School of Biochemistry and Immunology
School of Medicine
SS Molecular Medicine
2019–2020
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Dear SS Molecular Medicine students,

Welcome to Senior Sophister year, the culmination of your Molecular Medicine degree. It is a chance to really engage with Molecular Medicine as a subject and to graduate as well-rounded scientists with the ability to follow a wide range of career paths. This Handbook has been prepared as a guide to the Sophister year and contains information regarding the course content, course assessment and criteria, plagiarism and health & safety information etc. The Handbook is published on the school website but a number of hard copies are also available in the school office. Personal hard copies can be made available to students on request. In addition to learning within the context of formal lecture and laboratory sessions, I encourage co-operation with your fellow students so as you can learn from each other along the way.

If you have any problems during the year which affect your academic studies, please come and speak to me in confidence. I am here to help. Looking forward to working with you over the coming year.

Prof. Gareth Brady
SS Course Co-ordinator: bradyg1@tcd.ie
Senior Sophister Molecular Medicine (60 ECTS)

BIU44390 RESEARCH PROJECT IN MOLECULAR MEDICINE (Semester 1) 20 credits
The module comprises of an original research project in biochemistry, cell biology, immunology or clinical medicine.

BIU44010 ADVANCED RESEARCH SKILLS (Semester 1) 10 credits
This purpose of this module is to further develop research, critical analysis and communication skills that are essential for a graduate Molecular Medicine student. Students will be trained in data handling as well as solving quantitative problems in biochemistry and immunology. In addition, this module will introduce students to a wide array of cutting edge techniques and strategies used in biochemistry, immunology and molecular medicine.

BIU44310 NEUROBIOLOGY & IMMUNOLOGY (Semester 2) 10 credits
This module covers the structure, function and pharmacology of neurotransmitters, neuron-glia interactions, intraneuronal signalling and the neurobiology of behaviour and neurodegenerative disorders. This module also covers regional immunology (e.g. gastrointestinal immunology, respiratory immunology etc), autophagy and immunometabolism.

BIU44320 MICROBIAL DISEASES & IMMUNE SYSTEM DISORDERS (Semester 2) 10 credits
The first part of this module will focus on microbial diseases. Bacterial pathogens of medical importance will be covered in detail. Parasitic protozoa such as trypanosomes and helminths will be introduced. This module will also cover the basic and clinical aspects of auto-inflammatory and autoimmune conditions, including rheumatoid arthritis, multiple sclerosis and immunodeficiency syndromes.

BIU44330 CELL CYCLE, CANCER BIOLOGY AND THERAPEUTICS (SEMESTER 2) 10 credits
This module will provide an in-depth analysis of the cell cycle, cancer and metastasis. It will focus on the progression of disease and current therapeutic interventions. This module will also provide a detailed overview of the meiotic and mitotic cell cycle and its regulation and the molecular biology of cancer.

School of Medicine/Biochemistry and Immunology Personnel and Contact Details:
The Senior Sophister Course Co-ordinator is Prof Gareth Brady (email bradyg1@tcd.ie). The Head of School is Ed Lavelle (phone extension 2488, email lavellee@tcd.ie) and the School Administrator is Conor Spillane (phone extension 1604, email CSPILLAN@tcd.ie). Rachel Elshove (elshover@tcd.ie) is the point of contact in the School office on Level 3 TBSI. Remember that you also have a college tutor that you can contact at any time. A complete list of the Biochemistry Staff can be found at http://www.tcd.ie/Biochemistry/staff/
Attendance:
All students are expected to attend lectures, workshops, practical classes, in-course assessments and examinations. Scheduled classes play an important role in supporting progress through the academic year in particular course assignment work. Students are therefore expected to keep up a consistent rate of good attendance so that performance later in the year will not be adversely affected. In the event of not being able to attend classes due to illness, please inform the Course Advisor. Medical certificates are required for absences of more than a few days OR if the absence means a deadline or an assessment will be missed. Details of medical certificates and other personal information will be treated confidentially. Students who miss classes are responsible for updating themselves on any information provided during those classes.

The Department operates the College procedure in relation to ‘Non-satisfactory attendance and course work’ (Calendar). That is, any student who misses more than a third of a course in any term or fails to complete assignments may be declared ‘non-satisfactory’. Non-satisfactory returns are made to the Senior Lecturer; such students may be refused permission to take the annual examination and may be required by the Senior Lecturer to repeat the year.

‘Extract from University of Dublin Calendar 2018-19, Part II Undergraduate Studies, page 32.

Non-satisfactory attendance and course work

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

§26 At the end of the teaching term, students who have not satisfied the school or department requirements, as set out in §§19, 24 and 25 above, may be reported as non-satisfactory for that term. Students reported as non-satisfactory for the Michaelmas and Hilary terms of a given year may be refused permission to take their semester two assessment/examinations and may be required by the Senior Lecturer to repeat their year.’

Further details of procedures for reporting a student as non-satisfactory are given on the College website at https://www.tcd.ie/undergraduatestudies/academic-progress/attendance-course-work.php.
Explanation of ECTS:
The European Credit Transfer and Accumulation System (ECTS) is an academic credit system based on the estimated student workload required to achieve the objectives of a module or programme of study. It is designed to enable academic recognition for periods of study, to facilitate student mobility and credit accumulation and transfer. The ECTS is the recommended credit system for higher education in Ireland and across the European Higher Education Area.

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

The European norm for full-time study over one academic year is 60 credits. The Trinity College Dublin, University of Dublin academic year is 40 weeks from the start of Semester 1 to the end of semester 2. 1 ECTS credit represents 20-25 hours estimated student input, so a 10-credit module will be designed to require 200-250 hours of student input including class contact time and assessments.

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

For additional details see: https://www.tcd.ie/teaching-learning/NC_Proposal/ECTS/ects.php

Annual Year Structure:
Students should note that the annual year structure has changed this year. Information is available at https://www.tcd.ie/calendar/academic-year-structure/

Examinations/Assessments and Breakdown of Marks:

<table>
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<tr>
<th>Senior Sophister Module Name</th>
<th>ECTS Weighting</th>
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<tr>
<td>1) Research Project in Molecular Medicine</td>
<td>BIU44390</td>
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<td>2) Advanced Research Skills</td>
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<td>3) Neurobiology &amp; Immunology</td>
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<tr>
<td>5) Cell Cycle, Cancer Biology &amp; Therapeutics</td>
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SS year is broken down into a total of 60 credits.

Research Project in Molecular Medicine (Biu44390) Value: 20 ECTS

An 11-week research project and thesis. Project laboratory work will start on September 9th and terminate on the 22nd November. In general, students will finish in the laboratory by 6pm each day. Occasionally, experiments may run longer but this should not be the norm – please contact your supervisor if you need further information. In order to be fair to other students, no student is allowed to work in the laboratory after the 22nd November (even to finish one last experiment). Please contact your course coordinator if you need further information.

After the completion of laboratory work, you will be required to submit a draft of your project thesis to your supervisor. The absolute deadline for submission of thesis 1st draft is Monday 20th January 2020. We would strongly recommend that you submit your first draft at an earlier date in January in order to give you time to incorporate suggested revisions. Your supervisor should only see one or possibly two drafts of the thesis prior to submission. Listen carefully to their feedback and incorporate it.

A deadline for handing in final revised project thesis will operate. It is 4.00 pm on Monday 3rd February. For every working day that your thesis is late 2% will be deducted from your mark. Please submit TWO hard copies of your thesis (double-sided for printing) to the school office and sign the submission sheet. In addition, you must also submit a pdf version electronically to Rachel in the school office.

Following submission of your project thesis you will give a 15 min oral presentation (10 min plus 5 min for questions) that explains your project, its aims, your experimental approach, your results and conclusions (Monday 2nd March). Your presentation and your ability to answer questions will be assessed by a panel of three members of academic staff. Your classmates will also be present at this session. It is advisable to arrange at least one practise session with your project supervisor. This oral presentation will account for 15% of the project mark.

You will also present a Project Poster to the School at a poster session (Friday 6th March). All members of the School, both staff and students, are invited to attend and they may ask you questions about your research project. Your poster will be judged by 2 members of staff and you will be asked questions by these judges. This poster presentation will account for 5% of the project mark.

Ms Roisin Cleere and Dr Audrey Carroll (Preparation Room) will advise you about the presentation of your poster and print it for you. Further details on Project write-ups and poster presentations will be given at the end of semester 1.

Project Marking Scheme:
Lab performance: 15% (awarded by supervisor)
Thesis: 65% (awarded by supervisor & 1 other staff member)
Oral presentation: 15% (awarded by panel of 3 staff members)
Poster presentation: 5% (awarded by 2 staff members)

Copy of mark sheets and criteria for SS project, thesis and poster can be found below (pages 20-25)

- Lab performance report (supervisor only; 15%)
- Project thesis (supervisor’s report – made available without mark to 2nd marker)
- Project thesis (2nd marker) – marks independently, meets and agrees mark with supervisor (65% of the project mark)

Note: if the supervisor and the 2nd markers are more than 10% apart, the thesis will be given to a third marker before a final mark is agreed.

Advanced Research Skills (BIU44010) Value: 10 ECTS
This module covers quantitative biochemical problems, bioinformatics (sequence analysis), comparative medicine and a series of group presentations by students on various biochemical techniques. A series of 18 lectures will also introduce students to a wide array of cutting edge techniques and strategies used in biochemistry. Marks (100) for this module are awarded through continual assessment and in-course exams in semester 1 as follows:

- Quantitative Problems (4 in total, assessed by two 1 hour in-course exams of equal weighting-one compulsory question on each exam) (30 marks in total)
- Bioinformatics-Sequence Analysis (3 in total, assessed by assignments submitted online of equal weighting) (10 marks in total)
- Group BioTechniques (assessed by one 1 hour in-course MCQ exam (15 marks), oral presentation (5 marks) and summary report (5 marks) (25 marks in total)
- Comparative Medicine (assessed by one 1 hour in-course exam) (5 marks)
- BioTechniques Lectures (material assessed by one 1 hour in-course exam, answer 2 out of 3 essay style questions) (30 marks in total)

Quantitative Problem Sessions:
All Quantitative Problems will be given out at introductory sessions by various staff members (e.g. Prb 1 Intro on the timetable), at the times indicated. You will attempt the problem in your own time and must bring the problem with you to a timetabled tutorial session (e.g. Prb 1 Tutorial). You must be able to demonstrate that you have attempted the problem to the staff member and failure to do so will result in being returned as non-satisfactory. In the tutorial session, the staff member will go through the solution with you and answer any queries you may have.
There will be 4 quantitative problems in total and these will be assessed by two 1 hour in-course exams of equal weighting—one compulsory question on each exam.

**Sequence Analysis Sessions:**
There will be three Sequence Analysis Sessions (Dr Jerrard Hayes). The session will begin with a brief introduction in FRED. You will then move to the East End Public Access Mac Room for the practical session. Submission dates for the Sequence Analysis Exercises are indicated on the timetable. Dr Hayes will advise you as to how and where you submit the exercises.

**Semester 2 Examination Papers**  
**Value: 30 ECTS**
There are three exam papers at the end of semester 2, each with equal weighting as follows:

**Paper 1 (BIU44310) Neurobiology & Immunology**  
**Value: 10 ECTS**
Exam paper (100 marks) divided into 4 sections of equal weighting as follows:
- **Section 1:** Neurobiology (Answer 1 out of 2 questions) 25marks
- **Section 2:** Immunology (Answer 1 out of 2 questions) 25marks
- **Section 3:** General (Integrative/philosophical)  
  (Answer 1 out of 3 questions) 25marks
- **Section 4:** General (Quickie questions)  
  (Answer 4 out of 7 questions) 25marks

**Paper 2 (BIU44320) Microbial Diseases & Immune System Disorders**  
**Value: 10 ECTS**
Exam paper (100 marks) divided into 4 sections of equal weighting as follows:
- **Section 1:** Microbial Disease (Answer 1 out of 2 questions) 25marks
- **Section 2:** Immune System Disorders (Answer 1 out of 2 questions) 25marks
- **Section 3:** General (Integrative/philosophical)  
  (Answer 1 out of 3 questions) 25marks
- **Section 4:** General (Quickie questions)  
  (Answer 4 out of 7 questions) 25marks

**Paper 3 (BIU44330) Cell Cycle, Cancer Biology & Therapeutics**  
**Value: 10 ECTS**
Exam paper (100 marks) divided into 4 sections of equal weighting as follows:
- **Section 1:** Cell cycle & Cancer (Answer 1 out of 2 questions) 25marks
- **Section 2:** Cancer Biology & Therapeutics (Answer 1 of 2 questions) 25marks
- **Section 3:** General (Integrative/philosophical)  
  (Answer 1 out of 3 questions) 25marks
- **Section 4:** General (Quickie questions)  
  (Answer 4 out of 7 questions) 25marks

All answers from the above exam papers are double-marked.

The overall degree mark is comprised of 80% of SS year and 20% of JS year.
On completion of their annual examinations, some students sit a viva voce examination with the External Examiner (Prof. Paul Brennan, Cardiff University). Students are considered ‘borderline’ if they are 1% or less off a grade and following the viva voce examination the External Examiner may recommend at the Examiners’ meeting that the students’ degree mark be brought up to the next grade.

**Practise Vivas:**
Vivas (oral exams) are held approximately two weeks following the completion of your three exam papers. The maximum percentage marks that you can be brought up by is 1%. You cannot be marked down by a viva. You will not know your mark before sitting the viva.

**How can you prepare for the viva?**
Practise vivas will be held during the year. You will be assigned to a pair of academic staff members. The vivas take approximately 20 minutes and you will be asked a variety of questions. There are no marks assigned to this exercise. Please regard these vivas not as a test of your knowledge but as useful practise. They are also good interview experience.

If you are called for a viva in the summer, you should read over your project thesis as the Extern often starts off by asking you about your project. He/she will want to relax you and will generally start you off on a topic you know a lot about. The Extern will probably cover about 4-6 topics during the viva and it is impossible to second guess what they will ask. However, if you feel you did badly in one particular exam question, it is a good idea to revise this topic. The Extern has access to all your marks and if he/she sees a poor mark in an otherwise very consistent good set of marks they may wish to follow this up. The Extern may also ask you if there is a topic in Molecular Medicine that you find particularly interesting and that you wish to talk about. It is therefore a good idea to have something prepared but ensure that it is a specific topic. Do not be too general and say that you’re interested in protein structure! The Extern may also ask you on your views of the course; was there a part of the course you really enjoyed or not as the case may be. The role of the Extern is not only to assess your performance but also to assess our teaching capabilities and to identify strengths/weaknesses and even omissions in the course so that they can make recommendations for the following year.

**Tutorials:**
Tutors have been chosen randomly. Please contact your tutor during the first week of the first semester. You are expected to attend a tutorial every fortnight. Times and dates of tutorials given on timetable are a rough guide only. Your tutor will set various exercises and these should help you in your final examinations.

**Course Feedback:**
A Feedback Form for each course will be given out at the beginning of the term. These (anonymous) forms are a mechanism whereby students can make comments and suggestions that will help us to maintain and indeed improve the quality of the teaching offered by the School of Medicine and School of Biochemistry & Immunology. Please fill out the form upon completing each course, do not wait until the end of term (you will forget!). Put the forms into the box provided in the school office.
Addresses and Phone No’s:
Please enter your College based address, e-mail address and telephone number (if any) on the
sheet provided at the Introductory Briefing Session. Please also include a home (or other contact)
address and telephone number. This will enable us to contact you in an emergency or with
important changes in such details as timetables, exam venues, etc. If you do not enter these
details you may not be informed of any changes.

Prizes & Medals: A prize for the best poster in Molecular Medicine will be awarded to the student
who attains the highest marks in their poster presentation. Poster prizes will also be given out to
students in the Molecular Medicine and Immunology classes. The Margaret Ciotti Medal is
awarded each year to a Senior Sophister student in one of the three classes for excellence in
undergraduate research. It will be awarded to the student who attains the highest marks overall
in their research project. This award was initiated by Bruno Orsi to honour his wife’s
achievements in biochemistry and will now be a memorial to her. It is traditionally presented by
Bruno on a date between the end of the exams and the vivas. This year the award ceremony and
reception will take place on the afternoon of the 15th May.

Health and Safety Matters:

1) Registration with Safety Officer
Preliminary safety registration takes place during one of the mandatory health and safety briefing
sessions timetabled in the first week of Semester 1 (see timetable). You must also register, in
person, with the Safety Officer once you commence your project. This is necessary in order to
record your next-of-kin details in the unlikely event of an accident, to record where you will be
working, to ascertain whether or not you have to work with major hazards during your project
work (carcinogens, mutagens, cyto-toxics, biological agents, GMOs, radioactivity, etc), and to
ensure that you and your supervisor understand that you have to conduct a HIRAC review (hazard
identification, risk assessment and risk control) of the proposed work. (see below).

2) Formal Health and Safety Briefings
Mr Liam McCarthy (Chief Technical Officer) will describe the general management and security
features of the building on the first day of term. Dr Nóirín Nic a’ Bháird, the School Safety Officer
will give you two formal Health and Safety briefings on Monday 9th & Friday 13th September.
ATTENDANCE AT THESE BRIEFINGS AND ANY ADDITIONAL TRAINING SESSIONS (e.g.
Radiological Protection Workshop, viewing safety videos, etc.) IS MANDATORY. Some of these
actions are legal, license or College's insurer’s requirements that have to be complied with.

3) Safety Lab Coat & Spectacles
You must have at least one Howie-style laboratory safety coat, conforming to the NISO 1993, or
better, standard, along with a pair of safety spectacles with you at all stages during active
laboratory work.
4) Specific Aspects of Health and Safety Associated with Project Work

You are required to complete a ‘Personnel Training Form’ to ensure that you have been trained in all techniques/equipment that you will be using during your project, that you understand any risks associated with your project and that you understand how to minimize them. Any hazardous materials, steps or procedures (including off-site work connected with your research such as collecting samples from other laboratories, etc.) involved in your project will have been identified by, and discussed with you by your project supervisor. He/she is required, by law, to perform this hazard identification, risk assessment and risk control (HIRAC) on every experiment undertaken by you, but you have a role to play as well in making sure that you record the conclusions of this procedure in your notebook. The control measures necessary to reduce or eliminate risk must be written in your notebook for each hazardous step or procedure. The law requires this to be done. You are still in training so you cannot be classed as a competent researcher and thus able to do this yourself to ensure your safety. If in doubt about the proper procedures for any experiment, do not perform that experiment.

Senior Sophisters must make themselves aware of the College's and School’s Safety Statement which is displayed prominently in every laboratory in the School. [It can be downloaded from the School’s Local Home-Page at this URL: www.tcd.ie/biochemistry/]. You are still bound by the 'Science Faculty's Health and Safety Guidance Manual' and the associated Health Questionnaire which you completed at the start of JF year. If your health status has changed since then in terms of the categories listed (including pregnancy or lactation) you have to complete a new Health Questionnaire. If your health status again changes during the year you must consult, in confidence, with the Safety Officer. [This particularly applies in the case of pregnancy.]

If you intend working with radioactivity during your project you must first contact the School Radiation Safety Officer Dr James Murray (James.Murray@tcd.ie). You are not permitted to work with unsealed radionuclide sources.

Any student working with human materials (blood, buffy coats, semen, CSF, dialysis fluid, primary explants, etc.) must be vaccinated against Hepatitis B prior to commencing your project. You are not permitted to work with any risk group 3 or class 3 biological agents such as HIV, Hepatitis B and C, etc. or to culture Category 3 (or higher) pathogens.

You must request or otherwise obtain Material Safety Data Sheets (MSDS) for any toxic or dangerous chemicals or preparations that you are using in your project. These MSDS's have to be requested at the point of ordering any material. The MSDS must be stuck into your laboratory notebook. The guidance must be followed.

After 6:00 pm on working days, and at all times on weekends and public holidays, no Senior Sophister may work in any laboratory without the close presence of a member of the academic staff. It is the Senior Sophister's responsibility to ask that staff member if he/she will consent to act in a supervisory capacity for the time the student is working. During normal working hours no student may work alone in any laboratory.
Failure to observe these rules/procedures will cause the offenders to be officially warned, and be reported to the Head of School, school safety officer and project supervisor. Normal College disciplinary procedures can be invoked (including fines being levied as well as withdrawal of student i.d. card, etc.) Persistent failure to observe these rules may result in that student being banned from laboratory work with loss of those marks available for project work.
All the necessary forms are available to download on the local safety pages at https://www.tcd.ie/Biochemistry/local/safety_info.php
Once you have completed all the forms and safety briefings, bring them along in person to the Safety officer, Nóirín Nic a’ Bháird in Room 5.08.

5) Emergency Procedure
In the event of an emergency, dial Security Services on extension 1999. Security Services provide a 24-hour service to the college community, 365 days a year. They are the liaison to the Fire, Garda and Ambulance services and all staff and students are advised to always telephone extension 1999 (+353 1 8961999) in case of an emergency. Should you require any emergency or rescues services on campus, you must contact Security Services. This includes chemical spills, personal injury or first aid assistance. It is recommended that all students save at least one emergency contact in their phone under ICE (In Case of Emergency).

Students with Disabilities: The University Policy Relating to students with disabilities is available at www.tcd.ie/disability. The Student Disability Service is located in Room 2054 Arts Building, phone = 8963111, email = disab@tcd.ie. The Student Disability Services Committee provides the formal channel for raising issues affecting students with disabilities. Martha Motherway (motherm@tcd.ie) is the liaison officer for the disability services in our school.
MyCareer from Careers Advisory Service

An online service that you can use to:

- Apply for opportunities which match your preferences - vacancies including research options
- Search opportunities- postgraduate courses and funding
- View and book onto employer and CAS events
- Submit your career queries to the CAS team
- Book an appointment with your Careers Consultant
Simply login to MyCareer using your Trinity username and password and personalise your profile.

Careers Advisory Service
Trinity College Dublin, 7-9 South Leinster Street, Dublin 2
01 896 1705/1721  |  Submit a career query through MyCareer

Opening Hours
During term: 9.30am - 5.00pm, Monday - Friday
Out of Term: 9.30am - 12.30pm & 2.15 - 5.00pm, Monday - Friday

Careers Talk:
John Wynne will give a Careers Talk tailored for Life Sciences students, on Thursday 26th September at 9am in B2.36/37/38.

Plagiarism:
The full statement of College’s policy on plagiarism (see Calendar, General Regulations and Information, §82-§91 at http://tcd-ie.libguides.com/plagiarism are reproduced below. In addition members of staff of the School of Biochemistry & Immunology may scan your written assignments using plagiarism-detecting software such as Turnitin (additional information for which can be found at: http://turnitin.com/static/index.html). During your final year you will be expected to prepare material for the Biochemical Techniques course and to write a report on the research findings of your fourth year project. You will be provided with guidance notes for the completion of these exercises. In the first semester, Prof. Kingston Mills will give a tutorial class on how to prepare and write a report for your research project.

It is a college requirement that all students must complete an online tutorial on avoiding plagiarism ‘Ready, Steady, Write’, located at http://tcd-ie.libguides.com/plagiarism/ready-steady-write.

In addition, students must complete cover sheets or include text containing the following declaration when submitting assessed work in hard or soft copy or via Blackboard:
I have read and I understand the plagiarism provisions in the General Regulations of the University Calendar for the current year, found at: http://www.tcd.ie/calendar

I have also completed the Online Tutorial on avoiding plagiarism ‘Ready, Steady, Write’, located at http://tcd-ie.libguides.com/plagiarism/ready-steady-write

§82 General
It is clearly understood that all members of the academic community use and build on the work and ideas of others. It is commonly accepted also, however, that we build on the work and ideas of others in an open and explicit manner, and with due acknowledgement.

Plagiarism is the act of presenting the work or ideas of others as one’s own, without due acknowledgement.

Plagiarism can arise from deliberate actions and also through careless thinking and/or methodology. The offence lies not in the attitude or intention of the perpetrator, but in the action and in its consequences.

It is the responsibility of the author of any work to ensure that he/she does not commit plagiarism.

Plagiarism is considered to be academically fraudulent, and an offence against academic integrity that is subject to the disciplinary procedures of the University.

§83 Examples of Plagiarism

Plagiarism can arise from actions such as:
(a) copying another student’s work;
(b) enlisting another person or persons to complete an assignment on the student’s behalf;
(c) procuring, whether with payment or otherwise, the work or ideas of another;
(d) quoting directly, without acknowledgement, from books, articles or other sources, either in printed, recorded or electronic format, including websites and social media;
(e) paraphrasing, without acknowledgement, the writings of other authors.

Examples (d) and (e) in particular can arise through careless thinking and/or methodology where students:
(i) fail to distinguish between their own ideas and those of others;
(ii) fail to take proper notes during preliminary research and therefore lose track of the sources from which the notes were drawn;
(iii) fail to distinguish between information which needs no acknowledgement because it is firmly in the public domain, and information which might be widely known, but which nevertheless requires some sort of acknowledgement;
(iv) come across a distinctive methodology or idea and fail to record its source.

All the above serve only as examples and are not exhaustive.

§84 Plagiarism in the context of group work
Students should normally submit work done in co-operation with other students only when it is done with the full knowledge and permission of the lecturer concerned. Without this, submitting work which is the product of collusion with other students may be considered to be plagiarism. When work is submitted as the result of a group project, it is the responsibility of all students in the group to ensure, so far as is possible, that no work submitted by the group is plagiarised.

§85 Self plagiarism
No work can normally be submitted for more than one assessment for credit. Resubmitting the same work for more than one assessment for credit is normally considered self-plagiarism.

§86 Avoiding plagiarism
Students should ensure the integrity of their work by seeking advice from their lecturers, tutor or supervisor on avoiding plagiarism. All schools and departments must include, in their handbooks or other literature given to students, guidelines on the appropriate methodology for the kind of work that students will be expected to undertake. In addition, a general set of guidelines for students on avoiding plagiarism is available on http://tcd-ie.libguides.com/plagiarism.

§87 If plagiarism as referred to in §82 above is suspected, in the first instance, the Director of Teaching and Learning (Undergraduate), or their designate, will write to the student, and the student’s tutor advising them of the concerns raised. The student and tutor (as an alternative to the tutor, students may nominate a representative from the Students’ Union) will be invited to attend an informal meeting with the Director of Teaching and Learning (Undergraduate), or their designate, and the lecturer concerned, in order to put their suspicions to the student and give the student the opportunity to respond. The student will be requested to respond in writing stating his/her agreement to attend such a meeting and confirming on which of the suggested dates and times it will be possible for them to attend. If the student does not in this manner agree to attend such a meeting, the Director of Teaching and Learning (Undergraduate), or designate, may refer the case directly to the Junior Dean, who will interview the student and may implement the procedures as referred to under conduct and college regulations.

§88 If the Director of Teaching and Learning (Undergraduate), or designate, forms the view that plagiarism has taken place, he/she must decide if the offence can be dealt with under the summary procedure set out below. In order for this summary procedure to be followed, all parties attending the informal meeting as noted in §87 above must state their agreement in writing to the Director of Teaching and Learning (Undergraduate), or designate. If the facts of the case are in dispute, or if the Director of Teaching and Learning (Undergraduate), or designate, feels that the penalties provided for under the summary procedure below are inappropriate given the circumstances of the case, he/she will refer the case directly to the Junior Dean, who will interview the student and may implement the procedures as referred to under conduct and college regulations.

§89 If the offence can be dealt with under the summary procedure, the Director of Teaching and Learning (Undergraduate), or designate, will recommend one of the following penalties:
(a) Level 1: Student receives an informal verbal warning. The piece of work in question is inadmissible. The student is required to rephrase and correctly reference all plagiarised elements. Other content should not be altered. The resubmitted work will be assessed and marked without penalty;
(b) Level 2: Student receives a formal written warning. The piece of work in question is inadmissible. The student is required to rephrase and correctly reference all plagiarised elements. Other content should not be altered. The resubmitted work will receive a reduced or capped mark depending on the seriousness/extent of plagiarism;
(c) Level 3: Student receives a formal written warning. The piece of work in question is inadmissible. There is no opportunity for resubmission.

§90 Provided that the appropriate procedure has been followed and all parties in §87 above are in agreement with the proposed penalty, the Director of Teaching and Learning (Undergraduate) should in the case of a Level 1 offence, inform the course director and where appropriate the course office. In the case of a Level 2 or Level 3 offence, the Senior Lecturer must be notified and requested to approve the recommended penalty. The Senior Lecturer will inform the Junior Dean accordingly. The Junior Dean may nevertheless implement the procedures as referred to under conduct and college regulations.

§91 If the case cannot normally be dealt with under the summary procedures, it is deemed to be a Level 4 offence and will be referred directly to the Junior Dean. Nothing provided for under the summary procedure diminishes or prejudices the disciplinary powers of the Junior Dean under the 2010 Consolidated Statutes.
**Class Descriptors:** These Science Faculty Descriptors are given as a guide to the qualities that assessors are seeking in relation to the grades usually awarded. A grade is the anticipated degree class based on the consistent performance at the level indicated by an individual answer. In addition to the criteria listed, the Department’s examiners will also give credit for evidence of critical discussion of the facts or evidence.

<table>
<thead>
<tr>
<th>Class</th>
<th>Range</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>90 - 100</td>
<td>IDEAL ANSWER; showing insight and originality and wide knowledge. Logical, accurate and concise presentation. Evidence of reading and thought beyond course content. Contains particularly apt examples. Links materials from lectures, practicals and seminars where appropriate.</td>
</tr>
<tr>
<td></td>
<td>80 - 89</td>
<td>OUTSTANDING ANSWER; falls short of the ‘Ideal’ answer either on aspects of presentation or on evidence of reading and thought beyond the course. Examples, layout and details are all sound.</td>
</tr>
<tr>
<td></td>
<td>70 - 79</td>
<td>MAINLY OUTSTANDING ANSWER; falls short on presentation and reading or thought beyond the course, but retains insight and originality typical of the first class work.</td>
</tr>
<tr>
<td>II - 1</td>
<td>65 - 69</td>
<td>VERY COMPREHENSIVE ANSWER; good understanding of concepts supported by broad knowledge of subject. Notable for synthesis of information rather than originality. Sometimes with evidence of outside reading. Mostly accurate and logical with appropriate examples. Occasionally a lapse in detail.</td>
</tr>
<tr>
<td></td>
<td>60 - 64</td>
<td>LESS COMPREHENSIVE ANSWER; mostly confined to good recall of coursework. Some synthesis of information or ideas. Accurate and logical within a limited scope. Some lapses in detail.</td>
</tr>
<tr>
<td>II – 2</td>
<td>55 - 59</td>
<td>SOUND BUT INCOMPLETE ANSWER; based on coursework alone but suffers from a significant omission, error or misunderstanding. Usually lacks synthesis of information or ideas. Mainly logical and accurate within its limited scope and with lapses in detail.</td>
</tr>
<tr>
<td></td>
<td>50 - 54</td>
<td>INCOMPLETE ANSWER; suffers from significant omissions, errors and misunderstanding, but still with understanding of main concepts and showing sound knowledge. Several lapses in detail.</td>
</tr>
<tr>
<td>III</td>
<td>45 - 49</td>
<td>WEAK ANSWER; limited understanding and knowledge of subject. Serious omissions, errors and misunderstandings, so that answer is no more than adequate.</td>
</tr>
<tr>
<td></td>
<td>40 - 44</td>
<td>VERY WEAK ANSWER; a poor answer, lacking substance but giving some relevant information. Information given may not be in context or well explained, but will contain passages and words which indicate a marginally adequate understanding.</td>
</tr>
<tr>
<td>F - 1</td>
<td>35 - 39</td>
<td>MARGINAL FAIL; inadequate answer, with no substance or understanding, but with a vague knowledge relevant to the question.</td>
</tr>
<tr>
<td>F - 2</td>
<td>30 - 34</td>
<td>CLEAR FAILURE; some attempt made to write something relevant to the question. Errors serious but not absurd. Could also be sound answer to the misinterpretation of the question.</td>
</tr>
<tr>
<td>F - 3</td>
<td>0 - 29</td>
<td>UTTER FAILURE; with little hint of knowledge. Errors serious and absurd. Could also be a trivial response to the misinterpretation of the question.</td>
</tr>
</tbody>
</table>
Scheme for marking of projects:
The project mark is comprised of the Supervisor’s mark and one other Examiner’s marks for the project thesis. The Supervisor’s mark will be based on the student’s performance within the laboratory (technical ability, understanding of the project and literature pertaining to it, critical evaluation of results, demonstration of initiative and independent thought) and on the content and presentation of the project thesis. The supervisor will also make the other Examiner of the project thesis aware of any unforeseen difficulties that arose during the course of the project.

<table>
<thead>
<tr>
<th>Class</th>
<th>Mark Range</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>85-100</td>
<td>Exceptional project report showing broad understanding of the project area and excellent knowledge of the relevant literature. Exemplary presentation and analysis of results, logical organisation and ability to critically evaluate and discuss results coupled with insight and originality.</td>
</tr>
<tr>
<td></td>
<td>70-84</td>
<td>An excellent project report showing evidence of wide reading, with clear presentation and thorough analysis of results and an ability to critically evaluate and discuss research findings. Clear indication of some insight and originality. A very competent and well-presented report overall but falling short of exemplary in each and every aspect.</td>
</tr>
<tr>
<td>II-1</td>
<td>60-69</td>
<td>A very good project report which shows a good understanding of the problem and some knowledge of the relevant literature. Mostly sound presentation and analysis of results but with occasional lapses. Some relevant interpretation and critical evaluation of results, though somewhat limited in scope. General standard of presentation and organisation good to very good.</td>
</tr>
<tr>
<td>II-2</td>
<td>50-59</td>
<td>A moderately good project report which shows some understanding of the problem but limited knowledge and appreciation of the relevant literature. Presentation, analysis and interpretation of the results at a basic level and showing little or no originality or critical evaluation. Insufficient attention to organization and presentation of the report.</td>
</tr>
<tr>
<td>III</td>
<td>40-49</td>
<td>A weak project report showing only limited understanding of the problem and superficial knowledge of the relevant literature. Results presented in a confused or inappropriate manner and incomplete or erroneous analysis. Discussion and interpretation of results severely limited, including some basic misapprehensions, and lacking any originality or critical evaluation. General standard of presentation poor.</td>
</tr>
<tr>
<td>Fail</td>
<td>20-39</td>
<td>An unsatisfactory project containing substantial errors and omissions. Very limited understanding, or in some cases misunderstanding of the problem and very restricted and superficial appreciation of the relevant literature. Very poor, confused and, in some cases, incomplete presentation of the results and limited analysis of the results including some serious errors. Severely limited discussion and interpretation of the results revealing little or no ability to relate experimental results to the existing literature. Very poor overall standard of presentation.</td>
</tr>
<tr>
<td></td>
<td>0-19</td>
<td>A very poor project report containing every conceivable error and fault. Showing virtually no real understanding or appreciation of the problem and of the literature pertaining to it. Chaotic presentation of results, and in some cases incompletely presented and virtually non-existent or inappropriate or plainly wrong analysis. Discussion and interpretation seriously confused or wholly erroneous revealing basic misapprehensions.</td>
</tr>
</tbody>
</table>
# Senior Sophister Lab Performance Report

This mark contributes **15%** to the overall project mark. It is designed to assess lab performance, independent of the thesis and based on criteria listed below.

<table>
<thead>
<tr>
<th>Student Name:</th>
<th>Supervisor Name:</th>
</tr>
</thead>
</table>

| Attendance | Poor | ☐☐☐☐ | As expected |
| How diligently did the student work? | Well below expectation | ☐☐☐☐ | Intensively |
| How well did the student plan the experiments? | Slapdash | ☐☐☐☐ | Research level |
| How well were the experimental methods and results documented (e.g. in lab book)? | Slapdash | ☐☐☐☐ | Research level |
| How well did the student observe the relevant safety procedures (e.g. wear lab coat)? | Never | ☐☐☐☐ | Always |
| How accurate was the student’s experimental technique? | Slapdash | ☐☐☐☐ | Research level |
| Quantity of work done | Very little | ☐☐☐☐ | A great deal |
| Ability to trouble shoot in lab | Poor | ☐☐☐☐ | Excellent |
| Level of help in lab available | Very little | ☐☐☐☐ | A great deal |
| Ability to work independently | Poor | ☐☐☐☐ | Excellent |
| Attitude to work | Poor | ☐☐☐☐ | Highly motivated |
| Ability to work with others | Poor | ☐☐☐☐ | Excellent |
| Ability to respond to criticism | Poor | ☐☐☐☐ | Excellent |

**Comments:**

**Particular difficulties if any:**

**Mark out of 100%**
Senior Sophister Project Thesis - Supervisor’s report

This mark is independent of the lab performance. The research project thesis mark is to be agreed with the second examiner (and third examiner if first/second marks are greater than 10% apart). This agreed mark contributes 65% to the overall project mark. It is designed to capture the abilities of a student to engage in an academic research project, plan experiments, critically analyse data and communicate research findings and their implications.

<table>
<thead>
<tr>
<th>Student name</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Title</td>
<td></td>
</tr>
<tr>
<td>Supervisor name</td>
<td></td>
</tr>
<tr>
<td>Date</td>
<td></td>
</tr>
<tr>
<td>1st Draft submission on time</td>
<td>Yes ☐ No ☐</td>
</tr>
</tbody>
</table>

**Thesis**

| Presentation | Messy, poor English | Publication standard |
| Abstract | Wholly inadequate | Publication standard |
| Introduction | Trivial | Publishable |
| Literature coverage | Poor | Extensive and deep |
| Description of aims | Wholly inadequate | Perfectly clear |
| Materials and methods | Wholly inadequate | Perfectly clear |
| Description of results | Wholly inadequate | Perfectly clear |
| Figures/ legends/ tables | Wholly inadequate | Perfectly clear, complete |
| References | Wholly inadequate | Fully accurate |
| Quality of data | Poor | Exemplary |
| Analysis of data | Poor | Comprehensive analysis |
| Appropriate statistical analysis | Poor | Strict |
| Discussion | Poor | Publication standard |
| Scientific rigour e.g. use of controls | Weak | Strict |
| Understanding/ insight | Very little | Research level |
| Capacity for self-direction | Poor | Outstanding |
| Quality of first draft | Poor | Excellent |

Comments:
Particular difficulties if any:

Marks out of 100%:

---

Senior Sophister Project Thesis - Second Examiner’s report

This mark is independent of the lab performance. The research project thesis mark is to be agreed with the project supervisor (and third examiner if first/second marks are greater than 10% apart). This agreed mark contributes 65% to the overall project mark. It is designed to capture the abilities of a student to engage in an academic research project, plan experiments, critically analyse data and communicate research findings and their implications.

<table>
<thead>
<tr>
<th>Student name</th>
<th>Project Title</th>
<th>Date</th>
<th>Examiner’s name</th>
<th>Agreed mark (out of 100%):</th>
</tr>
</thead>
</table>

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<table>
<thead>
<tr>
<th>Thesis</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Presentation</td>
<td>Messy, poor English</td>
<td>☐ ☐ ☐ ☐ ☐</td>
<td>Publication standard</td>
<td></td>
</tr>
<tr>
<td>Abstract</td>
<td>Wholly inadequate</td>
<td>☐ ☐ ☐ ☐ ☐</td>
<td>Publication standard</td>
<td></td>
</tr>
<tr>
<td>Introduction</td>
<td>Trivial</td>
<td>☐ ☐ ☐ ☐ ☐</td>
<td>Publishable</td>
<td></td>
</tr>
<tr>
<td>Literature coverage</td>
<td>Poor</td>
<td>☐ ☐ ☐ ☐ ☐</td>
<td>Extensive and deep</td>
<td></td>
</tr>
<tr>
<td>Description of aims</td>
<td>Wholly inadequate</td>
<td>☐ ☐ ☐ ☐ ☐</td>
<td>Perfectly clear</td>
<td></td>
</tr>
<tr>
<td>Materials and methods</td>
<td>Wholly inadequate</td>
<td>☐ ☐ ☐ ☐ ☐</td>
<td>Perfectly clear</td>
<td></td>
</tr>
<tr>
<td>Description of results</td>
<td>Wholly inadequate</td>
<td>☐ ☐ ☐ ☐ ☐</td>
<td>Perfectly clear</td>
<td></td>
</tr>
<tr>
<td>Figures/ legends/ tables</td>
<td>Wholly inadequate</td>
<td>☐ ☐ ☐ ☐ ☐</td>
<td>Perfectly clear, complete</td>
<td></td>
</tr>
<tr>
<td>References</td>
<td>Wholly inadequate</td>
<td>☐ ☐ ☐ ☐ ☐</td>
<td>Fully accurate</td>
<td></td>
</tr>
<tr>
<td>Quality of data</td>
<td>Poor</td>
<td>☐ ☐ ☐ ☐ ☐</td>
<td>Exemplary</td>
<td></td>
</tr>
<tr>
<td>Analysis of data</td>
<td>Poor</td>
<td>☐ ☐ ☐ ☐ ☐</td>
<td>Comprehensive analysis</td>
<td></td>
</tr>
<tr>
<td>Appropriate statistical analysis</td>
<td>Poor</td>
<td>☐ ☐ ☐ ☐ ☐</td>
<td>Strict</td>
<td></td>
</tr>
<tr>
<td>Discussion</td>
<td>Poor</td>
<td>☐ ☐ ☐ ☐ ☐</td>
<td>Publication standard</td>
<td></td>
</tr>
<tr>
<td>Scientific rigour e.g. use of controls</td>
<td>Weak</td>
<td>☐ ☐ ☐ ☐</td>
<td>Strict</td>
<td></td>
</tr>
<tr>
<td>--------------------------------------</td>
<td>------</td>
<td>----------</td>
<td>-------</td>
<td></td>
</tr>
<tr>
<td>Understanding/ insight</td>
<td>Very little</td>
<td>☐ ☐ ☐ ☐</td>
<td>Research level</td>
<td></td>
</tr>
</tbody>
</table>

### Senior Sophister Poster Mark Sheet
This mark contributes 5% to the overall project mark.

<table>
<thead>
<tr>
<th>Student Name:</th>
<th>Degree:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Examiners:</td>
<td>Overall Mark:</td>
</tr>
<tr>
<td>Poster clearly communicates all key scientific information</td>
<td>Strongly Disagree</td>
</tr>
<tr>
<td>Information is accurate, no significant errors</td>
<td>Strongly Disagree</td>
</tr>
<tr>
<td>Poster is logically laid-out and easy to follow</td>
<td>Strongly Disagree</td>
</tr>
<tr>
<td>Poster is eye-catching and visually appealing</td>
<td>Strongly Disagree</td>
</tr>
<tr>
<td>Exhibits analytical and critical thinking</td>
<td>Strongly Disagree</td>
</tr>
<tr>
<td>Poster and presenter shows understanding of the topic</td>
<td>Strongly Disagree</td>
</tr>
<tr>
<td>Presenter explained the poster well</td>
<td>Strongly Disagree</td>
</tr>
<tr>
<td>Presenter answered questions fully</td>
<td>Strongly Disagree</td>
</tr>
</tbody>
</table>

Any Specific Comments:
Molecular Medicine
Breakdown of SS Papers 1, 2 and 3
2019-2020

Paper 1– BIU44310 Neurobiology & Immunology

Section 1: ‘Neurobiology’  Answer 1 of 2 questions
Neurochemistry (GD)
Neurodegenerative disorders (GD/CC)

Section 2: ‘Immunology’  Answer 1 of 2 questions
Gastrointestinal Immunology (EL)
Respiratory Immunology (MA)
Autophagy & Disease (JM))
Immunometabolism (DF/LON)
Metabolic Inflammation (FS)

Section 3: ‘General’  Answer 1 of 3 questions
Trans-subject integrative/philosophical questions

Section 4: ‘General’  Answer 4 of 7 questions
Quickie questions

Paper 2– BIU44320 Microbial Diseases & Immune System Disorders

Section 1: ‘Microbial Diseases’  Answer 1 of 2 questions
Trypanosomiasis (DN)
Helminths (PF)
Prokaryotic Pathogens (HW)
TB (FS)
Immunity to Infection (KM)

Section 2: ‘Immune System Disorders’  Answer 1 of 2 questions
Rheumatoid Arthritis (LON)
MS & EAE (JF/KM)
Autoinflammatory Disease (EC)
Inflammageing (NB)

Section 3: ‘General’ Answer 1 of 3 questions

Trans-subject integrative/philosophical questions

Section 4: ‘General’ Answer 4 of 7 questions

Quickie questions

Paper 3– BIU44330 Cell Cycle, Cancer Biology & Therapeutics

Section 1: ‘Cell Cycle and Cancer’ Answer 1 of 2 questions
Mitotic Cell Cycle (VK)
Initiation & Progression (VK)
Metastasis & Treatment (VK/KM)

Section 2: ‘Cancer Biology & Therapeutics’ Answer 1 of 2 questions
Haematological malignancies (TMcE)
Lung Cancer (GP)
Obesity & Cancer (JL)
Precision Medicine & Breast Cancer (KG)
Cancer Epigenetics (SG)

Section 3: ‘General’ Answer 1 of 3 questions

Trans-subject integrative/philosophical questions

Section 4: ‘General’ Answer 4 of 7 questions

Quickie questions
Practise Viva Groups 2019-2020

Please find below the students assigned to pairs of Staff Members. Would the first Staff Member in each group please arrange a time (afternoons are best) and venue agreed with their Staff partner and email these arrangements to the students concerned.

<table>
<thead>
<tr>
<th>Staff</th>
<th>Students</th>
</tr>
</thead>
</table>
| Profs. A.Dunne & J.Fletcher: | Kate Banks  
Anna Jadwiga Blasinska  
Christine Butler  
Glen Edward Byrne  
Ruth Byrne |
| Profs. G. Brady & C.Cunningham: | Robin Caird  
Aisling Cameron  
Eimear wwdDevilly  
Sarah El Hassani  
Nicholas dwFenelon |
| Profs. J.Hayes & V.Kelly | Aleksandra Helena Kusiak  
Tom Malone  
Eleanor Noone  
Janne Strydom  
Oliver Tredwin  
Aoife Teresa Whelan |
# Senior Sophister Tutors 2019-20

<table>
<thead>
<tr>
<th>Student</th>
<th>Tutor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kate Banks</td>
<td>Prof. Vincent Kelly</td>
</tr>
<tr>
<td>Anna Jadwiga Blasinska</td>
<td></td>
</tr>
<tr>
<td>Eleanor Noone</td>
<td></td>
</tr>
<tr>
<td>Christine Butler</td>
<td>Prof. Jean Fletcher</td>
</tr>
<tr>
<td>Glen Edward Byrne</td>
<td></td>
</tr>
<tr>
<td>Janne Strydom</td>
<td></td>
</tr>
<tr>
<td>Ruth Byrne</td>
<td>Prof. Gareth Brady</td>
</tr>
<tr>
<td>Robin Caird</td>
<td></td>
</tr>
<tr>
<td>Oliver Tredwin</td>
<td></td>
</tr>
<tr>
<td>Aisling Cameron</td>
<td>Prof. Fred Sheedy</td>
</tr>
<tr>
<td>Eimear Devilly</td>
<td></td>
</tr>
<tr>
<td>Aoife Teresa Whelan</td>
<td></td>
</tr>
<tr>
<td>Sarah El Hassani</td>
<td>Prof. Sarah Doyle</td>
</tr>
<tr>
<td>Nicholas Fenelon</td>
<td></td>
</tr>
<tr>
<td>Aleksandra Helena Kusiak</td>
<td>Prof. Aisling Dunne</td>
</tr>
<tr>
<td>Tom Malone</td>
<td></td>
</tr>
</tbody>
</table>
Learning outcomes:

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

- Pursue with a degree of independence an original research project in Molecular Medicine. 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

- Demonstrate a comprehensive understanding of the theory behind the techniques used in the research project and show a critical awareness of how these techniques can be applied to biological problems

- Discuss a specialised research area of Molecular Medicine in detail

- Work effectively as an individual and in a team and exercise initiative and personal responsibility

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

- Communicate results of research project effectively with the scientific community

- Show that they have acquired the learning skills to undertake further research with a high degree of autonomy

BIU44010 Advanced Research Skills (S1) (10 credits)

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

**Learning outcomes:**

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

- Apply appropriate statistical tests to experimental data and evaluate the results of these tests
- Demonstrate proficiency in the application of sequence analysis algorithms
- Solve numerical biochemical problems
- Demonstrate proficiency in the application of molecular modelling software
- Display a solid foundation in the ethics of and use of animals for experimentation
- Describe the principles behind and applications of current techniques in scientific research

**Sequence Analysis: Prof Jerard Hayes**

The course will provide an introduction into Bioinformatics. Topics covered include:

- DNA (including genomic) and protein databases
- Accessing sequence information from databases using the Internet
- Sequence similarity searches (i.e. BLAST, FASTA)
- Identification of homologous proteins
- Multiple sequence alignments (i.e. Clustal W)
- Searches for protein motifs, domain, patterns

Students will carry out three exercises:

**Exercise 1:** Accessing databases from the Internet, retrieval of sequences (DNA and protein), extracting relevant sequence information, presentation and annotation of a chosen sequence

**Exercise 2:** Sequence similarity search (BLAST), identification of homologous proteins, multiple sequence alignment (Clustal W)
Exercise 3: Sequence analysis of membrane proteins, hydrophobicity plots, identification of transmembrane helices and signal peptides

Reading list:

*essential reading
# recommended


#Rost, B. et al. 1995. Transmembrane helices predicted at 95% accuracy. Protein Science, 4: 521-533.


**X-ray crystallography: Prof. Ken Hun Mok (2 lectures)**

These two lectures will provide an introduction to X-ray crystallography and will include the following:
- overview of modern X-ray and cryo-EM techniques to visualize macromolecules (proteins, DNA, RNA) and larger assemblies at atomic resolution
- concept of resolution in imaging and its relationship to X-ray and cryo-EM hardware for data collection
- principles of X-ray diffraction and cryo-EM structure determination, advantages of the techniques and their limitations

**Recommended reading:**

Crystallography Made Crystal Clear
Gale Rhodes

Protein Crystallography: A concise guide
Eaton Lattman and Patrick Loll

**Metabolomics research: Profs Richard Porter & David Finlay (2 lectures)**

- Metabolic flux analysis (1 lecture) Richard Porter

Analysis of cellular oxygen consumption together with extracellular acidity rate are an excellent way to get an overview of metabolic flux in a cell. Furthermore, the use of selective inhibitors can allow a researcher to shed light on the bioenergetics and biochemical pathways that contribute to that flux. The Seahorse Flux Analyser and the Oroboros Respirometer are excellent apparti for determining such metabolic flux. The lecture will cover the principles behind the use of these apparti and will give examples of their use to researchers.

- Proteomics and metabolomics (1 lecture) David Finlay

Various approaches to proteomic and metabolomic analysis will be discussed. The types of experimental question that can be addressed using these techniques will be reviewed.

**Protein engineering: Prof. Jerard Hayes (2 lectures)**
Protein engineering is the process of developing valuable proteins, mainly for the biopharmaceutical market with a value of approximately $170 billion annually. This 2 lecture course will cover the production of recombinant proteins through genetic engineering and cell biology techniques for bioprocessing and biopharmaceutical manufacturing. Included in the course is upstream processing of proteins in bacterial, mammalian and insect cell lines, downstream processing in bioreactors and production of purified products, and optimisation of the bioprocess for the generation of desired post translational modifications, such as glycosylation.

**Flow Cytometry & Cell Sorting: Barry Moran (2 lectures)**

Flow cytometry is a key technology underpinning almost all biomedical research. Using fluorescent probes to tag molecules in or on the cell, it allows high-speed, high-parameter analysis of single cells as they flow through a fluid stream. Cell sorting extends the technology, enabling any identifiable cell population to be enriched to a very high purity. These lectures will cover the fundamentals of flow cytometry and cell sorting, including novel techniques and applications.

**NMR spectroscopy for biomedical scientists: Ken Hun Mok (2 lectures)**

**Lecture 1.** Brief overview of the theories and practices; How NMR is used in structural biology and in probing the dynamics of biomolecules.

**Lecture 2.** Application of NMR to metabolomics; How mass spectrometry and NMR are complementary in identifying metabolites.

Reading / Viewing Materials:
(2) Knowbee Tutoring, "Introduction to NMR Spectroscopy" Parts 1 and 2, [https://www.youtube.com/watch?v=TJhVotrZt9I](https://www.youtube.com/watch?v=TJhVotrZt9I), 2015.
(4) Wong F, “NMR Made Easy!” Parts 1-6, [https://www.youtube.com/watch?v=9orcRVTKcS0&list=PLP0TLbeMObSy4izIkMIC2QOpJcNZpC17](https://www.youtube.com/watch?v=9orcRVTKcS0&list=PLP0TLbeMObSy4izIkMIC2QOpJcNZpC17), 2012.

**Cellular Imaging: Prof. Derek Nolan (3 lectures)**
**Lecture 1:** Introduction to imaging and the concept of resolution. Application of electron microscopy in cell imaging. EM tomography and specialized techniques. Introduction to light microscopy.

**Lecture 2:** Advanced light microscopy: wide field and confocal microscopy.

**Lecture 3:** Application of fluorescent proteins and probes in multidimensional imaging in fixed and live cells.

**Suggested reading and references.**

http://www.nature.com/milestones/milelight/index.html
An excellent resource available on line. This series highlights the most influential developments in light microscopy in a series of short articles, each describing a major achievement. Almost a one stop shop

http://www.olympusmicro.com/
The Olympus Microscopy Resource Center. This site covers a wide range of topics in light microscopy: basic to advanced topics with primers and interactive tutorials in some sections.


Correlative cryo-light microscopy and cryo-electron tomography: from cellular territories to molecular landscapes. Current Opinion in Biotechnology, Volume 20, 2009, Pages 83-89 From nano to micometre scale in cells.

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**Transgenics: Profs Vincent Kelly & Derek Nolan (5 lectures)**

**Lecture 1. Mutagenic, transgenic & cloning technology (VK):** The concept of forward and reverse genetics in understanding gene function will be considered and how these mutations are physically introduced into the genome through random mutagenesis, viral mutagenesis, gene replacement and gene-targeting strategies. The process of microinjection to create transgenic animals, gene knockouts and cloned animal will be covered and the generation and use of induced pluripotent stem cells (iPS) in biomedical research applications.

**Lecture 2. Design and development of transgenic constructs (VK):** The design of targeting vectors relies on a detailed structural/functional understanding of the gene under study. Various strategies for controlling the activity of the gene are available including the creation of knockouts, knock-ins, conditional knockout and reporter systems. Gene-trap technology has, in recent times, gained significantly in popularity and the methodology will be examined in some detail.

**Lecture 3. Zinc Finger Nucleases and Talen Nucleases(VK):** These state-of-the-art technologies have the potential to revolutionise the manipulation of the eukaryotic genome, from cells in
culture to mice, rats, rabbits, pigs etc. This lecture will cover the principles of this technology and how it is being currently exploited in research.

**Lectures 4 & 5. RNA interference (DN):** The discovery of the classical RNA interference pathway involving siRNA will be described. The lectures will consider the concept of regulation of expression through siRNA and microRNAs along with the use and design of RNAi based approaches in functional genomics. The advantages and limitation of such approaches will investigated through the use of specific examples. The potential use of RNAi in therapeutic approaches will be outlined.

**Reading List:**

**Lectures 1-3:**

** Highly relevant material

# Papers relate to the endothelin B receptor and conditional mouse. These papers are discussed in the lectures and are given as an example of the power of inducible transgenics.


**Bockamp et al. 2002. Of mice and models: improved animal models for biomedical research. Physiol. Genomics. 11:115-132 (Very good overview of mouse transgenics, covers the endothelin receptor B example described in lectures)


#Lee et al. 2003. The endothelin receptor-B is required for the migration of neural crest-derived melanocyte and enteric neuron precursors. Developmental Biology 259; 162–175

Lectures 4-5

Comparative Medicine: Dr Peter Nowlan

The purpose of this lecture course is to introduce students to the basic requirements for working with animals. This is necessary if a full appreciation of animal related work is to be got from the projects. It is also a legal requirement that anybody involved in the use of animals for scientific purposes has appropriate training (EC directive 86/609)

This module is not intended to be a comprehensive training course. To do this would require a much more detailed and extensive series of talks. Most of the training which will be required by students will be obtained by working in close contact with a technician and with experienced supervisors.

The golden rule should be always 'if you don't know ask somebody'. The welfare of the animal and often the success of your Project will depend on using a correct approach to animals involved in your project.

Even if you are not undertaking a SS project which involves live animals you may do so in your future career.

- Introduction to Laboratory Animal Science
- The Law and Application for a licence
- Animal House Design; Its effect on Research
- Characteristics of Individual species
- Experimental design Choice of species
- Injections and tissue sampling
- Health Considerations
- Alternatives to live animal experimentation
- Handling Video, Safety, Local arrangements
- Video and discussion 'Ethics of Animal research'
- The Scientists Viewpoint
- Assessment
Reading List:

Laboratory animals an introduction for new experimenters
A. A. Tuffery
Handbook of laboratory animal management and care
S. Wolefensohn,
M. Lloyd
Introduction to laboratory animal science and technology
J. Inglis
Humane experimental technique
W. Russell, R. Burch
Experimental and surgical technique in the rat
H. Wayneforth,
P. Flecknell
Animals and alternatives in toxicology; present and future prospects
M. Balls, J. Bridges, J. Southee
In vitro toxicology
S. Cox Gad
UFAW handbook on the care & management of laboratory animals
T. Poole
Laboratory animals anaesthesia P. Flecknell
Handbook of rodent and rabbit medicine K Laber-Laird,
M. Swindle, P. Flecknell
The biology and medicine of rabbits and rodents J. Harkness J. Wagner
The laboratory animals, principles and practice W. Lane-Petter,
A. Pearson
Man and mouse, animals in medical research W. Paton
Lives in the balance; J. Smith, K. Boyd
The ethics of using animals in biomedical research
Vivisection in historical prospective R. Rupke

BIU44310 NEUROBIOLOGY & IMMUNOLOGY (S2)
(10 credits)

This module covers the structure, function and pharmacology of neurotransmitters, neuron-glia interactions, intraneuronal signalling and the neurobiology of behaviour and neurodegenerative disorders. This module also covers the molecular basis of immune mediated responses.
**Learning outcomes:**

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

- Recall and integrate key knowledge on structure of cell types in the brain and how they control neurotransmission and critically evaluate how various chemicals (biogenic amines, amino acids, peptides & labile gases) in the brain fulfill the criteria for characterisation as neurotransmitters.

- Employ an understanding of the molecular mechanisms that are involved in the major neurodegenerative disorders and the medical advances that are in development.

- Demonstrate an understanding of the complexities and unique aspects of immunology in organs such as Gi tract and respiratory system.

- Integrate biochemistry and immunology analyses to critically understand the impact of immunometabolism and autophagy on the immune response.

**PART 1: NEUROBIOLOGY & NEURODEGENERATIVE DISORDERS**

**Neurochemistry: Brain Biochemistry & CNS Acting Drugs (5 lectures). Prof Gavin Davey**

**Lecture 1:**
- Energy substrates for the brain
- Glucose/lactate transporters
- What uses ATP in the brain?
- Astrocytes-neuron lactate shuttle hypothesis
- Glucose sensing neurons
- What controls blood flow in the brain?

**Lecture 2:**
- Energy thresholds in the brain
- Mitochondria control glutamate release
- Mitochondrial fusion/fission dynamics
- Complex I activity & mitochondrial fusion

**Lecture 3:**
- In vivo techniques for measuring neurotransmitter release and actions
- Microdialysis & HPLC
- Classical neurotransmitters
• Atypical neurotransmitters
• Nitric oxide

Lecture 4:
• GABA metabolism & GHB
• Polyamine NTs
• Glial cells and NT release (D-serine, taurine, NAAG & neuropeptides)

Lecture 5:
• Melatonin as a NT
• Aspartate & pheromones

References: to be supplied closer to lectures

Neurodegenerative disorders: An interdisciplinary approach (6 lectures). Prof Gavin Davey


References: to be supplied closer to lectures

Reading/Learning Resources:
• *Proteins, Transmitters and Synapses* by D.G. Nicholls (1994) Blackwell, Oxford – The best on synaptic bioenergetics (out of print but there is a copy in the library).


• The Biochemical basis of neuropharmacology by JF Cooper, FE Bloom and RH Roth Oxford University Press, Eighth Edition


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**Neurological diseases: Prof. Colm Cunningham (4 Lectures)**

**Multiple Sclerosis & the brain’s immune privilege**
Contrast innate and specific immunity
- explain why specific immunity in brain is different
- incomplete privilege: EAE -> MS
- blood brain barrier, Cell infiltration
- Dendritic cells, antigen drainage etc
- What is immune privilege NOT (Galea)
- Multiple sclerosis, Th1, Th17 cells
- treatments; steroids, interferon-b
- Tysabri, VCAM inhibition (natalizumab)

**Alzheimer’s disease, microglia, transgenic models & vaccination studies**
Basal forebrain cholinergic loss, current treatments
- the amyloid hypothesis
- Discuss Tg2576 and other genetic AD models
- Microglia, inflammation and NSAID treatment
- The AD vaccination studies in vivo and in patients
- BACE inhibitors, gamma-secretase inhibitors

**PART 2: IMMUNOLOGY & IMMUNOMETABOLISM**

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**Gastrointestinal tract Immunology: Prof Ed Lavelle (3 lectures)**

**Lecture 1:** Overview of gut associated lymphoid tissue, Peyer’s patches, inductive and effector sites. Uptake of antigens across epithelial surfaces.

**Lecture 2:** Dendritic cells and T cells in the gastrointestinal tract. Homing of gut T cells

**Lecture 3:** Mucosal humoral immunity. IgA responses and their regulation.
Respiratory tract Immunology: Prof Michelle Armstrong (3 lectures)

**Lecture 1:** Introduction to the basic biology of the respiratory tract: conducting airways, mucosal surface, lung parenchyma and organization of the lung immune system. Understanding the concept that the lung is continually exposed to foreign antigens and must discriminate between recognition of innocuous environmental antigens and pathogenic antigens.

**Lecture 2:** Roles played by individual cells in regulating immune response in the lung: airway epithelial cells, alveolar macrophages, regulatory T-cells, T-cell homing to lung, innate lymphoid cells.

**Lecture 3:** Immunological challenges faced by the lungs: Infectious/inflammatory disease (cystic fibrosis), interstitial disease (IPF and pulmonary sarcoidosis) and allergic disease (asthma).

Autophagy: Prof James Murray (2 lectures)

**Lecture 1:** The mechanics of autophagy
- Early signalling events in autophagy
- Omegasomes: PI3P platforms that manufacture autophagosomes
- Sources of the autophagosome membrane
- Ubiquitin-like conjugation systems that mediate membrane formation
- Autophagosome maturation and lysosomal fusion

**Lecture 2:** Selective autophagy & disease
- Chaperone-mediated autophagy, macro/microautophagy & mitophagy
- Autophagy and cell death
- Autophagy and ageing: age-related neurodegenerative diseases
- Autophagy in cancer prevention, development and therapy
- Autophagy as a defence against intracellular pathogens

Reading list:
“Autophagy: molecules and mechanisms” by Jon Lane.

A list of suitable reviews will be given out during the lecture course

Immunometabolism: Profs David Finlay and Luke O’Neill (5 lectures)
Lecture 1. Cellular metabolism + immune cells (David Finlay)
Overview of metabolic pathways. Discuss why cells adopt different metabolic configurations. Outline the metabolic configurations used by different immune subsets.

Metabolic changes during macrophage polarization, roles of key metabolites in M1 and M2 macrophages. Role of mitochondria as signal generator in macrophages.

Lecture 3. Lymphocyte immunometabolism (David Finlay)
Central role for metabolism in the control of lymphocyte activation, differentiation and function; Effector, regulatory and memory T cells, NK cells and B cells.

Lecture 4. Nutrients and the tumour microenvironment (David Finlay) Discuss nutrient availability to immune cells and nutrients as fuels and key regulators of immune signalling. Focus on how the tumour microenvironment can alter immune function through altering nutrient levels. Potential for improved anti-cancer immunotherapy through manipulation of metabolism and nutrient levels.

Lecture 5. Targeting metabolism to treat inflammatory and infectious disease (Luke O’Neill)

### Metabolic Inflammation: Prof Fred Sheedy (3 lectures)

**Lecture 1:** “PAMPs & DAMPs”
Activation of the innate immune system by endogenous metabolite accumulation and danger signals

**Lecture 2:** “Dysfunctional Resolution”
Effectors in the immune response to metabolites, Removing danger, Resolving inflammation, Restoring homeostasis & strategies to boost this.

**Lecture 3:** “Inborn errors of meta-inflammation”

### BIU44320 MICROBIAL DISEASES & IMMUNE SYSTEM DISORDERS (S2) (10 credits)

This module covers the pathogenesis of infectious diseases. Bacterial pathogens of medical importance will also be covered in detail. It will provide an introduction to parasitic protozoa such as trypanosomes and helminths. The biochemical and genetic mechanisms by which bacteria, viruses and parasites evade the host immune responses.
will be covered. This module will also cover the pathogenesis of autoimmune and inflammatory disease.

**Learning outcomes:**

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

- Relate how African trypanosomes avoid the immune response and innate immunity of their human hosts.
- Define the molecular basis of pathogenesis of various prokaryotic pathogens of medical importance including *Helicobacter pylori*.
- Relate how *Mycobacterium Tuberculosis* avoid the immune response and innate immunity of their human hosts.
- Compare the strategies to control helminth infections, using specific species as examples and evaluate the global impact of helminth infections on endemic countries.
- Critically evaluate the contribution of immunology to a range of important human diseases including autoimmunity (rheumatoid arthritis), autoinflammatory diseases, immune deficiency and inflammaging.

**PART 1: MICROBIAL DISEASES**

**African trypanosomes: Prof Derek Nolan  (8 lectures)**

The aim of these lectures is to provide an introduction to African trypanosomes, parasitic protozoans that cause sleeping sickness in humans and a related disease, Nagana, in cattle. These parasites are a major problem for human and veterinary health throughout sub Saharan Africa and serious barrier to economic development of the region. Perhaps the most striking feature of these parasites is that they are exclusively extracellular. They grow and divide in the mammalian vasculature and consequently exposed the adaptive and innate defence responses of their mammalian hosts. In addition, for a variety of reasons, African trypanosomes have been come a favourite model organism for molecular and cell biologists and many discoveries of broad significance have emerged from studies on these model unicellular eukaryotes. Areas where such discoveries have been reported will be illustrated in the lectures where appropriate. The course is organized into two parts.

**Trypanosomes Part 1: Stealth strategies of an elusive parasite**
1. How are trypanosomes, such as Trypanosoma brucei, able to evade the host humoral immune response given that they are constantly exposed to this arm of the immune response?
2. What other strategies do trypanosomes employ to circumvent the innate immune responses?
3. How are these parasites able to acquire essential macromolecular growth factors from their hosts without attracting a response?

Trypanosomes Part 2: What is the molecular basis of human sleeping sickness?
The focus in part II is on the innate immunity that humans and other primates have to infection by all but a few trypanosomes. In effect in this part we will consider the molecular basis of African human sleeping sickness. We will consider the nature of the trypanolytic toxin present in human serum and how this toxin kills these parasites. We will see an amazing link between the toxin and an unsuspected programmed cell death pathway. Finally, we will see how two strains of trypanosomes have responded by developing independent mechanisms to resist this toxin and how in turn certain human populations are able to overcome this resistance and the price they pay for this capacity.

Reading List:
Additional specific references for key experiments will be provided within the lectures which are available on the school website.

Trypanosomes Part I

Trypanosomes Part II
Association of trypanolytic ApoL1 variants with kidney disease in African Americans
(6) Vanwalleghem G. et al. (2015) *NATURE COMMUNICATIONS* | 6:8078 | DOI: 10.1038/ncomms9078 Coupling of lysosomal and mitochondrial membrane permeabilization in trypanolysis by APOL1

**Helminths of Human Importance. Prof Padraic Fallon  (4 lectures)**

A third of the world’s population is infected with parasitic worms. These lectures will address the major parasitic worms that are of medical importance.

**Lecture 1-2:** Introduction to the major helminth parasites that infect man. Medical and economic impact of helminth parasites on society.


*A reading list will be given out during the course*

**Prokaryotic pathogens: Prof Henry Windle  (3 lectures)**

**Lecture 1:** Bacterial pathogens as a paradigm for chronic infection I: Molecular mechanisms of bacterial induced disease - modulation of host cell signalling responses and pathogenesis. Pro-carcinogenic microorganisms.

**Lecture 2:** Bacterial pathogens as a paradigm for chronic infection II. Infection and cancer – the *Helicobacter pylori* connection: molecular basis of pathogenesis

**Lecture 3:** Mixed microbial populations and disease. The microbiome in health and disease.

**General Reading:**

Human gut microbiome: hopes, threats and promises (Review article). Cani PD Gut. 2018;67(9):1716-1725. PMID: 29934437

**The immune response to tuberculosis: Prof Frederick Sheedy (2 lectures)**

**Lecture 1:** The innate immune response to tuberculosis; a model for pathogen evasion of the human host response. The alveolar macrophage and recruited inflammatory cells. First contact – Phagocytosis & Pattern Recognition.

**Lecture 2:** The adaptive immune response to TB – the TB granuloma; prison for the live bug. T-cells, IFNy and TNF orchestrating the granulomatous response.

**T cell immunity to bacterial and viral infection: Prof. Kingston Mills (2 lectures)**

**Lecture 1:** The bridge between innate and adaptive immunity. Pathogen activation of macrophages and dendritic cells through pattern recognition receptors. Role of dendritic cells in directing T cell subtypes.

**Lecture 2:** Role of Th1/Th2 cells in immunity to infection, including HIV, hepatitis C virus and Bordetella pertussis.

**PART 2: IMMUNE SYSTEM DISORDERS**

**Rheumatoid Arthritis: Prof. Luke O’Neill (2 lectures)**


**Lecture 2:** Key role of cytokines – IL-1, TNF, IL6. Current therapies – NSAIDs, steroids, biologic therapies (anti-TNF, anti-IL-1, anti-IL-6, anti-CD20 and CTLA-4 Ig). Prospect for future therapies.

**Multiple Sclerosis and EAE: Profs Jean Fletcher & Kingston Mills**
Lecture 1: Breakdown of tolerance in autoimmunity. Risk factors, pathogenesis, diagnosis and monitoring of MS

Lecture 2: MS therapies: Mechanisms of action, efficacy, side effects.

Lecture 3: EAE. Role of innate and adaptive immunity in pathogenesis of autoimmune diseases. Role of regulatory T cells in preventing autoimmune diseases.

**Autoinflammatory diseases: Prof Emma Creagh (2 lectures)**

Lecture 1: Key features of systemic autoinflammatory disorders. Classic hereditary 'Periodic Fever Syndromes' - FMF (Familial Mediterranean Fever), TRAPS (TNF Receptor Associated Periodic Syndrome) and HIDS (Hyperimmunoglobulinemia-D with periodic fever syndrome).

Lecture 2: NLRP3/Cryopyrin-associated periodic syndromes (CAPS): Familial Cold Inflammatory Syndrome (FCAS); Muckle-Wells Syndrome (MWS) and Neonatal onset multisystem inflammatory disease (NOMID). Autoinflammatory disorders associated with skin pustules, such as DIRA (deficiency of IL-1R antagonist), CARD14 mediated psoriasis (CAMPS) and early onset inflammatory bowel diseases (EO-IBD).

**Immunodeficiency: Prof Derek Doherty (2 lectures)**

Lecture 1: Primary immunodeficiencies. This lecture will cover the genetic bases, clinical presentations, diagnoses and treatments of primary immunodeficiencies, including antibody, complement, MHC and lymphocyte deficiencies.

Lecture 2: Acquired immunodeficiencies. This lecture will cover the different causes of acquired immunodeficiencies but will focus mainly on HIV-associated disease, including the virology, immunology, clinical features and recent progress in vaccine development. The significance of HIV in the developing world, where many other infectious disease are also endemic, will be emphasized.

**Inflammaging: Prof Nollaig Burke (2 Lectures)**

Lecture 1: The mechanisms of inflammageing. Inflammageing overview. Discussion of how innate and adaptive immune responses are dysregulated with age and how this contributes to increased systemic inflammation.
Lecture 2: The consequences of inflammageing. Specific focus on the impact of inflammageing with relation to age related diseases, particularly cardiovascular disease, neuro-cognitive decline and cancers. Discussion on therapeutic targeting of inflammageing.

**BIU44330 Cell Cycle, Cancer Biology & Therapeutics (S2)**

This module covers the cellular and regulatory mechanisms that control the cell cycle. It furthermore it covers the molecular basis of cancer, the progression of the disease and the therapeutic treatment strategies.

**Learning outcomes:**

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

- Explain the processes of growth, proliferation, and cellular division and outline the cellular changes and regulatory mechanisms that define the stages of the cell cycle
- Critically discuss the environmental and hereditary causes of cancer and relate how alterations to the cell cycle impact on cancer development
- Describe the genetic, metabolic and cellular alterations in various types of cancer and outline the process of metastasis
- Evaluate the contribution of the immune system to cancer
- Describe the therapeutic strategies for the control of cancer such as dietary mechanisms for reducing initiation, targeting oncogenes, overcoming drug resistance and immunotherapy

**Part 1: Cell Cycle & Cancer:**

**Mitotic cell cycle: Prof Vincent Kelly (4 Lectures)**

**Lecture 1. The cell cycle & growth.** This lecture will cover some of the seminal discoveries of the cell cycle, discussing the experiments performed on frog oocytes, sea urchins and yeast. Key regulators of cell cycle progression, as determined by these early studies, MPF, Cdc2/cdc28, wee1 and Cdc25, will be covered. Components of the mammalian cell cycle, which have been
discovered principally via bio-informatic approaches, will be discussed including mammalian cyclin dependant kinases (CDKs) and cyclin-dependant kinase inhibitors (CKI).

**Lecture 2. Start of the cell cycle, G1.** Signals for a cell to start proliferation are essential for initiation of the cell cycle. Examples will be provided of how growth signals through PI3K, AKT, mTOR and myc are co-ordinated to the uptake of amino-acids and glucose. In addition, we will discuss how cell-cell and cell-matrix contacts must be altered to permit cell cycle progression.

**Lecture 3. S-phase, DNA replication & DNA repair checkpoints.** The control of DNA replication is a major decision point of the cell cycle. This lecture will describe the replication licensing process, the selection of the origin(s) of replication and the proteins that make up the origin replication complex, e.g. Mcm, Cdc6. If the DNA to be replicated is not properly loaded or is damaged the cell initiates various checkpoints, i.e G1- and S-phase checkpoint. This lecture will cover the various protein complexes such as 911, the MRE11-Rad50-NBS1/γH2AX complex and the kinase pathways used to tell the cell to stop the cell cycle process including ATM & ATR, BRCA1, Chk1 Chk2 and P53.

**Lecture 4. Mitosis.** Chromosome cohesion/seperating sister chromatids/Overview of ubiquitin/Ubiquitin ligases and the cell cycle/SCF complex & G1 to M phase transitions/APC complex and anaphase entry/microsatellite instability (MIN) and chromosomal instability (CIN)/Centrosomes & centrosome inactivation checkpoint


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**Cancer and invasion: Profs Vincent Kelly & Kingston Mills**

**11 Lectures**

**Part 1: Initiation & Progression (4 Lectures) Vincent Kelly**

**Lecture 1. Underlying causes of cancer (VK):** The characteristics that are used to classify cancers and their stage of development will be described. A number of examples will be given of how environmental factors, i.e. xenobiotics, radiation and oxidative damage contribute to multistep
carcinogenesis. The means by which cancer is limited by DNA damage sensing, DNA repair and cellular adaptation to oxygen/radical damage will be covered.

**Lecture 2. Oncogenes and tumour suppressor genes (VK):** Many of the original discoveries on oncogenes were derived from work on viruses. The concepts of oncogenes and proto-oncogenes will discussed such as src and the Rous sarcoma virus and there will be an in dept examination of the ras oncoprotein pathway an the function of other oncogenes including abl, sis, c-myc and how they influence cellular proliferation. Suppressor genes play an important role in limiting cancer formation and a number of models were put forward from original studies including Knodson’s two-hit model and haploinsufficiency. The mode of action of tumour suppressors such as APC, MSH2, MLH1, BRCA1, p53 will be examined with particular focus on p53, Rb and APC.

**Lecture 3. Cancer epigenetics (VK):** Changes in the genetic code is but one means to arrive at a pre-malignant crossroads. Epigenetics changes in gene expression have been found to alter tumor suppressor gene activity through. These epigenetic changes may occur as a consequence of altered DNA methylation status at CpG promoter regions of aberrant histone modification. In fact, cooperative suppression by both mechanisms has recently become the focus of new anti-cancer therapies through the development of DNMT and histone deacetylase inhibitors.

**Lecture 4. Cancer metabolism & the tumor microenvironment (VK):** Many of the control points of cancer, oncogenes, tumor suppressor genes (including mTOR, PI3K, Akt, p53, AMPK) are intimately linked to metabolism, especially glycolysis, which provides the cancer with the building blocks for growth. The tumor cell microenvironment is invariably acidic and hypoxic causing the transcription factor HIF1α to set in place protective responses including unregulating the production of monocarboxylate transporters, VEGF, matrix metalloproteinases and angiogenic factors.

**Part 2: Metastasis and Cancer Treatments**

**Lecture 1. Angiogenesis and metastasis (VK):** The process by which cancer cells develop new blood supplies (angiogenesis) is reliant on being able to remodel the tumor environment and the extracellular matrix. A discussion of how this remodelling occurs through matrix metalloproteinases and plasminogen will be given along with the cause and consequences of breaking cell-cell interactions. The means used by cancer cells to physically move from the primary tumor (e.g. epithelial-mesenchymal transition) and how the immune system promotes this process will be described. Breast cancer will be used as a model of how cancer cells choose secondary sites for proliferation, especially the bone marrow; ‘the vicious cycle’.

**Lecture 2. Colon cancer, genetics and epigenetics (VK):** Arguably, colon cancer is one of the best studied cancers in terms of its formation and progression. This lecture will discuss the contribution of chromosomal instability in terms of changes to APC, COX2 and Smad4 and microsatellite instability caused by epigenetic suppression of mis-match repair enzymes including MSH2 & MLH1. The contribution of inflammation to colon cancer will be considered and how NSAIDS and IL-10 mediate polyp formation.
Lecture 3. Stem cell theory of cancer, focusing on colon cancer (VK): The intestinal crypt stem cells are maintained in a specialized compartment of the intestinal crypt through the Ephrin receptors. The maintenance and proliferation of these stems cells will be covered including the various signals used to control their proliferation, such as hedgehog, WNT, PDGF, Eph, NOTCH and BMP. The importance of the intestinal stems cells to cancer development and treatment will be considered.

Lecture 4. Cancer treatment (VK): Classical anti-cancer drugs such as antimetabolites, alkylating agents and antimitotic agents are still widely used in therapy today despite severe side-effects. Newer ‘magic bullets, hold promise of more specific cancer treatment strategies such as Imatinab in the treatment of CML. However, drug resistance is a problem and has revealed the phenomenon of oncogene addition. Recent drug strategies have begun to focus on targeting tumor cell metabolism, its environment and the cancer initiating cells (cancer stem cells) that perpetuate proliferation even after treatment.

Lecture 5. Cellular and humoral Immune responses to tumors (KM): These lectures include the role of antibody, cytotoxic T lymphocytes, macrophages, NK cells and Th1 cells; Evasion and subversion of immune responses by tumors - anti-inflammatory cytokine production and regulatory T cell induction; Tumor-specific antigens and breaking tolerance to self antigens

Lecture 6-7. Tumor immunotherapy (KM): Antibodies, Toll-like receptor agonists and cell-based therapies; Tumor vaccines - killed tumor cells, tumor specific peptides and antigens, heat shock proteins and dendritic cell vaccines

Cancer References:
11. Immunobiology by Janeway and Travers
Part 2: Cancer Biology & Therapeutics:

Haematology and haematological malignancies: Prof Tony McElligott
2 Lectures

Introduction to Haematology and haematological malignancies: Haematological malignancies are a group of neoplasms that arise through malignant transformation of bone marrow derived cells. The great diversity seen in this group of malignancies reflects the complexity of normal haematopoeisis and the immune system. The primary basis of classification is the distinction between tumours of lymphocytes and those of myeloid lineage. Haematological malignancies include leukaemias, lymphomas and multiple myeloma, and are defined and distinguished from one another according to clinical features, microscopic morphology, immunophenotype and molecular/genetic features.

Molecular biology of haematological malignancies and leukaemia: Many molecular genetic markers have been described in haematological malignancies including chromosomal translocations and rearrangements of the immunoglobulin and T-cell receptor genes. These prognostic or predictive markers can be useful in guiding clinical management of patients and permit the development of very sensitive and specific assays for the detection of neoplastic cells. In addition, these molecular markers have provided important clues in elucidating the biological mechanisms by which haematological malignancies develop and persist. More recently, it has been recognised that epigenetic changes and aberrant expression of miRNAs are common features of some haematological malignancies and may play an important role in carcinogenesis.

Molecular basis of lung cancer & Obesity/Cancer: Profs Graham Pigeon & Joanne Lysaght
4 Lectures


Lecture 3. Obesity and Cancer: An overview of the epidemiology of obesity and cancer. Particular focus on the mechanisms linking central obesity and metabolic syndrome the
progression of cancer, examining adipose tissue as an immunomodulatory and metabolic organ.

**Lecture 4. Obesity and Immunomodulation in Cancer:** A focus on central obesity as a chronic inflammatory condition, and how obesity may effect immune cell subsets and influence tumour progression and development.

*Information on these lectures will be available later in the term.*

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**Precision Medicine & Breast Cancer: Prof Kathy Gately (2 Lectures)**

These lectures will focus on cancer Rates in the 21st century, Hallmarks of Cancer, Tumour Heterogeneity, mutation profiles, Precision/Personalised Medicine molecular mechanisms in breast cancer etc.

*Information on these lectures will be available later in the term.*

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**Cancer Epigenetics: Prof Steven Gray (3 lectures)**

**Lecture 1:** The Basics. This lecture will introduce the student to both the history and current knowledge of the known mechanisms underpinning epigenetic regulation of gene expression.

**Lecture 2:** Epigenetics and Disease. This lecture will introduce the student to the various roles that epigenetics plays in the development of disease including cancerous and non-cancerous conditions, and will include aberrant epigenetic dysregulation, trans-generational epigenetics, and will introduce issues where epigenetics plays important roles in intra-tumoural heterogeneity and cancer stem cells.

**Lecture 3:** Targeting Epigenetics for the treatment of disease. This lecture will discuss the broad implications pertaining to the potential to target disease epigenetically. It will discuss the issues with respect to the failure of many epigenetic targeting approaches and how new epigenetic targeting strategies are changing the paradigms for therapy. The potential for nutritional interventions will also be introduced.