantum Mechanics I (S1)**  
This module covers solution of the Schrödinger Equation in specific topics, such as angular momentum and the hydrogen atom.  

**PYU33P02 Electromagnetic Interactions I (S2)**  
This module covers the fundamentals of electromagnetic theory together with quantum optics and lasers.  

**PYU33P03 Condensed Matter I (S1)**  
This module introduces condensed matter concepts such as crystal structure and thermal and electronic properties of matter.  

**PYU33P04 Condensed Matter II (S2)**  
This module extends the discussion of condensed matter into the key areas of magnetic properties and the physics of semiconductors.  

**CHU33104 Solid State Materials (S2)**  
This module covers topics such as inorganic polymers, structural inorganic chemistry, synthetic methodologies and characterisation techniques of solid-state materials.  

**CHU33303 Quantum Mechanical Concepts in Physical Chemistry (S1)**  
This module deals with quantum mechanics, spectroscopy and group theory.  

**CHU33305 Molecular Thermodynamics and Kinetics (S2)**  
This module deals with thermodynamics and statistical mechanics, electrochemistry and kinetics.  

**CHU33403 Analytical Methods (S1)**  
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.  

**CHU33610 Practical in Advanced Materials (S1 & S2)**  
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.
Senior Sophister Modules* 60 credits

PYU44P03 Condensed Matter and Nanoscience (S1&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.

PYU44P06 Modern Optics (S2) 5 credits
This module covers optical properties of materials and nonlinear optics.

PYU44N07 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.

CHU44167 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.

CHU44601 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.

PYU44NP2 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.

PYU44NP5 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.
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.
Graduate Attributes

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

The four Trinity Graduate Attributes are:

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

Why are the Graduate Attributes important?

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

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

How will I develop these Graduate Attributes?

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

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

You will also develop them through the co-curricular and extra-curricular activities. If you help to run a club or society you will be improving your leadership skills, or if you play a sport you are building your communication and team-work skills.
## Appendix 1: General Information

<table>
<thead>
<tr>
<th>Item</th>
<th>Reference/Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Regulations</td>
<td>Calendar, Part II, General Regulations and Information, Section II, Item 12</td>
</tr>
<tr>
<td></td>
<td>Calendar, Part III, General Regulations, Section 1.20</td>
</tr>
<tr>
<td>Student Support</td>
<td>Student Supports &amp; Services</td>
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<tr>
<td></td>
<td>Student Services Booklet</td>
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<td>Senior Tutor &amp; Tutorial Service</td>
</tr>
<tr>
<td></td>
<td>Graduate Studies Mature Student Office</td>
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<tr>
<td>Co-curricular Activities</td>
<td>Central Societies Committee</td>
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<td>DUCAC</td>
</tr>
<tr>
<td>Information on the TCDSU &amp; GSU, including Student Representation</td>
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<tr>
<td>Structures</td>
<td>TCDSU Student Representation Overview</td>
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<td>TCD GSU</td>
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<td>GSU - Student Representation Overview</td>
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<tr>
<td>Emergency Procedure</td>
<td>In the event of an emergency, <strong>dial Security Services on extension 1999</strong></td>
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<tr>
<td></td>
<td>Security Services provide a 24-hour service to the college community, 365 days a</td>
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<td>year. They are the liaison to the Fire, Garda and Ambulance services and all</td>
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<td></td>
<td>staff and students are advised to always telephone extension 1999 (+353 1 896</td>
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<td></td>
<td>1999) in case of an emergency.</td>
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<td></td>
<td>Should you require any emergency or rescue services on campus, you must contact</td>
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<td></td>
<td>Security Services. This includes chemical spills, personal injury or first aid</td>
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<td>assistance.</td>
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<td>It is recommended that all students save at least one emergency contact in their</td>
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<td>phone under ICE (In Case of Emergency).</td>
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<td><strong>Reference/Source</strong></td>
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<tr>
<td>Data Protection</td>
<td>Data Protection for Student Data</td>
</tr>
<tr>
<td>Timetable</td>
<td>My TCD</td>
</tr>
<tr>
<td>Key Locations</td>
<td>Blackboard Academic Registry</td>
</tr>
<tr>
<td>Internships/Placements for Credit</td>
<td>Provided by School/Discipline Handbook</td>
</tr>
<tr>
<td>Health and Safety Statements</td>
<td>Provided by School/Discipline Handbook</td>
</tr>
</tbody>
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| Plagiarism & Referencing Guidance            | Calendar, Part II, General Regulations and Information, Section II, Item 82  
                                        | Calendar, Part III, General Regulations & Information, Section 1.32  
                                        | Plagiarism Policy                                           
                                        | Plagiarism Declaration                                     
<pre><code>                                    | Library Guides - Avoiding Plagiarism                       |
</code></pre>
<p>| Explanation of ECTS Weighting                | Description of ECTS for use in Course Handbooks              |
| Programme Structure &amp; Workload               | Policy on Trinity Virtual Learning Environment                |
| Study Abroad                                 | Provided in School/Discipline Handbook.                      |
| Coursework Requirements                      | Student Learning Development                                  |
| Marking Scale                                | Calendar, Part II, General Regulations &amp; Information, Section II, Item 30  |
| Awards                                       | National Framework for Qualifications                        |</p>
<table>
<thead>
<tr>
<th>Item</th>
<th>Reference/Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Progression Regulations</td>
<td>Calendar, Part II, General Regulations &amp; Information</td>
</tr>
<tr>
<td></td>
<td>Calendar, Part II, Part C</td>
</tr>
<tr>
<td></td>
<td>Calendar, Part III, Section 3.8</td>
</tr>
<tr>
<td></td>
<td>See Science Sophister Course Programme Page 9</td>
</tr>
<tr>
<td>Attendance Requirements</td>
<td>Calendar, Part II, General Regulations and Information, Section II, Items 17-23</td>
</tr>
<tr>
<td></td>
<td>Calendar, Part III, General Regulations and Information, Sections 1.23; 2.11; and 3.2</td>
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<tr>
<td>Absence from Examinations</td>
<td>Calendar, Part II, General Regulations and Information, Section II, Item 35</td>
</tr>
<tr>
<td></td>
<td>Calendar, Part III, Section 3.5</td>
</tr>
<tr>
<td>Reference to Relevant University Regulations</td>
<td>Academic Policies</td>
</tr>
<tr>
<td></td>
<td>Student Complaints Procedure</td>
</tr>
<tr>
<td></td>
<td>Dignity &amp; Respect Policy</td>
</tr>
<tr>
<td>Feedback and Evaluation</td>
<td>Student Evaluation and Feedback</td>
</tr>
<tr>
<td></td>
<td>Student Partnership Policy</td>
</tr>
<tr>
<td>Foundation Scholarships</td>
<td>Calendar, Part II, Foundation and Non- Foundation Scholarships</td>
</tr>
<tr>
<td>Prizes, medals and other scholarships</td>
<td>Provided in Schools/Discipline Handbooks</td>
</tr>
</tbody>
</table>
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.

Produced by: The Science Course Office
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