



Trinity College Dublin

Coláiste na Tríonóide, Baile Átha Cliath

The University of Dublin

School of Biochemistry and Immunology

JS Immunology 2022–2023



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
 COVID-19 – Coronavirus Infectious Disease 2019
 HSE – Health Service Executive

SECTION 2 – PROGRAMME OVERVIEW

Welcome to Junior Sophister Immunology 2022:

Congratulations on starting your Junior Sophister year after some unprecedented times and for selecting an exciting and dynamic moderatorship, which given recent events, is more timely and relevant than ever before. This is an unusual but exciting time for Immunology. As we begin to live with COVID-19, the work which we do & the subject you will be studying, is more important now than ever before for many reasons; To research & understand the interaction between infectious pathogens and our body, To use this knowledge to develop treatments and vaccines, To communicate this knowledge to the general public & thereby, To inform & shape policy and public health guidance around this. “*Immunology, Inflammation & Infection*” has long been a central research theme in Trinity, but now more than ever, you as the next generation of immunologists will have the opportunity to impact society with the work you do and change the perception and appreciation of scientific training.

I am delighted to welcome you to the School of Biochemistry & Immunology, where the merging of these 2 unique disciplines has shaped the formation of new research topics in recent years, including the ever-expansive areas of immune signalling and immunometabolism. The investigators who will be teaching you are world class experts in their fields and as we resume in-person teaching, I urge you all to take advantage of the opportunities afforded to you – both lectures and one-to-one/small-groups.

Your Junior Sophister year now consists of 40 ECTS of Core material delivered by your home discipline, Immunology. This is associated with a range of Approved/Open Modules (10 ECTS), which are subjects outside your home discipline, but which are essential for your academic development within the Immunology programme. In your case, we have arranged an Open module taught by the Discipline of Biochemistry in Semester 1 (BIU33150), which will give students the fundamental requirements in protein biochemistry and cell biology. In Semester 2, the Approved/Open Module is Microbial Pathogenesis (MIU33012), delivered by the School of Genetics & Microbiology. After these, students can chose 2 Elective Modules (10 ECTS), which can come from the cross-faculty TRINITY ELECTIVE panel or an extra, optional Approved/Open Module, which will supplement your core subject. For Immunology, we allowed you to chose from a Genomics/Genetics module in Semester 1 (GEU33045) or a Zoology module on Ecology of Infectious Disease in Semester 2 (ZOU33030). These are optional and are dependent on how many Trinity Electives a student decides to take across each Semester. If you have any questions about the logistics or suitability involved in selecting these, please get in touch.

With respect to Core teaching, most modules in the School of B&I consist of a mix of lectures and Practical teaching, with various formal and informal tutorials and activities. Core modules are generally assessed by a 70% end-of-term written exam & 30% through Continuous Assessment of course-work. This is now divided into 15% for Post-Practical Assignment submissions and an in-course end-of-module MCQ based on material from the associated Practicals', worth an additional 15%. In Semester 2, one of the CORE modules has a slightly different structure, BIU33260: Research Skills for Immunologists. In place of the traditional lectures and end-of-term exam, students will undertake a literature review on a current topic in Immunology and under the supervision of an academic member of staff, will research and produce a mini-review report on the topic and present this in an open-forum to the class. This module also contains a series of tutorials related to Quantitative Problems (QP), which will hone students' data handling & analysis skills. For each problem, students will receive a background tutorial from an academic staff member, a sample problem and finally an in-class exam based on a selection of these problems. We also run a set of talks for students on key skills required to build a scientific career, either within research or otherwise. These include talks from academics

on putting together CVs, grant-writing, publishing papers etc. These sessions will not be examined but are intended to prepare you for final year and beyond.

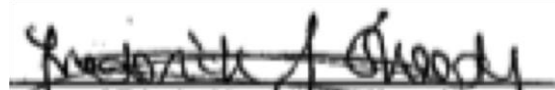
The School is running on the assumption that we can once again safely proceed with face-to-face Junior Sophister lectures for Semester 1, which will be complemented by Practical teaching in the Main Teaching Lab, with an element of social distancing. Crucially, for many of the Practicals at the beginning of the year, students will work alone (ie – not in pairs)_ which we have found is fundamental for students to achieve research independence. Some labs have been converted to online exercises, although this is a minority. A key part of the student experience in the School is interaction with world class Immunology researchers. Usually this occurs by assigning each student to an academic supervisor for their mini-review and also assigning Small Group Tutorials. These are usually non-timetabled events at the discretion of the student and lecturers. Although we encourage face-to-face interactions, since everyone's circumstances are slightly different this year, we will leave these up to the student and lecturers involved to decide how to proceed with this; whether you can meet safely face-to-face or schedule online meetings through Zoom/Teams or Blackboard Collaborate Ultra. There are some other events associated with specific modules (Revision Tutorials, Journal Clubs) that will be scheduled face-to-face in appropriate venues.

Unlike what you experienced in Senior Fresh, end-of-term exams this coming year will return to the in-person, written format. Our exams in the School typically require 2-3 page essays and shorter, specific questions. Every year, the most important piece of advice I give to students is TO ANSWER THE QUESTION ASKED. Students should not simply regurgitate lecture notes and facts/figures, but to use this knowledge and compose a specific and relevant answer to the question set and to take the opportunity throughout your answer to highlight this. For any course-work/essays/reviews throughout the year, students will submit answers via Turnitin, which flags extensive plagiarism from online sources. Automatically, answers scoring a similarity score of over 30% will be investigated thoroughly and the grade awarded will be at the examiners discretion. A general rule is sentences/paragraphs highlighted as plagiarism will be excluded and no marks returned for these sections. Extensive plagiarism will be subject to negative marking. Cases where students have high Turnitin scores throughout will be investigated & the work could be deemed inadmissible and the student will have to be re-assessed or returned as ZERO. There will be in-class MCQ's on Practical material at the end of each Semester, which will likely be completed online via Blackboard, but in a supervised room on-site. These questions will test knowledge of techniques, the background and data-handling.

The structure of the CORE Immunology modules has changed in the last few years, to align with the new degree structure. In Semester 1, alongside the Approved/Open Biochemistry module, students will first undertake BIU33220: Core Concepts in Immunology, which introduces the cellular and molecular components involved in the Immune System. The practicals linked to this module take place in the first few weeks of Semester 1 and will introduce students to lab work and common biochemical & signalling experiments. Following this, students will apply this knowledge to the key functions of the Immune System; protection from infectious disease and pathogenesis of inflammatory and autoimmune disease in BIU33270: Immunity & Disease. More intensive practicals linked to this module will be ran in the second half of Semester 1. In Semester 2, as well as the afore-mentioned Research Skills for Immunologists module (BIU33260), which is entirely course-work (Mini-Review, Practicals & QP Sessions), students will undertake BIU33230: Gene Regulation. The core material in this module is shared across the School's moderatorships (Biochemistry, Mol Med) and will consider nucleic acids and eukaryotic gene expression. There will be some additional introduction to the field of Immunogenetics/genomics and transplantation. This module runs across Semester 2 with longer molecular biology practicals scheduled in the second half of Semester 2. Advanced, immunology-specific practicals associated with the Research Skills module will run in the first few weeks of Semester 2.

We hope to have put together a functional and incremental course structure for the year, which will build on your Senior Fresh experience, while introducing you the core concepts in Immunology, and further developing biochemical and molecular biology concepts. All while training students in the lab and other key research-associated skills, including consultation of the literature, analysis and presentation of data and report writing. This booklet will outline the content & assessment of each module for the course, as well as the distribution of marks for the year. 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 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.



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Erasmus/International Student Coordinator:

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	Semester 1	Semester 2
CORE	[Module 1 - BIU33220] Core Concepts in Immunology (10 ECTS)	[Module 3 - BIU33230] Gene Regulation (10 ECTS)
	[Module 2 - BIU33270] Immunity & Disease (10 ECTS)	[Module 4 - BIU33250] Research Skills in Immunology (10 ECTS)
Approved A	[Biochem Open - BIU33150] Biochemistry for Biosciences (5 ECTS)	[Micro Open - MIU33012] Microbial Pathogenesis (5 ECTS)
Approved B /Trinity Elective (TE)	[Genetics Open - GEU33045] Genomics & Systems Biology - OR TE (5 ECTS)	[Zoology Open - ZOU33006] Ecology & Evolution of Infectious Disease - OR TE (5 ECTS)

Figure 1 – Overview of JS Immunology Course structure 2022-2023:

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. Three 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 = 300 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), analysis of quantitative data (3 quantitative problem sessions and associated exams) and advanced immunology practicals. This module will be assessed by continuous assessment across semester 2 (100%). Mini-review titles will be assigned to students early in semester 1 & students should start work on this throughout the semester. A tutorial on writing reviews & assessing the literature will be provided in Semester 1. Total mark for this module = 100 marks.
3. Two x 5 credit Approved/Open modules outside your home discipline of Immunology. These include BIU33150 Biochemistry for Biosciences in Semester 1 & MIU33012 Microbiology Pathogenesis in Semester 2. These modules differ in how they are delivered & assessed, depending upon the School involved. Further information is provided in the booklet. Mark for each component = 50 marks, total of 100 marks for Approved/Open Modules. For scheduling reasons, many of these modules will be available online as pre-recorded lectures with some coursework &/or interactive components.
4. All JS students are obliged to take 1 Trinity Elective (TE) module (5 credits). This will be outside your home school and in an unrelated subject. Students have the option of choosing 2 TE, 1 per Semester, or supplementing 1 TE with an additional, optional Approved/Open module. This can be from Genetics in Semester 1 or Zoology in Semester 2. Each module equates to 50 marks. Students must chose a combination of a) 2 TE's, b) 1 TE in Semester 1 + Approved/Open module in Semester 2 or c) 1 TE in Semester 2 + Approved/Open module in Semester 1, to a give a total of 10 ECTS or 100 marks.

The Junior and Senior Sophister years are integrated and the **Junior Sophister mark** (including the mark for Broad Curriculum) will contribute **30% 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 (Fig 2-3). Further information on course content and learning objectives is provided in Section 4: Teaching & Learning.

Figure 2 - Semester 1 Modules:

Core modules:

	Section	Topic	Lecturer(s)	Assessment		Marks
Module BIU33220 Core Concepts in Immunology 10 ECTS (100 marks)	A	Innate Immunity	Various	Xmas Paper	1 of 2 Questions	20 marks
	B	Adaptive Immunity	JF, COF	Xmas Paper	1 of 2 Questions	20 marks
	C	Immune Signalling	JH, FJS, EC	Xmas Paper	1 of 2 Questions	20 marks
		General module material (inc. Practicals)	Various	Xmas Paper	Short Questions	10 marks
	Lecture MCQ	Material from A & B	Various	Online MCQ		3 marks
	Practical 1	Solutions & Dilutions	Andrei Budanov	F2F	Online Test	1 mark
	Practical 2	pKA	Derek Nolan	F2F	Write-up	4 marks
	Practical 3	Protein Assay	Andrei Budanov	F2F	Write-up	3 marks
	Practical 4	Enzyme Kinetics	Jer Hayes	F2F	Write-up	4 marks
	Lab MCQ	Material from practical classes	Various	In-class MCQ		15 marks

	Section	Topic	Lecturer(s)	Assessment/Mode		Marks
Module BIU33270 Immunity & Disease 10 ECTS (100 marks)	A	Immunology & Infection	RMcL, NMW	Xmas Paper	1 of 2 Questions	20 marks
	B	Immune Disease	Various	Xmas Paper	1 of 2 Questions	20 marks
		Section A & B	Various	Xmas Paper	1 other Question	20 marks
		General module material (inc. Practicals)	Various	Xmas Paper	Short Questions	10 marks
	Practical 1	Phagocytosis	Rachel McLoughlin	F2F	Write-up	6 marks
	Practical 2	Innate immunity/DCs	Ed Lavelle	F2F	Write-up	6 marks
	Practical 3	cAMP/Binding assay	Daniela Zisterer	ONLINE	Write-up	3 marks
	Lab MCQ	Material from practical classes	Various	In-class MCQ		15 marks

Open/Approved module:

	Section	Topic	Lecturer(s)	Assessment		Marks
Module BIU33150 Biochemistry for Biosciences 5 ECTS (50 marks)	A	Proteins & Nucleic Acids	AK, KHM, VK	Xmas Paper	1 of 2 Questions	30 marks
	B	Membranes	Andrei Budanov			
	C	Cytoskeleton	Derek Nolan			
	D	Signalling	Emma Creagh	2 of 6 Questions		
	MCQ 1	Sections A-B	Various		In-class MCQ	10 marks
	MCQ 1	Sections B-D	Various	In-class MCQ	10 marks	

Figure 3 - Semester 2 Modules:

Core modules:

	Section	Topic	Lecturer	Assessment/Mode		Marks	
Module BIU33230 Gene Regulation 10 ECTS (100 marks)	A	Nucleic Acid Chemistry	Vincent Kelly	Summer Paper	1 of 2 Questions	20 marks	
	A	DNA structure	Andrew Bowie				
	A	Replication	Daniela Zisterer				
	B	Transcription	Andrew Bowie	Summer Paper	1 of 2 Questions	20 marks	
	B	Translation	Daniela Zisterer				
	C	Molecular cloning	Fred Sheedy	Summer Paper	1 of 2 Questions	20 marks	
	C	DNA Repair mechanisms	David Finlay				
	C	Immunogenetics	Clair Gardiner				
			General module material (inc. Practicals)	Various	Summer	Short Questions	10 marks
		Practical 1	Molecular biology	Fred Sheedy	F2F	Write-up	7.5 marks
	Practical 2	Inflammatory Gene Expression	Fred Sheedy	F2F	Write-up	7.5 marks	
	Lab MCQ	Material from practical classes	Various	In-class MCQ		15 marks	

	Component	Topic	Lecturer	Assessment		Marks
Module BIU33260 Research Skills in Immunology 10 ECTS (100 marks)	Mini-Review	Literature review	Various	Mini-Review		40 marks
		Presentation of Lit review	Fred Sheedy	In-class presentation		10 marks
	Quantitative Problems	Quantitative Problem 1	Derek Nolan	In-class exam	2 of 3 problems	20 marks
		Quantitative Problem 2	Rachel McLoughlin			
		Quantitative Problem 3	David Finlay			
	Seminars	Research Career Skills Seminars	Various	<i>not examined</i>		
	Practical 1	Cytokines	Andrew Bowie	Write-up		7.5 marks
	Practical 2	Lymphocytes	Clair Gardiner	Pre-practical MCQ		0.5 marks
				Write-up		7.0 marks
Lab MCQ	Material from practical classes	Various	In-class MCQ		15 marks	

Open/Approved module:

	Section	Topic	Lecturer	Assessment		Marks
Module MIU33012 Microbial Pathogenesis 5 ECTS (50 marks)	A	Bacterial - Host Invasion & Infection	Sinead Corr	Summer Exam Paper	1 of 2 Questions	50 marks
	A	Bacterial Toxins	Sinead Corr			
	B	Viral life-cycles & replication	Kim Roberts		1 of 2 Questions	
	B	Viral disease	Kim Roberts			

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. 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>

Scheduling & Venues:

TCD now runs on a 2-Semester academic year (<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 & another 2 at the end of Semester 2.

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). 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.

We are aiming to run most JS lectures live, in-person, in appropriately spaced venues. Where this will not be possible, for example, for some of the larger modules like the Open Modules, these lectures will be delivered on-line. You will be informed beforehand whether this will be a live & interactive event (eg – Blackboard Collaborate) or pre-recorded and made available on Blackboard through Panopto. We do not anticipate changes to our teaching plans throughout the year, however, if circumstances change in-line with public health guidance we will endeavour to inform students in advance.

Regarding Practical classes for JS year, students are asked to arrive in an orderly and timely fashion and avoid congregating in groups upon entering and leaving the lab. Training and guidance will be provided in advance of your first session in the Teaching Lab.

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

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. Practical classes cannot be rescheduled and students who miss these will be missing valuable components in the development of their laboratory and analysis skills. It will not be a case that sample data will be provided to students, such that the post-practical assessment can be completed. Alternative assessments will be set to ensure students grasp the skills they missed out on. Since working independently in the lab is critical for Senior Sophister year, students who miss multiple Practical classes may be returned as 'non-satisfactory'. This will affect progression to Senior Sophister year.

Students should make every effort to attend in-person lectures this year as live recordings of these are not guaranteed. If, in the instance of isolating because of a COVID-19 diagnosis, please contact the Module Co-ordinator, lecturer or Course Co-ordinator to find out how best we can supplement your learning. Students are reminded that attendance at lectures is both a courtesy to lecturers and a sign of professionalism and interest and will be noted when it comes to writing letters of recommendation throughout the year and after your studies.

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. Students should keep their lab notebooks up to date as lecturers and course co-ordinators can ask to examine these at any time during Practical classes.

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 a post-practical assessment form is not be submitted through Blackboard, these should be submitted to the School Office on the dates given in your practical manual.

Laboratory multiple choice exam

At the end of the each semester you will sit a multiple choice exam where you will be required to answer approximately 10 questions per module. 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 in advance. Importantly, we make these MCQ exams available simultaneously & at the end of each term each student will have to complete 2 separate MCQ's, 1 for each core module that Semester, on Blackboard. This will be done in a supervised manner in the TBSI computer room (PAC Room). These exams will be timetabled for the last week of term and punctual attendance is vital. If students are late and turn after the exam has commenced, they may be refused entry. It is important that students log-in to both modules and complete the MCQs during the designated times.

The Mini-review (40+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 & a tutorial on this will be delivered early in Semester 1. 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. 43 marks are awarded for the thesis itself and a further 7 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 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 (30%) and Senior Sophister marks (70%).

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.** In light of the Covid-19 pandemic, online/dry-lab projects may be proposed for successful students.

The School has contacts with other internship programs at various institutes and work-places including Eli Lilly in Cork, University of Massachusetts in USA and Sydney in Australia. As a result of the Covid-19 pandemic it is uncertain if these programs will run this coming summer. We will let students know throughout the year.

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

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.

For online exams, we will employ plagiarism detection software eg Turnitin. If a high score is detected it will be at the examiners discretion how to mark and proceed with the answer. The following general principles will be upheld by markers during online exams;

- Turnitin scores up to 30%, and comprising single sentences, will be accepted for marking. The plagiarised sentences are ignored and not graded resulting in a pro-rata drop in marks.
- Turnitin scores greater than 30% will be scrutinised to ensure it is not an artefact of the algorithm. The examiner will flag this on the exam script that plagiarism has occurred such that;
 - a. If one blocks of text (3 or more consecutive sentences) is obviously plagiarised the student lose 10% marks. The student will be given a written warning.
 - b. Evidence of more than one passage being copied results in a zero grade being returned for the answer.
 - c. When extensive plagiarism (greater than 30% Turnitin score) has been identified by an examiner, the module & course coordinators will be notified and carry out an independent evaluation of the grades and scripts returned during the year and in exams. Evidence of systemic plagiarism will trigger escalation of the issue to either the Schools Director of Undergraduate Teaching & Learning, the student's College tutor or the Senior Lecturer in alignment with the severity of the transgression. In this case, whole exams could be deemed inadmissible and the student will have to resit the exam or potentially, could failing the module/year.

For online exams, students will need to digitally sign statement indicating they have not wilfully plagiarised their answers or copied from online sources.

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 (BB). 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 normally 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. Usually, each lecturer has the option to upload as little or as much information from their lecture material as they like. For the coming semester, online learning will be encouraged for larger groups that cannot be safely held face-to-face in a safe manner. Therefore, more material is being made

available, including pre-recorded narrations of lecture content and staff will engage in interactive Q&A sessions after each series of lectures. Online material is generally designed to supplement but not substitute learning & students should take it upon themselves to go beyond the lecture notes and online content and do extra reading and exercises.

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 BIU33220: CORE CONCEPTS IN IMMUNOLOGY

LECTURERS: Luke O'Neill (LON), Andrew Bowie (AB), Rachel McLoughlin (RMcL), Frederick J Sheedy (FJS), Clair Gardiner (CG), Jean Fletcher (JF), Cliona O'Farrelly (COF), Derek Doherty (DD), Jerrard Hayes (JH), Emma Creagh (EMC), Andrei Budanov (AAB), Derek Nolan (DN), Jer Hayes (JH), Audrey Carroll (AC).

LECTURES (Weeks 3-8):

Part A – Innate Immunity

Lecture 1: Introduction to the immune system (LON)

The Immune System - review of component parts. The jobs of the immune system - self from non-self. Innate and adaptive immunity. The multiple roles of the Immune System - fighting infection and cancer. Autoimmunity and inflammatory diseases. Allergy. Transplantation. Harnessing and inhibiting immunity. Immunity as a prototypical self-regulating complex system.

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 (AB)

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: Polymorphonuclear cells (RMcL)

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 7: Monocytes & Macrophages (FJS)

Macrophage development, macrophage diversity, recruitment of monocytes, tissue resident macrophages, homeostatic functions of macrophages

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.

Part B – Adaptive Immunity

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: Major Histocompatibility Complex & Genetics of HLA-antigens (COF)**Lecture 15: T-lymphocyte development: (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,

Lecture 16: Antibody genetics (COF)

development of B cell lineages in bone marrow, generation of diversity in immunoglobulins, comparison with T cell receptor gene rearrangement events. B lymphocytes, plasma cells, antibody production,

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 (DD)**Lectures 29-30 **Scheduled at the end of module:* 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.

Part C – Immune Signalling**Lectures 19-28: Proteins & the Immune System, (JH)**

Lecture 19: 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. 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 20: Glycobiology and Glycoimmunology. Glycosylation and the immune system: structure and functions of glycans, antigen recognition and carbohydrate recognition domains

Lecture 21: 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 22: 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 23: 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.

Lectures 24-28: Innate Immune Signalling**Lecture 24: Principles of Signalling (FJS)****Lecture 25: Pattern Recognition – Innate Defences (FJS)****Lecture 26: Pattern Recognition - TLRs (FJS)****Lecture 27: Intracellular Complexes (EMC)**

Lecture 28: Organelle Signalling (EMC)**PRACTICALS (weeks 3-6)****Practical's 1-3:****Practical Boot Camp**

A series of introductory practical exercises to familiarize students with basic laboratory techniques in biochemistry and immunology.

These include Safety Training, a Pipetting/Solutions & Dilution online exercise (AB), a pH/pKa experiment (DN) & a protein concentration assay experiment (AB).

Practical 4:

Enzyme Kinetics Practical (JH), a supplemental Tutorial/Lecture introducing Kinetics for Immunologists will be provided in advance.

Further information on practicals is available in practical handbooks

TUTORIALS

Week 5: ENZYME KINETICS – Recap Lecture Tutorial for Immunologists (NNB)

Week 10: REVISION TUTORIAL – Core Concepts in Immunology (COF/FJS)

Week 11: IN-CLASS MCQ – based on Lecture material from Part A-C

Week 14: LAB-BASED MCQ – based on Practical material

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
- Integrate key knowledge relating to protein structure and the function of key molecules of the immune system (antibodies, receptors, signalling proteins).
- Perform independent lab experiments and analyse and store data accordingly

MODULE BIU33270: IMMUNITY & DISEASE**LECTURERS:**

Rachel McLoughlin (RMcL), Natalia Muñoz-Wolf (NMW), Jean Fletcher (JF), Ed Lavelle (EL), Cliona O'Farrelly (COF), Frederick Sheedy (FJS), David Finlay (DF), David Loane (DL), Daniela Zisterer (DZ).

LECTURES (Weeks 10-14):**Part A – Immunity & Infection****Lecture 1. Bacterial infections (RMcL)**

Introduction to pathogenesis, intracellular vs extra-cellular bacteria, virulence factors, e.g. of diseases/animal models of infection

Lecture 2. Innate immune response to bacterial infections (RMcL)

Mechanisms of innate immunity to bacteria: Anti-microbial peptides, complement, phagocytes: neutrophils, macrophages. Function of the phagocyte: phagosome maturation, intracellular killing mechanisms, antigen processing.

Lecture 3. 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.

Lecture 4-5. 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 6. 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 7-8. 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 9-10: 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.

Lectures 11-12. Positive effects of bacteria (RMcL)

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.

Part B – Immune Disease

Lectures 13-14: Immunological Tolerance, Autoimmunity and models of autoimmune disease (JF)

What is immunological tolerance? Anergy. Responses to self-antigens by specific adaptive responses can cause autoimmune disease. Autoimmunity versus tolerance – need for co-stimulation. Factors influencing autoimmunity include genetics and environment. Auto-antibodies and their properties. T cell mediated injury. Autoimmune diseases. Role of infection, PAMPs and DAMPs in precipitating autoimmune diseases.

Lectures 15-16: Allergies (EL)

Overview of the spectrum of allergic diseases. Anaphylaxis. Asthma. The immunopathology of asthma. Hygiene hypothesis and other hypotheses to explain increased incidence of asthma. Interplay of genes, cytokines and chemokines. Current and future therapies for allergies.

Lecture 17: 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 18. 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.

Lecture 19-20: 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

Lectures 21-22: Immunoregulation & Immunotherapies (COF)

Suppressors of cytokine signaling, steroids; lipoxins, immunoregulatory cytokines; regulatory apoptosis; T regulatory cells.

Lectures 23-24: Introduction to metabolic inflammation (FJS)

Introduction to metabolic syndrome, obesity and insulin resistance – role for obesity-associated inflammation. Introduction to cardiovascular disease, dyslipidemia and atherosclerosis.

Lecture 25: 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

Lecture 26: Introduction to Neuroinflammation (DL)

Lectures 27-28; Immunometabolism – a primer (FJS). Recap of central energy metabolism and importance of cellular metabolism in immune cell function. Systemic metabolism and its impact on immune function.

PRACTICALS (weeks 8-12)

Practical 1: Phagocytosis (Rachel McLoughlin)
Practical 2: Innate Immunity/Dendritic Cells (Ed Lavelle)
Practical 3: Binding Assay (Daniela Zisterer) - online
Further information on practicals' is available in practical handbooks

TUTORIALS

Week 6: Cell & Tissue Culture Tutorial (Daniela Zisterer) - online
Weeks 11-12: JOURNAL CLUB (FJS)
Week 13: IMMUNOLOGY FIELD TRIP (COF/FJS)
Week 14: LAB-BASED MCQ – based on Practical material

Dysregulated Immunity & Disease Journal Club (FJS):

1 hour introductory session (Revision Tutorial), Assignment of papers covering recent advances in immunology & disease – tuberculosis, tumor immunology, RA, sepsis, cardiovascular disease &/or COVID-19
 + 2 hr Presentation session

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.
- Identify how the immune system can cause disease and how it can be exploited therapeutically
- Critically analyse and appraise published work

MODULE BIU33150: BIOCHEMISTRY FOR BIOMEDICAL SCIENCES

LECTURERS: Amir Khan (AK), Ken H Mok (KHM), Vincent Kelly (VK), Andrei Budanov (AAB), Derek Nolan (DN), Emma Creagh (EMC) & Daniela Zisterer (DZ)

LECTURES (Weeks 3-14):**Part A – Proteins & Nucleic Acids**

Lecture 1: Amino acids and peptide bond (AK)

Lecture 2: Structures, motifs and folds (AK)

Lecture 3: Structure and mechanism: serine proteases (AK)

Lecture 4: Spectrophotometry of biomolecules (KHM)

Lecture 5: Protein folding and pathologies (KHM)

Lecture 6: The proteome (KHM)

Lecture 7: DNA, chromatin & the nucleus (VK)

Lecture 8: RNA structure, folds & function (VK)

Part B – Membranes

Lecture 9: An introduction to cellular and model membranes (MC)

Lecture 10: Membrane composition and therapeutic approaches (MC)

Lecture 11: The Synthetic & Assembly Mechanisms for Membrane Proteins that Form Specific Topologies (AB)

Lecture 12: Membrane transport of small molecules, specificity, mechanisms, energy Coupling (AB)

Part C – Cytoskeleton

Lecture 13: Structure of tubulin and microtubules and the Assembly / Disassembly of Microtubular Structures (DN)

Lecture 14: Microtubular motors, types, mechanism of movement, regulation, physiological roles (DN)

Lecture 15: Introduction to actin and the actin cytoskeleton (DN)

Lecture 16: F-actin nucleation & pathologies associated with actin cytoskeleton (DN)

Part D - Signalling

Lecture 17: Introduction to cell signalling & GPCRs (EC)

Lecture 18: G-Protein coupled Receptor (GPCR) regulation (EC)

Lecture 19: Receptor tyrosine kinases (RTKs)-PDGF and EGF (DZ)

Lecture 20: RTK signalling – PKB and PDK1 (DZ).

IN-COURSE ASSESSMENT

2 MCQ's based upon lecture material will be scheduled mid-way through & at the end of the module, dates to be confirmed.

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
- Understand the concept of the proteome and its importance in disease
- Demonstrate an understanding of the biochemical processes of nucleic acids in the cell
- Recall and integrate key knowledge and concepts concerning the role of lipids in membrane structure and function
- Describe the structure of microtubules, their assembly and disassembly and their polarity and the processes of directed vesicle transport and cytoplasmic streaming.
- Explain how actin nucleation is linked to pathological states.
- Describe the general principles of G-protein coupled receptor (GPCR) signalling and its regulation
- Discuss Receptor Tyrosine Kinase (RTK) signalling and details of MAP kinase cascades, using PDGF and EGF as examples.

MODULE BIU33230: GENE REGULATION

LECTURERS:

Vincent Kelly (VK), Andrew Bowie (AB), Daniela Zisterer (DZ), Frederick Sheedy (FJS), David Finlay (DF), Clair Gardiner (CG)

LECTURES (Weeks 22-33):**Part A) The Genome****Nucleic Acid Chemistry (Vincent Kelly)**

Lecture 1: Ribose, acetals, phosphate group, heterocyclic bases, tautomeric forms of purine and pyrimidine, glycoside linkage

Lecture 2: Formation of esters and phosphate (di)esters, anhydrides of phosphoric acid, diphosphate leaving group, Methylation of DNA, cAMP

DNA structure, Andrew Bowie (AB)

Lecture 3: DNA & Gene Structure I Genome sizes require packing of DNA. Nucleotide structure, base pairing. DNA structure: double-strand helix, A, B, Z forms, nucleosomes, chromatin fibre, chromosomes. Histones, nuclear matrix.

Lecture 4: DNA & Gene Structure II: Chromosome Structure Telomerases induce supercoils. Eu- and heterochromatin. Every chromosome needs: telomere, centrosome, origin of replication. Genome complexity.

Lecture 5: DNA & Gene Structure III: Gene structure Gene structure: intron/exon. Regulatory non-coding regions. Gene sizes. Tandem repeats, gene clusters, pseudogenes

Replication, Daniela Zisterer (DZ)

Lecture 6: Replication I: Fundamental rules of DNA replication. Common features of replication conserved in prokaryotes and eukaryotes. DNA polymerases and mechanism of action. Leading and lagging strand synthesis. Enzymes at the replication fork.

Lecture 7: Replication II: Initiation of replication. Model systems. Replication origins, origin recognition, origin-binding proteins. Regulation of replication initiation in eukaryotes. Cell cycle control of replication initiation. Anti-cancer drugs targeting DNA replication

Lecture 8: Replication III: Elongation of replication. Processivity of DNA polymerases. Fidelity of DNA replication (base-pair geometry, proofreading activity of DNA polymerases & mismatch-repair). Termination of replication. Telomeres and telomerases.

Part B) Gene Expression**Transcription, Andrew Bowie (AB)**

Lecture 9: Eukaryotic Transcription I Introduction. Overall themes of transcription. Overview of the transcription process Identification, structure and function of RNA Pol I, II and III. Promoters, enhancers, and methods to identify them.

Lecture 10: Eukaryotic Transcription II Transcription Factors – Different classes of TFs. Methods to identify TFs. General properties of TFs with examples. Response elements. DNA binding motifs. Activation domains.

Lecture 11: 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 12: Eukaryotic Transcription IV Regulation of the basal transcription apparatus by TAFs, Cofactors and Mediator. General mechanisms of altering transcription efficiency. The multiple roles of TFIIH. Elongation. Termination. RNA Pol I and III promoters.

Lecture 13: 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 14: 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.

Translation, Daniela Zisterer (DZ)

Lecture 15: 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 16: Eukaryotic Translation II (DZ) RNA-dependent synthesis of RNA and DNA. Reverse transcriptases and retroviruses. Some retroviruses cause cancer and AIDS. Inhibitors of reverse transcriptases. Self-splicing or catalytic RNA. The genetic code. Wobble hypothesis. The ribosome as a complex supramolecular machine. Amino acid activation. Initiation, elongation and termination of translation. Proof reading on the ribosome. Newly synthesised polypeptide chains undergo folding and processing. Protein synthesis is inhibited by many antibiotics and toxins.

Lecture 17: 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.)

Part C) Molecular Genetics & Technology

Molecular cloning, Frederick Sheedy (FJS)

Lectures 18-20 (FJS): The lectures will give an overview on methods that are frequently used in molecular biology. Molecular Cloning: Why and how to clone a gene. Enzymes used in DNA cloning techniques. Recombinant DNA technology. Cloning and expression vectors. Agarose gel electrophoresis. Southern/Northern blotting. DNA libraries. Polymerase chain reaction (PCR). Transformation of E.coli, selection, identification, and analysis of DNA clones.

DNA Repair Mechanisms, David Finlay (DF)

Lecture 21: 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.

Lecture 22: Double strand break repair. Homologous recombination, NHEJ (Non-homologous End Joining).

Lecture 23: Excision repair and mismatch repair. Nucleotide excision repair, base excision repair, mismatch repair.

Lecture 24: DNA damage response. DNA damage response – signal transduction. ATM and ATR signalling pathways. Downstream effects of DNA damage response.

Lecture 25: DNA damage response and human disease. ATM, BRCA1, BRCA2 – cancer, ataxia-telangiectasia. XP syndrome (UV sensitivity) & cancer. Mismatch repair defects. Premature aging; Cockayne's syndrome, Werner's syndrome. Fanconi's anaemia syndrome.

Immunogenetics, Clair Gardiner (CG)

Lecture 26: 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 27: Genetics of the MHC (CG)

The MHC genomic region contains genes involved in the immune response. MHC genes are polygenic and polymorphic. Class I and class II genes. Haplotypes and inheritance patterns. Generation of diversity. Structure function relationship. Non-classical class I genes.

Lecture 28: 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

PRACTICALS (weeks 29-32)

Practical 1: Molecular biology (Frederick Sheedy)

Practical 2: Gene Expression (Frederick Sheedy)

Further information on practicals is available in practical handbooks

TUTORIALS

Quantitative problem/data analysis: 1 in-course exams, 2 exam questions from the 3 problems, (20 marks).

Practicals: Pre & Post-Practical Assessments, (15 marks),

MCQ: End-of-term Lab-based MCQ, (Week 33 - 15 marks)

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.
- Compose a targeted and specific academic CV clearly demonstrating key skills acquired and experience.

MODULE MIU33012: MICROBIAL PATHOGENESIS

LECTURERS: Sinead Corr (SCC), Kim Roberts (KR)

LECTURES (Weeks 29-33):

Part A – Bacterial pathogenesis (SCC)

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

Part B – Virology (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

LEARNING OUTCOMES

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

- Describe and compare the receptors for bacterial toxins on cells, the internalisation of toxins into cells, the trafficking of toxins inside cells, and their modes of action
- 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
- Give examples of the effects of specific viral infections.

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
3. **Appropriate Response:** Expansion, Amplification, Proliferation, Action, Resolution.
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 $\gamma\delta$ 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 2021/2022 Immunology Class

Small group tutorial groupings

Please contact your small group tutor within the first 2 weeks to set up a tutorial. Students registered as studying abroad are listed in strikethrough.

Prof. Frederick Sheedy (fsheedy@tcd.ie)

Oyindamola Adelegan
Timothy Aigbe
Suzanne Brady

Prof. Andrew Bowie, (agbowie@tcd.ie)

Medivic Bakanababe
Riona Byrne
Samruddhi Dange

Prof. Clair Gardiner (gardinec@tcd.ie)

Jessica Davis
John Dizon
Darren Doherty

Prof. Luke O'Neill (laoneill@tcd.ie)

Leah Fearon
Adam Gordon
Sarah Hayes

Prof. Cliona O'Farrelly, (ofarrecl@tcd.ie)

Niall Moore
Liam Murray
Joanna Saheed

Prof. Ed Lavelle, (lavellee@tcd.ie)

Aisling Newing
Neasa Ni Ogain
Rebecca Rahman

Prof. Rachel McLoughlin, (mcloughrm@tcd.ie)

Rebecca Rahman
Anna Simpson
Hannah Sukumaran

Minireview allocations:

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

Oyindamola Adelegan	<i>"Exploring new ideas beyond beta amyloid in the search for a cure in Alzheimer's disease"</i> Dr. Michael Carty, carty@tcd.ie
Suzanne Brady	"..." Prof. Jean Fletcher, fletchj@tcd.ie
Ríona Byrne	"..." Prof. Clair Gardiner, gardinec@tcd.ie
Samruddhi Dange	"How exercise benefits the immune system" Prof. Luke O'Neill, laoneill@tcd.ie
Jessica Davis	<i>"The role of TIR domain-containing proteins in host defense across diverse organisms"</i> Prof. Andrew Bowie, agbowie@tcd.ie
John Dizon	"...?" Prof. Ed Lavelle, lavellee@tcd.ie
Darren Doherty	<i>"Cellular immunity against Mycobacterium tuberculosis – are we targeting TB vaccines correctly?"</i> Prof. Frederick Sheedy, fsheedy@tcd.ie
Leah Fearon	"..." Prof. Ed Lavelle, lavellee@tcd.ie
Adam Gordon	"..." Prof. Cliona O'Farrelly, ofarrecl@tcd.ie
Sarah Hayes	"..." Prof. Clair Gardiner, gardinec@tcd.ie
Niall Moore	"..." Prof. Rachel McLoughlin, (mcloughrm@tcd.ie)
Liam Murray	"..." Prof. Jean Fletcher, fletchj@tcd.ie
Aisling Newing	"..." Prof. Rachel McLoughlin, (mcloughrm@tcd.ie)
Neasa Ni Ogain	<i>"Dimethylfumarate: blockbuster treatment for Multiple Sclerosis and a predictor for future therapies that target immunometabolism"</i> Prof. Luke O'Neill, laoneill@tcd.ie
Rebecca Rahman	<i>"The role of inflammasomes in the host response to viruses"</i> Prof. Andrew Bowie, agbowie@tcd.ie

Anna Simpson	<i>“Teaching old dogs new tricks – the mechanisms of Innate immune memory”</i> Prof. Frederick Sheedy, fsheedy@tcd.ie
Hannah Sukumaran	<i>“New opportunities for the treatment of a range of human diseases using mRNA.”</i> Dr. Michael Carty, carty@tcd.ie
Timothy Aigbe	n/a
Medivic Bakanababo	n/a
Joanna Saheed	n/a

Journal Club Assignments:

Theme 1: Adipose Tissue Inflammation

A) Obesity is associated with macrophage accumulation in adipose tissue. Weisberg et al, J Clin Invest. 2003 Dec;112(12):1796-808. doi: 10.1172/JCI19246. PMID: 14679176.

Group 1: *Oyindamola Adelegan, Sarah Hayes, Adam Gordon*

B) Obesity induces a phenotypic switch in adipose tissue macrophage polarization. Lumeng CN, Bodzin JL, Saltiel AR. J Clin Invest. 2007 Jan;117(1):175-84. doi: 10.1172/JCI29881. PMID: 17200717.

Group 2: *Timothy Aigbe, Niall Moore, Darren Doherty*

C) Lipid-Associated Macrophages Control Metabolic Homeostasis in a Trem2-Dependent Manner. Jaitin et al, Cell. 2019 Jul 25;178(3):686-698.e14. doi: 10.1016/j.cell.2019.05.054. PMID: 31257031.

Group 3: *Suzanne Brady, Liam Murray, Aisling Newing*

Theme 2: COVID-19 & Cytokines

D) Longitudinal analyses reveal immunological misfiring in severe COVID-19. Lucas et al. Nature. 2020 Aug;584(7821):463-469. doi: 10.1038/s41586-020-2588-y. PMID: 32717743.

Group 4: *Ríona Byrne, Neasa Ni Ogain, Rebecca Rahman*

E) Impaired type I interferon activity and inflammatory responses in severe COVID-19 patients. Hadjadj et al. Science. 2020 Aug 7;369(6504):718-724. doi: 10.1126/science.abc6027. PMID: 32661059.

Group 5: *Samruddhi Dange, Jessica Davis, Anna Simpson*

F) Retrospective Multicenter Cohort Study Shows Early Interferon Therapy Is Associated with Favorable Clinical Responses in COVID-19 Patients. Wang et al, Cell Host Microbe. 2020 Sep 9;28(3):455-464.e2. doi: 10.1016/j.chom.2020.07.005. PMID: 32707096.

Group 6: *John Dizon, Hannah Sukumaran, Leah Fearon,*

Instructions:

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, followed by some questions/discussion.

There will be 2 topics, 3 papers each.

Each paper expands on the themes in the topic as well as using different (more advanced) methods & methodologies to make different or new conclusions. After all 3 in the topic 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 papers 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. Or papers C) & F) within each topic.

http://www.cell.com/pb/assets/raw/shared/figureguidelines/GA_guide.pdf,

Example: <https://www.ncbi.nlm.nih.gov/pubmed/22440612>

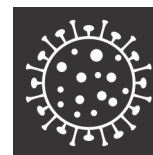
Intro Session: 4 pm, Friday 11th November 2023, Venue tbc

Journal Club: 10am-12midday, Friday 18th November 2021, L5.16

PDFs of articles & a sample Cell publishing group article will be made available on Blackboard.

Like all good journal clubs, baking is encouraged.

Coronavirus COVID-19



Coronavirus
COVID-19
Public Health
Advice

Guidelines for Teaching Practicals & Lectures in the School of Biochemistry & Immunology:

If you have any symptoms of coronavirus (COVID-19), you should self-isolate and contact your GP immediately.

Common symptoms of Coronavirus include:

- ❖ **A fever (high temperature -38 degrees Celsius or above)**
- ❖ **A cough**
- ❖ **Shortness of breath or breathing difficulties**
- ❖ **Loss or change to your sense of taste or smell**

PRACTICALS:

- All necessary information with regard to practicals will be available on Blackboard in advance of the practical – this will include your bench location which must be noted before entry into the lab.
- All students must maintain 1m physical distancing at all times in the lab.
- All students must adhere to the coughing and sneezing etiquette, as per HSE guidelines, when in the lab.
- All students must obey the one way system operating in the Teaching lab.
- We recommend that students leave all their personal belongings in their lockers prior to the practical. The only items that should be brought with you are Howie-style lab coats, safety spectacles, lab manuals, calculator, pen, pencil, eraser and a ruler.
- Each student must adorn the appropriate **PPE (Howie-style lab coats and Safety spectacles)** before entering the lab.
- Disposable 3-ply **facemasks** will be given to students on arrival and these **must be worn** at all times in the lab.
- A number of hand-sanitising stations have been set up in the lab – it is imperative that all students sanitise their hands upon entry and exit of the lab.
- Each student must do the practical on their OWN. Students working in pairs is not permitted.
- A Safety talk will be given prior to the commencement of practicals – this will include all aspects of Safety in the lab but will also include some of the Covid-19 Practical Teaching plan.
- Each student will be assigned a demonstrator
- A roll-call will be taken at the start of each practical.
- All reagents and equipment required for the practical will be set out at each student's workstation area.
- Each student must remain at their workstation areas at all times throughout the practical.
- All students must wash and sanitise your hands before leaving the lab.
- Please exit the lab adhering to the one way system operating in the Teaching lab.

LECTURES:

- For face-to-face Lectures in suitable venues, students **MUST** wear a face-mask & sanitize hands on the way into the lecture theatre and maintain social distance when seated in the lecture theatre.
- Lectures will be 45 min initially, until public health guidance & College policy deems otherwise.
- No food or beverages should be consumed within lecture theatres.