WELCOME TO JUNIOR SOPHISTER IMMUNOLOGY

Congratulations on choosing an exciting and dynamic subject area for your degree. In the last 15 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 (BI3220) and apply this to its most recognized function – fighting infection (BI3240). To support this, you will also go more in depth on the fundamental processes in biochemistry and cellular signalling (BI3210) and molecular biology and genetics (BI3240).

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 Analytical Skills module (BI3215), 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 (BI3020), 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.

This booklet will outline the content of each module for the Immunology course 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 provides the official college timetable. However, we find that a Google calendar works best locally, as we can edit in real time. You will all be provided with access to this calendar and I urge you to double-check this throughout the year. Notice will be
provided of any major changes, re-scheduled/cancelled lectures or classes, via e-mail and through the class representative.

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
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](https://www.tcd.ie/undergraduate-studies/general-regulations/ects.php)
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 in the summer (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 throughout the year (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 bioanalysis module covering basic biochemical and immunological laboratory skills (practical sessions) and data handling lectures. This module will be entirely in-course assessed. 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. Total mark for this component = 50 marks.

In summary; there will be four exam papers in the summer; papers 1 to 4 (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.

The Junior Sophister Immunology course content, module-by-module with associated mark weightings and methods of assessment are outlined in the next 2 pages:
### Semester 1:

<table>
<thead>
<tr>
<th>Code</th>
<th>Topic</th>
<th>Lecturer</th>
<th>Assessment</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>BI3111</td>
<td>Alpha, beta, tertiary domain interactions</td>
<td>Amir Khan</td>
<td>Paper 1</td>
<td>20 marks</td>
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<tr>
<td>BI3112</td>
<td>Active site architecture</td>
<td>Amir Khan</td>
<td>Paper 1</td>
<td>20 marks</td>
</tr>
<tr>
<td>BI3114</td>
<td>Post-translation modifications</td>
<td>David Finlay</td>
<td>Paper 1</td>
<td>20 marks</td>
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<tr>
<td>BI3021</td>
<td>Proteins of the immune system</td>
<td>Jerrard Hayes</td>
<td>Paper 1</td>
<td>20 marks</td>
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<tr>
<td>BI3028</td>
<td>Cellular signalling</td>
<td>Aisling Dunne &amp; Emma Creagh</td>
<td>Paper 1</td>
<td>20 marks</td>
</tr>
<tr>
<td>BI3129</td>
<td>Membrane proteins and the cytoskeleton</td>
<td>Paul Voorheis &amp; Derek Nolan</td>
<td>Paper 1</td>
<td>20 marks</td>
</tr>
<tr>
<td></td>
<td>General module material (inc. Practicals)</td>
<td>Various</td>
<td>Paper 1</td>
<td>10 marks</td>
</tr>
<tr>
<td>Practical 1</td>
<td>Enzyme Kinetics</td>
<td>James Murray</td>
<td>Write-up</td>
<td>3 marks</td>
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<tr>
<td>Practical 2</td>
<td>cAMP assay</td>
<td>Daniela Zisterer</td>
<td>Write-up</td>
<td>4 marks</td>
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<tr>
<td>Practical 3</td>
<td>Binding assay</td>
<td>Daniela Zisterer</td>
<td>Write-up</td>
<td>3 marks</td>
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<tr>
<td>Lab MCQ</td>
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<td>In-class MCQ</td>
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### Module BI3220

#### Core Concepts in Immunology

<table>
<thead>
<tr>
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<th>Marks</th>
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<tr>
<td>BI3022</td>
<td>Immunology I</td>
<td>Various</td>
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<tr>
<td>BI3023</td>
<td>Immunology II</td>
<td>Various</td>
<td>Paper 4</td>
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<tr>
<td>Practical 1</td>
<td>Phagocytosis</td>
<td>Rachel McLoughlin</td>
<td>Write-up</td>
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<tr>
<td>Practical 2</td>
<td>Dendritic cells</td>
<td>Ed Lavelle</td>
<td>Write-up</td>
<td>2.5 marks</td>
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<tr>
<td>Lab MCQ</td>
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### Module BI3215

#### Bioanalysis I

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<tbody>
<tr>
<td>Lectures</td>
<td>Data Handling</td>
<td>Andrew McDonald</td>
<td>Data Handling Exercise</td>
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<tr>
<td>Computer Lab</td>
<td>Kinetics &amp; Prism Analysis</td>
<td>James Murray</td>
<td>In-class MCQ</td>
<td>15 marks</td>
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<tr>
<td>Pre-Practical</td>
<td>Solutions &amp; Dilutions</td>
<td>Glynis Robinson</td>
<td>In-class test</td>
<td>1 mark</td>
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<tr>
<td>Practics</td>
<td>Lab Skills Experiments 1-4</td>
<td>Glynis Robinson</td>
<td>Write-up</td>
<td>3 marks</td>
</tr>
<tr>
<td>Lab Exam</td>
<td>Practical Examination</td>
<td>Glynis Robinson</td>
<td>In-class Write-up</td>
<td>4 marks</td>
</tr>
<tr>
<td>All Practicals</td>
<td>Lab Book Notes &amp; Record Keeping</td>
<td>Fred Sheedy</td>
<td>Lab Book Inspection</td>
<td>2 marks</td>
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<tr>
<td>Lab MCQ</td>
<td>Material from practical classes</td>
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<td>In-class MCQ</td>
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## Semester 2:

<table>
<thead>
<tr>
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<th>Assessment</th>
<th>Marks</th>
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<tbody>
<tr>
<td>BI3136</td>
<td>Genetic Techniques</td>
<td>Glynis Robinson</td>
<td>Paper 3</td>
<td>1 of 2 Questions</td>
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<tr>
<td>BI3132</td>
<td>DNA structure</td>
<td>Andrew Bowie</td>
<td>Paper 3</td>
<td>1 of 2 Questions</td>
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<tr>
<td>BI3133</td>
<td>Replication</td>
<td>Daniela Zisterer</td>
<td>Paper 3</td>
<td>1 of 2 Questions</td>
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<td>BI3034</td>
<td>Transcription</td>
<td>Andrew Bowie</td>
<td>Paper 3</td>
<td>1 of 2 Questions</td>
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<td>BI3035</td>
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<td>Paper 3</td>
<td>1 of 2 Questions</td>
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<td>BI3139</td>
<td>DNA Repair mechanisms</td>
<td>David Finlay</td>
<td>Paper 3</td>
<td>1 of 2 Questions</td>
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<tr>
<td>BI3411</td>
<td>Immunogenetics and genomics</td>
<td>Cliona O’Farrelly &amp; Kieran Meade</td>
<td>Paper 3</td>
<td>1 of 2 Questions</td>
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### General module material (inc. Practicals)

<table>
<thead>
<tr>
<th>Lecturer</th>
<th>Assessment</th>
<th>Marks</th>
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<tbody>
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<td>Short Questions</td>
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<thead>
<tr>
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<th>Molecular biology</th>
<th>Glynis Robinson</th>
<th>Write-up</th>
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<td>Practical 2</td>
<td>Recombinant Ras expression</td>
<td>Amir Khan</td>
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| Lab MCQ | Material from practical classes | Various | In-class MCQ | 20 marks |

## Semester 1 & 2:

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<th>Assessment</th>
<th>Marks</th>
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<tr>
<td>BI3008</td>
<td>Immunology III</td>
<td>Kingston Mills &amp; Rachel McLoughlin</td>
<td>Paper 2</td>
<td>1 of 2 Questions</td>
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<tr>
<td>MI3011</td>
<td>Bacterial pathogenicity</td>
<td>Sinead Corr</td>
<td>Paper 2</td>
<td>1 of 2 Questions</td>
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<tr>
<td>MI3051</td>
<td>Virology I</td>
<td>Kim Roberts</td>
<td>Paper 2</td>
<td>1 of 2 Questions</td>
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### General module material (inc. Practicals)

<table>
<thead>
<tr>
<th>Lecturer</th>
<th>Assessment</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Various</td>
<td>Paper 3</td>
<td>Short Questions</td>
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<table>
<thead>
<tr>
<th>Practical 1</th>
<th>Cytokines</th>
<th>Andrew Bowie</th>
<th>Write-up</th>
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<tr>
<td>Practical 2</td>
<td>Lymphocytes</td>
<td>Clair Gardiner</td>
<td>Pre-practical MCQ</td>
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<td>Write-up</td>
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| Lab MCQ | Material from practical classes | Various | In-class MCQ | 20 marks |

## Research Skills 10 ECTS (100 marks)

<table>
<thead>
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<th>Code</th>
<th>Topic</th>
<th>Lecturer</th>
<th>Assessment</th>
<th>Marks</th>
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<td>Fred Sheedy</td>
<td>In-class presentation</td>
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<tr>
<th>Quantitative Problem 1</th>
<th>Rachel McLoughlin</th>
<th>In-class exam</th>
<th>1 of 2 problems</th>
<th>20 marks</th>
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<tbody>
<tr>
<td>Quantitative Problem 2</td>
<td>Gavin Davey</td>
<td>In-class exam</td>
<td>1 of 2 problems</td>
<td>20 marks</td>
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<tr>
<td>Quantitative Problem 3</td>
<td>Fred Sheedy</td>
<td>In-class exam</td>
<td>1 of 2 problems</td>
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<tr>
<td>Quantitative Problem 4</td>
<td>Jean Fletcher</td>
<td>In-class exam</td>
<td>1 of 2 problems</td>
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MODULE DESCRIPTIONS & COURSE CONTENT:

MODULE BI3210: BIOCHEMISTRY

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

BI3112 - Active site architecture, Amir Khan
Lecture 8 (AK): Proteins, proteomics and post-translational modifications
Lecture 9 (AK): Active site architecture, examples of cofactors and catalysis

BI3114 – Post-translation modifications, David Finlay (DF)
Lecture 1 (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 2 (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: The three-dimensional, atomic-level structure of IgG molecules and the techniques used for characterization; The immunoglobulin fold; High-resolution analytical techniques used to detect heterogeneity.
Lecture 2: Stability, folding, and aggregation of IgG molecules. Primary systemic amyloidosis
Lecture 3: The development of MAb-based biopharmaceuticals; The ‘humanisation’ of MAbs and MAb protein engineering.
Lecture 4: Post-translational modification and methodologies for analyses/separation; Variation in glycosylation and function.
Lecture 5: 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 (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 2 (AD): RTKs and PI3K. PKB (Akt) and PDK1 signalling. Pleckstrin homology domains. Insulin signalling and IRS1/2 activation. Overview of JAK/STAT signalling
Lecture 3 (EC): GPCR signalling: evidence for extracellular localisation of receptor, discovery of G-proteins linked to cyclase, metabolic and transcriptional effects of cAMP.
Lecture 4 (EC): GPCR-linked signal-activated phospholipases, PLC as a paradigm with brief coverage of PLD and PLA2.
BI3129 - MEMBRANE PROTEINS AND THE CYTOSKELETON, Paul Voorheis (HPV) and Derek Nolan (DN)


Lecture 2 (HPV): Diffusion of membrane proteins, patch & cap formation, ligand valency, role of cytoskeleton, protein composition of lipid rafts, lymphocyte activation, Ca^{2+} requirement & spikes, commitment period, c-myc & c-fos, inositolphosphate signalling system, protein kinase C, diglyceride and phorbol ester. Endosome structure & function, P-, V- & 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, stripped vesicle 110kD polypeptide, self-assembly of pentagons & hexagons, receptor-mediated endocytosis, prelocalized & randomly disposed receptors.


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 & Kirchner population versus individual microtubule behavior experiments, role of calmodulin & Ca^{2+}, cold stable microtubules.

Lecture 7 (HPV): Force generating microtubular motors: Kinesin structure / function, classes of kinesins, anterograde & retrograde cytoplasmatic streaming, cytoplasmatic 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 NicBhaird
Practical 2: cAMP Assay (Daniela Zisterer)
Practical 3: Binding Assay (Daniela Zisterer)

Further information on practicals is available in practical handbooks
MODULE BI3220: CORE CONCEPTS IN IMMUNOLOGY

BI3022 - IMMUNOLOGY I
Luke O’Neill (LON), Cliona O’Farrelly (COF), Andrew Bowie (AB), Rachel McLoughlin (RMcL), Frederick Sheedy (FJS), Clair Gardiner (CG), Jean Fletcher (JF).

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

Lecture 4: 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

Lectures 5-6: 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 7: 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 8: Macrophage Diversity (FJS)
Macrophage development, macrophage diversity, recruitment of monocytes, tissue resident macrophages, homeostatic functions of macrophages

Lecture 9: Cytotoxic cells: Natural Killer Cells and CTL (CG)
Anti-viral and anti-tumour roles; cytotoxicity, surface molecules, structure and function, cytokine

Lecture 10-11: 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 12: 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 13-14: 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 15: 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 16-17: Antibody structure and function (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 18-19: Lymphocyte Maturation and 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.

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)

Lecture 20: 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 21: Genetics of the MHC (CG)

Lecture 22: 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 23: 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 24-25: Immunological Tolerance, Autoimmunity and models of autoimmune disease (JF)

Lectures 26-27: 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 28-29: 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 30-31: Immunoregulation & Immunotherapies (COF)**
Suppressors of cytokine signaling, steroids; lipoxins, immunoregulatory cytokines; regulatory apoptosis; T regulatory cells.

**Practical 1:** Phagocytosis (Rachel McLoughlin)
**Practical 2:** Dendritic Cells (Ed Lavelle)
**Practical 3/Tutorials:** Cell culture (Daniela Zisterer)

*Further information on practicals is available in practical handbooks*
MODULE BI3230: GENE REGULATION

THE GENOME

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

BI3132 - DNA structure, Andrew Bowie (AB)

BI3133 – Replication, Daniela Zisterer (DZ)

GENE EXPRESSION

BI3134 – Transcription, Andrew Bowie (AB)
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 2:** 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 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.

**Lecture 2:** Double strand break repair. Homologous recombination, NHEJ (Non-homologous End Joining).

**Lecture 3:** Excision repair and mismatch repair. Nucleotide excision repair, base excision repair, mismatch repair.

**Lecture 4:** DNA damage response. DNA damage response – signal transduction. ATM and ATR signalling pathways. Downstream effects of DNA damage response.


BI3411 - Immunogenomics/Immunogenetics, Cliona O'Farrelly (COF), Frederick Sheedy & Kieran Meade (KMe)

**Lecture 1-2:** Evolution of immune genes (COF)
Evolution of immune genes and gene families; β-defensins and TLRs as examples

**Lecture 3:** Genetic Variation in immune genes (FJS)
Contribution of variations in immune genes to disease; SNPs; GWAS analysis, & Personalized medicine in infectious disease

**Lecture 4-6:** Epigenetic modulation of immune genes (KMe)

**Practical 1:** Molecular biology (Glynis Robinson)

**Practical 2:** Recombinant Ras expression (Amir Khan)

*Further information on practicals is available in practical handbooks*
MODULE BI3240: MICROBIOLOGY & IMMUNOLOGY

BI3008 - Immunology III, Kingston Mills (KM) & Rachel McLoughlin (RMcL)

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)

Lecture 3-4. Adaptive immune response to infections (KM)
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.

Lecture 5. 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.

Lectures 6. Bacterial evasion of adaptive immunity (KM)
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 (KM)
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.

9-10: Vaccines (KM)
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 11: Parasites (KM)
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 12. Pathogen regulation of allergy and autoimmunity (KM)
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 13-14. 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.
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*
MODULE BI3125: BIOANALYSIS I

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 session 1 (JM): Tutorial on the use of Prizm software to present and analyze biochemical data (50 min).

Computer session 2 (JM): Practical class on analyzing data from a typical biochemical experiment (involves standard curve generation and plus analysis and comparison of treatment groups) (90 min).

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).

In-class MCQ: based on material covered in lectures.

Practical 1: Solutions & Dilutions (Glynis Robinson)
Practical Exam: Students will be required to independently carry out biochemical analysis based on material covered in all practicals from all modules and write-up and in-class assessment/report which will be graded. Marks will also be available for competency and work ethic during the exam.

Further information on practicals is available in practical handbooks.
MODULE BI3020: RESEARCH SKILLS

This purpose of this module is to develop research, critical analysis and communication skills that are essential for a graduate biochemist. 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 at the beginning of 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 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. Problems 1 and 2 will be examined by in-course exam in Week 10, Problems 3 and 4 will be examined by in-course exam in weeks 12. VERY IMPORTANT: You will be notified of the times and locations of these exams 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 that there is a Problems Paper in the Senior Sophister year (that these JS problems may appear on).

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: Two in-course exams (40 marks in total).

BROAD CURRICULUM (BC)

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

Please consult the Broad Curriculum website [https://www.tcd.ie/Broad_Curriculum/] for information on the various options available.
All other Modules will run during the day and potentially may clash with you timetable. It would be important to check this prior to selection of your BC option. The workload of Broad Curriculum courses can vary, so it is wise to obtain information on the workload before you make your choice of course.
Student are advised to select and double-check their BC modules as soon as possible.
Rules Regarding Attendance & Satisfactory Completion Of Course Work & Progression

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.
Students must sit all of the annual examination papers.

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.

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 or co-ordinator in the Michaelmas semester where your lab book will be examined and discussed.

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 secretary’s 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 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 Current Opinion in Cell Biology or Current Opinion 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 by 4 pm on the first Friday of 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 Michaelmas 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’.

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.

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.

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.

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.

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%).
Useful Information for 2017/2018 Immunology Class

Contacts:
Junior Sophister Course Coordinators
Immunology: Dr Frederick Sheedy, 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 Glynis Robinson, Room 3.25 (enter via Practical Teaching Lab, 3.22) robinsog@tcd.ie

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

Director of Teaching and Learning:
Dr Derek Nolan, Room 5.06 and e-mail: denolan@tcd.ie

School Office: Ms Sara Geoghegan, sageoghe@tcd.ie

Locations/Venues Guideline:
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
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
TCJ1 = will refer to locations in St. James (for Mol. Meds)
TERCENTENARY = L2.15 = Tercentenary Hall, Level 2, TBSI
QUEK = B1.15 = Stanley Quek Lecture Theatre, level -1, TBSI
Common Science Verbs Explained:

**Analyse:** Interpret data to reach stated conclusions.

**Annotate:** Add brief notes to a diagram, drawing or graph.

**Apply:** Use an idea, equation, principle, theory or law in a new situation.

**Calculate:** Find an answer using mathematical methods. Show the working unless instructed not to do so.

**Compare:** Give an account of similarities and differences between two or more items, items referring to both (or all) of them throughout. Comparisons can be given using a table.

**Construct:** Represent or develop in graphical form.

**Contrast:** Show differences. See in opposition.

**Deduce:** Reach a conclusion from information given.

**Define:** Give the precise meaning of a word or phrase as concisely as possible.

**Derive:** Manipulate a mathematical equation to give a new equation or result.

**Describe:** Give an account, including all the relevant information.

**Design:** Produce a plan, object, simulation or model.

**Determine:** Find the only possible answer.

**Discuss:** Give an account including where possible a range of arguments, assessments of the relative importance of various factors or comparison of alternative hypotheses.

**Distinguish:** Give the difference(s) between two or more different items.

**Draw:** Represent by means of pencil lines. Add labels unless told not to do so.

**Estimate:** Find an approximate value for an unknown quantity, based on the information provided and application of scientific knowledge.

**Evaluate:** Assess the implications and limitations.

**Explain:** Give a clear account including causes, reasons, or mechanisms.

**Identify:** Find an answer from a number of possibilities.

**Illustrate:** Give concrete examples. Explain clearly by using comparisons or examples.

**Interpret:** Comment upon, give examples, describe relationships. Describe then evaluate.

**List:** Give a sequence of names or other brief answers with no elaboration. Each one should be clearly distinguishable from the others.

**Measure:** Find a value for a quantity.

**Outline:** Give a brief account or summary. Include essential information only.

**Predict:** Give an expected result.

**Solve:** Obtain an answer using algebraic and/or numerical methods.

**State:** Give a specific name, value, or other answer. No supporting argument or calculation is necessary.

**Suggest:** Propose a hypothesis or other possible explanation.

**Summarise:** Give a brief, condensed account. Include conclusions and avoid unnecessary details.