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
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

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>1</td>
</tr>
<tr>
<td>Allocation of Places</td>
<td>1</td>
</tr>
<tr>
<td>Choice of subject form</td>
<td>3</td>
</tr>
<tr>
<td>Course Advisors</td>
<td>4</td>
</tr>
<tr>
<td>Moderatorships Pre-requisites &amp; Quotas</td>
<td>5</td>
</tr>
<tr>
<td>Table of Pre-requisites</td>
<td>6</td>
</tr>
<tr>
<td>Changing Course</td>
<td>8</td>
</tr>
<tr>
<td>Field Courses</td>
<td>8</td>
</tr>
<tr>
<td>Non-Satisfactory Attendance and Course Work</td>
<td>8</td>
</tr>
<tr>
<td>Junior Sophister Examinations</td>
<td>9</td>
</tr>
<tr>
<td>Dates to Note</td>
<td>11</td>
</tr>
<tr>
<td><strong>TR071</strong></td>
<td></td>
</tr>
<tr>
<td>BIOCHEMISTRY</td>
<td>12</td>
</tr>
<tr>
<td>CHEMISTRY</td>
<td>17</td>
</tr>
<tr>
<td>ENVIRONMENTAL SCIENCE</td>
<td>22</td>
</tr>
<tr>
<td>GENETICS</td>
<td>30</td>
</tr>
<tr>
<td>GEOGRAPHY</td>
<td>38</td>
</tr>
<tr>
<td>GEOLOGY</td>
<td>47</td>
</tr>
<tr>
<td>IMMUNOLOGY</td>
<td>53</td>
</tr>
<tr>
<td>MICROBIOLOGY</td>
<td>58</td>
</tr>
<tr>
<td>MOLECULAR MEDICINE</td>
<td>65</td>
</tr>
<tr>
<td>NEUROSCIENCE</td>
<td>70</td>
</tr>
<tr>
<td>PHYSICS</td>
<td>75</td>
</tr>
<tr>
<td>PHYSICS and ASTROPHYSICS</td>
<td>79</td>
</tr>
<tr>
<td>PHYSIOLOGY</td>
<td>84</td>
</tr>
<tr>
<td>PLANT SCIENCES</td>
<td>90</td>
</tr>
<tr>
<td>ZOOLOGY</td>
<td>97</td>
</tr>
<tr>
<td><strong>TR074</strong></td>
<td></td>
</tr>
<tr>
<td>Chemistry with Molecular Modelling</td>
<td>103</td>
</tr>
<tr>
<td><strong>TR073</strong></td>
<td></td>
</tr>
<tr>
<td>Human Genetics</td>
<td>109</td>
</tr>
<tr>
<td><strong>TR075</strong></td>
<td></td>
</tr>
<tr>
<td>Medicinal Chemistry</td>
<td>118</td>
</tr>
<tr>
<td><strong>TR076</strong></td>
<td></td>
</tr>
<tr>
<td>Nanoscience, Physics and Chemistry of Advanced Materials</td>
<td>124</td>
</tr>
</tbody>
</table>
FOREWORD

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

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

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

Professor Kevin Mitchell
Associate Dean of Undergraduate Science Education
Introduction

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

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

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

Allocation of Places

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

The numbers of places available in each moderatorship subject is limited by quota. Admission is based on the overall mark obtained in the Senior 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.

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

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

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

3. Students failing the Annual examinations must reapply for the remaining unfilled places until quotas are reached. Second round choice of subject forms will be made available on-line following publication of the Annual examination results. http://www.tcd.ie/Science/current/sophister/js-moderatorship-form.php. The closing date for the online second round form is Friday 25th August 2017.
4. In the event of two or more students having equal overall averages seeking one place, the choice will be made in favour of the student gaining the higher mark in the SF module that are pre-requisites for the moderatorship in question.

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

6. Publication of the JS places will be available by student number on the science website https://www.tcd.ie/Science/local/, by the end of July 2017 and on the Science Course notice-boards. Places are listed anonymously and by student number.

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

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

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

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

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

Special note: Students who have passed their Senior Freshman examinations may not repeat the SF year in order to improve their performance.
The choice of subject form is available online: 
http://www.tcd.ie/Science/current/sophister/

The form may be submitted online or returned as a hardcopy to the Science Course Office. The closing date is 31st March 2017. Failure to meet this deadline will disadvantage you in relation to your choice of department.
<table>
<thead>
<tr>
<th>Course Advisers</th>
<th>Prof. 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>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. I. Donohue</td>
<td><a href="mailto:donohui@tcd.ie">donohui@tcd.ie</a></td>
</tr>
<tr>
<td>Genetics</td>
<td>Prof. D. Bradley</td>
<td><a href="mailto:daniel.brady@tcd.ie">daniel.brady@tcd.ie</a></td>
</tr>
<tr>
<td>Geography</td>
<td>Prof. P. Coxon</td>
<td><a href="mailto:pcoxon@tcd.ie">pcoxon@tcd.ie</a></td>
</tr>
<tr>
<td>Geology</td>
<td>Prof. D. Chew</td>
<td><a href="mailto:chewd@tcd.ie">chewd@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>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. E. Scanlan</td>
<td><a href="mailto:scanlae@tcd.ie">scanlae@tcd.ie</a></td>
</tr>
<tr>
<td>Microbiology</td>
<td>Prof. A. Fleming</td>
<td><a href="mailto:alastair.fleming@tcd.ie">alastair.fleming@tcd.ie</a></td>
</tr>
<tr>
<td>Molecular Medicine</td>
<td>Prof. F. Sheedy</td>
<td><a href="mailto:fsheedy@tcd.ie">fsheedy@tcd.ie</a></td>
</tr>
<tr>
<td>Neuroscience</td>
<td>Prof. A. Minogue</td>
<td><a href="mailto:aminogu@tcd.ie">aminogu@tcd.ie</a></td>
</tr>
<tr>
<td>Physics</td>
<td>Prof. C. Patterson</td>
<td><a href="mailto:charles.patterson@tcd.ie">charles.patterson@tcd.ie</a></td>
</tr>
<tr>
<td>Physics and Astrophysics</td>
<td>Prof. C. Patterson</td>
<td><a href="mailto:charles.patterson@tcd.ie">charles.patterson@tcd.ie</a></td>
</tr>
<tr>
<td>Nanoscience, Physics and Chemistry of Advanced Materials</td>
<td>Prof. I. Gounko</td>
<td><a href="mailto:npcam@tcd.ie">npcam@tcd.ie</a></td>
</tr>
<tr>
<td>Plant Sciences</td>
<td>Prof. J. Parnell</td>
<td><a href="mailto:john.parnell@tcd.ie">john.parnell@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. J. Rochford</td>
<td><a href="mailto:rchfordj@tcd.ie">rchfordj@tcd.ie</a></td>
</tr>
</tbody>
</table>
Moderatorship Pre-Requisites & Quotas

To be qualified for a moderatorship, students must have completed satisfactorily both Freshman years and must have taken the stated prerequisite modules (see page 7) for any moderatorship for which they wish to be considered. Students who have not completed the pre-requisites for a moderatorship may still be considered for that moderatorship subject to the following:

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

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

<table>
<thead>
<tr>
<th>Moderatorship</th>
<th>Quotas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biochemistry</td>
<td>24</td>
</tr>
<tr>
<td>Chemistry</td>
<td>28</td>
</tr>
<tr>
<td>Environmental Sciences</td>
<td>25</td>
</tr>
<tr>
<td>Genetics</td>
<td>20</td>
</tr>
<tr>
<td>Geography</td>
<td>15</td>
</tr>
<tr>
<td>Geology</td>
<td>22</td>
</tr>
<tr>
<td>Immunology</td>
<td>20</td>
</tr>
<tr>
<td>Microbiology</td>
<td>30</td>
</tr>
<tr>
<td>Molecular Medicine</td>
<td>18</td>
</tr>
<tr>
<td>Neuroscience</td>
<td>22</td>
</tr>
<tr>
<td>Physics</td>
<td>26</td>
</tr>
<tr>
<td>Physics and Astrophysics</td>
<td>20</td>
</tr>
<tr>
<td>Physiology</td>
<td>18</td>
</tr>
<tr>
<td>Plant Sciences</td>
<td>24</td>
</tr>
<tr>
<td>Zoology</td>
<td>36</td>
</tr>
</tbody>
</table>
# Table of Prerequisites for Moderatorship 2017

<table>
<thead>
<tr>
<th>Moderatorship</th>
<th>Senior Freshman</th>
<th>Junior Freshman</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biochemistry¹</td>
<td>BY2201, BY2203, BY2205, BY2208</td>
<td>CH1101, CH1102, &amp; MA1S11 or MA1M01</td>
</tr>
<tr>
<td>Chemistry</td>
<td>CH2201, CH2202</td>
<td>CH1101, CH1102, &amp; MA1S11 or MA1M01</td>
</tr>
<tr>
<td>Environmental Sciences</td>
<td>4 of the following: BY2201, BY2202, BY2203, BY2204, BY2205, BY2206, BY2207, BY2208, BY2209, BY2210</td>
<td>BY1101, BY1102</td>
</tr>
<tr>
<td>Genetics</td>
<td>BY2201, BY2203, BY2205, BY2208</td>
<td>BY1101, CH1101, CH1102, &amp; MA1S11 or MA1M01</td>
</tr>
<tr>
<td>Geography</td>
<td>GG2024, GG2025</td>
<td>GG1024 and/or GG1025</td>
</tr>
<tr>
<td>Geology</td>
<td>GL2205, GL2206</td>
<td>GL1101</td>
</tr>
<tr>
<td>Immunology¹</td>
<td>BY2201, BY2203, BY2205, BY2208</td>
<td>CH1101, CH1102, &amp; MA1S11 or MA1M01</td>
</tr>
<tr>
<td>Microbiology</td>
<td>BY2201, BY2203, BY2205, BY2208</td>
<td>BY1101, CH1101, CH1102, &amp; MA1S11 or MA1M01</td>
</tr>
<tr>
<td>Molecular Medicine¹</td>
<td>BY2201, BY2203, BY2205, BY2208</td>
<td>CH1101, CH1102, &amp; MA1S11 or MA1M01</td>
</tr>
<tr>
<td>Neuroscience¹</td>
<td>BY2201, BY2202, BY2203, BY2208</td>
<td>CH1101, CH1102, &amp; MA1S11 or MA1M01</td>
</tr>
<tr>
<td>Physics</td>
<td>PY2P10, PY2P20, MA22S1, MA22S2, MA22S3, MA22S4</td>
<td>PY1P10, PY1P20, MA1S11, MA1S12</td>
</tr>
<tr>
<td>Physics and Astrophysics</td>
<td>PY2P10, PY2P20, MA22S1, MA22S2, MA22S3, MA22S4</td>
<td>PY1P10, PY1P20, MA1S11, MA1S12</td>
</tr>
<tr>
<td>Physiology²</td>
<td>BY2201, BY2202, BY2203, BY2208</td>
<td>MA1S11 or MA1M01</td>
</tr>
<tr>
<td>Plant Sciences</td>
<td>4 of the following: BY2201, BY2202, BY2203, BY2204, BY2205, BY2206, BY2207, BY2208, BY2209, BY2210</td>
<td>BY1101 or BY1102</td>
</tr>
<tr>
<td>Zoology</td>
<td>BY2201, BY2202, BY2203, BY2208</td>
<td>BY1101, BY1102, &amp; MA1S11 or MA1M01</td>
</tr>
</tbody>
</table>

¹Junior Freshman Biology 1101 is advisable
²Junior Freshman Biology 1101 and 1102 are advisable
## Junior Freshman Modules 2015/16

<table>
<thead>
<tr>
<th>Module</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BY1101</td>
<td>Molecular and Cellular Biology</td>
<td>10</td>
</tr>
<tr>
<td>BY1102</td>
<td>Evolution, Biodiversity &amp; the Environment</td>
<td>10</td>
</tr>
<tr>
<td>CH1101</td>
<td>General and Physical Chemistry</td>
<td>10</td>
</tr>
<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>
</tr>
<tr>
<td>MA1S11</td>
<td>Mathematics – Semester 1</td>
<td>10</td>
</tr>
<tr>
<td>MA1S12</td>
<td>Mathematics – Semester 2</td>
<td>10</td>
</tr>
<tr>
<td>MA1M01</td>
<td>Mathematical Methods</td>
<td>10</td>
</tr>
<tr>
<td>PY1P10</td>
<td>Physics – Semester 1</td>
<td>10</td>
</tr>
<tr>
<td>PY1P20</td>
<td>Physics – Semester 2</td>
<td>10</td>
</tr>
<tr>
<td>PY1F01</td>
<td>Foundation Physics for Life and Earth Sciences</td>
<td>10</td>
</tr>
</tbody>
</table>

## Senior Freshman Modules 2016/17

<table>
<thead>
<tr>
<th>Module</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BY2201</td>
<td>Cell Structure and Function</td>
<td>5</td>
</tr>
<tr>
<td>BY2202</td>
<td>Vertebrate Form and Function</td>
<td>5</td>
</tr>
<tr>
<td>BY2203</td>
<td>Metabolism</td>
<td>5</td>
</tr>
<tr>
<td>BY2204</td>
<td>Evolution</td>
<td>5</td>
</tr>
<tr>
<td>BY2205</td>
<td>Microbiology</td>
<td>5</td>
</tr>
<tr>
<td>BY2206</td>
<td>Ecosystem Biology and Global Change</td>
<td>5</td>
</tr>
<tr>
<td>BY2207</td>
<td>Behaviour</td>
<td>5</td>
</tr>
<tr>
<td>BY2208</td>
<td>Genetics</td>
<td>5</td>
</tr>
<tr>
<td>BY2209</td>
<td>Infection and Immunity</td>
<td>5</td>
</tr>
<tr>
<td>BY2210</td>
<td>Agriculture, Environment and Biotechnology</td>
<td>5</td>
</tr>
<tr>
<td>CH2201</td>
<td>Chemistry 1</td>
<td>10</td>
</tr>
<tr>
<td>CH2202</td>
<td>Chemistry 2</td>
<td>10</td>
</tr>
<tr>
<td>GG2024</td>
<td>Physical Geography: Changing Environments</td>
<td>10</td>
</tr>
<tr>
<td>GG2025</td>
<td>Human Geography: Changing Worlds</td>
<td>10</td>
</tr>
<tr>
<td>GL2205</td>
<td>The Dynamic Earth 1: rocks and evolution</td>
<td>10</td>
</tr>
<tr>
<td>GL2206</td>
<td>The Dynamic Earth 2: structure and microscopy</td>
<td>10</td>
</tr>
<tr>
<td>MA22S1</td>
<td>Multivariable calculus for Science</td>
<td>5</td>
</tr>
<tr>
<td>MA22S2</td>
<td>Vector calculus for Science</td>
<td>5</td>
</tr>
<tr>
<td>MA22S3</td>
<td>Fourier analysis for Science</td>
<td>5</td>
</tr>
<tr>
<td>MA22S4</td>
<td>Mechanics</td>
<td>5</td>
</tr>
<tr>
<td>MA22S6</td>
<td>Numerical and data analysis techniques</td>
<td>5</td>
</tr>
<tr>
<td>PY2P10</td>
<td>Classical Physics</td>
<td>10</td>
</tr>
<tr>
<td>PY2P20</td>
<td>Modern Physics</td>
<td>10</td>
</tr>
</tbody>
</table>
**Changing Course**

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

**Field Courses**

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

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

**Non-Satisfactory Attendance and Course Work**

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

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

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

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

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

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

Junior Sophister Passing by Compensation
In single honor courses, in order to pass by compensation a student must:
a) Have an overall mark of at least 40%, and
b) Pass outright modules totalling at least 40 credits, and
c) Get a minimum mark of 30% in each failed module, up to a maximum of 20 credits

Junior Sophister Passing by Aggregation
In single honor type courses, a student may pass by aggregation if they have a mark of less than 30% in one or more failed modules up to a maximum of 10 credits provided that they:
a) Have an overall result of at least 40%, and
b) pass outright modules totalling at least 40 credits, and
c) have a minimum mark of 30% in any remaining failed module.

To qualify to proceed to the Senior Sophister year, students sitting the Junior Sophister examination must pass the year and achieve an overall credit-weighted average mark of 45% or higher in the overall examination.
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.
<table>
<thead>
<tr>
<th>Day</th>
<th>Date</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thursday</td>
<td>23rd February 2017</td>
<td>Moderatorship Fair</td>
</tr>
<tr>
<td>Friday</td>
<td>31st March 2017</td>
<td>Closing date – Submit choice of subject forms</td>
</tr>
<tr>
<td>Friday</td>
<td>7th April 2017</td>
<td>Semester 2 - Hilary Lecture Term ends</td>
</tr>
<tr>
<td>Tuesday</td>
<td>2nd May 2017</td>
<td>Annual Examinations begin</td>
</tr>
<tr>
<td>Friday</td>
<td>26th May 2017</td>
<td>Annual Examinations end</td>
</tr>
<tr>
<td>Friday</td>
<td>16th June 2017</td>
<td>Annual Examination Results Published By end of July 2017</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Notification of JS Moderatorship Subject</td>
</tr>
<tr>
<td>Friday</td>
<td>25th August 2017</td>
<td>Closing date – 2nd Round Choice Subject Form</td>
</tr>
<tr>
<td>Monday</td>
<td>28th August 2017</td>
<td>Supplemental Examinations begin</td>
</tr>
<tr>
<td>Friday</td>
<td>8th September 2017</td>
<td>Supplemental Examinations end</td>
</tr>
<tr>
<td>Friday</td>
<td>15th September 2017</td>
<td>Supplemental Examination Results Published</td>
</tr>
<tr>
<td>Monday</td>
<td>18th September 2017</td>
<td>Notification of JS Moderatorship Subject (2nd Round)</td>
</tr>
<tr>
<td>Monday</td>
<td>25th September 2017</td>
<td>Semester 1 - Michaelmas Lecture Term begins</td>
</tr>
<tr>
<td>Friday</td>
<td>15th December 2017</td>
<td>Semester 1 - Michaelmas Lecture Term ends</td>
</tr>
</tbody>
</table>
Biochemistry is a moderatorship course run by the School of Biochemistry and Immunology. The focus is on understanding how living cells function at a molecular and cellular level. It encompasses a wide range of topics such as cancer biology, stem cell biology, immunology, neurobiology, developmental biology and drug discovery. Senior Sophister students spend a number of weeks in one of the research laboratories in the new Biomedical Sciences Institute where they conduct state-of-the-art research in areas such as cancer, obesity, ageing, neurobiology, nutrition, parasitology and biotechnology. Graduates in the discipline of biochemistry will be able to describe cellular function and regulation in terms of the molecules, proteins and structures involved, be trained in the application of appropriate technologies to investigate these processes and have a special insight into the nature of human pathological states and their treatment at a molecular level.

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

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

SS Assessment and Examination Procedures:
There are four final exam papers in the summer. Papers 1 and 2 contain questions on all the SS Biochemistry and Cell Biology lecture modules. Paper 3 examines problem solving and techniques and Paper 4 is general in nature and examines core concepts in Biochemistry and Cell Biology. Each paper carries equal marks and contributes a total of 66.6% to the final SS mark. The BI4015 data handling module covers quantitative biochemical problems, bioinformatics and molecular modelling. This module is examined by in-course assessment during the year and contributes 8.4% to the final mark. Finally, an 11-week research project will be carried out and contributes 25% to the SS mark. The overall degree mark is comprised of 80% of SS mark and 20% of JS mark.
### JUNIOR SOPHISTER MODULES

<table>
<thead>
<tr>
<th>Module Code</th>
<th>Module Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BI3110</td>
<td>PROTEIN STRUCTURE (S1)</td>
<td>10 credits</td>
</tr>
<tr>
<td>BI3120</td>
<td>MEMBRANE AND CELL BIOLOGY (S1)</td>
<td>10 credits</td>
</tr>
<tr>
<td>BI3010</td>
<td>NUCLEIC ACIDS (S2)</td>
<td>10 credits</td>
</tr>
<tr>
<td>BI3140</td>
<td>BIOCHEMISTRY IN HEALTH AND DISEASE (S2)</td>
<td>10 credits</td>
</tr>
<tr>
<td>BI3020</td>
<td>RESEARCH SKILLS (S1 &amp; S2)</td>
<td>10 credits</td>
</tr>
<tr>
<td>BI3115</td>
<td>BIOCHEMICAL ANALYSIS (S1)</td>
<td>5 credits</td>
</tr>
<tr>
<td>BC</td>
<td>BROAD CURRICULUM (S1 or S2)</td>
<td>5 credits</td>
</tr>
</tbody>
</table>

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

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

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

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

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

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

**BI4115 NEUROBIOLOGY (S1)**  5 credits
This module covers the structure, function and pharmacology of neurotransmitters, neuron-glia interactions, intraneuronal signalling and the neurobiology of behaviour and neurodegenerative disorders.

**BI4125 DEVELOPMENTAL BIOLOGY (S2)**  5 credits
This module covers the molecular basis of cellular differentiation and will describe how the vertebrate body plan is laid down.

**BI4025 MICROBIAL DISEASES (S1)**  5 credits
This module provides an introduction to parasitic protozoa such as trypanosomes and helminths. The biochemical and genetic mechanisms by which these parasites evade the host immune responses will be covered. Bacterial pathogens of medical importance will also be covered in detail.

**BI4145 STEM CELL BIOLOGY (S1)**  5 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 and the generation and use of transgenic organisms in research and medicine.

**BI4155 CANCER BIOLOGY (S1)**  5 credits
This module covers the molecular basis of cancer, the progression of the disease and the therapeutic treatment strategies.

**BI4165 METABOLIC DISEASES (S1)**  5 credits
This module covers the biochemistry of genetic deficiency diseases and metabolic diseases.

**BI4135 STRUCTURAL BIOCHEMISTRY AND CELLULAR IMAGING (S1 & S2)**  5 credits
This module addresses how biomolecular and cellular structure determine function. It also covers the high resolution and multidimensional imaging of molecules and cells.

**BI4175 IMMUNOLOGY (S1)**  5 credits
This module covers pathogen recognition by and signal transduction in immune cells. The biochemical and genetic mechanisms by which bacteria and viruses evade the host immune responses will be covered.

**BI4195 RESEARCH PROJECT IN BIOCHEMISTRY (S 1 & S2)**  15 credits
The module comprises of an original research project in biochemistry and a research thesis.

**BI4015 DATA HANDLING (S1 & S2)**  5 credits
This module covers quantitative biochemical problems, bioinformatics and molecular modelling.
Biochemistry Moderatorship Learning Outcomes:

On completion of this moderatorship students will be able to:

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

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

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

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

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

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

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

**Junior Sophisters:**

In addition to the core modules (55 credits), you may choose an optional module or a Broad Curriculum 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 period. 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

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

CH3104 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

CH3203 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 stereoelectronic effects, and physical organic chemistry. **NOTE:** 50% of the marks for this module are associated with the Organic component of the laboratory exercises.

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

Physical Chemistry

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

CH3304 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

CH3403 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.
CH3404 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

CH3441 Medicinal Chemistry (S1 & S2)  5 credits
This module encompasses an introduction to medicinal chemistry, antiviral and anticancer chemistry and the computational method QSAR.

OR

CH3601 Computational Chemistry (S1 & S2)  5 credits
This module covers numerical methods – optimisation, introduction to static and dynamic atomistic simulation, and computational molecular quantum chemistry.

OR

CH3602 Computational Chemistry II (S1 & S2)  5 credits
This module encompasses courses on Unix/Linux, Fortran 77 and Fortran 90+. This material is assessed during the year (no end-of-year examination).

OR

BC Broad Curriculum  5 credits
Senior Sophister Modules 60 credits

Research in Chemistry (S1)
This research-oriented module involves a research project and thesis, oral presentation of a research seminar and attendance at scheduled School research seminars. Note that the marks associated with the research project are included in module CH4119.

CH4112 Advanced Organic Transformations I (S2) 5 credits
This module involves core lectures in organic and biological photochemistry and reactive intermediates.

CH4113 Advanced Organic Transformations 2 (S2) 5 credits
This module involves core lectures in asymmetric synthesis and retrosynthesis.

CH4104 Advanced Inorganic Chemistry I (S2) 5 credits
This module involves core lectures on advanced inorganic materials and characterisation techniques in Bioinorganic Chemistry.

CH4105 Advanced Inorganic Chemistry II (S2) 5 credits
This module involves core lectures in heavy transition metal chemistry and in advanced coordination chemistry.

CH4106 Advanced Physical Chemistry I (S2) 5 credits
This module involves core lectures in photochemistry, redox active nanostructured materials and systems and advanced reaction dynamics.

CH4107 Advanced Physical Chemistry II (S2) 5 credits
This core module involves lectures in quantum chemistry and solid state chemistry.

CH4108 Option Module (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.

CH4119 Chemistry Research and Data Analysis 25 credits
This module combines the mark from the problem solving paper and the research project. The problem-solving element is a self-directed reading module that concentrates on a review and the attainment of a mature understanding of the fundamental chemical topics introduced over the entire period of the Moderatorship programme.
Chemistry Moderatorship Learning Outcomes

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

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

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

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

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

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

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

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

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

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

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

MANDATORY MODULES

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

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

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

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

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

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

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

OPTIONAL MODULES (students choose 15 credits from these modules)

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

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

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

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

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

MANDATORY MODULES

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

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

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

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

ZO4092 Environmental Impact Assessment (S2) 5 credits
This module involves an introduction to the principles and processes of Environmental Impact Assessment, particularly in relation to national and international requirements. All stages of the EIA process, from initial project screening to the final review, are covered, with the emphasis throughout on the role of the natural scientist. Strategic Environmental Assessment is also briefly covered. In addition to the lectures, students carry out a scoping exercise for a proposed development and conduct a quality review of an actual EIS.
BO4105 Global Environmental Change (S2) 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)

BO4013 Plant Conservation and Biodiversity (S1) 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.

ES4020 Water Technology (S1) 5 credits
This module sets out to examine the practical aspects of managing the human water cycle from water treatment and supply through wastewater characteristics, treatment and disposal. As an introductory module it is limited in what it covers, but is primarily designed for those who are interested in a possible future in the water industry, environmental consultancy or who want to do postgraduate studies in a water-related topic.

ZO4013 Conservation & Wildlife Management (S1) 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.

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

BO4107 Plant-Animal Interactions (S2) 5 credits
Plant-animal interactions have increasingly become recognized as drivers of evolutionary change and important components of ecological communities. This module will focus on herbivory (the consumption of plants by animals) and pollination (the transfer of pollen between male and female reproductive structures in flowers).
ES4056 Environmental Governance II (S2)
This module focuses on conflicts that arise from environmental problems and their management. It introduces students to the concept of governing environmental conflict through lectures, multimedia presentations, set readings and research activities, using examples from Ireland and overseas.

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

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

- Identify and describe plant and animal communities and analyse their distribution. Know the principles of geochemical cycling in the global context with specific reference to environmental change.

- Know the principles of hydrology and its relationship with groundwater quality.

- Know the causes and effects of terrestrial, atmospheric and marine pollution and present day mitigation strategies.

- Show a good working knowledge of skills and tools, such as spatial data analysis and statistical techniques, which can be used selectively to address complex problems, or to conduct closely guided research.

- Identify, formulate, analyse and suggest reasoned solutions to current environmental problems.

- Design an Environmental Impact Assessment for a range of diverse habitats.

- Critically assess scientific literature.

- Work effectively as an individual, in teams and in multidisciplinary settings.

- Communicate effectively with both the scientific community and with society at large.
Genetics is a two-year moderatorship course run by the School of Genetics and Microbiology. It encompasses a wide range of topics such as medical genetics (including the genetics of cancer), stem cell biology, neurobiology, plant and microbial genetics, molecular evolution, developmental genetics, and genomics and systems biology. Senior Sophister students work part-time in a laboratory where they have the opportunity to acquire basic laboratory skills and conduct state-of-the-art research.

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

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

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

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

GE3M07 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.

GE3M09 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.

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

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

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

GE3M17 EVOLUTIONARY GENETICS (S1) 5 credits
This module provides an introduction to genetic variation – its origins and its evolutionary consequences.

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

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

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

GE3M41 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.

GE3M31 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.

THE BROAD CURRICULUM 5 credits
Students can freely choose between available Broad Curriculum options.
### Senior Sophister Modules

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

### Lecture Module: GE4017 *Medical & Cellular Genetics* 10 credits

**GE4037 Transgenic Animals & Gene Therapy (Prof. Farrar) (S2)**

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

**GE4049 Functions, Mechanisms and Prion-like proteins (Prof. Ramaswami) (S1)**

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

**GE4051 Programmed Cell Death (Prof. Martin) (S2)**

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

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

Lecture Module: GE4018 Analytical & Developmental Genetics 10 credits

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

GE4032 Developmental Genetics of Drosophila (Prof. Martin) (S2)
This module component discusses how the creation of simple gradients of relatively few transcription factors sets up the complex patterns of gene expression that create a cell fate ‘map’ within the developing fly embryo. We will look at sets of genes (called segmentation genes) whose expression switches on master regulatory genes (Hox genes) that dictate whether an individual fly segment will carry a wing, a bristle, or an antenna. This is a fascinating topic that discusses work leading to the award of the 1995 Nobel Prize in Medicine/Physiology to Christiane Nusslein-Volhard and Eric Weischaus.

33
GE4034  Human Evolutionary Genetics (Prof. Bradley) (S1)
Our concepts of human origins and migrations have been profoundly formed by human genetic analysis. The human genome is now the best studied genome for variation in both space and time. This module component follows how genetic insights help us understand: our relationships with the great apes and which are the important genetic changes on the human lineage; the origins of modern humans in Africa and the nature of the migration from there to the rest of the world; the different patterns between male and female lineage inheritance; the interaction between cultural and genetic inheritance patterns. Recent advances in ancient DNA sequencing and archaic human genomes are discussed in detail and a close look at European and even Irish genetic origins are included.

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

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

TBD  General and Molecular Genetics

10 Credits

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

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

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

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

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

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

Compulsory Geography Modules

G3028 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 Prof McGlynn

GG3056 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). Modules commencing with GG34 include a mixed-year group of JS and SS students.

GG3015: Globalisation S2 5 credits
Prerequisites: None
Outline: The module aims to introduce students to the forces underlying ‘globalisation’ and its impacts in both the developed and the Third Worlds. It adopts a critical perspective on the process of globalisation by examining social forces which drive it and how it is politically and economically constructed. It seeks to unpack the interaction between differently scaled social processes to interrogate the nature, meaning, construction, impacts, contradictions and resistances to contemporary neoliberal or corporate globalisation.
Module coordinator Prof Carmody
GG3025 Advanced Research Methods in Geography II  S1  5 credits
Prerequisites: None
Outline: This module is focused on fieldwork. It provides students with practical experience in conducting primary research across a range of geographical themes. Students are required to complete a series of guided research tasks and to present the results of their work in evening seminars and as a field notebook. During the module, students are required to work individually and as part of a group, and to complete tasks within a limited timeframe.
Module coordinator Prof Coxon

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

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

GG3034 Practical Physical Geography  S1  5 credits
Prerequisites: SF Geography including GG2024
Outline: This module is aimed at students who are considering a physical geography dissertation project. The student numbers will be limited. A white laboratory coat is required for this module. Sharp pencils, calculator, ruler (metric) and a protractor are also required. Basic map work using OS 1:50,000 series maps and GSI geological maps. Fluvial geomorphology from maps, simple drainage basin analysis, analysing geological and climatic controls on fluvial landscapes. Orientation and altitude of corrie basins. Basic field and laboratory methods including sediment description, clast fabric, particle size analysis and loss of ignition measurements. Simple data handling using spreadsheets and graphics packages.
Module coordinator Prof Coxon
GG3054 Tropical Environments S2 5 credits

Prerequisites: None

Outline: This module examines the host of environmental challenges facing tropical regions, with a focus on understanding environmental change drivers and processes. Particular attention will be paid to several case study areas in the humid tropics. Topics covered include: tropical climates and ecosystems; long-term drivers of environmental change; the role of human-environment interactions; climate change predictions and impacts; current environmental management challenges.

Module coordinator: Prof McGlynn

GG3055 Deserts of our Solar System S1 10 credits

Prerequisites: GG2024

Outline: This module explores the landforms of our solar system. It focuses on the arid environments of Earth and Mars. Using the latest data from NASA and ESA we examine how landforms and geomorphic processes vary under different atmospheric, gravity and temperature regimes.

Module coordinator: Prof Bourke

GG3475 Glacial Geomorphology (2015-16; not in 2016-2017) S1 10 credits

Prerequisites: SF Geography including GG2024

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

Module coordinator Prof Coxon


Prerequisites: GG1024; GG2024

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

Module coordinator: Prof Edwards
GG3478 Periglacial Geomorphology (2016-2017; not in 2017-18) S1 10 credits
Prerequisites: SF Geography including GG2024
Outline: This module covers the regions of the world that experience at present (or have experienced in the past) permanently frozen ground or processes associated with frost action. The processes producing a variety of landforms of all scales are looked at in detail and a pervading theme in the module is the identification and significance of fossil periglacial features in the landscape. Topics covered include: climatic zones, freeze-thaw cycles, permafrost, ground-ice, frost action, patterned ground, hardware modelling of processes, ice-mounds, thermokarst, man and periglacial regions, slopes, fluvial processes, fossil periglacial features in Europe, USA and Britain and Ireland.
Module coordinator: Prof Coxon

GG3479 Palaeoceanography & Palaeoclimate (2016-2017; not in 2017-18) S2 10 credits
Prerequisites: GG1024; GG2024
Outline: The module will cover the role of oceans as both agents and archives of climate change during the last 2.6 million years of Earth history. It will include the following topics: Drivers of glacial-interglacial climate change; ice sheet – ocean interactions; Foraminifera as environmental proxies; sea-level change.
Module coordinator: Prof Edwards
Senior Sophister (Year 4)

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

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

Optional Geography Modules

GG3475 Glacial Geomorphology (2015-16; not in 2016-2017) S1 10 credits
Prerequisites: SF Geography including GG2024
Outline: The module is an introduction to the landforms and processes of glaciation. It covers past and recent work on glacial geomorphology and concentrates on landforms and sediments and their production by glaciers. The topics covered include: history of glacial studies, physical properties of ice, ice motion, glacier systems, thermal regime, erosional processes and landforms, glacial deposition, mineral exploration in glacial terrain, engineering geology in glaciated areas, moraines and drumlins, meltwater deposition and erosion (process and form). Examples are taken from Ireland where relevant and the module outlines the need for further work in many regions of the country.
The module includes a fieldtrip and laboratory work.
Module coordinator Prof Coxon

Prerequisites: GG1024; GG2024
Outline: This module provides a general introduction to the field of palaeoanthropology with particular focus on the contributions made by Earth Scientists to the study of the origins of our species. The module will examine how diverse lines of evidence from subjects such as archaeology, anatomy and genetics, can be combined to examine the changing relationships between humans and their environment. It will introduce the world of our ancestors and evaluate the science behind stories of popular interest such as Neanderthals, “hobbits”, and the rise and spread of our species, Homo sapiens.
Module coordinator: Prof Edwards
GG3478 Periglacial Geomorphology (2016-2017; not in 2017-18)  S1  10 credits
Prerequisites: SF Geography including GG2024
Outline: This module covers the regions of the world that experience at present (or have experienced in the past) permanently frozen ground or processes associated with frost action. The processes producing a variety of landforms of all scales are looked at in detail and a pervading theme in the module is the identification and significance of fossil periglacial features in the landscape. Topics covered include: climatic zones, freeze-thaw cycles, permafrost, ground-ice, frost action, patterned ground, hardware modelling of processes, ice-mounds, thermokarst, man and periglacial regions, slopes, fluvial processes, fossil periglacial features in Europe, USA and Britain and Ireland.
Module coordinator: Prof Coxon

GG3479 Palaeoceanography & Palaeoclimate (2016-2017; not in 2017-18)  S2  10 credits
Prerequisites: GG1024; GG2024
Outline: The module will cover the role of oceans as both agents and archives of climate change during the last 2.6 million years of Earth history. It will include the following topics: Drivers of glacial-interglacial climate change; ice sheet – ocean interactions; Foraminifera as environmental proxies; sea-level change.
Module coordinator: Prof Edwards

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

GG4061 Understanding Environmental Change  S1  10 credits
Prerequisites: None
Outline: The global environment, including climate, is changing. This change has major economic, social and policy implications and will thus underpin living conditions for the whole of humanity going forward. The course will introduce the functional aspects of this change using an Earth Systems Science approach by providing the basis to understand how major components of the Earth System are linked and how these links change over time. Conceptual developments in this understanding, as well as the basic modern concepts in Environmental Change (both human-induced and natural) will be discussed as a basis to comprehend the utility of forecast tools used as a basis for societal response.
Module coordinator: Prof Rocha
GG4062 Spatial Analysis using GIS  S1  5 credits
Prerequisite: GG3055 or GG3033
Note: Places on this module are limited to 15. In the case of oversubscription, places will be allocated on the basis of student performance in GG3055 or GG3033.
Outline: The Introduction to Advanced Spatial Analysis using GIS module is designed to introduce the student to spatial analysis using a Geographic Information Systems (GIS) platform and guide her/him through the learning process of advanced ArcGIS extensions dedicated to network analysis, spatial data mining and environmental phenomena modelling.
Module Co-ordinator: Prof Pilla (fpilla@tcd.ie)

GG4063 Advanced Spatial Analysis using GIS S2  5 credits
Prerequisite: GG4062
Note: Places on this module are limited to 15. In the case of oversubscription, places will be allocated on the basis of student performance in GG4062.
Outline: Course description: In this course we will explore in greater depth and breadth many concepts introduced in introduction to Spatial Analysis with GIS (which is a prerequisite). The course addresses ‘spatial problem solving’ by focusing on both the theoretical/conceptual and practical aspects of GIS modeling and spatial analysis. The course will cover in detail the use of the following extensions/tools:

- ArcGIS Geostatistical Analyst to use advanced statistical tools to investigate the data.
- ArcGIS Network Analyst to perform sophisticated routing, closest facility, and service area analysis.
- ArcGIS Spatial Analyst to derive answers from the data using advanced spatial analysis.
- ArcGIS Tracking Analyst to reveal and analyze time-based patterns and trends in the data.
- ArcGIS Online and/or ESRI StoryMap as a dissemination tool.

Module Co-ordinator: Prof Pilla (fpilla@tcd.ie)

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

GG4066 Historical Geography I S1  5 credits
Prerequisites: None
Outline: This module presents an overview of the historical geography of Ireland from the earliest human settlement in the Mesolithic through to c.1000 A.D. Throughout the module developments in Ireland are set within appropriate comparative and theoretical contexts. The principal topics explored are settlement, land use and agriculture, the changing environment (including human impacts), patterns of cultural variation and interaction and how these have come together to forge changing landscapes and regions.
Module coordinator Prof Hennessy
GG4067 Historical Geography II  S1  5 credits
Prerequisites: None
Outline: This module presents an overview of the historical geography of Ireland from c.1000 A.D. through to c.1900 A.D. Throughout the module developments in Ireland are set within appropriate comparative and theoretical contexts. The principal topics explored are settlement, land use and agriculture, the changing environment (including human impacts), patterns of cultural variation and interaction and how these have come together to forge changing landscapes and regions.
Module coordinator Prof Hennessy

GG4068 the City and Social Space S2  10 credits
Prerequisites: None
Outline: This module is aimed at getting students to connect wider social, cultural and economic processes with the everyday experiences of people living in the city. The course is project-based, and, in drawing upon Dublin as a case study, seeks to promote active student engagement with our urban social environment. Thus, the course will begin with an introduction to core elements of urban theory and seek to gain an understanding of the role of different policies in reordering urban space. This will range from issues such as the urban economy, residential transformation, to experiences of urban public space. Following from this, the students will be asked to take on a particular thematic element of the course to carry out research on within groups of five to six students. Each group will then contribute the overall project, which will take the form of a final report.
Module coordinator TBC
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

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>GL3324</td>
<td>Geological field skills 1</td>
<td>10</td>
</tr>
<tr>
<td>GL3325</td>
<td>Geological field skills 2</td>
<td>10</td>
</tr>
<tr>
<td>GL3326</td>
<td>Sedimentology</td>
<td>10</td>
</tr>
<tr>
<td>GL3328</td>
<td>Structural Geology</td>
<td>5</td>
</tr>
<tr>
<td>GL3334</td>
<td>Introduction to Geochemistry</td>
<td>5</td>
</tr>
<tr>
<td>GL3335</td>
<td>Stratigraphy and the Geology of Ireland</td>
<td>5</td>
</tr>
</tbody>
</table>

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

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

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

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

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

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

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

<table>
<thead>
<tr>
<th>Module</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>GL4401 Project (M)</td>
<td>CN (S1) 15</td>
</tr>
<tr>
<td>GL4402 Fieldwork (M)</td>
<td>QC (S2) 5</td>
</tr>
<tr>
<td>GL4404 Geological Literature (M)</td>
<td>PNWJ (S1) 5</td>
</tr>
<tr>
<td>GL4406 Global Igneous Petrology (O)</td>
<td>ET (S1) 5</td>
</tr>
<tr>
<td>GL4412 Laboratory Project (O)</td>
<td>JDB (S1) 5</td>
</tr>
<tr>
<td>GL4414 Petroleum Geology &amp; Exploration (M)</td>
<td>CN (S1) 10</td>
</tr>
<tr>
<td>GL4416 Planet formation and the early Earth (O)</td>
<td>BK (S2) 5</td>
</tr>
<tr>
<td>GL4419 Economic Geology (M)</td>
<td>SMcc (S2) 5</td>
</tr>
</tbody>
</table>

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.

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.

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.

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.

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.

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.

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

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

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

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

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

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

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

- identify, formulate, analyse and suggest reasoned solutions to geological problems
- identify earth materials and interpret three and four dimensional distributions of these materials from incomplete data sets
- apply scientific procedure to solving problems
- critically assess previously produced geological data sets and interpretations
- work effectively as an individual, in teams and in multidisciplinary settings
- communicate effectively with both the geological community and with society at large
- Update their knowledge and undertake further study with a high degree of autonomy.
'Immunology' is a moderatorship course run by the School of Biochemistry and Immunology (http://www.tcd.ie/Biochemistry/). Immunology is the study of the molecules and cells of the body that are involved in recognising and fighting infection and disease. 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 James Murray at jmurray6@tcd.ie.

**Junior Sophisters:**

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

**Assessment and Examination Procedures**

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

SS Assessment and Examination Procedures
There are four final exam papers in the summer. Papers 1 and 2 contain questions on all the SS Biochemistry and Immunology lecture modules. Paper 3 examines problem solving and techniques and Paper 4 is general in nature and examines core concepts in Biochemistry and Immunology. Each paper carries equal marks and contributes a total of 66.6% to the final SS mark. The BI4490 data handling module covers quantitative biochemical problems, bioinformatics and molecular modelling. This module is examined by in-course assessment during the year and contributes 8.4 % to the final mark. Finally, an 11-week research project will be carried out and contributes 25% to the SS mark. The overall degree mark is comprised of 80% of SS mark and 20% of JS mark.
### Junior Sophister Modules  

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BI3220</td>
<td><strong>Core Concepts in Immunology (S1)</strong></td>
<td>10</td>
</tr>
<tr>
<td>BI3240</td>
<td><strong>Microbiology and Immunology (S2)</strong></td>
<td>10</td>
</tr>
<tr>
<td>BI3210</td>
<td><strong>Biochemistry (S1)</strong></td>
<td>10</td>
</tr>
<tr>
<td>BI3230</td>
<td><strong>Gene Regulation (S2)</strong></td>
<td>10</td>
</tr>
<tr>
<td>BI3215</td>
<td><strong>Analytical skills I (S1)</strong></td>
<td>5</td>
</tr>
<tr>
<td>BI3020</td>
<td><strong>Research skills (S2)</strong></td>
<td>10</td>
</tr>
<tr>
<td>BI3894</td>
<td><strong>Broad Curriculum</strong></td>
<td>5</td>
</tr>
</tbody>
</table>

This module introduces fundamental processes and molecules associated with the immune system. The different immune responses to diverse pathogens will be covered. The role of the immune system in disease e.g. autoimmunity will also be addressed. There will be Immunology practicals associated with these lectures.

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.

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.

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.

This module involves practicals and data handling project.

This module involves a literature review and essay on an immunology topic and a presentation in addition to quantitative problem analysis.
Senior Sophister Modules  

BI4035  CELLS OF THE INNATE AND ADAPTIVE IMMUNE SYSTEM (S1)  5 credits  
This module outlines the differentiation and roles of specific leukocyte populations in mediating innate and adaptive immune responses

BI4235 IMMUNE SIGNALLING (S1)  5 credits  
This module covers immune-related signalling events including cell signalling in apoptotic cell death, cytokine signalling, the molecular basis for immune signalling, PI3 kinase and MTOR and T cell receptor signalling

BI4245 IMMUNITY TO PATHOGENS AND VACCINATION (S1)  5 credits  
This module covers immune responses to viruses and bacteria including tuberculosis and Borreli pertussis, vaccines and the danger theory

BI4225 AUTOIMMUNE AND INFLAMMATORY CONDITIONS (S1)  5 credits  
This module covers basic and clinical aspects of autoinflammatory and autoimmune conditions, including rheumatoid arthritis and multiple sclerosis and immunodeficiency syndromes.

BI4255 IMMUNOTHERAPY, IMMUNOGENETICS AND IMMUNOMODULATION (S1)  5 credits  
This module covers key concepts and specific examples in immunogenetics, immunotherapy and immunomodulation. It also covers transplantation, graft rejection and immunosuppressive therapies.

BI4025 MOLECULAR AND CELLULAR PARASITOLOGY’ (S1)  5 credits  
This module provides an introduction to parasitic protozoa such as trypanosomes, plasmodium, and helminths. The biochemical and genetic mechanisms by which these parasites evade the host immune responses will be covered.

BI4215 ORGAN‐SPECIFIC IMMUNITY  (S1)  5 credits  
This module describes characteristic and distinctive features of the innate and adaptive immune responses at mucosal sites, the liver and the central nervous system.

BI4265 TUMOUR IMMUNOLOGY  (S1)  5 credits  
This module addresses cancer, invasion and tumour immunity including stem cell therapy, immunotherapy, vaccines and the immune response to tumours.

BI4295 RESEARCH PROJECT IN IMMUNOLOGY  15 credits  
The module comprises of an original research project in biochemistry and a research thesis.

BI4015 DATA HANDLING  (S1)  5 credits  
This module covers quantitative biochemical problems, bioinformatics and molecular modelling.

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

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

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

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

Junior Sophisters:

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

Assessment and Examination Procedures

The core Microbiology lecture modules (totalling 25 credits) will be examined in one of five written papers taken in the annual examination period in Trinity Term. Further information relating to the number and composition of papers will be given in the Microbiology Undergraduate Course Booklet 2017/18 issued to rising Junior Sophisters.

Practical courses (totalling 25 credits), Research Essay and Transferable Skills (MI3M03, 5 credits) and the optional module (MI3M07, 5 credits) will be assessed in-course by laboratory practical report, practical test, written test or other assignments. Students are referred to the Microbiology Undergraduate Course Booklet 2017/18 for further details regarding the nature and timing of assessments.
Marks for Microbiology modules MI3M01-MI3M06 plus the Optional Course (MI3M07 or Broad Curriculum) will form the JS Microbiology mark that is carried forward to Moderatorship.

**Senior Sophisters:**

**Assessment and Examination Procedures**

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

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

Further information relating to the assessed components, composition of written papers and weightings will be given in the Senior Sophister Microbiology Booklet 2017/18 issued to rising Senior Sophisters.
Junior Sophister Modules 60 credits

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

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

MI3M03: Research Essay & Transferable Skills, Prof A. Fleming (S1-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.

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

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

Optional Courses

Students can choose between either:

A. Microbiology Past and present (MI3M07), Prof A. Fleming (S1-S2) 5 credits
This module will look at the emergence and development of the discipline of Microbiology. A combination of lectures and tutorials will allow students to consider the influence of Microbiology and Microbiologists on, *inter alia*, mankind’s thinking about the origins of life and the nature of disease; the discovery of the varied natures and lifestyles of “germs”; the many and various approaches taken to combat microorganisms and their unwanted effects; the parts microbes have played in plagues, pestilences, conquests & colonisations and the roles of microorganisms as enemies and allies in warfare. Students will also consider some of the Microbiological challenges facing modern societies. The module also gives the student the opportunity to attend selected Microbiology seminars given by visiting academics, which will then be discussed.

OR

B. A Broad Curriculum (BC) Cross Faculty Course 5 credits
Module managers, and the location of each module within semester 1 (S1) or semester 2 (S2), are indicated in parenthesis. All modules are subject to change and availability of academic staff.
<table>
<thead>
<tr>
<th>Senior Sophister Modules</th>
<th>60 credits</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MI4M01: Research in Microbiology (S1-S2)</strong></td>
<td>20 credits</td>
</tr>
<tr>
<td>This research oriented module involves a full-time <strong>9-week research project</strong> and thesis, the writing of a <strong>research essay</strong>, attendance at research seminars, and discussions of professional and ethical issues in Microbiology.</td>
<td></td>
</tr>
<tr>
<td><strong>MI4M02: Microbial Molecular &amp; Cellular Biology (S1)</strong></td>
<td>10 credits</td>
</tr>
<tr>
<td>This module involves core lectures and advanced data handling sessions in Microbial &amp; Molecular Cell Biology.</td>
<td></td>
</tr>
<tr>
<td><strong>MI4M03: Microbial Pathogenicity (S1)</strong></td>
<td>10 credits</td>
</tr>
<tr>
<td>This module involves core lectures and advanced data handling sessions in Microbial Pathogenicity.</td>
<td></td>
</tr>
<tr>
<td><strong>MI4M04: Applied &amp; Environmental Microbiology (S1)</strong></td>
<td>10 credits</td>
</tr>
<tr>
<td>This module involves core lectures and advanced data handling sessions in Applied &amp; Environmental Microbiology.</td>
<td></td>
</tr>
<tr>
<td><strong>MI4M05: Advanced Topics in Microbiology (S1)</strong></td>
<td>10 credits</td>
</tr>
<tr>
<td>In this module students select three <strong>advanced optional modules</strong> from a list which currently includes: Gram-Positive Bacterial Pathogens; Clinical Microbiology; Lessons from Yeasts - Applying Yeast Genetics to the Study of Human Disease; Regulation of Bacterial Gene Expression; Legislation, Standards System &amp; Issues in Current Microbiological Practice; Virology and Eukaryotic Genome Structure and Function.</td>
<td></td>
</tr>
</tbody>
</table>
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 occuring in some of the best-characterised microorganisms
  - the interactions between some of the best-characterised pathogenic microorganisms and their hosts
  - the roles, uses and manipulation of microorganisms in health and disease, agriculture, biotechnology and the environment
  - the roles of microorganisms as model systems in related fields
  - the scientific method of investigation and testing of hypotheses and the distinction between scientific and unscientific arguments.
- 3. Demonstrate in written and oral form a detailed, critical knowledge and understanding, supported by the use of advanced textbooks, journal articles and data sets, of one or more specialist areas, some of it at the current boundaries of the field.
- 4. Apply the knowledge and understanding gained to the critical analysis of experimental data, to sustaining evidence-based arguments on microbiological hypotheses, to solving microbiological problems and to designing microbiological experiments.
- 5. Pursue with a degree of independence an original microbiological research project including project planning; identification, appraisal and safe application of the appropriate experimental techniques; accurate recording and presentation of data; identification of the limitations of and sources of error in experiments; analysis and interpretation of complex data; formulation of logical conclusions; and appraisal of the project outcome in the context of related, published work.
- 6. Demonstrate proficiency in the application of computers to such problems as the searching of literature databases, analysis of biological sequence data, visualisation of biological macromolecules and analysis of experimentally acquired data.
- 7. Demonstrate recognition of the value of scientific inquiry and an understanding of the ethical responsibilities of scientists.
- 8. Demonstrate the capacity to apply international standards and practices within the discipline.
- 9. Act effectively, under the guidance of senior scientists as necessary, as an individual, as part of a team, and/or in a multidisciplinary environment.
10. Communicate information and ideas at a high level to both specialist and non-specialist audiences.
11. Show that they have acquired the learning skills necessary to update their knowledge and to undertake further study with a high degree of autonomy.
Molecular Medicine is a moderatorship course offered jointly by the School of Biochemistry and Immunology and the School of Medicine, St. James’ Hospital. The emphasis of this course is on the study of fundamental life processes and how discoveries in basic science lead to new diagnostics and therapies for human disease.

For all international visiting student queries please email Prof James Murray at jmurray6@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. Broad curriculum options will be examined by in-course assessment during the year. JS marks contribute to 20% of the final degree.

Senior Sophisters

The Senior Sophister year will cover topics in neurobiology, oncology, haematology, immunology, diagnostics & therapeutics and diseases of nutrition & metabolism. A research project in the area of biochemistry, cell biology, immunology or clinical medicine forms an essential part of the final year. 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. There will also be a module on data handling that includes such topics as quantitative biochemical problems, bioinformatics and molecular modelling. Students will also be required to give a presentation on a biochemical technique.
Assessment and Examination Procedures:

Assessment of the Senior Sophister year is made by four examination papers, totalling 66% and a research project that constitutes 25% of the final year mark. A number of quantitative problems are given during the year and are examined by continual assessment. The overall degree mark will be calculated by taking 80% of SS year results and 20% of those obtained in the JS year.
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BI3310</td>
<td>Proteins and drugs (Semester 1)</td>
<td>10</td>
</tr>
<tr>
<td>BI3320</td>
<td>Cell Biology (Semester 1)</td>
<td>10</td>
</tr>
<tr>
<td>BI3330</td>
<td>Disease and Development (Semester 2)</td>
<td>10</td>
</tr>
<tr>
<td>BI3335</td>
<td>Bioanalysis (Semester 1 &amp; 2)</td>
<td>5</td>
</tr>
<tr>
<td>BI3010</td>
<td>Nucleic Acids (Semester 2)</td>
<td>10</td>
</tr>
<tr>
<td>BI3020</td>
<td>Research Skills (Semester 1 &amp; 2)</td>
<td>10</td>
</tr>
<tr>
<td>BC</td>
<td>BROAD CURRICULUM</td>
<td>5</td>
</tr>
</tbody>
</table>
Senior Sophister  

**BI4315 Neurobiology & Endocrinology (Semester 1)**  
5 credits  
Neurological function and the causes of neurological and endocrinological disorders will be discussed in this module.

**BI4375 Innate & Adaptive Immunity (Semester 1)**  
5 credits  
The focus of this module is on the development of blood and immune system and the function of these cells in non-diseased and diseased states.

**BI4055 Microbial Diseases (Semester 1)**  
5 credits  
Protozoan, bacterial and viral diseases will be covered in detail.

**BI4045 Autoimmune & Inflammatory Conditions (Semester 1)**  
5 credits  
This module explores the causes and consequences of the immune system attacking the body and the development of disease models for effective therapeutic development.

**BI4335 Molecular Haematology & Oncology (Semester 1)**  
5 credits  
An in-dept analysis of cancers of blood, lung, prostate and oesophagus.

**BI4345 Genomics, Metabolism & Disease (Semester 1)**  
5 credits  
The effect of nutrition, gene mutation on inherited diseases will be discussed in this module.

**BI4355 Molecular Diagnostics & Therapeutics (Semester 1)**  
5 credits  
This module explores how the diagnosis and treatment of disease has been revolutionised by recent advances in molecular biology and genetics.

**BI4365 Cell Cycle & Cancer (Semester 1)**  
5 credits  
This module covers the meiotic and mitotic cell cycle and its regulation and the molecular biology of cancer.

**BI4395 Research Project in Molecular Medicine (Semester 2)**  
15 credits  
This module comprises an original research project in molecular medicine and a research thesis.

**BI4015 Data Handling (Semester 1)**  
5 credits  
This module covers quantitative biochemical problems, bioinformatics and molecular modelling.
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 practicals, workshops and seminars that cover different aspects of Neuroscience. In addition, throughout the Junior Sophister year, students take courses that will give them a broad based foundation in Data Handling and Statistics, Psychology, Physiology, Pharmacology and Cellular and Molecular Biology. Additionally, a broad curriculum course will have to be selected.

**Assessment and Examination Procedures**
Some courses are assessed by examination; however, some courses are assessed entirely by in-course assessment, and some are assessed by a combination of 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 60 credits

PG3100 Cellular Physiology (S1) 5 credits
Topics include: membrane structure, membrane proteins, membrane properties, receptors, neurotransmitters — definition and release. Neurotrophic factors, cytokines, Leptin, Stem cells, opiate peptides, nitric oxide, measuring molecules.

AN3MNA Neuroanatomy (S2) 5 credits
This module deals with the location, structure and function of the various components of the nervous system.

PG3360 Neurophysiology I (S1 & S2) 5 credits
Topics include: ion channels, synaptic transmission, the somatosensory system, nociception, addiction and rewards, arousal and sleep, vision, motor control, plasticity, memory and learning, sensory physiology. Practicals consist of EEG recordings on humans.

BI3445 Basic Neurochemistry I (S2) 5 credits

ZO3050 Developmental Biology (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.

BI3455 Research Skills (S1) 5 credits
This module gives an introduction to experimental design, data handling and statistical analysis of data, data interpretation and presentation. Additionally, students will gain experience in the comprehension and critical analysis of research articles.

GE3M13 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.

NS3PH1 General Principles of Pharmacology (S1) 5 credits
To introduce the student to the basic principles of pharmacology, drug development and experimental techniques used in pharmacology.

BI3425 Nucleic acids (S2) 5 credits
This module covers the structure and function of nucleic acids and the molecular basis of gene regulation including DNA replication and repair, transcription and translation.
BI3415 Biochemistry in Health and Disease (S2) 5 credits
This module provides an introduction into how imbalances in metabolism result in disease states. It also covers the biochemical defense mechanisms against infection and aspects of the drug discovery process.

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

Broad Curriculum 5 credits
A module of the broad curriculum has to be selected.
Senior Sophister Modules 60 credits

BI4445 Neurochemistry II (S1) 5 credits
Advanced courses on brain biochemistry, CNS acting drugs, neurotransmission and neurodegenerative conditions such as Alzheimer’s disease, Parkinson’s disease and stroke.

PG4460 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.

BI4455 Neuroimmunology & Neurodegeneration (S1) 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).

NS4PH2 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.

BI4415 Research Literature Skills (Neuroscience) (S1) 15 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. The Hilary term student research project will be preceded by a review of the literature pertaining to the project.

GE4060 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.

PS4020 Neuropsychology and Systems Neuroscience (S2) 5 credits
The students will learn about information processing in biological and theoretical networks, encoding and processing of the neuronal signal and its dependence on experience. Novel neuroscience methodologies will be discussed: massive parallel recording, isolation of single units with electrophysiological techniques and optogenetic techniques to manipulate of networks and behaviour.

BI4495 Neuroscience Research Project (S2) 15 credits
Students will conduct a research project in one of the Neuroscience laboratories across campus, including those contributing to Trinity College Institute of Neuroscience.
Neuroscience Moderatorship Learning Outcomes.

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

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

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

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

**Assessment and Examination Procedures**
Each 5 credit lecture module will be examined in a separate 2 hour (120 minute) examination in Trinity Term. PY3P03 may be assessed by both examination and continuous assessment. Continuous assessment of the practical module (PY3PP1) contributes 20 credits.

**Senior Sophisters:**
The SS year consists of lectures, tutorials and practical physics delivered in modules, as listed below. A major component of the practical module is an independent research project, which may be carried out at a facility off-campus. A component of problem solving completes this module.

**Mandatory Modules**
All modules are mandatory. In PY4P07 Advanced Topics in Physics students choose two of the topics offered.

**Assessment and Examination Procedures**
Each 5 credit lecture module will be examined in a separate 2 hour (120 minute) examination in Trinity Term. The practical module PY4PP1 (25 credits) is assessed as follows: one three-hour examination “Physics Practical – Problem Solving” (7.5 credits) and assessment of a nine-week full-time research project carried out in Michaelmas term (report and poster: 17.5 credits).
Junior Sophister Modules 60 credits

PY3P01 Quantum Mechanics I (S1) 5 credits
This module covers solution of the Schrödinger Equation in specific topics, such as angular momentum and the hydrogen atom.

PY3P02 Electromagnetic Interactions I (S2) 5 credits
This module covers the fundamentals of electromagnetic theory together with quantum optics and lasers.

PY3P03 Condensed Matter I (S1) 5 credits
This module introduces condensed matter concepts such as crystal structure and thermal and electronic properties of matter.

PY3P04 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.

PY3P05 Atomic & Nuclear Physics (S2) 5 credits
This module covers atomic and molecular spectroscopy together with nuclear structure and related effects.

PY3P06 Dynamical Systems (S1) 5 credits
This module covers the mechanics of matter together with statistical thermodynamics.

PY3P07 Experimental Techniques (S1 & S2) 5 credits
This module covers common device electronics together with the instrumentation used in physics research.

PY3A03 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.

PY3PP1 Practical in Physics (S1 & S2) 20 credits
In this module students complete a number of advanced experiments in Physics. Minor components include training in communication skills, personal and career development and attendance at School Seminars.
## Senior Sophister Modules  
### PY4P01 Quantum Mechanics II (S1 & S2)  
5 credits  
This module extends the discussion of quantum physics into the areas of multi-electron atoms, the time dependent Schrödinger Equation and perturbation theory.

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

### PY4P03 Condensed Matter III (S2)  
5 credits  
This module covers metal physics and superconductivity together with semiconductor devices.

### PY4P04 Nanoscience (S2)  
5 credits  
This module covers the modified properties of nanoscale matter, its fabrication and potential applications.

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

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

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

### PY4PP1 Practical in Physics (S1 & S2)  
25 credits  
This module combines a major research project with a component of general problem solving 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 a major part of the core moderatorship in Physics with specialist modules in astrophysics theory and practice. This moderatorship reflects the increasing interest in astronomy and space science.

**Junior Sophisters:**

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

**Mandatory Modules:**

All modules are mandatory.

**Assessment and Examination Procedures**

Each 5 credit lecture module will be examined in a separate 2 hour (120 minute) examination in Trinity Term. PY3C01, PY3P03, PY3A06, and PY3A07 may be assessed by both examination and continuous assessment. Continuous assessment of the practical module (PY3AP1) contributes 20 credits.
**Senior Sophisters:**
The SS year consists of lectures, tutorials and practical work delivered in modules, as listed below. A major component of the practical module is an independent research project, which may be carried out at a facility off-campus. A component of problem solving completes this module.

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

**Assessment and Examination Procedures**

Each 5 credit lecture module, except PY4A04 and PY4A03, will be examined in a separate 2 hour (120 minute) examination in Trinity Term. PY4A04, PY4A05 and PY4A03 may be assessed by both examination and continuous assessment. The practical module PY4AP1 (25 credits) is assessed as follows: one three-hour examination “Physics Practical – Problem Solving” (7.5 credits) and assessment of a nine-week full-time research project carried out in Michaelmas term (report and poster: 17.5 credits).
<table>
<thead>
<tr>
<th>Module Code</th>
<th>Module Name</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>PY3P01</td>
<td>Quantum Mechanics I (S1)</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>This module covers solution of the Schrödinger</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Equation in specific topics, such as angular</td>
<td></td>
</tr>
<tr>
<td></td>
<td>momentum and the hydrogen atom.</td>
<td></td>
</tr>
<tr>
<td>PY3P02</td>
<td>Electromagnetic Interactions I (S2)</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>This module covers the fundamentals of</td>
<td></td>
</tr>
<tr>
<td></td>
<td>electromagnetic theory together with quantum</td>
<td></td>
</tr>
<tr>
<td></td>
<td>optics and lasers.</td>
<td></td>
</tr>
<tr>
<td>PY3P03</td>
<td>Condensed Matter I (S1)</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>This module introduces condensed matter concepts</td>
<td></td>
</tr>
<tr>
<td></td>
<td>such as crystal structure and thermal</td>
<td></td>
</tr>
<tr>
<td></td>
<td>and electronic properties of matter.</td>
<td></td>
</tr>
<tr>
<td>PY3P05</td>
<td>Atomic &amp; Nuclear Physics (S2)</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>This module covers atomic and molecular</td>
<td></td>
</tr>
<tr>
<td></td>
<td>spectroscopy together with nuclear structure</td>
<td></td>
</tr>
<tr>
<td></td>
<td>and related effects.</td>
<td></td>
</tr>
<tr>
<td>PY3C01</td>
<td>Computer Simulation I (S1)</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>This module introduces the LINUX/UNIX</td>
<td></td>
</tr>
<tr>
<td></td>
<td>environment and programming in Python, together</td>
<td></td>
</tr>
<tr>
<td></td>
<td>with various numerical and statistical computer</td>
<td></td>
</tr>
<tr>
<td></td>
<td>simulation techniques.</td>
<td></td>
</tr>
<tr>
<td>PY3A03</td>
<td>Stellar and Galactic Structure (S1)</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>This module covers the origin and evolution of</td>
<td></td>
</tr>
<tr>
<td></td>
<td>the Sun and planets in our solar system and</td>
<td></td>
</tr>
<tr>
<td></td>
<td>newly discovered extra-solar planetary systems</td>
<td></td>
</tr>
<tr>
<td></td>
<td>from both observational and theoretical</td>
<td></td>
</tr>
<tr>
<td></td>
<td>perspectives.</td>
<td></td>
</tr>
<tr>
<td>PY3A06</td>
<td>Statistical Thermodynamics &amp; Astrophysical</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Spectroscopy (S1)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>This module covers thermodynamics and</td>
<td></td>
</tr>
<tr>
<td></td>
<td>statistical mechanics, together with the</td>
<td></td>
</tr>
<tr>
<td></td>
<td>underlying physics required to interpret spectra</td>
<td></td>
</tr>
<tr>
<td></td>
<td>from across the electromagnetic spectrum.</td>
<td></td>
</tr>
<tr>
<td>PY3A07</td>
<td>Experimental Techniques for Astrophysics (S1 &amp;</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>S2)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>This module covers common device electronics</td>
<td></td>
</tr>
<tr>
<td></td>
<td>and astronomical spectroscopy, astronomical</td>
<td></td>
</tr>
<tr>
<td></td>
<td>instrumentation.</td>
<td></td>
</tr>
<tr>
<td>PY3AP1</td>
<td>Practical in Physics and Astrophysics (S1 &amp; 2)</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>In this module students complete a number of</td>
<td></td>
</tr>
<tr>
<td></td>
<td>advanced experiments in Physics together</td>
<td></td>
</tr>
<tr>
<td></td>
<td>with an introduction to computer methods in</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Astrophysics. Minor components include training</td>
<td></td>
</tr>
<tr>
<td></td>
<td>in communication skills, personal and career</td>
<td></td>
</tr>
<tr>
<td></td>
<td>development and attendance at School Seminars.</td>
<td></td>
</tr>
</tbody>
</table>
**Senior Sophister Modules** 60 credits

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

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

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

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

**PY4C01 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.

**PY4A03 Planetary and Space Science (S2)** 5 credits
This module covers advanced stellar structure and planetary systems

**PY4A05 Cosmology (S1 & S2)** 5 credits
This module derives the basic equations of cosmology and uses these, together with observations, to examine the history and future of the Universe. Recent results concerning Dark Matter and Dark Energy, and possible future directions are also examined.

**PY4AP1 Practical in Physics & Astrophysics (S1 & S2)** 25 credits
This module combines a major research project in Astrophysics or Physics with a component of general problem solving 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 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 [ZO3040] from the Zoology Department) or Broad Curriculum, 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 [PG4500] and a comprehensive literature review and preparatory research skills [PG4400].

**Assessment:** All modules are partly assessed in-course. Annual examination - Four three-hour papers and a *viva voce* examination.

Non-physiology students taking physiology modules will be examined by in-course assessments only.
Junior Sophister 60 credits

PG3000 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.

PG3135 Nerve, muscle and sensation (S1) 5 credits
This laboratory based module 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 work then covers 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).

PG3110 Cell and Tissue structure (S1) 5 credits
The lectures cover basic tissue structure and function. The practical 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.

PG3980 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.

PG3700 Gut, Metabolism and Hormones (S1 & S2) 5 credits
This module covers the endocrine regulation of physiological function, renal and GIT function, growth, metabolism and reproductive function. Endocrine regulation in response to environmental stressors is considered. Some lectures are shared with the first Medical year.

PG3950 Seminars in Pharmacological & Physiological Research (S1 & S2) 10 credits
This module covers advanced topics in cell function and the pharmacological regulation of cell physiology. First, the module covers the cell membrane, neurotransmitters and receptors. Subsequently, key concepts of drug action and drug development including drug toxicity are explored. Gene-based therapy, immunotherapy and neuropharmacology are discussed. 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.
PG3300 Physiology of Brain, Nerve and Muscle (S1 & S2) 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. The brain is introduced and its role in sensory and motor physiology and pathophysiology. Cognitive function - particularly learning and memory are introduced.

PG3200 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.

PG3500 Cardiovascular Physiology (S2) 5 credits
This module covers the function and regulation of the cardiovascular system and includes lectures, practical 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.

PG3800 Respiratory Physiology (S2) 5 credits
This module covers the function and regulation of the respiratory system and includes lectures, practical 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.
Senior Sophister 60 credits

PG4150 Synaptic properties (S1) 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.

PG4205 Journal Club (S1) 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.

PG4400 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.

PG4500 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.

PG4600 Biomechanics and Neural Control of Movement (S1) 5 credits
This lecture and laboratory module covers 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.

PG4700 Cellular Neurophysiology (S1) 5 credits
The 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.

PG4900 Techniques in Cellular Physiology (S1) 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.
**PG4815 Integrative Physiology (S1)**

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.
Plant science 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 Plant Sciences modules, students also take either a Broad Curriculum module or choose an optional module (5 credits) from outside of the core Plant Sciences 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 is likely to take place during the study week in the Hilary Term.

**Seniors Sophisters**
In the Senior Sophister year, students attend a series of lectures, laboratory practicals, field work, seminars, tutorials and workshops. In addition, they are required to undertake a 15 credit research project which culminates in the submission of a dissertation. The year consists of a total of 55 mandatory credits and 5 optional credits for one of two modules taken from outside the Plant Sciences course. These modules are indicated in greater detail below.
Junior Sophister Modules  60 credits

Mandatory modules

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

BO3105 Fundamentals of Ecology (S1)  5 credits
This module is run jointly with the Zoology Department. The module examines the factors that affect the distribution, growth and survival of plant and animal communities. It describes how organisms interact with their environment and the role that they have in ecosystem and community structure. There is an introduction to the concepts and models that help to explain and predict organism distributions and interactions.

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

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

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

BO3110 The Plant Kingdom – Evolution and Diversity (S2)  5 credits
This module traces the broad sweep of plant evolution, from its prokaryotic origins through unicellular plankton to the immense diversity of non-flowering plants. We focus on groups of particular evolutionary, ecological or economic significance; also on native or widely-planted species and the features used in their identification. We track the changes brought about by the transition from an aquatic to a terrestrial environment, as we explore the range of morphology and life cycle among the algae, mosses, ferns, cycads and conifers. A field trip to the Powerscourt area focuses on bryophyte ecology and conifer diversity.
**BO3111 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.

**BO3120: 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.

**BO3121 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.

**BO3123 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.

**BO3124 Economic Botany (S1)**  
5 credits
This module represents a review of the economic importance of plants, ranging from the commercial use of algae in the food and biofuel industry, agriculturally important crops, plants as sources of pharmaceuticals to the use of non-food crops in industry. The module is entirely continually assessed. The continual assessment will be in the form of a desk-based study using FAO data on global food production, student talks on key economic crops from around the globe to practicals on brewing and tissue culture.
ZO3070 Experimental Design and Analysis (S2) 5 credits
This module, designed specifically for Environmental Scientists, Plant Scientists, Functional Biologists and Zoologists aims to put data collection and analysis in the context of research design and will be an important foundation for the Senior Sophister research project. The module consists of two parts. The emphasis will be practical with a more 'hands on' approach rather than the theory of statistics. Initially students will be taught about experimental design, data collection and sampling and the use of spreadsheets for data entry. This will lead on to preliminary data exploration and issues of normality.

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

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

### Mandatory modules

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FB4000 Research Project (S1 &amp; S2)</strong></td>
<td>15 credits</td>
</tr>
<tr>
<td>A research project is carried out by each Senior Sophister student under the supervision of a staff member. The project will be selected in consultation with the supervisor. It will be written up as a dissertation and submitted by a given deadline.</td>
<td></td>
</tr>
<tr>
<td><strong>BO4103 Plant Conservation and Biodiversity (S2)</strong></td>
<td>5 credits</td>
</tr>
<tr>
<td>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.</td>
<td></td>
</tr>
<tr>
<td><strong>BO4105: Global Environmental Change (S2)</strong></td>
<td>5 credits</td>
</tr>
<tr>
<td>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.</td>
<td></td>
</tr>
<tr>
<td><strong>BO4106 Seminars, Tutorials and Workshops (S1 &amp; S2)</strong></td>
<td>10 credits</td>
</tr>
<tr>
<td>The aim of the seminars is to introduce undergraduate students to current research topics on key issues related to the Plant Sciences 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.</td>
<td></td>
</tr>
<tr>
<td><strong>BO4108 Plant-Environment Interactions (S1)</strong></td>
<td>5 credits</td>
</tr>
<tr>
<td>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.</td>
<td></td>
</tr>
<tr>
<td><strong>BO4109 Vegetation Description and Analysis (S1)</strong></td>
<td>5 credits</td>
</tr>
<tr>
<td>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.</td>
<td></td>
</tr>
<tr>
<td><strong>FB4060 Plant Breeding and Biotechnology (S2)</strong></td>
<td>5 credits</td>
</tr>
<tr>
<td>The module covers the principles and practice of plant breeding and biotechnology. Lectures cover key topics such as the origins of agriculture, genetic resources, disease resistance, conventional breeding, modern breeding, genetic engineering, and case studies in breeding and biotechnology. Practicals cover crop diversity, polyploid estimation and a least one site visit to a Teagasc research centre (Oak Park, Carlow and/or Ashtown Dublin).</td>
<td></td>
</tr>
</tbody>
</table>
ZO4030: Data Handling (S1)  
This module will develop hypothesis testing with a revision of t-tests and explore general linear models, using ANOVA, product-moment correlation and regression. Experimental design will also be covered using ANOVA examples. Equivalent non-parametric approaches will be described. The module will go on to cover chi-squared and goodness of fit, and end with a brief introduction to multivariate statistics with a focus on ordination and classification. The module will be delivered by lectures, demonstration and discussion sessions, and by hands on use of various software packages.

Optional modules
ZO4017 Tropical Ecology (S1)  
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 montane forest and alpine communities, aquatic ecosystems [freshwater rivers and lakes, wetlands and saline lakes] and grasslands) and the connectivities among them. Issues and problems to do with human impacts and the conservation and management of these diverse habitats will also comprise an important element of the course.

BO4107 Plant-Animal Interactions (S2)  
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).
**Plant Sciences 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 Plant Sciences.

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

- Articulate the fundamental concepts in plant science.

- Discuss current research developments in plant science.

- Review and criticise published scientific information.

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

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

- Collaborate effectively in teams and work independently.

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

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

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

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

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

### Core Modules

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZO3000</td>
<td>Marine Biology (Prof. Nessa O’Connor)</td>
<td>5</td>
</tr>
<tr>
<td>ZO3003</td>
<td>Animal Diversity (Prof. Andrew Jackson)</td>
<td>10</td>
</tr>
<tr>
<td>ZO3020</td>
<td>Behavioural Ecology (Prof. Nicola Marples)</td>
<td>5</td>
</tr>
<tr>
<td>ZO3030</td>
<td>Introduction to Parasitology (Prof. Celia Holland)</td>
<td>5</td>
</tr>
<tr>
<td>ZO3040</td>
<td>Comparative Physiology (Prof. Colleen Farmer)</td>
<td>5</td>
</tr>
<tr>
<td>ZO3050</td>
<td>Introduction to Developmental Biology (Prof. Paula Murphy)</td>
<td>5</td>
</tr>
<tr>
<td>ZO3070</td>
<td>Experimental Design and Analysis (Prof. Celia Holland)</td>
<td>5</td>
</tr>
</tbody>
</table>

This team taught module, which includes a residential field course element in the first week of the Michaelmas Term, will introduce students to aspects of marine biology, together with invertebrate form and function, and provide foundational skills appropriate for the two year Sophister programme in Zoology.

This team-taught module provides a detailed consideration of the evolution, and comparison of the structure, life cycles and general biology of invertebrate and vertebrate animals. The module is based on lectures, practicals and demonstrations from the Zoological collections.

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.

This module covers host-parasite relationships, epidemiology, host behaviour, genetics and immunity. The concept of a parasite community at the infracommunity and component community level is developed. Parasites of human importance receive particular emphasis.

This module includes lectures and practical demonstrations using examples drawn from mammals, reptiles, fish and birds. Emphasis is placed on respiration, feeding and digestion, and on sensory perception.

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.

Students will be taught data collection and sampling and the use of spreadsheets for data entry, experimental design and statistical analysis. It will introduce a powerful and freeware statistics package R. A series of sessions will address the preparation for the Senior Sophister research project (FB4000) and the project proposal.
ZO3085 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.

BO3105 (ZO3010) Fundamentals of Ecology (Prof. Ian Donohue) (S1)  5 credits
This module is run jointly with the Botany Discipline. The module examines the factors that affect the distribution, growth and survival of plant and animal populations. It describes how organisms may interact with their environment and the role that they have in ecosystem and community structure.

BO3122 (ZO3084) Entomology (Prof. Jane Stout) (S2)  5 credits
There are more species of insects on Earth than any other group of organisms and they are of massive ecological and economic importance. This module will address behavioural, social, ecological and applied aspects of entomology, including their role in delivering ecosystem services (such as biocontrol and pollination), invasive species (such as fire ants and harlequin ladybirds) and conservation (both in Ireland and internationally). The practicals will provide students with the skills for sampling and identification of insects, which will be further enhanced through small group and individual projects.
### Senior Sophister Modules

<table>
<thead>
<tr>
<th>Core Modules</th>
<th>60 credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>FB4000 Research Project (All staff) (S1 &amp; S2)</td>
<td>15 credits</td>
</tr>
<tr>
<td>ZO4020 General Zoology (All staff) (S1 &amp; S2)</td>
<td>10 credits</td>
</tr>
<tr>
<td>ZO4030 Data Handling (Prof. Andrew Jackson) (S1)</td>
<td>5 credits</td>
</tr>
<tr>
<td>ZO4040 Extended Essay: Zoology and Society (All staff) (S1)</td>
<td>5 credits</td>
</tr>
<tr>
<td>ZO4060 Research Comprehension (Prof. Andrew Jackson) (S1 &amp; S2)</td>
<td>5 credits</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Elective Modules</th>
<th>20 credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZO4012 Advances in Parasitology (Prof. Celia Holland) (S2)</td>
<td>5 credits</td>
</tr>
</tbody>
</table>

*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.*

*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.*

*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.*

*The essay, which shall not exceed 4,000 words, requires extensive literature analysis. It will be set on a topical problem in modern zoology or the zoological information that is relevant to a topical sociological, ethical, medical or environmental problem.*

*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.*

*Students select 4 of the 5-credit tutorial modules on offer. Each module will include lectures and student participation in the form of presentations, debates or critiques as appropriate.*

*This elective explores the practical challenges of parasitological research on human subjects (e.g. growth, cognitive ability, immunocompetence) and the relative merits of using animal model systems as alternatives.*
ZO4013 Conservation and Wildlife Management (Prof. John Rochford) (S1) 5 credits
This module looks at practical applications of wildlife biology to the conservation and management of animals, both in- and ex-situ, including the role of zoos in captive breeding programmes, and the design and management of conservation areas.

ZO4015 Evolution (Prof. Nicola Marples) (S1) 5 credits
This module explores evolutionary concepts in greater detail giving insights into the processes underlying evolution. It covers different types of selection, co-evolution, sociality and altruism among other topics.

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

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

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

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

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

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

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

**Assessment and Examination Procedures:**
The lecture material will be examined in module examination papers taken during the Annual examination period. Practical work is assessed in course. Further information relating to the assessed components, composition of written papers and credit weightings will be given in the Junior Sophister Chemistry Booklet (all chemistry courses) issued to rising Junior Sophisters. The JS Chemistry mark will constitute 35% of the final degree mark.
Senior Sophisters:
In SS year, students attend a series of core modules in Physical, Organic and Inorganic Chemistry and Molecular Modelling, four specialised 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 ab (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 are assessed in course. All modules are weighted according to their respective credit rating. The JS Chemistry mark will constitute 35% of the final Moderatorship mark. Further information relating to the assessed components, composition of written papers and credit weightings will be given in the Senior Sophister Chemistry Booklet (all chemistry courses) issued to rising Senior Sophisters.
Junior Sophister Modules 60 credits

Inorganic Chemistry

CH3103 Organometallics & Coordination Chemistry (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 reactions mechanism. NOTE: 50% of the marks for this module are associated with the Inorganic component of the laboratory exercises.

CH3104 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

CH3203 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 stereoelectronic effects, physical organic chemistry. NOTE: 50% of the marks for this module are associated with the Organic component of the laboratory exercises.

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

Physical Chemistry

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

CH3304 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

CH3403 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

**CH3601 Computational Chemistry I (S1 & S2) 5 credits**
This module covers a range of topics in computational molecular quantum chemistry, forcefield based methods, molecular dynamics and numerical optimization methods.

**CH3602 Computational Chemistry II (S1 & S2) 5 credits**
This module covers programming and related skills, with courses on Unix and Fortran 90(+). This material is assessed during the year through practicals and assignments.
### Senior Sophister Modules  

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CH4119</td>
<td>Research in Chemistry (S1)</td>
<td>60</td>
</tr>
</tbody>
</table>

This research-oriented module involves a research project and thesis, oral presentation of a research seminar and attendance at scheduled School research seminars. Note that the marks associated with the research project are included in module CH4119.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CH4112</td>
<td>Advanced Organic Transformations I (S2)</td>
<td>5</td>
</tr>
</tbody>
</table>

This module involves core lectures in organic and biological photochemistry and reactive intermediates.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CH4105</td>
<td>Advanced Inorganic Chemistry II (S2)</td>
<td>5</td>
</tr>
</tbody>
</table>

This module involves core courses in heavy transition metal chemistry and in advanced coordination chemistry.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CH4106</td>
<td>Advanced Physical Chemistry I (S2)</td>
<td>5</td>
</tr>
</tbody>
</table>

This module involves core courses in photochemistry, redox active nanostructured materials and systems and advanced reaction dynamics.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CH4107</td>
<td>Advanced Physical Chemistry II (S2)</td>
<td>5</td>
</tr>
</tbody>
</table>

This core module involves lectures in quantum chemistry and solid state chemistry.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CH4701</td>
<td>Advanced Molecular Modelling I (S2)</td>
<td>5</td>
</tr>
</tbody>
</table>

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.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CH4702</td>
<td>Advanced Molecular Modelling II (S2)</td>
<td>5</td>
</tr>
</tbody>
</table>

Courses in computational drug design and more advanced lectures in molecular quantum chemistry.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CH4703</td>
<td>Advanced Molecular Modelling III (S2)</td>
<td>5</td>
</tr>
</tbody>
</table>

Courses in High Performance Computing and Advanced Molecular Dynamics.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CH4709</td>
<td>Chemistry Research and Data Analysis</td>
<td>25</td>
</tr>
</tbody>
</table>

This module combines the mark from the problem solving paper and the research project. The problem-solving element is a self-directed reading module that concentrates on a review and the attainment of a mature understanding of the fundamental chemical topics introduced over the entire period of the Moderatorship programme.
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 practicals, tutorials and research essays. Additionally, students have an opportunity to select a Broad Curriculum option.

**Assessment and Examination Procedures:**

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

**Senior Sophisters:**

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

**Assessment and Examination Procedures:**

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

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

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

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

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

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

GE3M17 EVOLUTIONARY GENETICS (S1) 5 credits
This module provides an introduction to genetic variation – its origins and its evolutionary consequences.

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

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

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

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

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

THE BROAD CURRICULUM 5 credits
Students can freely choose between available Broad Curriculum options.
Senior Sophister Modules

<table>
<thead>
<tr>
<th>Literature Review</th>
<th>5 Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research Project</td>
<td>15 Credits</td>
</tr>
<tr>
<td>Problems Paper</td>
<td>5 Credits</td>
</tr>
<tr>
<td>Essay Paper</td>
<td>5 Credits</td>
</tr>
<tr>
<td>Lecture Module 1 GE4210: Core curriculum I: Human &amp; Medical Genetics</td>
<td>10 Credits</td>
</tr>
<tr>
<td>Lecture Module 2 GE4220: Core curriculum II: Human Genetics</td>
<td>10 Credits</td>
</tr>
<tr>
<td>Lecture Module 3 GE4230: Principles of Human Genetics and General Genetics</td>
<td>10 Credits</td>
</tr>
</tbody>
</table>

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

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

Many underlying principles relating to Human Genetics will be addressed during this module including human population history, mutation and selection, the genetics underlying the inheritance of Mendelian disorders (single gene disorders), the effects of genetic background on phenotype, the inheritance of complex disorders and various methodologies that can be employed to elucidate the genetic pathogenesis of such disorders, the fields of clinical genetics and pharmacogenomics, imprinting and X-chromosome inactivation, the mitochondrial genome, inheritance and mutation, amongst other topics. This comprehensive module component will provide students with an overview of the field and knowledge of many of the fundamental principles of Human Genetics.
**GE4040  Principles of Genetics (Profs Wellmer, Kavanagh, Devine; S1)**

This course introduces and reviews key concepts of genetics and hence conveys fundamental knowledge for all genetics students, including students of Human Genetics. The following topics will be covered: Population Genetics, Inheritance of Complex Traits, Evolution of Genes and Traits, Gene Interactions, Gene Isolation and Manipulation, Genome Structure, DNA replication, RNA transcription and processing, Regulation of gene expression in bacteria and eukaryotes.

**GE4055  Genetic and Epigenetics of Cancer (Prof Bracken; S2)**

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

**GE4037  Transgenic Animals & Gene Therapy (Prof Farrar; S1)**

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

**GE4276  Stem Cell Biology (Prof Bracken; S1)**

Stem cells have the remarkable potential to develop into many different cell types in the body during early life and growth and therefore offer huge potential in regenerative medicine. This module component will provide an overview of the development of our understanding of stem cells, through the first isolation of embryonic stem cells and adult stem cells, to the discovery of cancer stem cells and Induced Pluripotent (iPS) stem cells. How our expanding knowledge of stem cells is now being used in the development of new and advanced methods of therapeutic intervention will also form an important part of this module component.
GE4061 Genetics and Immunology of Neural Diseases (Prof Campbell; S1)
With no neuron in the brain being more than 12 µm from a capillary, the vascular and nervous systems share common developmental pathways that allows for coordination of nutrients and information transfer. In addition, almost every neurological malignancy involves dysregulation of the blood vessels associated with neural tissues. This module component will provide an overview of the complexities of blood vessel development in the brain and retina. In addition, the module component will focus on several common neurological conditions such as Alzheimer’s disease, describing the underlying genetic causes of the condition and examining the current trends for future research and therapies. The module component will also explore the involvement of blood vessel and immune system dysfunction in conditions such as age-related macular degeneration (AMD) and neuropsychiatric disorders, with a focus on the genetic pre-disposition to such conditions.

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

GE4034 Human Evolutionary Genetics (Prof Bradley; S1)
Our concepts of human origins and migrations have been profoundly formed by human genetic analysis. The human genome is now the best studied genome for variation in both space and time. The module component follows how genetic insights help us understand: our relationships with the great apes and which are the important genetic changes on the human lineage; the origins of modern humans in Africa and the nature of the migration from there to the rest of the world; the different patterns between male and female lineage inheritance; the interaction between cultural and genetic inheritance patterns. Recent advances in ancient DNA sequencing and archaic human genomes are discussed in detail and a close look at European and even Irish genetic origins are included.

GE4053 Genetics of Neural Development (Prof Labrador; S2)
This module is intended for Senior Sophists with a neuroscience background. Students should have previously attended GE3006 (Neurogenetics) as a prerequisite. The module component covers different aspects of nervous system development from neural induction to early steps of circuitry assembly. There is a focus on different genetic experimental methods employed to identify central mechanisms of nervous system development. We will use different models to explain processes and provide examples of networks and concepts. The emphasis will be on the conservation of signaling pathways in development of very diverse organisms. This will include Drosophila melanogaster and vertebrates Xenopus laevis, Chick and Mouse.
GE4054 Behavioural Genetics (Prof Mitchell; S2)
This module component examines how genetic differences contribute to behavioural differences between individuals in a species. It considers examples from worms, flies, mice and humans. It will also explore how genetics can be used to dissect the biochemical and neural circuitry underlying specific behaviours.

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

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

GE4029 Microbial Molecular Genetics (Prof Devine; S1)
This module component focuses on adaptation of bacteria to nutritional and environmental stresses using Bacillus subtilis as a model organism. The history of research in B. subtilis and the features that facilitated its emergence as a model organism are addressed. The use of integrating plasmids and transposons in the genetic analysis of adaptative processes in B. subtilis and their applicability to other bacteria are then discussed. We explore the genetic analysis of competence development at the onset of nutrient limitation in B. subtilis in detail, describing the signal transduction pathway by which the process is controlled and made responsive to cell density and nutrient availability. We discuss instances of bistable bacterial populations, detailing essential features of the genetic switches required to generate bistability and show how these conditions apply to the development of genetic competence. We discuss the structure of biofilms and how expression of their development is regulated. We also discuss the developmental process of sporulation in B. subtilis, showing how gene expression is spatially and temporally regulated during the 8-hour developmental cycle and how the separate sporangium and mother cell compartments communicate to ensure coordinate regulation of the developmental process. Finally we discuss the regulatory network that operates to decide on the response (ie. enzyme production, competence, development, biofilm construction or sporulation) most appropriate to the prevailing conditions.
GE4032 Developmental Genetics of Drosophila (Prof Martin; S2)

This module component discusses how the creation of simple gradients of relatively few transcription factors sets up the complex patterns of gene expression that create a cell fate ‘map’ within the developing fly embryo. We will look at sets of genes (called segmentation genes) whose expression switches on master regulatory genes (Hox genes) that dictate whether an individual fly segment will carry a wing, a bristle, or an antenna. This is a fascinating topic that discusses work leading to the award of the 1995 Nobel Prize in Medicine/Physiology to Christiane Nusslein-Volhard and Eric Weischaus.
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
  - The nature of biological inheritance
  - The genetic basis of evolution and population variation
  - The molecular, cellular and physiological basis of human genetics
  - The role of genetics in rare and common disease
  - The study of genetics in model organisms
  - 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 specialises in drug discovery. The specialisation really begins in the Sophister years, building upon the fundamental principles covered in the Freshman 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 Annual examination period in Trinity Term. 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 annual examination period in Trinity Term. The Research Project is assessed in course. All modules are weighted according to their respective credit rating. The JS Medicinal Chemistry mark will constitute 35% of the final Moderatorship mark. 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**

**CH3203 Synthetic Organic Chemistry I (S1)**  
This module gives a basic grounding in the general methodology employed in organic synthesis. Topics covered include organometallic C-C couplings, pericyclic reactions, FMO theory & stereoelectronic effects and physical organic chemistry.

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

**Medicinal Chemistry**

**CH3441 Medicinal Chemistry (S1 & S2)**  
This module includes an introduction to medicinal chemistry, antiviral and anticancer chemistry and the computational method QSAR.

**CH3446 Microbiology and Medicinal Chemistry (S1 & S2)**  
This module covers antimicrobial agents, antiinfective agents, antimalarial chemistry and aspects of industrial chemistry.

**CH3447 Biochemistry and Pharmacology (S1 & S2)**  
This module covers protein structure and chemistry, steroid drugs, receptor pharmacology and the autonomic nervous system.

**Inorganic Chemistry**

**CH3103 Organometallics & Coordination Chemistry (S1)**  
This module covers topics such main group and transition metal organometallics, transition metal compounds and complexes, homogeneous catalysis and inorganic reactions mechanism.

**Physical Chemistry**

**CH3304 Molecular Thermodynamics and Kinetics (S2)**  
This module deals with thermodynamics and statistical mechanics, electrochemistry and kinetics.

**Cross-Disciplinary Modules**

**CH3403 Analytical Methods (S2)**  
This module deals with both the fundamental principles and application of spectroscopic and other characterization techniques. Topics such as analytical chemistry, organic spectroscopy and structural methods in inorganic chemistry will be covered.
CH3404 Biomaterials and Macromolecules (S2) 5 credits
This module will cover bioorganic chemistry and natural products, bioinorganic chemistry, colloids and other soft matter systems.

Practical Chemistry
CH3080 Practical Chemistry (S1 and S2) 15 credits
This is a laboratory module aimed at broadening the student’s knowledge in Physical, Organic and Inorganic Chemistry.
### Senior Sophister Courses  

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CH4101</td>
<td>Research Project (S1)</td>
<td>20</td>
</tr>
<tr>
<td>CH4112</td>
<td>Advanced Organic Chemistry I (S2)</td>
<td>5</td>
</tr>
<tr>
<td>CH4113</td>
<td>Advanced Organic Chemistry II (S2)</td>
<td>5</td>
</tr>
<tr>
<td>CH4401</td>
<td>Advanced Medicinal Chemistry I (S2)</td>
<td>5</td>
</tr>
<tr>
<td>CH4402</td>
<td>Advanced Medicinal Chemistry II (S2)</td>
<td>5</td>
</tr>
<tr>
<td>CH4403</td>
<td>Advanced Medicinal Chemistry III (S2)</td>
<td>5</td>
</tr>
<tr>
<td>CH4404</td>
<td>Advanced Medicinal Chemistry IV (S2)</td>
<td>5</td>
</tr>
<tr>
<td>CH4405</td>
<td>Advanced Medicinal Chemistry V (S2)</td>
<td>5</td>
</tr>
<tr>
<td>CH4406</td>
<td>General Chemistry</td>
<td>5</td>
</tr>
</tbody>
</table>

This research oriented module involves a term long research project and thesis (either in TCD or with one of our collaborating universities), oral presentation of a research seminar based on the research project and attendance at scheduled School research seminars.

This module involves core lectures in asymmetric synthesis and retrosynthesis.

This module involves core lectures in organic and biological photochemistry and reactive intermediates.

This module involves the chemistry, biochemistry and drugs associated with the central nervous system.

This module involves computational medicinal chemistry and analytical methods.

This module involves site-specific drug delivery and combinatorial chemistry.

This module involves the chemistry, biochemistry and drugs associated with the cardiovascular system and specialised case studies.

This module involves advanced synthetic organic chemistry, bioorganic chemistry, supramolecular chemistry and the chemistry of DNA-drug interactions.

This is a self-directed reading module which concentrates on a review and the attainment of a mature understanding of the fundamental chemical topics introduced over the entire period of the Moderatorship programme.
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 analyze 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 Freshman 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:** In order 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:** The lecture material will be examined by module in examination papers taken during the Annual examination period. Two modules may be examined in a single examination paper. Examined modules are weighted according to their respective credit rating, giving a total of 40 credits.

Continuous assessment of practical work contributes 20 credits, of which 12% (2.5 credits) is associated with the communications skills and career-development component.

A portion of the practical work will include some training in techniques in materials science and nanoscience within the Centre for Research on Adaptive Nanostructures and Nanodevices (CRANN).

JS marks contribute to 35% of the final degree Moderatorship mark.
Senior Sophisters:
The SS year consists of lectures, tutorials and practicals delivered in modules, as listed below. The major component of the practical module is an independent research project in nanoscience, physics, chemistry or advanced materials, which may be carried out at a facility off-campus during the first semester. Projects are also hosted by the Schools of Chemistry and Physics and by CRANN. Projects external to Trinity College are either hosted by cognate universities or research institutes. A component of problem-solving and scientific comprehension is also included in this module.

Mandatory Modules: All modules are mandatory.

Assessment and Examination Procedures:
The lecture material will be examined by module in examination papers taken during the Annual examination period. Two modules may be examined in a single examination paper. Examined modules are weighted according to their respective credit rating, giving a total of 35 credits. A paper on problem-solving ability and scientific comprehension, together with assessment of the research project, contributes 25 credits in the ratio 30:70, respectively. SS marks contribute 65% of the final degree Moderatorship mark. JS marks contribute 35% of the final degree Moderatorship mark.
## Junior Sophister Modules

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

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

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

### PY3P04 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.

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

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

### CH3304 Molecular Thermodynamics and Kinetics (S2)
10 credits
This module deals with thermodynamics and statistical mechanics, electrochemistry and kinetics.

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

### CH3093 Practical in Advanced Materials (S1 & S2)
15 credits
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.
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>PY4P03</td>
<td>Condensed Matter III (S2)</td>
<td>5</td>
</tr>
<tr>
<td>PY4P04</td>
<td>Nanoscience (S2)</td>
<td>5</td>
</tr>
<tr>
<td>PY4P06</td>
<td>Modern Optics (S2)</td>
<td>5</td>
</tr>
<tr>
<td>PY4N07</td>
<td>Advanced Topics for Nanoscience (S2)</td>
<td>5</td>
</tr>
<tr>
<td>CH4107</td>
<td>Advanced Physical Chemistry II (S2)</td>
<td>5</td>
</tr>
<tr>
<td>CH4601</td>
<td>Materials Chemistry 1 (S2)</td>
<td>5</td>
</tr>
<tr>
<td>CH4602</td>
<td>Materials Chemistry 2 (S2)</td>
<td>5</td>
</tr>
<tr>
<td>PY4NP1</td>
<td>Practical in Nanoscience (S1)</td>
<td>25</td>
</tr>
</tbody>
</table>

This module covers metal physics and superconductivity together with semiconductor devices.

This module covers the modified properties of nanoscale matter, its fabrication and potential applications.

This module covers optical properties of materials and nonlinear optics.

This module consists of specialist courses in polymer physics and thin films.

This core module involves lectures in quantum chemistry and solid state chemistry. It encompasses units on quantum chemistry and solid state.

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.

This module involves lectures on photochemistry and organic polymers. It encompasses units on Photochemistry and Materials, and organic polymeric materials.

This module combines a major research project with a component of general problem-solving in physics and chemistry.
Nanoscience, Physics & Chemistry of Advanced Materials Moderatorship
Learning Outcomes

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

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

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

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

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

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

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

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

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

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