SECTION 1 – HANDBOOK INFORMATION

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Common Abbreviations used throughout handbook:

JS – Junior Sophister,
SS – Senior Sophister,
Imm – Immunology
BC – Biochemistry
MM – Molecular Medicine
B&I – School of Biochemistry & Immunology
SoM – School of Medicine
ECTS – European Credit Transfer System
MCQ – multiple choice questions
SECTION 2 – PROGRAMME OVERVIEW

Welcome to Junior Sophister Immunology:

Congratulations on choosing an exciting and dynamic subject area for your degree. In the last 20 years, Immunology has advanced so much and skills from all biomedical sciences are now central to solving questions in Immunology, which has now been realized as central to all disease in our bodies. In Junior Sophister year, you will learn the basic functioning of the immune system (BIU33220) and apply this to its most recognized function – fighting infection (BIU33240). To support this, you will also go more in depth on the fundamental processes in biochemistry and cellular signalling (BIU33210) and molecular biology and genetics (BIU33240).

As well as going in-depth in the area of Immunology through the 4 modules outlined above, you will develop your skills as a scientist – through the practical classes associated with each module and through the Laboratory Methods module (BIU33030), which is designed to introduce students to the problems associated with experimental design, analysis and quantitatively making sense of data and interpreting your results. The Research Skills module (BIU33020), which consists of a “mini-review” – an in-depth literature review on a topic in immunology which will be directed by an academic staff member, will also involve quantitative problems – which again will develop analytical and data-handling skills, as well as increase your knowledge of the experimental techniques employed by School staff on an everyday basis. All of this will prepare you for your final year research project in the Senior Sophister year.

The Freshman years in College are very different to the Sophister years you are now entering. They were preparatory years, whereas what you do now counts towards your degree. The ethos is also different. Over the Freshman years the class size can be large and the atmosphere impersonal. Despite this, you coped and obviously did well as you have succeeded in obtaining a place in a dynamic School. However, the smaller class size now means that teaching can be more interactive – feel free to ask questions and initiate discussions during lectures. If you have not understood, assume that the lecturer has not explained things properly. Above all, try to see lecturers in supportive, as well as directive roles. In this School, you are allocated a tutor – a full-time academic staff member whom you will meet regularly and who will advise you in a small group situation. You should embrace this opportunity and see it as advantageous for you, not an imposition, although it means more work. There will also be tutorial sessions related to the practical classes which accompany each module, outlining key techniques and skills.

The formal extended essay or mini-review, the practical assessment, as well as the essays written as part of the tutorials, will help you develop the organisation and style in writing needed to get a good degree. In your future career you will need to present clear, well-structured reports. Discuss your work and take cognisance of the comments made by the staff member – they are as important as the mark. Poor exam technique is a feature of early undergraduate years, so now is a good time to deal with this ahead of your finals next year. Exam answers often read like summaries, not developed accounts of a topic. Do not assume that the reader has a good knowledge of the subject and explain details properly. First and foremost, read the question being asked very carefully and be sure to address this question in your answer. Always keep this in mind when you organise your answers and essays. Do not regurgitate pre-prepared essays and do not question spot from previous exam papers.

This booklet will outline the content of each module for the Immunology course across both Semesters, as well as the distribution of marks for the year. A detailed breakdown of the 4
Exam Papers is also provided. We have made every effort to ensure that the information provided regarding lecture content, practical classes etc is correct. We may update some of the information as we go along during the year. CMIS/mytcd provides the official college timetable. Notice will be provided of any major changes, re-scheduled/cancelled lectures or classes, via e-mail and through the class representative – who you should elect promptly & make themselves known to School staff.

From myself and all the academic staff in the School, we look forward to meeting with you during the year. You are the future of Immunology in this School and we embrace the opportunity to help you on this exciting journey.

Frederick J Sheedy,
Ussher Assistant Professor in Immunology
School of Biochemistry & Immunology
Course co-ordinator, JS Immunology degree
fsheedy@tcd.ie

School Contacts:

Junior Sophister Course Coordinators
Immunology:  Dr Frederick Sheedy, Room 5.50 and email: fsheedy@tcd.ie
Biochemistry: Dr Derek Nolan Room 5.06 and e-mail: denolan@tcd.ie
Molecular Medicine:  Dr James Murray, James.Murray@tcd.ie

Junior Sophister Practical Coordinator / Blackboard Coordinator:
Dr Audrey Carroll, Room 3.25 (enter via Practical Teaching Lab, 3.22) aucarrol@tcd.ie

Erasmus/International Student Coordinator:
Dr Andrei Budanov, budanova@tcd.ie

Senior Sophister Immunology Course Coordinator:
Prof Clair Gardiner, gardinec@tcd.ie

Director of Undergraduate Teaching and Learning:
Dr Aisling Dunne, Room 3.10 and e-mail: aidunne@tcd.ie

School Office: Ms Una Murphy, Room 3.07 and email: murphyu1@tcd.ie
OVERVIEW OF JUNIOR SOPHISTER COURSE STRUCTURE AND ASSESSMENT:

A Junior Sophister student must complete 60 ECTS credits in the year. The 60 ECTS credits translate into 600 marks that are distributed across the course as follows:

1. Four 10 credit modules consisting of lectures and linked practicals. Each of these modules will be assessed by continuous assessment (30% weighting) and by an exam paper at the end of the semester (70% weighting). There will be a separate exam paper for each module. Total marks for this component = 400 marks.

2. A 10 credit research skills module covering literature skills (a minireview of a topic proposed by a member of staff), presentation skills (involving a short oral presentation of the minireview topic) and analysis of quantitative data (4 quantitative problem sessions and associated exams). This module will be assessed by continuous assessment across both semesters (100%).
   The continuous assessment component will be linked to the literature review and an element associated with in-course exams linked to the problem sessions. Total mark for this module = 100 marks.

3. A 5 credit laboratory skills module covering basic biochemical and immunological laboratory skills (practical sessions) and data handling lectures. This module will be entirely in-course assessed in semester 1. Total mark for this component = 50 marks.

4. All JS students are obliged to take a Broad Curriculum option (5 credits) all of which are in-course assessed & can are scheduled across both semesters. Total mark for this component = 50 marks.

In summary; there will be four exam papers in total; 2 at the end of Semester 1, 2 at the end of Semester 2, (2 hours each), which will assess the ten-credit core modules associated with lectures. You should note that in-course assessment includes a laboratory-based practical exam, MCQs and problem exams, as well as home-work elements (laboratory assessments, mini-review etc.).

The Junior and Senior Sophister years are integrated and the Junior Sophister mark (including the mark for Broad Curriculum) will contribute 20% to your final degree mark.

Importantly, the pass-mark for Junior Sophister Immunology is 40% but to progress to Senior Sophister year, students must obtain a minimum grade of 45% in JS year.

The Junior Sophister Immunology course content, module-by-module with associated mark weightings and methods of assessment are outlined in the next 2 pages. Further information on course content and learning objectives is provided in the final “Teaching & Learning” section.
### Semester 1:

<table>
<thead>
<tr>
<th>Module</th>
<th>Code</th>
<th>Topic</th>
<th>Lecturer</th>
<th>Assessment</th>
<th>Marks</th>
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<tr>
<td>BIU33210 Biochemistry</td>
<td>BI3111</td>
<td>Alpha, beta, tertiary domain interactions</td>
<td>Amir Khan</td>
<td>Paper 1</td>
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<td>BI3021</td>
<td>Proteins of the immune system</td>
<td>Jerrard Hayes</td>
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<td>BI3028</td>
<td>Cellular signalling</td>
<td>Aisling Dunne &amp; Emma Creagh</td>
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<td>BIU33030 Laboratory Methods</td>
<td>BI3025</td>
<td>Pre-Practical Solutions &amp; Dilutions</td>
<td>Noinn Nic Bhaird</td>
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<td>Practical</td>
<td>Derek Nolan</td>
<td>Write-up</td>
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<td>Lab Skills Experiments 1-4</td>
<td>Derek Nolan</td>
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<td>Lab Exam</td>
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Scheduling & Venues:

TCD now runs on a 2-Semester academic year ([https://www.tcd.ie/calendar/academic-year-structure/academic-year-structure.pdf](https://www.tcd.ie/calendar/academic-year-structure/academic-year-structure.pdf)). The important aspect of this is that it involves 2 end-of-term examination periods. There will be increased assessment throughout the year through various forms, so students are advised to keep on top of their workload and revise accordingly. There will be more opportunities for feedback and in most cases, the modules formally taught in each semester must be examined in the corresponding exam period. This will mean 2 exam papers for our JS students at the end of Semester 1 (December 2019) & another 2 at the end of Semester 2 (April/May 2020).

The official College system for student timetables is CMIS, which students can access via mytcd system ([https://my.tcd.ie/urd/sits.urd/run/siw_lgn](https://my.tcd.ie/urd/sits.urd/run/siw_lgn)). For major changes, students will be emailed directly and I urge the class to nominate 1 class representative, who any changes can be communicated with.

Some common venues used by the School & their abbreviations are listed below:

- **TBSI** = Trinity Biomedical Sciences Institute
- **B2.50** = Seminar Room, Level -2, TBSI
- **B2.72-2.74** = Combined Tutorial Room, Level -2 TBSI
- **CHLLT** = Chemistry Large Lecture Theatre, located in the Chemistry Building on campus
- **FRED** = Room 5.16, Level 5, TBSI (formerly *First Right after Entering Department!*)
- **JOLY 4** = Lecture Theatre located in the Hamilton Building on main campus
- **LB11** = Lecture theatre (Lloyd Building) situated in Trinity Centre for Neuroscience, Lloyd Building, (enter building and take staircase downwards on your left).
- **LTEE1 EE4-5** = Lecture Theatre 1, Basement, East End
- **LTEE2** = Lecture Theatre 2, Basement, East End
- **LTEE3** = Lecture Theatre 3, Basement, East End
- **MacNeill 3** = lecture in the Hamilton Building
- **Maxwell 5** = lecture theatre in the Hamilton Building
- **MOYN LT** = Moyne Lecture theatre, located in the Moyne Building (Microbiology)
- **Rm 3.22** = the main Biochemistry Teaching Lab on Level 3 in TBSI
- **Room 6.07** = Seminar Room, Level 6, TBSI
- **SALMON 1** = Salmon Lecture Theatre, Ground Floor, Hamilton Building, East End
- **TERCENTENARY/TERC** = L2.15 = Tercentenary Hall, Level 2, TBSI
- **QUEK** = B1.15 = Stanley Quek Lecture Theatre, level -1, TBSI
SECTION 3 – GENERAL STUDENT INFORMATION & REGULATIONS

THE EUROPEAN CREDIT TRANSFER SYSTEM (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, 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 academic year is 40 weeks from the start of Michaelmas Term to the end of the annual examination period. Each ECT 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.

Further information is available at https://www.tcd.ie/undergraduate-studies/general-regulations/ects.php

Attendance:
The college regulations regarding attendance, as laid out in ‘General regulations and information’ in the College Calendar (http://www.tcd.ie/calendar/), will apply.

Additional requirements of the School of Biochemistry and Immunology with regard to attendance are:

Students are required to attend and participate in all lectures, pre-practical talks, practicals, small group tutorials and problem sessions that have been organized for them.

The requirements of the School of Biochemistry and Immunology with regard to the satisfactory performance of course work are in accordance with Calendar directives. In addition, The School of Biochemistry and Immunology requires that Junior Sophister students should complete and submit all practical assessments, problems, a minireview, a data handling project and any work set by their tutor.

Lecturers will be provided with a list of students registered for each module & may use this as a sign-in sheet, which will be kept on record in the School. All absences must be accounted for by medical certificates from the College Health Service or your GP or using a letter from DUCAC to account for absences due to college activities. For sudden & short-term medical absences of maximum 2-days, students can ‘self-certify’ by informing the School Office.
immediately upon their return, which should be relayed to the Course co-ordinator. This option should not be abused & will not be allowed to be used alongside certified medical leave. Arrangements should be made by the student to assure marks for missed course-work are accounted for upon their return to College. For cases where students miss a Practical, they should make necessary arrangements with the associated Lecturer & Course Co-ordinator regarding Assessment. Students can be returned as ‘non-satisfactory’ in a particular module if attendance and input to course-work is poor.

Students must sit all of the annual examination papers. In cases where students miss exams due to unforeseen medical or other circumstances, they should inform School staff & their College tutor immediately.

Course Work:

Laboratory note books
We will provide you with a hardbound laboratory notebook. All records of your practical work must be kept in the book provided and not on rough sheets of paper or on laptop computers. Advice on keeping a good lab notebook is given in the front of the Practical Manual. Each student will meet with their course co-ordinator in the first semester where your lab book will be examined and discussed. Marks will be allocated to the Laboratory Methods module for this assessment.

Laboratory assessments
All practicals will be assessed and graded. Some of these will be administered through BlackBoard. Assessment forms will be provided for each laboratory. You must submit your assessment according to the instructions provided—If assessment form is not be submitted through BlackBoard, they should be submitted to the School Office on the dates given in your practical manual.

Laboratory multiple choice exam
At the end of each semester you will sit a multiple choice exam where you will be required to answer approximately 15 questions; 3 minutes per question. These questions will be directly related to the material that you have covered in the practicals’ associated with each module. Sample exam questions will be provided.

The Mini-review (50+10 marks)
Students will be required to carry out a literature search and write an extended essay consisting of diagrams plus 6,000-8,000 words in the text. The ability of a student to survey and evaluate the literature and produce an organised, cogent synthesis will be taken into account. Guidelines on writing a review and a sample review are posted in Blackboard. Minireviews have been assigned randomly and you will be given your topic in the first week of term. In preparation for the review you could look at some review articles in Nature Reviews Immunology or Trends in Immunology. All reviews must be typed in 12 point font and spacing must be at least 1.5. Students are required to sign a declaration to the effect that the mini-review is entirely their work. 50 marks are awarded for the thesis itself and a further 10 marks will be awarded for an oral presentation based on the mini-review. The mini-review must be handed into the School office during the Second Semester.

Small Group Tutorials
Each student meets regularly with a tutor, in groups of 2-3 students. Tutors have been assigned and will stay with you throughout the year. Please contact your tutor during the first week of the first Semester to arrange the first meeting. There will be 6-10 tutorials per year. These will include exercises covering course material, training in getting the most out of research papers, and giving presentations on topics chosen by the tutor. These tutorials are
useful times to discuss lecture courses and practicals, and the various exercises set should help you in your development as a scientist, and in examinations. **Attendance at these tutorials and completion of any exercises set is MANDATORY. Students who fail to comply will be returned as ‘non-satisfactory’**.

**College Regulations regarding Exams & Progression:**

**FACULTY OF ENGINEERING, MATHEMATICS AND SCIENCE REGULATIONS REGARDING JUNIOR SOPHISTER EXAMS**

Timetables for Sophister examinations are published in advance of the dates of the examinations, and available on-line. The onus lies on each student to find out the dates of examinations by consulting these timetables. No timetables or reminders will be sent to any individual student.

Junior Sophister students must, in the first instance, sit the annual examination and meet the requirements of the course.

The Junior Sophister Annual Examination has a two-fold purpose. It is (a) the final examination for the Ordinary BA degree and (b) a qualifying examination to proceed to the Senior Sophister year as a Moderatorship candidate. A student who rises to, and completes, the Senior Sophister year, **but fails the Moderatorship examination**, is still qualified for the award of an Ordinary BA degree on the basis of a successful performance in the Junior Sophister examination.

Students who pass the Junior Sophister examination can have the Ordinary BA degree conferred if they do not choose, or are not qualified to proceed to Moderatorship. Except by special permission of the University Council, on the recommendation of the Course Director, the ordinary degree of BA may be conferred only on candidates who have spent at least three years in the course.

To pass the Junior Sophister examination, students must achieve a mark of 40% or higher in each of their modules, or pass by compensation or aggregation.

To compensate / aggregate students must

(i) obtain an overall mark of 40% or higher **AND**

EITHER (compensate)

(ii) obtain individual marks of 40% or higher in modules to the value of 40 credits with a minimum mark of 30% in the each of the failed modules up to a maximum of 20 credits.

OR (aggregate)

(iii) obtain individual marks of 40% or higher in modules to the value of 40 credits with a minimum mark of 30% in additional modules of at least 10 credits.

To qualify to proceed to Moderatorship, students sitting the Junior Sophister examination for the first time must pass the year and achieve a mark of **45%** or higher in the overall examination.

Students who achieve an overall grade of 35% or higher, but who are not qualified to proceed to Moderatorship can repeat the Junior Sophister year in order to qualify to proceed to Moderatorship or qualify for an Ordinary BA degree.

Students whose overall mark is 34% or lower in the annual examinations are not permitted to repeat their year and must withdraw from the course.
If a student’s examination result indicates the remark ‘See tutor’, the student must contact their tutor immediately. If appropriate, an appeal can be lodged by the tutor to the Court of First Appeal.

A student may not repeat the Junior Sophister year more than once, except by special permission of the University Council. The final degree award for students who pass the Senior Sophister examination will be comprised of a combination of the Junior Sophister marks (20%) and Senior Sophister marks (80%).

**Junior Sophister Summer Awards:**
Assuming that the necessary funds are available, the School will award some internships at the end of Junior Sophister Year. The awards will take the form of salaries for six weeks to work in one of the research laboratories in the School of Biochemistry and Immunology. The awards will be offered to the student in Immunology who obtains the highest total mark in their practical assessments. Details of how to apply will be circulated in the Hilary Semester. **Please note that students who spend any time in a research lab during the summer (whether paid or unpaid) cannot do their SS project in that lab.**

**Eli Lilly**, the pharmaceutical company based in Cork, will sponsor a summer internship for one of our JS students. Students interested in applying for the internship will submit formal applications and a short-list of candidates will be interviewed. It is anticipated that the process will be concluded by December. Further details will be provided in due course. It is anticipated that the internship will start on the Tuesday after the June bank holiday weekend and will run for approximately 12 weeks.

**Guidelines for Applications for Academic References**
*Students applying for Summer Internships require an academic reference. To assist us in processing the many requests that we receive please follow the guideline below:*
Two weeks is an appropriate time for the processing of a reference.
It is not a good idea for three people who are going to the same institution to each get their reference from the same one member of staff.
Please provide the following:
Title of project, Nature of project / Internship, max two lines.
Where you are going, why are you going there, what do you hope to achieve?
How will this internship / summer project etc contribute to your professional development
Transcript from Science Course Office with first and second year results
If appropriate, a copy of breakdown of JS course works marks to date: Obtainable from the office, must be stamped with office stamp and provided to staff as a hard copy

**Social Events:**
There are a number of social events throughout the year that provide an opportunity for students and staff to meet in an informal setting. These include poster day, when the Senior Sophister students present the results of their research projects; this is followed by an informal reception for students and staff. After the end of year exams, there will a reception (“The Bruno Bash”) to accompany the presentation of best-project prize to a Senior Sophister student. Exact dates will be circulated in due course.

**Students with Disabilities / Long Term Health Issues:**
The Schools Academic Liaison Officer is Ms Martha Motherway-Gildea (motherm@tcd.ie), based in the Preparation Room, Biochemistry Teaching Laboratory.
Please notify Ms Motherway in confidence if you have any disabilities or health issues that might affect your ability to complete your practicals or the associated assignments. Large print manuals can be provided to students with a visual impairment. Students are encouraged to register with the disability officer, Mr Declan Reilly - reillyde@tcd.ie. It is particularly important to do this well before the examination period.

**Plagiarism:**
The College Calendar defines plagiarism, describes the levels of plagiarism and the sanctions. All students are required to complete the online tutorial ‘Ready, Steady, Write’. It is located at http://tcd-ie.libguides.com/plagiarism.

When you submit coursework you will have signed a declaration to the effect that you have read and understood the plagiarism provisions of the College. Therefore all cases of matching text will be treated as Level 3 offences, see http://tcd-ie.libguides.com/plagiarism/levels-and-consequences, zero marks will be assigned to all plagiarised text and there will be no option to resubmit.

Where an assignment (or part assignment) cross matches with text in the assignment of another student both students and their tutors will be notified by email and invited to explain the match. As both students will have signed a declaration that they have read and understood the plagiarism provisions of the College all cases of matching text will be treated as Level 3 offences by both students, zero marks will be assigned to the two texts and there will be no option to resubmit. Level 3 applies even if a student was given permission to use another student’s work.

**Virtual Learning Environment:**
College & the School utilises a virtual learning environment to facilitate ongoing access of students to module information, activities and learning resources outside formal timetables and class time. In the School, we commonly refer to this as Blackboard. Student access to Blackboard is granted at registration – so if a student is blocked out of BB, this could indicate registration issues and students are urged to resolve this as soon as possible. We use BB to provide module information, class notes, links to extra reading as well as for the submission of ongoing course work. Some labs in JS year will require students to submit pre-practical or post-practical assessment online via BB, whereas some will require students to submit hard-copies of their data and analysis. Further information on the format required will be provided in the practical manuals and at pre-practical talks which students are required to attend. Each lecturer has the option to upload as little or as much information from their lecture material as they like and students are urged not to see the information on BB as a substitute for attending the lectures. The online material will be designed to supplement and not substitute learning. Access is through the following link; https://tcd.blackboard.com/webapps/login/

**Feedback & Student Development:**
Students will have access to their ongoing continuous assessment marks throughout the year, after reasonable time has passed to allow assessment and correcting of marks and can request feedback at any stage. Students are encouraged to make use of their assigned small group tutor within the School to help promote their academic development and skills such as presenting, report writing and exam questions. Students will be invited to provide anonymous feedback at the end of each module and information on the format will be provided closer to the time.
SECTION 4 – TEACHING & LEARNING

Module descriptions & course content:
A brief summary of the modules constituting the course work for JS Immunology is provided below with further information on course content following.

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**MODULE BIU33210: BIOCHEMISTRY**

**PROTEIN STRUCTURE & FUNCTION:**
BI3111 - Alpha, beta, tertiary domain interactions, Ken Mok (KHM)
* Lecture 1 (KHM): Introduction to amino acid chemistry and peptide bonds*
* Lecture 2 (KHM): Principles of protein conformation and definitions of dihedral angles*
* Lecture 3 (KHM): Secondary structures, motifs, and relationship between sequence and structure*
* Lecture 4 (KHM): Folding of polypeptides into tertiary and quaternary structures*
* Lecture 5 (KHM): Motifs and folds, examples of α-helical and β-sheet proteins*
* Lecture 6 (KHM): Protein folding and unfolding, chaperones, natively unfolded proteins*
* Lecture 7 (KHM): Energetics of protein folding, diseases of protein conformation*

**BI3112 - Active site architecture, Amir Khan**
* Lecture 8 (KHM): Proteins, proteomics and post-translational modifications*
* Lecture 9 (KHM): Active site architecture, examples of cofactors and catalysis*
* Lecture 10 (KHM): Introduction to the study of protein enzyme activity by biophysical methods*

**BI3114 – Post-translation modifications, David Finlay (DF)**
* Lecture 11 (DF): Protein Phosphorylation. This lecture will describe protein phosphorylation as a mechanism to regulate protein function: enzyme activity, protein localisation, protein stability or molecular interactions. The enzymes that control protein phosphorylation will also be discussed*
* Lecture 12 (DF): Ubiquitination: How proteins become ubiquitinated, the different types of ubiquitin linkages and how they regulate protein function will be described. Sumoylation and NEDDylation will also be briefly discussed*

**BI3021 - PROTEINS AND THE IMMUNE SYSTEM, Jerrard Hayes (JH)**
* Lecture 1: Immunoglobulins. The three-dimensional, atomic-level structure of antibody molecules and the techniques used for characterization; The immunoglobulin fold and complimentary determining regions; High-resolution analytical techniques used to detect heterogeneity. Stability, folding, and aggregation of IgG molecules. Primary systemic amyloidosis*
* Lecture 2: Glycobiology and Glycoimmunology. Glycosylation and the immune system:
structure and functions of glycans, antigen recognition and carbohydrate recognition domains

**Lecture 3:** Receptors of the immune system. Fc Receptors and activation/inhibition of immune responses. Immune complex formation and antibody induced effector responses (ADCC, phagocytosis, CDC, antibody recycling).

**Lecture 4:** Biotherapeutics, Complement activation and Reporter proteins in immunology. The ‘humanisation’ of MAbs and MAb protein engineering. Production systems for recombinant therapeutics and post-translational modifications. Complement activation and the proteins involved, Reporter proteins used in immunology research: Green fluorescent protein.

**Lecture 5:** Structural biology of pattern recognition receptors. Nine important domains in immunology: LRR (leucine-rich repeat) domain; TIR [Toll/IL (interleukin)-1 receptor] domain; NBS (nucleotide-binding site); CARD (caspase recruitment domain); PYD (pyrin domain); Helicase domain; CTLD (C-type lectin domain); Ig domain; ITAM (immunoreceptor tyrosine-based activation motif) domain.

**BI3128 – CELLULAR SIGNALLING, Aisling Dunne (AD) & Emma Creagh (EC)**

**Lecture 1 (EC):** Introduction & overview of Cellular Signalling pathways. GPCR signalling: evidence for extracellular localisation of receptor, discovery of G-proteins linked to cyclase, metabolic and transcriptional effects of cAMP.

**Lecture 2 (EC):** Regulation of GPCR signalling. GPCR-linked signal-activated phospholipases, PLC as a paradigm with brief coverage of PLD and PLA₂.

**Lecture 3 (AD):** Receptor tyrosine kinases (RTKs). PDGF and EGF as examples of RTKs. Recruitment of SH₂-domain containing modules focussing on PI3 Kinase. Overview of GAP, SOS and Grb2 proteins. Details of Map kinases cascades.

**Lecture 4 (AD):** RTKs and PI3K. PKB (Akt) and PDK1 signalling. Pleckstrin homology domains. Insulin signalling and IRS1/2 activation. Overview of JAK/STAT signalling.

**Lecture 5 (EC):** Steroid hormones. Paradigms for transcriptional regulation.

**BI3129 - MEMBRANE PROTEINS AND THE CYTOSKELETON, Paul Voorheis (HPV) and Derek Nolan (DN)**

**Lecture 1 (HPV):** Summary of membrane functions, bilayer model (Gorter & Grendle, 1925; Davison & Danielli, 1935), EM picture of unit membrane (Robertson, 1959). Experimental determination of membrane sidedness of constituent proteins, penetrant & non-penetrant radiolabelling, proof of transmembrane disposition, differential labelling.

**Lecture 2 (HPV):** Diffusion of membrane proteins, patch & cap formation, ligand valency, role of cytoskeleton, protein composition of lipid rafts, lymphocyte activation, Ca²⁺ requirement & spikes, commitment period, c-myc & c-fos, inositolphosphate signalling system, protein kinase C, diglyceride and phorbol ester. Endosome structure & function, P₂-, V₂- & M-type H⁺ pumps, gated H⁺/Na⁺ exchanger, C¹⁺-cotransport, effects of methylamine & monensin/nigericin, receptor segregation, endosome budding, receptor recycling, exocytosis.

**Lecture 3 (HPV):** Signal hypothesis of Blobel, types of signal sequences, stop-insertion sequence, orientation of transmembrane spans, synchronized insertion/glycosylation, VSV experiments of Rothman & Lodish, IgM-membrane receptor on lymphocytes, O-glycosylation, divisions of Golgi, summary of structure of transmembrane proteins. Coated patches/pits/vesicles, clathrin, triskelin light and heavy chains, striped vesicle 110kD polypeptide, self-assembly of pentagons & hexagons, receptor-mediated endocytosis, prelocalized & randomly disposed receptors.

**Lecture 4 (HPV):** Assay of membrane transport, radio-labelled substrates, cold-stop / wash (eukaryotic versus prokaryotic cells, temperature dependent uncoupling), inhibitor-stop / centrifugation through oil, warm membrane filtration, problem of contamination, extracellular markers, measurement of intracellular water. Comparison of typical carrier-mediated flux with diffusional flux, relative magnitudes, substrate specificity, competitive inhibition, irreversible inhibition & substrate protection, stereospecificity, temperature dependence, symport/antiport, investigation of one system with many substrates & one substrate with many systems, assessment of metabolism versus uptake, nonmetabolizable substrates information in initial rates & final steady states. Water transport across biological membranes. Discovery of water...

**Lecture 5 (HPV):** Characteristics of microtubules: cellular location, diversity of structures formed from microtubules, morphological dimensions, tubulin heterodimer structure, protofilaments, cycle purification, factors required for polymerization, light scattering assay, kinetics of assembly, treadmilling, identification of microtubule associated proteins & microtubule stabilization, MT-acting drugs.

**Lecture 6 (HPV):** Nucleated assembly & dynamic disassembly of microtubules: Models of assembly, role of GTP, allosteric & catalytic effects of GTP, exchangeable and non-exchangeable sites, initiation and growth, critical concentration of tubulin, dynamic instability and GTP/GDP caps, Carlier flux experiments, Mitchison & Kirschner population versus individual microtubule behavior experiments, role of calmodulin & Ca²⁺, cold stable microtubules.

**Lecture 7 (HPV):** Force generating microtubular motors: Kinesin structure / function, classes of kinesins, anterograde & retrograde cytoplasmic streaming, cytoplasmic dynein structure / function, cargo transport experiments, microtubular organizing centers.

**Lecture 8 (DN):** The structure of globular (G) and filamentous (F) actin. Assembly of F-actin. Actin is a polarized filament and this polarity is essential for actin function

**Lecture 9 (DN):** Assembly of actin in macrophages. Role of actin in macrophage functions e.g. movement and phagocytosis. Defects in actin assembly and immunosupression (Wiskott–Aldrich syndrome)

**Practical 1:** Enzyme Kinetics (James Murray), Pre-practical tutorial with Noirin Nic Bhaird
**Practical 2:** cAMP Assay (Daniela Zisterer)
**Practical 3:** Binding Assay (Daniela Zisterer)

*Further information on practicals is available in practical handbooks*

**Learning outcomes:**

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

- Explain the link between a protein structure and its biological activity, and with appropriate examples, how human diseases arise from a deviation in structure with particular emphasis on proteins of the immune system
- Describe the factors that determine the mobility of membrane proteins and explain the role their mobility has in signal and energy transduction.
- Compare and contrast the structure of prokaryotic and eukaryotic membrane transporters; explain the various mechanisms of membrane transport, the procedures for assaying membrane transport and describe the way membrane potentials and ion gradients are generated and used physiologically.
MODULE BIU33220: CORE CONCEPTS IN IMMUNOLOGY

BI3022 - IMMUNOLOGY I
Frederick Sheedy (FJS), Luke O’Neill (LON), Michael Carty (MC), Michelle Mulcahy (MM), Clair Gardiner (CG), Jean Fletcher (JF), Cliona O’Farrelly (COF), Lydia Lynch (LL).

Introductory session/Module overview: (FJS)

Lecture 1: Introduction to the immune system (LON)

Lectures 2-3: Innate Immunity & Inflammation (LON)
Function of innate immunity: containment and elimination. Barriers to infection: skin / epithelium: mechanical (tight junctions, cilia), chemical (pH, lysozyme, defensins) and microbiological (normal flora/commensals). anti-microbial peptides especially defensins: When the barriers are breached: role of neutrophils and macrophage / DC. Pathogen recognition and phagocytosis. Opsonisation. Respiratory burst within the neutrophil. Complement activation, induction of cytokines and prostaglandins in the activated macrophage: the start of the inflammatory process.

Toll-like receptors (TLRs) - discovery: relevance to IL-1 signalling. The TIR domain: Toll in the fruit fly. LPS signalling: role of TLR-4. Other TLRs: receptors for pathogen-associated molecular patterns. TLR-2, TLR-3, TLR-5, TLR-6, TLR-7 and TLR-9. TLR knock-outs. Roles in inflammation, adjuvancy and autoantibody production; Other PRR e.g. NLR and RIG-I, novel DNA sensors

Lectures 4-5: Cytokines (MC)
Definition, classes. Structures of cytokines and their receptors. Hematopoietic cytokines, T cell activating cytokines, inflammatory cytokines, interferons, chemokines. Intracellular cytokine signalling. Key roles of IL-10, IL-4, IFN-gamma, IL-12 and IL-18.

Lecture 6: Macrophage Diversity (FJS)
Macrophage development, macrophage diversity, recruitment of monocytes, tissue resident macrophages, homeostatic functions of macrophages

Lecture 7: Polymorphonuclear cells (MM)
Neutrophils are a first line of defense during infection. Excessive neutrophil activation is a hallmark of inflammatory disease. This lecture will discuss a) Granulopoiesis, b) neutrophil migration, chemotaxis, c) neutrophil killing mechanisms i.e. phagocytosis, oxidative and non-oxidative killing mechanisms, neutrophil extracellular-traps c) mechanisms of neutrophil cell death i.e. apoptosis, necrosis, netosis.

Lecture 8: Cytotoxic cells: Natural Killer Cells and CTL (CG)
Anti-viral and anti-tumour roles; cytotoxicity, surface molecules, structure and function, cytokine

Lecture 9-10: Dendritic cells, MHC and antigen presentation (CG)
Comparison of cytosolic pathogens, intra-vesicular pathogens and extracellular pathogens. Endogenous and exogenous routes. Class I: TAPs and calnexin. Class II; invariant chain. HLA-DM. Loading of Class I and Class II.

Lecture 11: T Cell Receptor/Signalling (JF)
What happens when the T cell receptor encounters its specific peptide in the context of its antigen presenting molecule; signalling through CD3; cytokine production.

Lecture 12-13: Production & Function of Effector T Cells (JF)
DCs present antigen to T cells and cause their activation. T cells can differentiate along a number of routes (Th1, Th2, Treg, Th17, CTL). Activated T cells can become memory T cells which no longer require co-stimulation.

Lecture 14-15: B-cells & Lymphocyte differentiation (COF)
Haematopoietic stem cells; lymphocyte precursors, trafficking to bone marrow, thymus, gene rearrangement, recombination of V, D and J segments, role of RAG-1 and RAG-2; positive and negative selection in the thymus, role of MHC molecules, development of B cell lineages in bone marrow, generation of diversity in immunoglobulins, comparison with T cell receptor gene rearrangement events

**Lecture 16: Antibody genetics (COF)**
B lymphocytes, plasma cells, antibody production, immunoglobulin structure; FAb and Fc fragments; 5 classes, IgM, IgA, IgD, IgG, IgE. Distribution and function of immunoglobulin classes/isotypes. Immunoglobulin function: complement activation; antibody dependent cytotoxicity; role of Fc receptors.

**Lecture 17: T & B lymphocyte interaction (COF)**
B cells express antibody receptors. They process antigen and present it to T cells in the lymph nodes. Germinal centre formation. The role of Helper T –cells in antibody production. The role of cytokines

**Lecture 18: Innate Lymphocytes (LL)**

**REVISION TUTORIAL – Core Concepts in Immunology (COF)**

***IN-CLASS MCQ***

**BI3023 - IMMUNOLOGY II**
Clair Gardiner (CG), David Finlay (DF), Jean Fletcher (JF), Ed Lavelle (EL), Cliona O’Farrelly (COF), Frederick Sheedy (FJS),

**Lecture 19: Inherited immunodeficiencies (CG)**
Recessive gene defects cause disease. B cell defects. T cell defects including SCID. Immunodeficiencies help us understand normal immune functions. Treatments for immunodeficiencies.

**Lecture 20: Genetics of the MHC (CG)**

**Lecture 21: Transplantation (CG)**
Transplantation is a routine clinical treatment. Graft rejection is mediated by host T cells. MHC matching. Antibodies in graft rejection. Immunosuppression in Tx. Bone marrow transplantation is associated with graft-versus-host disease. Beneficial graft

**Lecture 22: Tumour Immunity (DF)**
Recognition and elimination of tumours by the immune system. Tumour antigens. Innate and adaptive immune cell subsets that play a role in the anti-tumour immune response. Strategies of tumour immune evasion and escape. Current state of cancer immunotherapies.

**Lectures 23-24: Immunological Tolerance, Autoimmunity and models of autoimmune disease (JF)**

**Lectures 25-26: Allergies (EL)**

**Lectures 27-28: Immunoregulation & Immunotherapies (COF)**
Suppressors of cytokine signaling, steroids; lipoxins, immunoregulatory cytokines; regulatory apoptosis; T regulatory cells.
Lecture 29-30: Mucosal Immunology (EL)
The common mucosal immune system. Distinctive nature of antigen presenting cells, B and T cells at mucosal sites. Uptake of antigens, pathogens and particles across mucosal epithelia. Mucosal tolerance. Secretory IgA. Mucosal immunisation. Adjuvants

Lecture 31-32: Evolution of the immune system (COF)
Evolution of life; nutrition and defence key driving forces; recognition and ingestion of nutritional sources also key to defence; phagocytosis; evolution of multicellular organisms - ability to differentiate self from non-self; C elegans: first differentiated cell type: sentinel cell; evolution of gut & liver; driven by anaerobic bacteria; co-evolution of metabolic and defence mechanisms. Innate immune mechanisms in insects, molluscs and vertebrates; conserved pathogen detection molecules, signaling pathways, cytokines and effector molecules; adaptive immunity in fish, birds and mammals; generation of receptor specificity and memory

Dysregulated Immunity & Disease Journal Club (FJS),
1 hour introductory session, Assignment of papers covering recent advances in immunology & disease – tuberculosis, tumor immunology, RA, sepsis, cardiovascular disease
+ 2 hr Presentation session

Practical 1: Phagocytosis (Rachel McLoughlin/Michelle Mulcahy)
Practical 2: Dendritic Cells (Ed Lavelle)
Practical 3/Tutorials: Cell culture (Daniela Zisterer)
Further information on practicals is available in practical handbooks

Learning outcomes:
On successful completion of this module students will be able to:
- Identify cells, receptors and soluble component of the innate immune system and how they function to eliminate pathogen.
- Define how an adaptive immune response is initiated and how different types of adaptive immune responses are used to eliminate particular pathogens.
- Identify how the immune system specifically deals with different pathogens including bacteria, viruses and parasites
- Identify how the immune system can cause disease and how it can be exploited therapeutically
MODULE BIU33230: GENE REGULATION

BI3136 - Techniques in Molecular Biology, Frederick Sheedy (FJS)
Lectures 1-3 (FJS): The lectures will give an overview on methods that are frequently used in molecular biology.

BI3132 - DNA structure, Michael Carty (MC)

BI3133 – Replication, Daniela Zisterer (DZ)

BI3134 – Transcription, Michael Carty (MC)
Lecture 3: Eukaryotic Transcription III RNA Pol II General Transcription Factors and the initiation of transcription. The pre-initiation complex. TFIID (TBP and TAFs), TFIIA, TFIIB, TFIIF, TFIIE, TFIIH
Lecture 5: Eukaryotic Transcription V Regulation of transcription by chromatin remodelling. Role of histones. The SWI/SNF complex. Histone acetylases and histone deacetylases and complexes containing them. The histone code hypothesis.
Lecture 6: Eukaryotic Transcription VI (AB)
Signalling pathways converging on transcription. Inducible transcription factors (hormone receptors, CREB, AP1, STATs. Regulation of transcription factors by phosphorylation. NFkB – history, structure and function, signalling pathways, mechanism of interaction with basal apparatus.

BI3135 – Translation, Daniela Zisterer (DZ)
Lecture 1: Eukaryotic Translation I (DZ) RNA processing. Acquisition of 5’CAPs and polyadenylate tail to primary RNA transcript. Splicing exons/introns, Splicesomes, Snurps etc. Diseases caused by aberrant splicing. rRNA and tRNA processing. Transport of nuclear mRNA to cytoplasm through nuclear pores.


Lecture 3: Eukaryotic Translation III (DZ) Cytoplasmic mechanisms of post-transcriptional control. Micro RNAs repress translation of specific mRNAs. Cytoplasmic polyadenylation promotes translation of some mRNAs. Protein synthesis is globally regulated. The TOR pathway. eIF2 kinases. Sequence specific RNA binding proteins control specific mRNA translation (e.g. iron-dependent regulation of mRNA translation and degradation.)

BI3139 – DNA Repair Mechanisms, David Finlay (DF)
Lecture 1: Introduction. Importance of protecting the genetic code, causes of DNA damage, types of distinct DNA damage lesion and the different specific repair mechanisms, the DNA damage response.


BI3411 - Immunogenetics, Kieran Meade
Lecture 1: The evolution of immune genes. UPDATE

Lecture 2: Immune genes in humans
Lecture 3: Genetic variation and disease
Lecture 4: Epigenetics and development
Lecture 5: Epigenetics and immune cells

Practical 1: Molecular biology (Frederick Sheedy)
Practical 2: Gene Expression (Frederick Sheedy)

Further information on practicals is available in practical handbooks

Learning outcomes:
On successful completion of this module students will be able to:
- Recall and integrate key knowledge and concepts about nucleic acid structure and function
- Demonstrate an understanding of the process and importance of DNA replication
- Compare and contrast how gene expression is regulated in eukaryotes and prokaryotes and demonstrate an understanding of the processes and importance of transcription and translation
- Recall and integrate key knowledge and concepts about DNA repair mechanisms
- Relate the theory behind techniques used in recombinant DNA technology and evaluate how these techniques can be applied to biological problems
- Demonstrate how immune genes evolved, describe their inherent variation and define how epigenetics modify their functions,
MODULE BIU33240: MICROBIOLOGY & IMMUNOLOGY

BI3008 - Immunology III, Natalia Munoz-Wolf (NMW), Michelle Mulcahy (MM) & Rachel McLoughlin (RMcL)

Lecture 1-2. Adaptive immune response to infections (NMW)
Adaptive immunity to bacteria and other pathogens, including the role of antibody and T cells. The role of CD8 T cells and Helper cells including Th1, Th2, Th17 and Treg cells.

Lectures 3. Bacterial evasion of adaptive immunity (NMW)
Mechanisms of immune evasion employed by bacteria to circumvent adaptive immune responses: antigenic variation, subverting/interfering with antigen processing or presentation, induction of anti-inflammatory cytokines and regulatory T cells that suppress protective immune responses of the host, production of proteins by bacteria that mimic regulatory molecules of the immune system thereby suppressing protective immunity.

Lectures 4-5. Anti-viral immunity and viral therapies (NMW)
Overview of viral replication. Introduction to immunity to viruses, with specific examples including, HIV, hepatitis C virus, influenza virus and poliovirus. Antiviral therapeutic strategies. Anti-retroviral drugs.

Lectures 6-7: Vaccines (NMW)
History of vaccine development. Immunological basis of vaccination. Type of vaccines, adjuvants, and vaccine delivery systems. Examples of vaccines in use today and how they work. Risks associated with vaccine use. New development in vaccination, including recombinant proteins, conjugated polysaccharides, live vector, DNA vaccines and candidate vaccines against HIV.

Lecture 8: Parasites (NMW)
Introduction to parasitology including typical life cycle. The immune responses to Protozoan parasites including Plasmodium species and malaria. Mechanisms of immune evasion by parasites. Overview of helminth parasites and the associated immune response. Brief overview of relationship of parasitic disease to other immunological diseases such as allergy and asthma

Lecture 9. Pathogen regulation of allergy and autoimmunity (NMW)
Role of regulatory T cells in controlling the immune responses that mediate allergy and autoimmunity in normal individuals. Epidemiological evidence that the prevalence of certain infections may be related to the incidence of allergy and autoimmune diseases (the hygiene hypothesis). Future therapeutics for autoimmunity or allergy based on parasite infection or products for microbes for mucosal vaccines versus-leukaemia effect of bone marrow Tx.

Lectures 10-11. Positive effects of bacteria (MM)
Introduction to the concept of commensals, symbionts, pathobionts. Sites of colonisation i.e. nasal, skin, gut. The microbiome. How the commensal flora benefits the host. Factors impacting upon the gut microbiota which, therefore can impact upon human health. Impact of the intestinal flora on the development of the intestinal immune system and in turn immune tolerance which helps to protect against autoimmune and allergic disease.

Lecture 12. Bacterial infections (RMcL)
Introduction to pathogenesis, intracellular vs extra-cellular bacteria, virulence factors, e.g. of diseases/animal models of infection

Lecture 13. Innate immune response to bacterial infections (RMcL)

Lecture 14. Bacterial evasion of innate immunity (RMcL)
Mechanisms of immune evasion employed by bacteria to circumvent innate immune responses: inhibition of complement cascade, inhibition of anti-microbial peptides. Mechanisms employed by intra-cellular and extra-cellular bacteria to manipulate phagocytic responses i.e. Inhibition of phagosome maturation, inhibition of intra-cellular killing mechanisms, modulation of apoptosis.
MI3011 - Bacterial Pathogenicity, Sinead Corr (SC)
Lecture 1: Clostridial neurotoxins. Tetanus and botulism, diseases caused by a single toxin
Lecture 2: Vibrio cholerae and the cholera enterotoxin.
Lecture 3: Shigella dysenteriae. A classic intracellular pathogen.
Lecture 4: Salmonella
Lecture 5: Enteropathogenic and enterohaemorrhagic Escherichia coli. Diarrhoeal disease and haemolytic uraemic syndrome
Lecture 6: Listeria monocytogenes
Lecture 7: Staphylococcus aureus. Pathogenesis and immune evasion
Lecture 8: Adherent-invasive E. coli
Lecture 9: Streptococci
Lecture 10: Neisseria meningitidis. Bacterial meningitis

MI3051 - Virology I, Kim Roberts (KR)
Lecture 1: Virus diversity, structure and classification
Lecture 2: Virus replication, entry and exit strategies
Lecture 3: (+)ssRNA, Picornaviruses: diseases, replication strategy and control methods
Lecture 4: (-)ssRNA, Influenza virus: disease, replication strategy and pandemics
Lecture 5: dsDNA, Poxviruses: disease, replication strategy and eradication
Lecture 6: dsDNA, Herpes viruses and Papilloma viruses: diseases, replication strategies, latency and cancer
Lecture 7: HIV: disease, replication strategy and treatment
Lecture 8: Hepatitis viruses: diseases and replication strategies
Lecture 9: Emerging viruses: zoonoses and vector transmission
Lecture 10: Applied virology: virus vectors, protein expression systems and viral oncotherapy

Practical 1: Cytokines (Andrew Bowie)
Practical 2: Lymphocytes (Clair Gardiner)

Further information on practicals is available in practical handbooks

Learning outcomes:
On successful completion of this module students will be able to:
• Identify cells, receptors and soluble components of the adaptive immune system and how they function to eliminate pathogen
• Relate how vaccines are made and how they work, including new developments in vaccine technologies.
• Describe and compare the receptors for bacterial toxins on cells, the internalisation of toxins into cells, the trafficking of toxins inside cells, and the molecular modes of action of toxins within cells or at cell surfaces
• Demonstrate how knowledge of the actions of bacterial toxins at both the cellular and molecular levels has permitted their use as therapeutic agents and in prophylactic immunization strategies
• Describe the structure and classification of viruses and give examples of the effects of specific viral infections.
MODULE BIU33030: LABORATORY METHODS

BIOCHEMISTRY JS COURSE IN DATA HANDLING, Andrew McDonald (AMD) & James Murray (JM)

Lecture 1 (AMD): Understanding measurement issues and the effects of bias and imprecision on data accuracy; errors and variability; describing data in terms of general magnitude and spread; estimation of standard deviation, standard error of the mean and coefficient of variation.

Lecture 2 (AMD): Understanding the idea of a distribution; the Normal distribution and what information can be derived from data that fit a Normal distribution; using the Normal distribution to set limits and understanding the concept of confidence intervals; introduction to the concept of p values and hypothesis testing; the T-distribution.

Lecture 3 (AMD): Dealing with data that are not Normally distributed; alternative estimates of general magnitude and spread; differences between groups; the strategy of hypothesis testing; interpreting a non-significant result; alpha and beta errors; the concept of power and the effect of sample size; planning a study.

Lecture 4 (AMD): Understanding and proper use of common tests for significance; paired and unpaired T-tests; alternative non-parametric tests; ANOVA.

Lecture 5 (AMD): Other important probability distributions in biochemical analysis; use of Chi Square and Fisher’s Exact test; estimating, interpreting and correct use of correlation analysis.

Lecture 6 (AMD): Introduction to regression and use of theoretical models in data analysis; understanding linear regression – slope, intercept, standard errors, residuals, and comparing linear regression models.

Lecture 7 (AMD): Non-linear regression methodology; best fit parameters; weighting; notes on method development; critically examining research papers.

Computer sessions: Training in the use of PRISM (JM & AMD)

Class Project: Eight problems are presented, of which some answers are intuitive and some are calculated using suitable software (students can use Prizm but any package is acceptable). Problems take in the content of all lectures and computer sessions. Students have 2 months to hand in the project. A 1 hour tutorial session is held after results are available (in Semester 2).

On–line MCQ: based on material covered in lectures.

Laboratory Methods Practicals (Derek Nolan): Six laboratory sessions covering solutions preparation and dilutions, spectrophotometry, buffers, protein assays, chromatography and laboratory safety.

On-line MCQ: assessing solutions and dilutions

Written Assignment: assessing results from experiments carried out in the Methods practical sessions.

Practical Exam (Lab based): Students will be required to independently complete a particular task (or tasks) using the knowledge and skills acquired during the Laboratory Methods practical sessions.

Practical Exam MCQ (On-line): Covering the Laboratory Methods practical sessions.

Further information on practicals is available in practical handbooks.

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

- Perform and interpret appropriate statistical analyses of experimental data.
- Use appropriate graphing and statistics computer software to present and analyse experimental data.
• Demonstrate good and safe laboratory technique including the operation of basic laboratory equipment including pipettes, spectrophotometers, pH metres, chromatography columns and balances.
• Prepare a solution of given concentration and pH and carry out calculations involving dilutions.
• Demonstrate an ability to apply theoretical concepts to a new experimental situation and to use those concepts to interpret experimental data.

**MODULE BIU33020: RESEARCH SKILLS**

This purpose of this module is to develop research, critical analysis and communication skills that are essential for a graduate immunologist. Students will undertake a major written review of a subject area of biochemical relevance under the supervision of a member of the staff of the school. The topic for this review will be given to the student in the first week of the first semester with the review to be submitted early in the second semester. There will also be a tutorial session on the use of Endnote for referencing within the context of the minireview. In addition, each student will prepare and present a short oral summary of their review. Critical analysis of primary data is a key skill and this is addressed through a series of 4 separate quantitative problem sessions in the second semester. Each problem subject will involve three sessions: In Session 1 the problem will be introduced and distributed to the students. Students will complete the solution to the problem as home work. In Session 2 the solution to the problem will be discussed. The final session involves an in-course exam. VERY IMPORTANT: You will be notified of the times and locations of this exam well in advance. **It is your responsibility to be present for this exam. Be advised that these dates cannot be changed nor can alternative times be provided.** Note linked-material from these sessions could appear in short question exams in both the Junior & Senior Sophister years.

**Assessment:**

*Minireview:* marked by the member of staff responsible for the review topic (50 marks).  
*Oral presentation:* assessed by a panel consisting the supervising staff member and the course co-ordinator (10 marks).  
*Quantitative problem/data analysis:* 1 in-course exams, 3 exam questions from the 4 problems, Answer 2, (40 marks in total).

**Learning outcomes:**

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

• Carry out a systematic literature review in a given area using databases, bibliography and review articles to source the relevant and important studies.
• Critically analyse research findings in terms of experimental design and outcomes.
• Write a clear, accurate and thorough scientific essay giving perspective and opinion
• Present and discuss findings in a small group format.
• Apply data analysis and statistical techniques to scientific and experimental problems.
• Increase knowledge of the range of cutting edge molecular techniques employed in immunological and biochemical research.

**TRINITY ELECTIVE**

All JS students are obliged to take a Trinity Elective module (5 credits) outside the scope of your moderatorship & all of which are in-course assessed. Total mark for this component = 50 marks. You will have picked & registered for this already.  
Student are advised to double-check their Trinity Elective option & time-tabling as soon as possible.
COURSE OVERVIEW:

IMMUNOLOGY: 6 CORE CONCEPTS

1. **Identification & Discrimination** (harmful and harmless microbes/harmful & harmless self)

2. **Tolerance** of harmless foreign antigens: foetal, dietary, commensal: no response


4. **Immunisation** referring to both specific, adaptive and non-specific memory displayed by cells of the immune system

5. **Breakdown** or inappropriate immunoregulation: disease
   a. chronic infection
   b. chronic inflammation
   c. autoimmunity
   d. allergy
   e. cancer

6. **Immunotherapy**

TEN CORE PRINCIPLES IN IMMUNOLOGY

1. The **innate immune system** is activated following recognition of conserved moieties expressed by microbes or released during host cell death or tissue damage. Recognition is mediated by highly conserved receptors (TLRs, NLRs, RIGs) which signal through pathways of conserved components to initiate expression of a large number of genes that code for proteins with effector (AMPs) and regulatory functions (cytokines & chemokines). Cytokines produced during local inflammatory responses induce systemic inflammation by activating the acute phase response in the liver.

2. **Innate effector mechanisms** which are activated by the above recognition systems during inflammation resulting in target killing and/or elimination, include Natural Killer cells, complement, opsonisation, phagocytosis, respiratory burst and antimicrobial peptide (AMPs) activity and γδ T cell activation.

3. **Adaptive immunity**, involving T and B lymphocytes, relies on generation of receptors of exquisite specificity and immunological memory, both key features of successful vaccination. These antigen receptors are coded for by gene segments that rearrange during lymphocyte development and when translated into protein, mediate selection during T cell development as well as clonal expansion of T & B cells.

4. Cells of the innate and adaptive immune system are generated from **haemopoietic stem cells** which differentiate along myeloid and lymphoid lineages to give rise to NK cells, lymphocytes, granulocytes, macrophages and dendritic cells.

5. **Antigen presenting cells** (DCs) in the peripheral tissues and organs phagocytose and process pathogen derived molecules, travel to lymph nodes and present resulting peptide antigens in the context of MHC molecules expressed on their
surface. MHC:peptide complexes are recognised by T Cell Receptors (TCRs which have been generated by gene rearrangement) on naïve mature T cells in lymph nodes.

6. B cells use **antigen receptors**, also generated by **gene segment rearrangement**, to recognise soluble antigen; they then proliferate, differentiate and secrete antibody of the same specificity as the receptor expressed on their cell surface. Class switching results in a different antibody type of the same specificity.

7. There are five classes of **antibody** (IgM, IgD, IgG, IgA, IgE) whose specificity resides in the Fab portion and biological function is dependent on the FC portion; two identical **heavy chains** and two identical **light chains** combine to form the basic unit of all antibody molecules.

8. **Cytotoxic T lymphocytes** kill virally infected cells through recognition of peptide generated endogenously and presented by MHC class I; viral infection and transformation alters class I expression, thus allowing NK cell mediated killing.

9. **CD4 T cell** recognition of antigen presented by Class II expressing DCs results in their clonal expansion and differentiation towards specialised cytokine secreting subsets of cells (Th1, Th2, TH17, Treg etc.) which can direct and amplify innate and adaptive immune responses.

10. Elaborate **regulatory mechanisms** control all of these activities. Breakdown in these mechanisms results in disease, including autoimmune disease, chronic infection, allergy and cancer. Understanding **immunoregulation** and identifying its molecular targets underpins discovery of new **immunotherapies**.
SECTION 5 – APPENDIX I
Useful Information for 2019/2020 Immunology Class

Small group tutorial groupings
Please contact your small group tutor within the first 2 weeks to set up a tutorial.

Dr Frederick Sheedy (fsheedy@tcd.ie)
Aisling Cassidy, Yunzhu Chen, Aimee Cuddihy, Aoife Walsh

Prof. Clair Gardiner (gardinec@tcd.ie)
Jack Dunne, Isabelle McLornan, Cillian Gartlan,

Prof. Luke O’Neill (laoneill@tcd.ie)
Tara Gleeson, Sarah Henry, Cian Horneck Johnston

Prof Cliona O’Farrelly, (ofarrecl@tcd.ie)
Akhil Joseph, Mark McFeely, Alan McGinley,

Dr Nigel Stevenson, (stevennj@tcd.ie)
Antanas Murelis, Kate Roche, Daniel Shamavu,

Dr Lydia Lynch, (lynchl3@tcd.ie)
Alanna Slater, Frances Smith, Alana Ward,

Minireview allocations:
Please contact your assigned supervisor by e-mail within the first 2 weeks to discuss the review & meet in person.

Aisling Cassidy "The Role of IL17 in Reproductive Immunology"
Prof. Cliona O’Farrelly, ofarrecl@tcd.ie

Yunzhu Chen "CAR-cell therapies for cancer: T cells versus NK cells"
Prof. Clair Gardiner, gardinec@tcd.ie

Aimee Cuddihy "The role of resident memory T cells in skin?"
Dr Jean Fletcher, fletchj@tcd.ie

Jack Dunne "The role of amphiregulin in the immune response"
Dr Lydia Lynch, lynchl3@tcd.ie

Cillian Gartlan "The role of IL-1 family cytokines in vaccine and infection induced cell-mediated immunity"
Dr. Natalia Munoz-Wolf, munozwon@tcd.ie

Tara Gleeson "Inflammasomes: critical regulators of immunity and inflammation"
Prof. Luke O’Neill, laoneill@tcd.ie

Sarah Henry "The role of Suppressor of Cytokine Signalling (SOCS) proteins in antiviral immune responses?"
Dr Nigel Stevenson, stevennj@tcd.ie

Cian Horneck Johnston "Stem Cell ER: Interruptions to immune homeostasis & the impact on bone marrow hematapoesis"
Dr Frederick Sheedy, fsheedy@tcd.ie
Akhil Joseph  “Describe the efforts in the ongoing search for new antibiotics”
Dr Michael Carty, cartymi@tcd.ie

Mark McFeely  “Innate Anti-Viral Mechanisms in the Hepatocyte”
Prof. Cliona O’Farrelly, ofarrecl@tcd.ie

Alan McGinley  “New treatments for curing childhood Neuroblastoma?”
Prof. Clair Gardiner, gardinec@tcd.ie

Isabelle McLornan  "Targeting the IL-17 pathway in human skin disease "
Dr Jean Fletcher, fletchj@tcd.ie

Antanas Murelis  “Cellular metabolism of IL-17 producing cells”
Dr Lydia Lynch, lynchl3@tcd.ie

Kate Roche  “The gut-lung axis of immune regulation.”
Dr. Natalia Munoz-Wolf, munozwon@tcd.ie

Daniel Shamavu  “How single cell RNA Seq is informing our understanding of the immune system?”
Prof. Luke O’Neill, laoneill@tcd.ie

Alanna Slater  “The role of Suppressor of Cytokine Signalling (SOCS) proteins: SOCS4-7.”
Dr Nigel Stevenson, stevennj@tcd.ie

Frances Smith  “Yellow alert: A role for myeloid cells mediating immune tolerance to the gut microbiota?”
Dr Frederick Sheedy, fsheedy@tcd.ie

Aoife Walsh  “Describe the efforts in the on going search for new antiviral agents”
Dr Michael Carty, cartymi@tcd.ie

Alana Ward  “The fungal mycobiome & immune function - mush-room for further investigation?”
Dr Frederick Sheedy, fsheedy@tcd.ie

Journal Club Assignments:
Each group will present 1 research paper.
This will be a brief 5 min presentation on the main points, the methods used to support the conclusions, the impact of the work etc.

There will be 3 topics, 2 papers each. Most importantly, each paper is “matched” to 1 other, “complementary” paper. After both are presented, the class will discuss exactly how these “complement” (or even contrast) each other & consider what this can mean for the ‘final destination’ of our work & its impact on science and scientists. I would encourage each group to read the complementary paper in their topic.

Powerpoint slides are not required but the group can use the blackboard/whiteboard to sketch a “Graphical Abstract” of the main findings – see Cell journals for examples of this.
Example: https://www.ncbi.nlm.nih.gov/pubmed/22440612
Topic A – Cytokines in Infection

Group 1: Aisling Cassidy, Yunzhu Chen, Aimee Cuddihy
An interferon-inducible neutrophil-driven blood transcriptional signature in human tuberculosis.

Group 2: Jack Dunne, Cillian Gartlan, Tara Gleeson
Immunosuppression in patients who die of sepsis and multiple organ failure.

Topic B – Innate Lymphoid Cells in Obesity

Group 3: Sarah Henry, Cian Horneck Johnston, Akhil Joseph
Adipose tissue invariant NKT cells protect against diet-induced obesity and metabolic disorder through regulatory cytokine production.

Group 4: Mark McFeely, Alan McGinley, Isabelle McLorman
Metabolic reprogramming of natural killer cells in obesity limits antitumor responses.

Topic C – T-cells in Rheumatoid Arthritis

Group 5: Antanas Murelis, Kate Roche, Daniel Shamavu
Defects in CTLA-4 are associated with abnormal regulatory T cell function in rheumatoid arthritis.

Group 6: Alanna Slater, Frances Smith, Aoife Walsh, Alana Ward
Polyfunctional, Pathogenic CD161+ Th17 Lineage Cells Are Resistant to Regulatory T Cell-Mediated Suppression in the Context of Autoimmunity.

Intro Session: 4pm, Tuesday 08th October 2019, L5.16 (FRED)
Journal Club: 11am-1pm, Tuesday 15th October 2019, Rm 6.07 (MSc Room)

PDFs of articles & a sample Cell publishing group article will be made available on Blackboard. Like all good journal clubs, baking is encouraged.