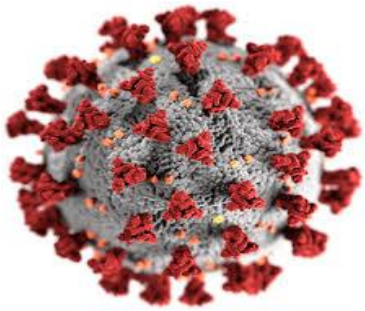
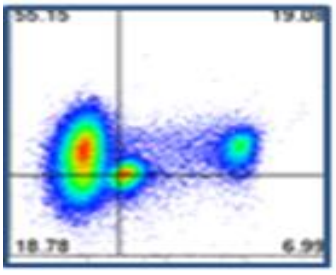
TRINITY COLLEGE DUBLIN

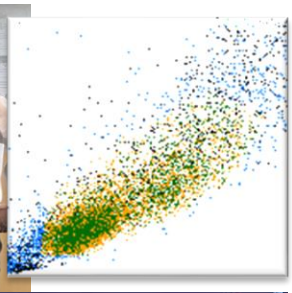
M.Sc. in Immunology

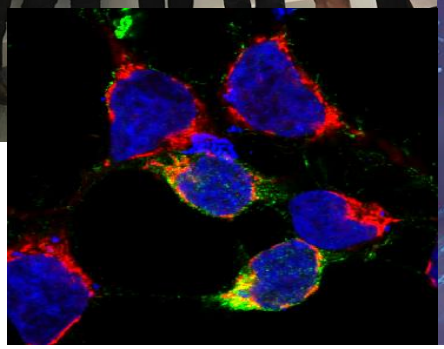
2022 | 2023

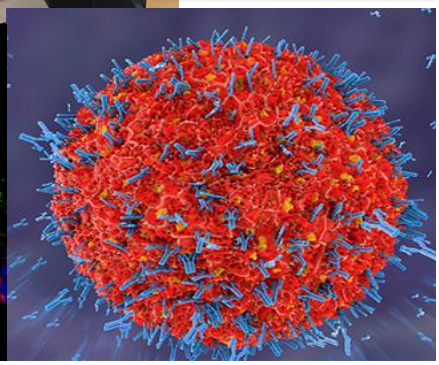
Course Handbook
(PTBI-MIMM-1F)











SCHOOL OF BIOCHEMISTRY AND IMMUNOLOGY

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Foreword

Welcome to Trinity College Dublin! A busy year lies ahead, which we hope will be engaging and rewarding for you all. With the help of our colleagues and friends across campus and from other institutes, in Ireland and abroad, we have been working hard to put together a comprehensive Immunology program, which is designed to stimulate, entertain and inform.

Contributors to this masters program are international leaders in their field, who have made a significant contribution to our understanding of immune function. In the face of COVID-19, we were reminded of the role the immune system plays in defending us from the constant threat of invading viruses and other microbes. Indeed, COVID-19 raises so many fascinating immunological questions and challenges. There has never been a greater need for more scientists who are experts in immunology, so from that perspective you are joining us at a great time! We hope that you will graduate from this course with a deep understanding and love for immunology and immunological research. This MSc in Immunology is internationally renowned and will open doors to exciting new career prospects. Our graduates have taken up PhD positions, studied medicine, secured employment as science communicators, medical laboratory scientists and various roles in the pharmaceutical industry. Upon graduation you will be our ambassadors at leading universities, hospitals, and pharmaceutical companies across the globe. Enjoy the journey, work hard, and make great discoveries!

Cliona O'Farrelly, Ph.D.
Professor of Comparative Immunology,
Co-Director, M.Sc. Immunology Course

Michael Carty, Ph.D.
Assistant Professor of Immunology
Co-Director, M.Sc. Immunology Course

Module Co-Ordinators and Academic Staff

Cliona O'Farrelly, (Co-director) is Professor of Comparative Immunology at Trinity College Dublin (TCD) since 2007, has been researching human gut, liver and reproductive immune systems, with a particular focus on cancer and viral immunology, for over three decades. Having graduated with a BA Mod in Microbiology and a PhD in Immunology from Trinity College Dublin, Cliona post-doced at TCD and Sussex University before becoming Lecturer of Biology at Harvard University. She was then Director of the Research Laboratories at St.Vincent's University Hospital from 1993-2007. Cliona has published more than 200 papers, reviews and book chapters, has raised almost 15 million Euro in grant funding and has graduated 40 PhD students, 8 MD and 5 MCh students. She designed, developed and co-directs the successful MSc in Immunology at TCD. A recipient of the Irish Research Scientists' Association Gold Medal, the Graves Medal, the Conway Medal, the Isla Haliday Award and the 2014 Nature Mentoring Award, Cliona was President of the Irish Society of Immunology from 2000-2007 and served on the Board of the Irish Cancer Society from 2008-2013. She has also served on the Boards of Trinity College Dublin, the Science Gallery at TCD and the Royal Dublin Society, and currently serves on the Board of Amnesty International Irish Section and the editorial board of Philosophical Transactions B of the Royal Society London. She was recently elected the first female Chair of Fellows of TCD. She is passionate about public understanding of science, has co-curated several events at the Science Gallery, was academic lead in 2014 and 2015 for TCD's Discover Research Dublin, and was co-organiser of 'Schrodinger at 75' held in the NCH in 2018 and attended by 1000 people. She regularly chairs and contributes to public engagement in science events. Email: ofarrecl@tcd.ie

Michael Carty (Co-Director) is Assistant Professor in the School of Biochemistry and Immunology at TCD. In 2000 he graduated from Queens University Belfast (QUB) with an Honours Degree in Biomedical Science. Under the supervision of Prof. Paul Harkin at QUB, he completed his PhD studies in cancer focusing on the breast cancer susceptibility gene BRCA1. In 2004 he joined the laboratory of Prof. Andrew Bowie in the School of Biochemistry and Immunology as a postdoctoral scientist. In 2008 he was awarded a postdoctoral fellowship from the Health Research Board into the role of the protein SARM in the immune system. His research papers and review articles have been published in the journals *Nature Immunology, Trends in Immunology* and *Immunity.* Email: cartymi@tcd.ie

David Finlay is Associate Professor in Immunometabolism in the Schools of Biochemistry and Immunology, and Pharmacy and Pharmaceutical Science at Trinity College Dublin. He was awarded a B.A. (Mod) in Biochemistry in 2001. He completed his PhD (2006) and postdoctoral training at the University of Dundee in Scotland and was elected to fellowship of Trinity College Dublin in 2018. He has been a principal investigator in the Trinity Biomedical Sciences Institute since 2011. His research expertise lies at the interface of immunology and cellular metabolism with a focus on Natural Killer cells and Dendritic cells. His team is

revealing novel strategies to modulate immune cell function through targeting metabolism and metabolic signalling pathways. Dr Finlay's research has been supported by awards including a Science Foundation Ireland Career Development Award in 2014 and a European Research Council Consolidator Award in 2017. Email: finlayd@tcd.ie

Andrew Bowie is Professor of Innate Immunology in the School of Biochemistry and Immunology TCD. He obtained his PhD in Biochemistry from TCD in 1997, was elected a Fellow of TCD in 2008, and a member of the Royal Irish Academy in 2014. His research expertise is in the area of innate immunity, and work in his laboratory has shed light on how the innate immune system detects pathogens, how pathogens evade and subvert such detection, and also how innate immunity contributes to harmful inflammation. Email: AGBOWIE@tcd.ie

Rachel McLoughlin is a Professor in Immunology within the School of Biochemistry and Immunology. Rachel completed her Ph.D. at the Institute of Nephrology at Cardiff University, UK and following post-doctoral positions at Cardiff University and Brigham and Women's Hospital, Boston, Rachel obtained an Assistant Professor position at Harvard Medical School where she established her research program investigating the host immune response to infection. In 2010 Rachel moved to the School for Biochemistry and Immunology at TCD, where she established the Host Pathogen Interaction research group. Rachel's research centres on understanding the interaction of bacteria and the molecules they express, with the host's immune system and is primarily focused on understanding the immune response elicited by the gram-positive bacterium Staphylococcus aureus, in the context of infection, and through exposure to this organism as a commensal. Email: mclougrm@tcd.ie

Derek Nolan is an associate Prof in biochemistry and the current head of the school of Biochemistry and Immunology. Dr. Nolan's research interests in African trypanosomes began as a postgraduate student in Paul Voorheis' laboratory at the Dept. Biochemistry, TCD and continued at postdoctoral level when, following the award of a long term fellowship from EMBO, Derek moved to Prof. Etienne Pays' group at the Universite Libre De Bruxelles (ULB) to investigate surface proteins in trypanosomes (1992). Subsequently, through Marie Curie and PIA Belgium fellowship awards he continued to work on the cell biology and biochemistry of trypanosomes at the ULB in Brussels. Following the award of a Wellcome Trust Senior Fellowship in basic biomedical sciences, Derek returned to Trinity to establish an independent research group for research on these remarkable parasites. The research conducted in Dr Nolan's group is broad in scope but a linking theme is to try and understand how these extracellular parasites survive and thrive in their mammalian hosts in order to develop new, improved therapies against African trypanosomes. In addition, trypanosomes are of great intrinsic scientific interest in their own right. The product of hundreds of millions of years of evolution, trypanosomes do not always follow the usual rules in their basic biochemistry, cell

biology and genetics. Conversely, other processes first described and characterized in trypanosomes are now known to be important in many eukaryotes cells. This combination of medical and economic importance allied to a fundamental novelty makes these unicellular eukaryotes a worthwhile, fascinating and productive area of study. Email: denolan@tcd.ie

Derek Doherty completed his Ph.D. studies at King's College School of Medicine and Dentistry, London and postdoctoral research in the University of Washington, Seattle and University College Dublin before holding lecturing positions at Maynooth University and subsequently TCD. Derek is interested in the mechanisms by which cells of the innate immune system control adaptive immune responses and how they can be exploited for the design of improved vaccines and therapies. His group is currently investigating how human natural killer cells, natural killer T cells, γδ T cells and mucosa-associated invariant T (MAIT) cells influence the functions of dendritic cells, B cells and conventional T cells; how they contribute to immunity against viral, bacterial and parasitic pathogens; and how they are defective in patients with autoimmune disease, obesity and cancer. Email: dohertde@tcd.ie

Eleanor Wallace is Chief Medical Scientist in the Department Immunology in St. Vincent's University Hospital, and Lecturer in Immunology in the Department of Clinical Immunology in St James's Hospital & Trinity College Dublin. She graduated from Dublin University, Trinity College in 1988 with a B.A. Mod (Biochemistry). In 1994 she was awarded a Ph.D in Immunology (TCD) for her research in C1-Inhibitor proteinase interactions and implications for inflammatory processes. Eleanor has held senior scientist posts in the Departments of Immunology in Beaumont Hospital and St. James's Hospital, Dublin and has significant experience in the area of clinical immunology. Together with Drs Mary Keogan and Paula O'Leary, Eleanor has published the course text book on clinical immunology, Concise Clinical Immunology for Healthcare Professionals (Routledge, London). Dr. Wallace's research interests include investigation of the molecular mechanisms causing common variable immunodeficiency (CVID); investigation of the significance of mannan binding lectin (MBL) deficiency in acquired immunodeficiency states; investigation of clinically useful markers of the severe complication allergic bronchopulmonary aspergillosis (ABPA) in patients with CF; evaluation of a range of markers of disease severity in patients with SLE.
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Dr. Joanne Lysaght is an Associate Professor at Trinity College Dublin and leads the Cancer Immunology and Immunotherapy Group in the Trinity Translational Medicine Institute at St. James's Hospital. She is also course coordinator for the M.Sc. in Translational Oncology.
Her research group focuses on the impact of obesity on immune responses in gastrointestinal cancer patients, with a particular focus on T lymphocytes. Joanne examines the impact of obesity on hepatic inflammation and post-operative recovery and elucidating the role of

adaptive immunity in the progression of pre-malignant conditions to cancer. In addition, a large component of her research is focused on identifying and developing new immunotherapeutic strategies and targets for gastrointestinal cancers, through targeting chemokine pathways and cellular metabolism, identifying the impact of standard therapies such as chemotherapy and radiotherapy on immune cells and the best combination approaches with immunotherapy. This work mainly focuses on immune checkpoint inhibitors and developing approaches to circumvent immune evasion in order to boost response rates to immunotherapy. In addition, her group are also investigating the role of inflammation in conditions such as cancer cachexia and the use of inflammatory markers such as CRP as a diagnostic tool. Email: JLYSAGHT@tcd.ie

Luke O'Neill is Professor of Biochemistry in the School of Biochemistry and Immunology, Trinity Biomedical Sciences Institute at Trinity College Dublin, Ireland. He is a world expert on innate immunity and inflammation. His main research interests include Toll-like receptors, Inflammasomes and Immunometabolism. He has published over 200 papers and reviews on his research, in journals such as Nature, Science, Cell, Nature Immunology, Nature Medicine, Nature Genetics and PNAS. He is listed by Thompson Reuters/ Clarivates in the top 1% of immunologists in the world, based on citations per paper. Professor O'Neill is co-founder of Inflazome and Sitryx, which aim to develop new medicines for inflammatory diseases.
He was awarded the Royal Dublin Society / Irish Times Boyle Medal for scientific excellence, the Royal Irish Academy Gold Medal for Life Sciences, The Society for Leukocyte Biology (SLB) Dolph O. Adams award, the European Federation of Immunology Societies Medal and in 2018 the Milstein Award of the International Cytokine and Interferon Society. He is a member of the Royal Irish Academy, EMBO (European Molecular Biology Organisation) and a Fellow of the Royal Society. LAONEILL@tcd.ie

Kingston Mills is Professor of Experimental Immunology, School of Biochemistry and Immunology, TCD. He is Academic Director of Trinity Biomedical Sciences Institute and Leader of The Immunology, Inflammation and Infection Research theme at TCD. He is a graduate of Trinity College and trained as a Postdoctoral Fellow at University College London and the National Institute for Medical Research, Mill Hill, London, before joining the Scientific Staff of the National Institute for Biological Standards and Control in Herts, UK. He returned to Ireland in 1993 to take up an academic position at Maynooth University. He was appointed to a Personal Chair at TCD in 2001 and was Head of the School of Biochemistry and Immunology from 2008-2011. He heads an active research team focusing on immunity to infection and dysregulated immunity in autoimmune diseases. He co-founded Opsona Therapeutics and TriMod Therapeutics, drug development companies focusing on the development of immunotherapeutics for inflammatory diseases and cancer. Email: kingston.mills@tcd.ie

Course Objectives

On successful completion of the M.Sc. in Immunology students should be able to:

1. Demonstrate in-depth knowledge of the cellular and molecular basis of innate and adaptive immunity
2. Describe the key cells, organs and molecules of the innate and adaptive immune systems and how they function.
3. Describe the biological basis of major immunologically mediated diseases
4. Discuss evolutionary and genetic influences on the immune system
5. Discuss innate and adaptive immunological defence in viral, bacterial and parasitic infections.
6. Discuss the role of the tumour microenvironment and the immune system in the development of cancer and in cancer therapeutics.
7. Demonstrate practical laboratory skills and expertise in selected methodologies used to study the immune system.
8. Identify the scientific and clinical challenges pertinent to the treatment and management of immunological diseases.
9. Discuss the principles of immunotherapy discovery from target identification, to validation and commercialisation.
10. Critically appraise research protocols and manuscripts, statistically evaluate data and write research reports.
11. Demonstrate knowledge of key techniques used to answer research questions in Immunology.
12. Describe how immunological research approaches might direct a research project or research-related career.
13. Assess research hypothesis, design experimental studies and conduct quality scientific research in an ethical manner and communicate research findings in an appropriate scholarly manner to specialist and non-specialist audiences.
14. Interpret experimental findings and evaluate in relation to study hypothesis and existing research.
15. Critically analyse research findings in terms of experimental design and outcomes.
16. Analyse and present data
17. Write clear and accurate scientific essays and reports

Course Structure

Module Title	Module Coordinator	ECTS Weight	Term
Basic Immunology (IM7101)	Prof. Cliona O'Farrelly & Dr. Michael Carty	10	**Michaelmas**
Immunological Technologies (IM7102)	Prof. Rachel McLoughlin	10	**Michaelmas**
Communicating Science & Critical Analysis (IM7103)	Dr. Michael Carty	5	**Michaelmas & Hilary**
Tumour Immunology (IM7109)	Prof. Cliona O'Farrelly & Dr. Michael Carty	5	**Michaelmas**
Data science & Immunogenetics (IM7105)	Prof. Cliona O'Farrelly & Dr. Michael Carty	5	**Michaelmas**
Microbe Detection & Evasion (IM7106)	Prof. Andrew Bowie & Dr. Michael Carty	5	**Hilary**
Clinical Immunology (IM7107)	Prof. Eleanor Wallace & Dr. Michael Carty	5	**Hilary**
Global Infectious Diseases (IM7110)	Prof. Derek Doherty & Prof. Derek Nolan	10	**Hilary**
Immunotherapeutics & Product Development (IM7111)	Dr. Michael Carty	5	**Hilary**
Research Project (IM7112)	Prof. Cliona O'Farrelly Dr. Michael Carty	30	**Hilary**
Total		**90**	

Modules

Basic Immunology (IM7101)

Term: Michaelmas
Credit weighting: 10 ECTS
Module co-ordinator: Cliona O'Farrelly and Michael Carty

Module Overview:
This module aims to give students who have had little formal prior exposure to immunology, a general and comprehensive introduction to immunology. Basic terms and concepts of innate and adaptive immunity will be presented in a logical and accessible fashion. Students will be familiarised with immunological terms and introduced to the functions of the principle organs, cells, molecules and genes involved in initiating and mediating successful immune responses. By the end of the module, students should be able to explain fundamental immunological concepts and discuss the roles of functional components of the immune system including haematopoietic cells, acute phase proteins, pattern recognition receptors, complement, TCRs, immunoglobulins and cytokines. They should also understand some basic concepts of immunological dysregulation seen in inflammatory and autoimmune diseases, allergy, malignancy and immunopathogenesis**.** Lectures will be supplemented with peer-to-peer group learning sessions and tutorials, where lecture topics will be discussed and each student will help present and explain research articles chosen from scientific review articles thereby further relating the module topics with course material.

Learning Outcomes
On successful completion of this module students should be able to:

- Understand the fundamental concepts of immunology
- Describe the organs and origin of cells of the immune system
- Describe the cells and molecules of the innate immune system
- Describe the sensors and effector mechanisms of the innate immune system
- Describe the cells and molecules of the adaptive immune system
- Describe the mechanisms of activation and effector mechanisms of the adaptive immune system
- Describe and understand the mechanisms of immune tolerance
- Describe and understand the mechanisms of Immune regulation

Lecture sessions (2 hr duration):	**Lecturer**
1. Introductory Overview	Cliona O'Farrelly

Innate Immunity:

2. Cells and Organs of the Immune System	Cliona O'Farrelly
3. Introduction to Immunological Techniques	Cliona O'Farrelly
4. Innate immune systems: Pathogen Detection, Inflammation and TLR signalling	Louise Glover
5. Innate immune systems: Cytokines	Michael Carty
6. Innate effector mechanisms: Natural Killer Cells: phenotype, function, detection of non-self and roles in anti-viral and anti-tumour immunity	Clair Gardiner
7. Innate effector mechanisms: Tissue Resident and Circulating Myeloid Cells of the Immune System	Mary Canavan
8. Innate effector mechanisms: Complement	Michael Carty

Adaptive immunity:

9. Antigen Processing and Presentation	Derek Doherty
10. Cellular and Molecular Components of Adaptive Immunity I CD3+ T cells TCR Structure and Function	Cliona O'Farrelly
11. Cellular and Molecular Components of Adaptive Immunity II	Kingston Mills
12. Cellular and Molecular Components of Adaptive Immunity III T cell help and B cell activation.	Cliona O'Farrelly
13. Antibody Structure and Function I	Jerrard Hayes
14. Antibody Structure and Function II	Jerrard Hayes
15. Immunology Mechanisms in Action	Derek Doherty
16. Immunometabolism I	David Finlay
17. Immunometabolism II	Luke O'Neill
18. Lymphocyte Development I	Cliona O'Farrelly
19. Lymphocyte Development II, gene rearrangement and thymic interactions	Cliona O'Farrelly
20. Tolerance and Immunoregulation	Cliona O'Farrelly

Peer to Peer Group Activities

"Tell me and I forget, teach me and I may remember, involve me and I learn"
Benjamin Franklin

Immunology is complex and challenging to learn [1] – a good way of helping to sort out the topics that others can help decipher from the concepts that are particularly challenging, is to discuss them with a group of peers. This exercise is designed to encourage students to begin these discussions in small groups. **The aims are:**

a. To help students appreciate the value of discussing complex immunological topics for better understanding – (often way better than spending hours in front of the screen or over books)

b. To identify the topics that are particularly challenging for all students and therefore require additional input by Tutorial Group Leaders and course leaders
c. To improve students' communication skills

The class will be divided into groups; ~5 students in each group.

1. Groups will meet after each lecture session of module 1; ideally, they should meet face to face but can meet online, perhaps set up discussion groups on Blackboard or ZOOM.
2. At the first meeting, each member of the group will introduce themselves.
3. Each group will identify a rapporteur (or representative) from amongst their group who will record the list described below.
4. At each peer-to-peer group meeting, each student will bring along queries, questions or comments on aspects of the lecture session just completed.
5. During these peer-to-peer meetings the group will discuss these queries, questions or comments and identify the 5 most pertinent or puzzling – the queries, questions or comments that most need further explanation.
6. To prepare for the tutorial the rapporteur will create a list compiled of students' contributions (5 from each student = 25 queries, questions or comments), including each contributor.
7. The rapporteur will email the tutorial leaders the complete list of 25 queries, questions or comments (identifying who had contributed each) with the 5 selected items highlighted for the tutorial leaders, which require more explanation, in time for that week's tutorial.
8. The tutorial group leaders will prepare the week's tutorial based on the 5 selected items identified at the week's peer-to-peer group meetings.
9. Each student in the group should take turns acting as rapporteur.

locations for peer-to-peer group meetings in TBSI

a. The Knowledge Exchange on Level 2
b. The area outside the Tercentenary lecture theatre
c. The balconies on Level 2, 3, 4, and level 5
d. The Bull Nose outside the Stanley Quek lecture theatre on -1
e. B2.50, 5.16 and 6.07 if available

References

1. ED YONG Immunology Is Where Intuition Goes to Die. The Atlantic August 5 2020

Tutorials:

Six tutorial sessions will accompany the lectures.

There are 2 aims of the tutorials:

1. Address the topics raised at the peer-to-peer group meetings
2. Explore the review article of the day

Six reviews have been chosen and one will be discussed at each tutorial.

The following **exercise** has been designed to promote this discussion:

For all tutorials (except the first – which is led by the tutorial group leader), the students will read and discuss the selected review.

A 1-page report will be prepared each week (except the first), by all students providing the following:

1. A referenced statement/sentence chosen from the review
2. The title of the paper from the primary literature upon which the chosen statement is based.
3. Figure of key experiment in the paper supporting the chosen statement
4. Main technology used in the experiment supporting the chosen statement
5. 100-150 word summary of key findings of the experiment.

In the tutorials the review articles are used to explore the material presented at lectures in more depth and to discuss misunderstandings or misconceptions. Students will be expected to contribute, ask questions and engage in discussions at each tutorial. The contributions during the tutorials will be asessed. Each student will be expected to have read the relevant reviews prior to the tutorials. At the end of the module, an MCQ exam will be held which will cover the material in the lectures and the review articles. Therefore it is important for students to read and understand the review articles.

Tutorial Leaders will be introduced at the start of the course.

Assessment:

3 MCQs (70%)

Tutorial contributions (30%)

Tutorial assessment (worth 30% of module):

A. 5% for submission of queries and comments to the tutorial leaders from the peer-to-peer sessions
B. The five reports and each student's contribution to the general discussion will be marked out of 25%.

Reading/Learning Resources:

Janeway's Immunobiology. Murphy, K., Travers, P., Walport, M., Janeway, C. (2012) Garland Science.

Concise Clinical Immunology for Healthcare Professionals (2007) Mary Therese Keogan, Eleanor M. Wallace, Paula O'Leary. Routledge, London.

Cellular & Molecular Immunology. Abbas, Lichtman, Pillai 8th Edition (2014)

The Immune System Peter Parham, 4th Edition (2014) Garland Press

Reviews to be covered in tutorials will be provided at the beginning of the course.

Immunological Technologies (IM7102)

Term: Michaelmas
Credit weighting: 10 ECTS
Module co-ordinator: Rachel McLoughlin

Overview:
This course will introduce the theory and practice of basic technologies used in immunological research. Specifically, students will learn how to dissect and section immunological organs and tissues; they will culture and analyse cells of the immune system; they will become proficient with flow cytometry and microscopy. They will learn how to identify and quantify specific genes by Polymerase Chain Reaction (PCR) and proteins using a range of assays including ELISAs and Western Blotting. At the end of this module, students will be proficient in the techniques required for their research projects, as well as understanding the underpinning science.

Learning Outcomes:
Having completed this module students will be able to:

- Describe key immunological technologies
- Perform each immunological technique described
- Apply technologies to specific research questions

Lectures:	**Lecturer:**
1. Animal models in research	Peter Nolan
2.Introduction to antibody technology-western blotting,	Andrei Budanov
3. Introduction to Flow cytometry	Jean Fletcher & Barry Moran
4.Introduction to PCR	Michael Carty

Practical's:	**Practical leader:**
1.Cells and Organs of the Immune System	Michael Carty
2.Activation & assessment of cellular inflammatory responses – western blotting	Andrei Budanov
3.ELISA Assay	Rachel McLoughlin
4.Flow Cytometry	Jean Fletcher & Barry Moran
5.PCR	Michael Carty

Assessment:
Practical write-ups x 5 (40%)
MCQ (60%)

Reading/Learning Resources:

At the Bench : a Laboratory Navigator. Barker, K. (2005)

Analytical molecular biology : quality and validation. Saunders, G. C. and Parkes, H. C. (1999)

Janeway's Immunobiology. Murphy, K., Travers, P., Walport, M., Janeway, C. (2012) Garland Science

Introduction to Bioinformatics. Lesk, A. M. (2008) Oxford University Press, Oxford.

Lab coat and spectacles:

Specific “TCD designed” Howie style lab coats (designed by the College Safety Office to conform to the appropriate NISO standards) and safety spectacles must be worn during all practicals and should be purchased in advance by each student (from Student Union shops on the TCD campus).

Communicating Science and Critical Analysis (IM7103)

Term: Michaelmas and Hilary
Credit weighting: 5 ECTS
Module co-ordinator: Michael Carty

Overview:
The aim of this module is for students to learn immunology through the medium of scientific research seminars**.** Students will attend 10 online research seminars organised by Global Immunotalks (https://labs.biology.ucsd.edu/zuniga/global_immunotalks.htm) or by the School of Biochemistry and Immunology during the Michaelmas and Hilary Terms. These seminars in the areas of Immunology will be presented by specialists in their field. Pairs of students will be allocated a speaker and will be asked to:

A. Send the class a review article written by their allocated speaker and share it with the class a week before the seminar.
B. Prepare a written assignment based on their allocated speakers work the week after the seminar. The student pair will prepare an academic summary of the research presented during the seminar, 500-1000 words plus images. The summary will also include the answers to 2 questions asked after the seminar.

C. The student pair will present a summary of their speaker's seminar to the class.

To help students prepare these pieces, a lecture series on general issues of importance in science communication will be presented including presenting scientific principles, ethical issues in scientific research and critical thinking.

Learning outcomes:
Having completed this module students will be able to:

- Critically assess and discuss current research findings in Immunology
- Interpret scholarly articles and research seminars in Immunology
- Formulate a summary suitable for a specialist academic group

Lectures:	**Lecturer:**
1. Scientific communication and critical analysis	Michael Carty
2. Why bother communicating science?	Trevor Butterworth
3. Plagiarism	Trevor Butterworth
4. Thesis writing	Michael Carty

Assessment:

1. Written summary of the allocated speaker seminar (include a brief description of each student's contribution. Student 1: Background, introduction and methods. Student 2: Results, discussion, and future work). 500 words plus images from each student (1000 words total). (50%)
2. Presentation (10 mins) of the above document (12 slides, each student provides 6 slides each) (50%)
3. Attendance at the lectures, seminars and student presentations is mandatory.

Reading/Learning Resources:

The Sense of Style: The Thinking Person's Guide to Writing in the 21st Century. Pinker, S. (2014). New York, NY: Penguin.

Eats, Shoots & Leaves. Lynne Truss. (2008) Gotham Books.
The Elements of Style. Strunk and White (1999)

Megan Hanlon podcast: https://unravellingscience.podbean.com/#

Tumour Immunology (IM7109)

Term: Michaelmas

Credit weighting: 5 ECTS

Module co-ordinator: Michael Carty and Cliona O' Farrelly

Module overview

The aim of this module is to provide a fundamental understanding of how important immunological concepts apply to the field of tumour immunology. The module will explore how both the innate and adaptive immune systems recognise and eliminates cancerous cells and how immune cells can be hijacked by the tumour to support cancer development. The workshops will focus on specific cancer types and explore how current and emerging immunotherapies are being used in the clinic.

Learning Outcomes:

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

- Describe how the innate and adaptive immune system identifies and responds to malignant cells.
- Outline the mechanisms whereby tumours evade or subvert the immune system
- Appreciate how the tumour microenviroment influences tumour progression
- Analyse current immunological strategies being employed clinically to combat malignant disease and the associated challenges.

Lectures :		**Lecturer:**
1	Introduction to Cancer Immunology & Immunotherapy 1	Cliona O' Farrelly
2	Introduction to Cancer & Cancer Cell Immunogenicity	Vincent Kelly
3	Introduction to Cancer Immunology & Immunotherapy 2 (how the innate and adaptive immune systems identifies and responds to malignant cells).	Cliona O' Farrelly
4	Introduction to Cancer Immunology & Immunotherapy 3 (mechanisms whereby tumours evade or subvert the immune system)	Joanne Lysaght

Workshops:

	<u>Haematological Cancers</u>	
5	Pathogenesis & Immunotherapies workshop	Tony McElligott
6	Clinical background & Case study presentation	Cliona Grant
	<u>Oesophageal and Oral Cancers</u>	
7	Pathogenesis & Immunotherapies workshop	Danny Zisterer
8	Clinical background & Case study presentation	Michael McCarthy
	<u>Liver Cancer</u>	
9	Pathogenesis & Immunotherapies workshop	Cliona O'Farrelly
10	Clinical background & Case study presentation	Austin Duffy

Cancer Vaccination

11	Pathogenesis & Immunotherapies workshop	Michael Carty
12	Clinical background & Case study presentation	Colm MacEochagain

Assessment:

1. Presentation. Students will present in pairs: Identify and describe an immunotherapy type, describe how well it works, describe the barriers to it working and future directions to improve its functionality. Presentation are 10 minutes in duration, 12 slides, where each student provides 6 slides each. (20%)
2. 500-word written report (plus references) on material and preparation for the presentation (include a brief description of each student's contribution) (20%)
3. Written Exam (short answer questions) (60%)

Reading and Learning Resources:

6 Selected review articles on the topic of Tumour Immunology will be provided at the start of the module.

Data science & Immunogenetics (IM7105)

Term: Michaelmas

Credit weighting: 5 ECTS

Module Coordinators: Cliona O'Farrelly and Michael Carty

Overview:

Immunological responses are controlled by genes encoding contributing proteins and other molecules. Many immune genes are highly conserved and thus most human immune genes have homologues in other mammalian species. Non-coding regions of the genome are also now known to have important regulatory functions. However, important differences exist in the numbers and sequences of DNA, which account for differences in immune responses both between species and individuals. Similarly, variation in the copy numbers of immune genes or their sequences can have major impact on their function in immunity thus accounting for the significant inter-individual variation seen in all immune responses.

The aim of this module will be to provide sufficient background in basic genetics, genomics and epigenetics in order to better understand the relationship between genome and immune function. A key aspect of this module will be to enable student to critically assess studies focused on high-throughput analyses at the DNA and RNA levels and introduce the technologies which enable the identification of genes associate with disease susceptibility. With the sequencing of genomes becoming quicker and cheaper, it is now possible to explore the immunomes of many species by bioinformatic analyses and to identify the genes linked to disease susceptibility using advanced technologies such as Genome-Wide Association Studies (GWAS). This module will therefore introduce students to high-throughput and systems biology approaches used to investigate the immune response at a systems level. Another important aim of this module is to familiarize students with key immunological studies in diverse species and the relevance of species-specific immune responses to studies of human disease. This module will include the examination of datasets from patients with COVID-19 along with lecture sessions on the appropriate statistical methods used to analyse and understand such data. In addition, immunological studies are increasingly based on "big data", therefore appropriate computational methods are required to analyse genomic, transcriptomics, proteomics and metabolomic profiles, all of which impact the immune response. In this module you will be introduced to computational methods to characterize such large data sets.

Analysis of immunological datasets using the computer programming language R

Experiments will be setup with a small number of pre-defined readouts that are analysed using pre-defined statistical tests, thus producing simple numerical readouts. This type of data can be visually presented using single (histograms, bar charts) or two (scatter plots) parameter graphics to communicate results. However, with the advance of multi-parameter

technologies (arrays, RNA-sequencing, flow cytometry, etc.) cell biology/immunology experiments can now generate 10s, 100s, or even 1000s of readouts (parameters) for each data point (patient, or replicate). This presents huge challenges to those unfamiliar with 'Big Data', where standard low parameter analysis pipelines (excel, GraphPad Prism, SPSS) are inappropriate, as such methods fail to capture the 'message in a bottle' in a sea of data. High parameter 'messy' data generated from real immunology experiments will be examined and basic principles of data science will be used to filter, tidy, cluster and reduce the dimensionality of the data before exploring how best to present results by concentrating on effective data visualisation. To achieve these aims the R programming language will be used. Those with no programming experience would benefit from taking the Software Carpentry 'R for Reproducible Scientific Analysis' course: http://swcarpentry.github.io/r-novice-gapminder/

The following topics will be addressed:

Data science for immunologists: a practical approach.

1. Introduction to R programming (from an immunologist's perspective)
2. Using R for metanalysis of tabular immunology data
3. Data visualisation
4. Analysis of multiparameter data using machine learning

Analysis of single cell RNA-sequencing data

1. Retrieve counts level data from online repositories
2. Load data into R and perform quality control and filtering to clean data
3. Data normalisation, feature filtering, and dimension reduction.
4. Clustering and biological interpretation

Learning Outcomes:

Having completed this module students will be able to:

- Describe the structure of the genome – genes, promoter regions, non-coding regions, copy number variation, alternative splicing and miRNA.
- Understand the potential effects of specific genes and polymorphisms on the outcome of the immune response.
- Understand the multiple levels of control of the immune response - including at the epigenetic level.
- Appreciate the tools and technologies (and their limitations) available to scientists to uncover genetic associations with complex traits, such as immunity and inflammation
- Describe genome-wide association studies
- Understand the main differences in the immune response between man, model and non-model organisms
- Critically evaluate and analyse species-specific information from immunological studies

- Describe the basic concepts of systems biology
- Possess the ability to use appropriate statistical tests to examine biological datasets
- Use the R programming language to work with raw immunological data, perform data tidying, filtering, graphing and statistical analysis.
- Know the basic principles of effective data visualisation
- Understand transcriptomic datasets and the principles behind RNA seq.

Lectures/workshops:

1. Introduction	Cliona O'Farrelly
2. Datasets from COVID-19 patients	Liam Townsend
3. Statistics I	Andrei Budanov
4. Statistics II	Andrei Budanov
5. Genetics & Epigenetics	Michael Carty
6. Immunogenetic variation in human disease	Jamie Sugrue
7. Transcriptomics	Conor Finlay
8. Computational Immunobiology I	Conor Finlay
9. Computational Immunobiology II	Conor Finlay
10. Computational Immunobiology III	Jamie Sugrue

Assessments:

A. Examination (40%)
B. Statistics assignment (20%)
C. Computational Immunobiology presentation (40%)

For the computational Immunobiology presentation of analysed datasets, students working in pairs, are asked to analyse a set of publicly available data and present their analysis to the class. The presentations will be 10 mins in duration followed by 5 minutes of questions and discussion. The presentations should include:
Background on dataset, methodology and results to include graphs, tables and interpretation of datasets.

Reading/Learning Resources

Mark Davis -

Introduction to bioinformatics by Arthur Lesk 2019
Data Science for Immunologists Niclas Thomas 2018
Immunological Bioinformatics Ole Lund, Morten Nielsen, Claus Lundegaard, Can Kesmir & Søren Brunak 2005

Microbe Detection and Evasion (IM7106)

Term: Hilary
Credit weighting: 5 ECTS
Module co-ordinators: Andrew Bowie and Michael Carty

Overview:
This module will be a research-led course covering pathogen detection by the innate immune system leading to effective pro-inflammatory and anti-pathogenic signalling responses. The module will explore mechanisms of pathogenic immune evasion and subversion and will also focus on the role of the immune response in health and disease. The past two decades has seen huge progress in the discovery and characterisation of pattern recognition receptors (PRRs) such as Toll-like receptors, RNA helicases, DNA sensors and NOD-like receptors, which are now known to be responsible for the detection of pathogens. This module will describe pathogen detection and recognition receptor function and include lectures and workshops by experts in this field, who have made significant contributions to our current understanding of innate immunity.

Learning outcomes:
Having completed this module students will be able to:

- Explain viral and bacterial infection at a molecular and pathogenic level
- Describe the concept and examples of pathogenic detection
- escribe proinflammatory and anti-pathogenic responses at a molecular and cellular level
- Describe key immune evasion strategies of viruses and bacteria

Lecture/workshop sessions:

1.	Overview of pathogen detection	Michael Carty
2.	PRRs for viruses: TLRs and cytosolic detection pathways	Andrew Bowie
3.	Role of inflammasomes in innate detection of pathogens and PRRs for bacteria: TLRs and NOD-like receptors	Gareth Brady
4.	The anti-viral interferon response	Michael Carty
5.	Viral Immune evasion of innate immunity I	Andrew Bowie
6.	Viral Immune evasion of innate immunity II	Andrew Bowie
7.	Bacterial Immune evasion	Rachel McLoughlin

Assessment: 100% exam
MCQ (25%)
Short answer questions (75%)

Reading/Learning Resources:

Janeway's Immunobiology. Murphy, K., Travers, P., Walport, M., Janeway, C. (2012) Garland Science

Cellular & Molecular Immunology. Abbas, Lichtman, Pillai 8th Edition (2014)

The Immune System Peter Parham, 4th Edition (2014) Garland Press

Cellular & Molecular Immunology. Abbas, Lichtman, Pillai 8th Edition (2014)

The Immune System, Peter Parham, 4th Edition (2014) Garland Press

Clinical Immunology (IM7107)

Term: Hilary

Credit weighting: 5 ECTS

Module co-ordinators: Eleanor Wallace and Michael Carty

Overview:

The Departments of Clinical Immunology at St. James's Hospital and St.Vincent's University Hospital are involved in the investigation and treatment of patients with a range of different immunological disorders including allergy, autoimmunity, immunodeficiency and malignancy. They have particular experience and expertise in the diagnosis and management of patients with immunodeficiency, vasculitis and autoimmune diseases. The Department of Clinical Immunology at St. Vincent's University Hospital has a key role in providing diagnostic services for the leading National Referral Centre for Rheumatology and musculoskeletal disease. In addition, the Department supports the National Liver Transplant Programme providing services for the diagnosis of liver disease and a regional service for monitoring patients post-liver transplant. An overview of clinical immunology will be presented. The immunotechniques used in these laboratories to investigate common immunological clinical problems will also be presented and explored. Students will be given real life case histories to discuss; the class will decide on which tests should be done; results will be presented and analysed; treatments and alternative strategies will also be discussed.

Learning outcomes:

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

- Outline the range of medical clues that lead to the possible diagnosis of immunodeficiency
- Discuss the molecular processes and genetic influences that can result in primary immunodeficiency disorders
- Explain the nature of inflammatory events leading to many diseases
- Describe mechanisms of autoimmunity and various common autoimmune disorders
- Explain the mechanisms of hypersensitivity reactions
- Describe the clinical manifestations of atopy and allergic inflammation
- Describe the investigation, diagnosis and management of conditions within paediatric allergy and immunology.
- Describe liver immunology, pathology & transplantation
- Discuss the rationale for a range of immunotherapies
- Describe the range of tests that help specifically diagnose immunological disorders including immunodeficiency, autoimmunity, allergy and transplant rejection.

Lectures/workshops:

1.	Immunodeficiency	Eleanor Wallace
2.	Immunodeficiency: Case Studies	Con Feighery
3.	Autoimmunity	Eleanor Wallace
4.	Autoimmunity: Case Studies	Con Feighery
5.	New approaches to diagnosis and treatment of autoimmune disease : MS Case studies I	Jean Fletcher
6.	New approaches to diagnosis and treatment of autoimmune disease : RA Case studies II	Mary Canavan
7.	Liver Immunology, Pathology & Transplantation	Cliona O'Farrelly
8.	Liver Immunology, Pathology & Transplantation: Case Studies	Tom Gallagher
9.	Allergy	Eleanor Wallace
10.	Allergy: Case studies	Niall Conlon
11.	Paediatric Immunology	Lynn Kelly

Assessment:

Written examination (100%)

Reading/Learning Resources:

Concise Clinical Immunology for Healthcare Professionals (2007) Mary Therese Keogan, Eleanor M. Wallace, Paula O'Leary. Routledge, London.

Essentials of Clinical Immunology 6th Edition (2014) Helen Chapel, Mansel Haeney, Siraj Misbah & Neil Snowden, Wiley Blackwell.

Janeway's Immunobiology. Murphy, K., Travers, P., Walport, M., Janeway, C. 9th Edition (2017) Garland Science

Cellular & Molecular Immunology. Abbas, Lichtman, Pillai 9th Edition (2017)

The Immune System Peter Parham, 4th Edition (2014) Garland Press

Global Infectious Diseases (IM7110)

Term: Hilary
Credit weighting: 10 ECTS
Module co-ordinator: Derek Doherty and Derek Nolan

Overview:

This module aims to give an in-depth overview of the interactions that take place between viruses, bacteria and parasites and the human host; focusing on the most important global infectious diseases in humans. Students will be familiarised with the mechanisms by which the immune system senses, contains and eliminates pathogens, while tolerating harmless commensal organisms. The mechanisms by which infecting organisms subvert host immune responses, leading to pathology, will be examined in detail. Students will also learn how infectious diseases spread, leading to epidemics. Much of the module will focus on progress towards immunisation, treatment and eradication of infectious diseases. By the end of the module, students should have an understanding of the biology, pathology and current challenges that we face in the fight against global infectious diseases such tuberculosis, HIV/AIDS, hepatitis, influenza, *Salmonella*, diarrhoeal disease, trypanosomiasis, malaria and schistosomiasis. The module will introduce parasite immunology and consider why parasites so successfully infect humans and evade immune mechanisms. Interactions between parasites and host that potentiate the parasite's prime objective of life cycle completion will also be considered. Research programmes dedicated to the discovery and analysis of parasite derived immunomodulatory molecules will also be explored. Part of the assessment of this module will involve the student researching an infectious disease of global importance and presenting their research findings to the class.

Learning outcomes:

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

- Describe how the immune system deals with infectious viruses, bacteria and parasites
- Describe the biology of the most important global infectious diseases in humans and the interactions between the causative pathogens and the host immune system
- Analyse current strategies being employed to design vaccines and to combat global infectious disease and the associated challenges
- Describe basic mechanisms of parasite-induced immunopathology and immunity against parasite infection
- Explore the pros and cons of using animal models for studying parasite infection
- Identify the challenges in researching the immunology of infectious diseases
- Read, interpret and critically analyse primary literature on the immunology of global infectious diseases

Lectures/workshops:

1.	Overview of global infectious disease challenges, vaccine-preventable diseases and progress in eliminating infectious pathogens.	Derek Doherty
2.	Immunisation and current progress in vaccine design for global infectious diseases	Derek Doherty
3.	Antimicrobial resistance.	Rachel McLoughlin
4.	Biology and immunology of tuberculosis	Joe Keane
5.	Human immunodeficiency virus and AIDS	Derek Doherty
6.	Hepatitis viruses	Derek Doherty
7.	The pathogenesis of diarrheal disease in developing nations	Derek Doherty

Parasite Immunology Introduction Lectures	Derek Nolan
1. Innate mechanisms underpinning basic parasite immunology	
2. Adaptive mechanisms underpinning basic parasite immunology	
3. Vaccination against parasitic disease	

Parasite Immunology Lecture/Workshops:	
1. Strategies used by African Trypanosomes to evade the mammalian humoral immune response and how they overcome human innate defences to cause human sleeping sickness.	Derek Nolan
2. Basic mechanisms of parasite induced immunopathology and how they might be manipulated using Schistosomes as a model	Padraic Fallon
3. Malaria and the immune response	Marian Brennan
Oral presentations of literature assignments	**Derek Doherty**

Assessment:

Examination (70%)

Presentation (30%)

Reading/Learning Resources:

Janeway's Immunobiology. Murphy, K., Travers, P., Walport, M., Janeway, C. (2012) Garland Science.

Cellular & Molecular Immunology. Abbas, Lichtman, Pillai 8th Edition (2014)

The Immune System Peter Parham, 4th Edition (2014) Garland Press

Immunotherapeutics and Product Development (IM7111)

Term: Hilary
Credit weighting: 5 ECTS
Module co-ordinator: Michael Carty

Overview:
Research in the field of immunology has led to the generation of effective vaccines against a number of infectious diseases and also anti-inflammatory biologics that are routinely used for the treatment of autoimmune disorders such as rheumatoid arthritis, inflammatory bowel disease and multiple sclerosis. This module will give a detailed overview of drugs targeting both innate and adaptive immune responses and will describe in detail the drug development process from bench to bedside with particular focus being placed on vaccine adjuvants, cancer immunotherapeutics and treatments for autoimmune disease. In addition, the module will offer workshops detailing the intellectual property/technology transfer process as well as matters relating to regulatory affairs and clinical trial design.

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

- Describe how agents that target innate/adaptive immune pathways can modulate immune responses and provide therapy for immunological disorders.
- In addition, students will have a clear understanding of the drug development process from bench to bedside.

Workshops:

1.	Pre-clinical Development workshop: Road to a successful product	Peter Nowlan
2.	Intellectual property/Technology transfer workshop	Emma O'Neill
3.	Clinical Trial design workshop	Brian Keogh
4.	Regulatory Affairs workshop	Sarah Gilgunn
5.	Pharmaceutical Marketing	Siobhan Mulhern
6.	Finance of Product Development	Kingston Mills
7.	Biotech start-ups from Academic research: The 'How To…'	Jeremy Skillington

Lectures:

1.	Introduction	Michael Carty
2.	Infectious disease vaccines and adjuvants - innate immune activators	Ed Lavelle
3.	Immunotherapeutics for cancer – TLR agonist and Treg cell inhibitors	Kingston Mills

4. Immunotherapeutics for autoimmunity – Inhibitors of pro-inflammatory cytokines — Kingston Mills
5. Therapeutic opportunities in the treatment of sepsis — Michael Carty

Assessment:

Group assignment: Groups of students will be asked to identify/predict a new immunological therapeutic target, invent a 'virtual' therapeutic, carry out patent searches on existing products to ensure novelty and pitch their product to experts in product development, asking for realistic financial investment. The groups should pitch their therapeutic at the stage between pre-clinical and clinical development. Students will be assessed on their background knowledge from a scientific and intellectual property point of view, as well as their overall ability to market the product to potential investors (70%). A written summary of each project (with each student's contribution/section clearly outlined) must also be submitted 48 hours prior to the group presentation (30%).

Immunotherapeutics & Product Development (IM7111) Judging mark sheet for presentations

Marking Topics	Comments	Mark out of 10
Presentation skills, Quality of slides & overall innovation		
Target identification (novelty, patent checks, product/solution value (national & global)		
Pre-clinical development (appropriate in vitro assays, animal trials etc)		
Clinical Development (Clinical trials, subject selection, blinding etc)		
Product Patenting & Licencing		

Product marketing		
Understanding of development costs, financial returns and financial impact of this solution		
Ability to answer questions		
Total (out of 80)		

Reading/Learning Resources:

Reviews and research papers as directed in lectures

Research Project (IM7112)

Term: Hilary
Credit weighting: 30 ECTS
Module co-ordinators: Michael Carty & Cliona O'Farrelly

Overview:

This module is a key element of the course where the theoretical and technical aspects of immunology which have been presented, analysed and discussed in other modules are brought into practical and innovative focus on specific research questions. Each student will be expected to engage in a piece of original research to reveal novel aspects of immune activity or function. Emphasis will be placed on generating publishable and/or patentable data. Based on discussions with the students, the course directors will allocate research projects to the students. The students will then meet with their project supervisor who will discuss the project and help plan a 3000-word literature review on a title based around the topic of their project. After the research project, students will submit a 10,000-word dissertation based on the results obtained during their research project. All students will also be required to present the findings of their research project at the M.Sc. in Immunology poster day.

Learning outcomes:

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

- Identify an area of research interest and formulate a project proposal: outlining the hypothesis behind the project, identifying the specific aims and objectives and designing a work plan that will ensure the project is achieved in a suitable time frame
- Prepare a comprehensive literature review, evaluating previous studies carried out in the specific research area
- Identify suitable research methods to carry out the experimental plan
- Formulate a coherent hypothesis that draws on engagement with, and critical appraisal of, existing knowledge relevant to their research project
- Carry out experimental work that addresses the hypothesis
- Assemble and analyse the data collected in an efficient and logical manner, using appropriate statistical software (e.g. Excel, Prism, SPSS)
- Evaluate potential solutions for experiments that are not working or where unexpected results are obtained
- Interpret the research findings and draw appropriate conclusions based on research outcomes and how this relates to the peer-reviewed literature
- Write a substantial research dissertation in a clear and concise manner with respect to both data illustration and text in accordance with scientific conventions

Module supervision:

The 12-week laboratory-based research project will be carried out in relevant laboratories under the supervision of principal investigators within the School of Biochemistry and Immunology, within other TCD schools or external to TCD.

Please note, depending on your research project, you may need to be vaccinated against Hepatitis B. Please discuss this with you project supervisor in the first teaching term, so that, if required, you can complete the Hepatitis B vaccination schedule before the beginning of your project.

The research project literature review will be submitted to the supervising PI by the 5th of April, 4 weeks into the research project. The literature review must also be submitted online via Turnitin.

The 12-week research project will start in March and finish in June.

The final thesis will be submitted 2 weeks after the end of the project and the following week students will present the findings of their research project during the poster day.

(Exact dates will be communicated in the Hilary term)

Module assessment:

IM7112 will make up 33% of the overall marks of the entire M.Sc. broken down as follows:
Literature review: 10%
Final 10,000-word thesis based on a laboratory research project: 85%
Poster presentation: 5%

Extra Information

Examinations

Details of timing and examinations are indicated in the timetable. If these dates change, the class will be informed by email in advance.

Assessment Summary

The nature of the assessments will vary from one module to another. Individual teaching staff will give more details of assessment procedures at the beginning of each module. Details of assessments can be found in the module descriptors above.

Submission deadlines

For each item of coursework there will be a submission deadline. Students are expected to meet ALL deadlines.

Deadline penalties

- A 1% mark penalty per day past the deadline will be applied
- Extensions will only be granted in exceptional circumstances
- Cases for special circumstances must be made to the course co-ordinator and director.

Attendance

Attendance will be monitored in all components of the M.Sc. course. Full attendance at all classes is considered a measure of professional behaviour expected of all students. All activities are considered to be core and lack of attendance may affect student progression. All absences must be reported to both the course directors in advance of the class.

Word Limitations

All course assessments must comply with the stated word limit (+/- 10%).

Scheme for marking of projects

The 10,000-word thesis (85%) mark is comprised of the supervisor's mark and a second marker evaluation for the project thesis. The supervisor's mark will be based on the student's performance within the laboratory (technical ability, understanding of the project and literature pertaining to it, critical evaluation of results, demonstration of initiative and independent thought) and on the content of the thesis. The supervisor will also make the second examiner of the project dissertation aware of any unforeseen difficulties that arose during the course of the project.

Class	Mark Range	Criteria
I	85-100	Exceptional project report showing broad understanding of the project area and excellent knowledge of the relevant literature. Exemplary presentation and analysis of results, logical organisation and ability to critically evaluate and discuss results coupled with insight and originality.
	70-84	A very good project report showing evidence of wide reading, with clear presentation and thorough analysis of results and an ability to critically evaluate and discuss research findings. Clear indication of some insight and originality. A very competent and well presented report overall but falling short of excellence in each and every aspect.
II-1	60-69	A good project report which shows a reasonably good understanding of the problem and some knowledge of the relevant literature. Mostly sound presentation and analysis of results but with occasional lapses. Some relevant interpretation and critical evaluation of results, though somewhat limited in scope. General standard of presentation and organisation adequate to good.
II-2	50-59	A moderately good project report which shows some understanding of the problem but limited knowledge and appreciation of the relevant literature. Presentation, analysis and interpretation of the results at a basic level and showing little or no originality or critical evaluation. Insufficient attention to organization and presentation of the report.
III	40-49	A weak project report showing only limited understanding of the problem and superficial knowledge of the relevant literature. Results presented in a confused or inappropriate manner and incomplete or erroneous analysis. Discussion and interpretation of result severely limited, including some basic misapprehensions, and lacking any originality or critical evaluation. General standard of presentation poor.
Fail	20-39	An unsatisfactory project containing substantial errors and omissions. Very limited understanding, or in some cases misunderstanding of the problem and very restricted and superficial appreciation of the relevant literature. Very poor, confused and, in some cases, incomplete presentation of the results and limited analysis of the results including some serious errors. Severely limited discussion and interpretation of the results revealing little or no ability to relate experimental results to the existing literature. Very poor overall standard of presentation.

	0-19	A very poor project report containing every conceivable error and fault. Showing virtually no real understanding or appreciation of the problem and of the literature pertaining to it. Chaotic presentation of results, and in some cases incompletely presented and virtually non-existent or inappropriate or plainly wrong analysis. Discussion and interpretation seriously confused or wholly erroneous revealing basic misapprehensions.

Plagiarism

To ensure that you have a clear understanding of what plagiarism is, how Trinity deals with cases of plagiarism, and how to avoid it, you will find a repository of information at http://tcd-ie.libguides.com/plagiarism

We ask you to take the following steps:
(i) Visit the online resources to inform yourself about how Trinity deals with plagiarism and how you can avoid it at http://tcd-ie.libguides.com/plagiarism . You should also familiarize yourself with the Calendar entry on plagiarism located on this website and the sanctions which are applied;
(ii) Complete the 'Ready, Steady, Write' online tutorial on plagiarism at http://tcd-ie.libguides.com/plagiarism/ready-steady-write. Completing the tutorial is compulsory for all students.
(iii) Familiarise yourself with the declaration that you will be asked to sign when submitting course work at http://tcd-ie.libguides.com/plagiarism/declaration;
(iv) Contact your Course Director, or your Lecturer if you are unsure about any aspect of plagiarism.

Submitting the IM7112 Literature Review & IM7112 Thesis

The IM7112 literature review and thesis must be submitted to plagiarism detecting software. You will do this via Blackboard. The software is SafeAssign and your work is automatically routed through SafeAssign when you submit. Your document must be saved in one of the following formats: doc, .docx, odt, .txt, .rtf, .pdf or .html. Go to the Module Code (IM7112) in Blackboard. You will see the Submission Link (left hand menu). Follow the instructions within that link. You are allowed a single "trial run" submission and will receive a plagiarism report. An overall identity score of less than 30% is acceptable, as this will take into account references and commonly used terms picked up by the software.

If your score is in excess of 30% you should consider rewording the highlighted passages and resubmitting. If you have any queries contact Bernie Butler (BBUTLER@tcd.ie).

Examination rules

General

- The onus lies on each student to establish the dates, times and venues of their own examinations. No timetable or reminder will be sent to individual students by any office.
- You are expected to familiarise yourself with the location of every examination venue to which you have been assigned.
- Mobile phones, or other electronic or communication devices, are not permitted in examination venues - if a phone rings or an alarm on a phone is heard, or it is discovered in any other way in the venue it will be confiscated.
- Students must follow the instructions given by the invigilators in a co-operative and respectful manner.

Before entering an examination venue

- Leave your personal belongings, including bags, coats, hats, etc at the designated place within your examination venue as directed by the invigilator.
- You will not be admitted to the examination after the first half-hour, and will not be allowed to leave during the last half-hour. If you arrive after the first half-hour, contact the module coordinator and course coordinator as a matter of urgency.

While in an examination venue

- Once you have entered a venue, complete SILENCE must be maintained at all times.
- Each student must be in possession of their student ID card for each examination session. You should place your student ID card on the right-hand side of your desk for the duration of each examination.
- A ‘Clean Desk’ policy applies for all examinations. In addition to pens, pencils, rulers, student ID card, etc. only materials permitted for an examination may be placed on the desk. Invigilators will be instructed to request students to remove any non-permitted items from their desk. Pencil cases and calculator covers are not permitted. Students are advised that random pocket searches may be conducted during an examination session. Upon request, students should remove all items from their pockets for scrutiny by an invigilator. Failure to empty pockets when requested is considered a disciplinary offence and will be referred to the Dean.

During an examination

- You should check the title of the paper on your desk to ensure that it is the correct examination paper for your course, and read carefully all the instructions given.

- You are not allowed to start your examination until instructed to do so by the invigilators. Please use any spare time at the start to fill in your answer book cover(s), remembering to complete the section at the bottom right-hand corner as requested before sealing the flap on every anonymous booklet used. Write legibly in ink – pencils are only allowed for MCQ forms.
- You will be advised of the time thirty minutes and ten minutes before the end of the examination.
- If you wish to leave the examination venue at any stage during the examination you must be escorted by an Invigilator. If necessary you will be accompanied to a bathroom by an Invigilator.
- If you wish to leave before the end of the examination you must hand your booklet(s) to an Invigilator and ensure you hand up everything you wish to have marked.
- If you are taken ill just before an examination and are unable to sit it, immediately contact your module coordinator and course coordinator. If you feel unwell during your examination, please inform an Invigilator - you will be asked if you wish to go to the College Health Centre and will be accompanied by an Invigilator.
- Smoking breaks are not allowed during examination sessions.
- Dictionaries and Programmable calculators are not permitted at examinations.

On completion of an examination session

You will be advised that:

- you must immediately stop writing and hand up your booklets when instructed to do so by an Invigilator;
- you should ensure that all of your answer books are labelled correctly with your examination number (where appropriate) and all other required information;
- it is your responsibility to hand in everything you wish to have marked by ensuring all materials are fastened securely with a treasury tag;
- you must remain in your seat until all scripts have been collected;
- you must not remove from the examination venue answer books, rough work, or other materials supplied.
- While every effort will be made to give due notice of major changes, the College reserves the right to amend the examination timetable.
- College regulations and further information can we found on the TCD website and at the following web addresses:

  https://www.tcd.ie/academicregistry/exams/

  https://www.tcd.ie/academicregistry/exams/student-guide/

  https://www.tcd.ie/academicregistry/exams/assets/local/guideexam.pdf

Any further information or queries can be made to the course director, coordinator or graduate studies (contact details on page 3).

Student conduct for examinations

Students are forbidden during an examination to do or to attempt to do, any of the following: to have in their possession or consult or use any books, papers, notes, memoranda, mobile phones or written or electronic material of any nature, or to copy from or exchange information with other persons, or in any way to make use of any information improperly obtained.

Where the examination is of such a nature that materials are provided to the candidates, or where the candidates are allowed by the rules of that examination to have materials in their possession, then candidates may of course make use of such materials, but only of such materials, and the general prohibition above continues to apply in respect of any and all other materials.

Where candidates have the prior written permission of the examiner(s), of the Senior Lecturer, or of the Disability Officer, to have materials in their possession during an examination, then candidates may of course make use of such materials, but only of such materials, and the general prohibition above continues to apply in respect of any and all other materials.

Where candidates are allowed to bring personal belongings into the examination venues upon condition that such belongings are stored in an area – such as the back of the venue – away from the area in which the candidates are sitting their examinations, then candidates may bring personal belongings into the hall, provided that they are placed in the indicated area and are not returned to by the candidates until they have finished their examinations and are leaving the hall.

Any breach of this regulation is regarded as a major offence for which a student may be expelled from the University.

Students must not leave the hall before the time specified for the examination has elapsed, except by leave of the invigilator.

Examinations or other exercises which are part of continuous assessment are subject to the same rules as other College examinations. Where submitted work is part of a procedure of assessment, plagiarism is similarly regarded as a major offence and is liable to similar penalties.

Pass/Fail

a) Each module must be passed at a minimum of 50%. The final module mark will be calculated using the weighted assessment components. Students must pass all modules in order to be awarded a M.Sc. in Immunology. Failure of the basic Immunology module (IM7101) requires exit from the course.

b) Failure of modules

(i) In cases where students fail to achieve a minimum of 50% in a module, a repeat of a written exam or written assignment will be permitted during the appropriate repeat periods. Only one repeat will be allowed. Marks of repeat exams will be capped at 50%.
Please note: due to the nature of IM7102, practicals cannot be repeated.

c) Failure of a module.
(i) Students must pass term 1 modules before they can progress to term 2.
(ii) Term 2 modules will be assessed at their end. Any students failing any of the term 2 modules (apart from module IM7112) will be able to repeat.
(iii) Failure on the second attempt indicates failure of the whole course, requiring exit from the course.

d) Compensation.
Students who fail a module (apart from module IM7112), but obtain 45% or more in that module, may compensate from marks awarded for the other modules, as appropriate, up to a total of 5%.

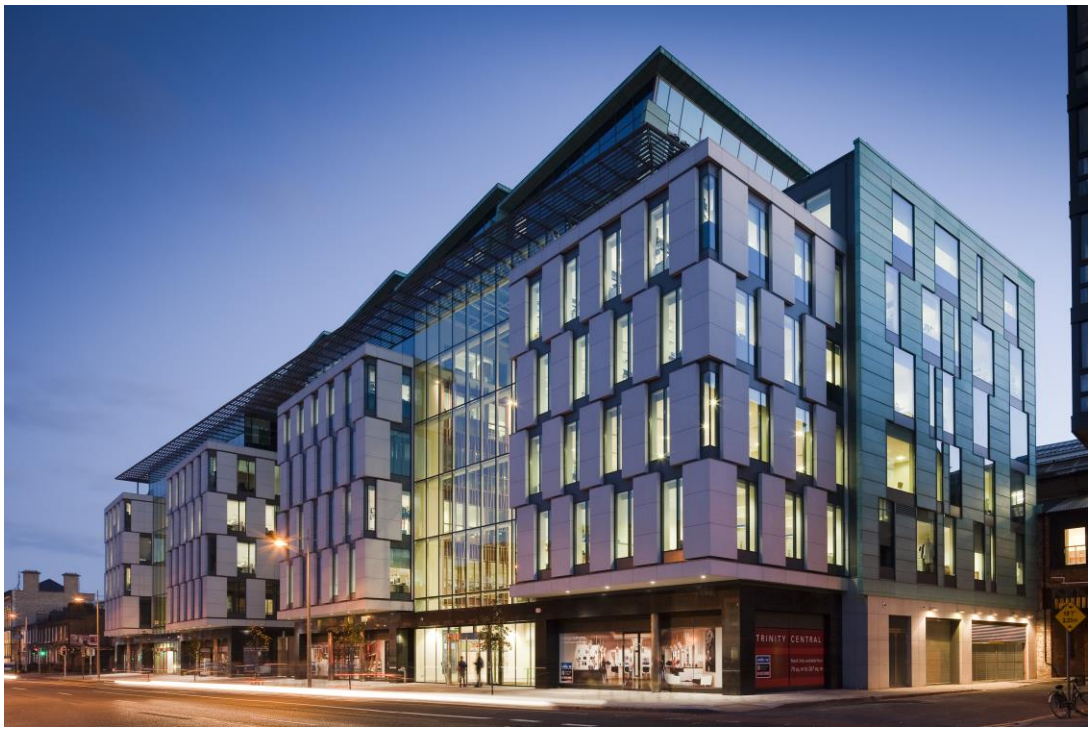
e) IM7112:
To begin the research project, students must have completed and passed all the taught modules. Module IM7112 must be passed in order for the student to be considered for an award of Masters degree. Compensation is not possible for module IM7112; neither can module IM7112 be used to compensate for any of the taught modules. Module IM7112 will make up 33% of the overall marks in the final evaluation of the awarding of the M.Sc. degree. Students must achieve 50% in module IM7112 to fulfil criteria for the award of the M.Sc. course.

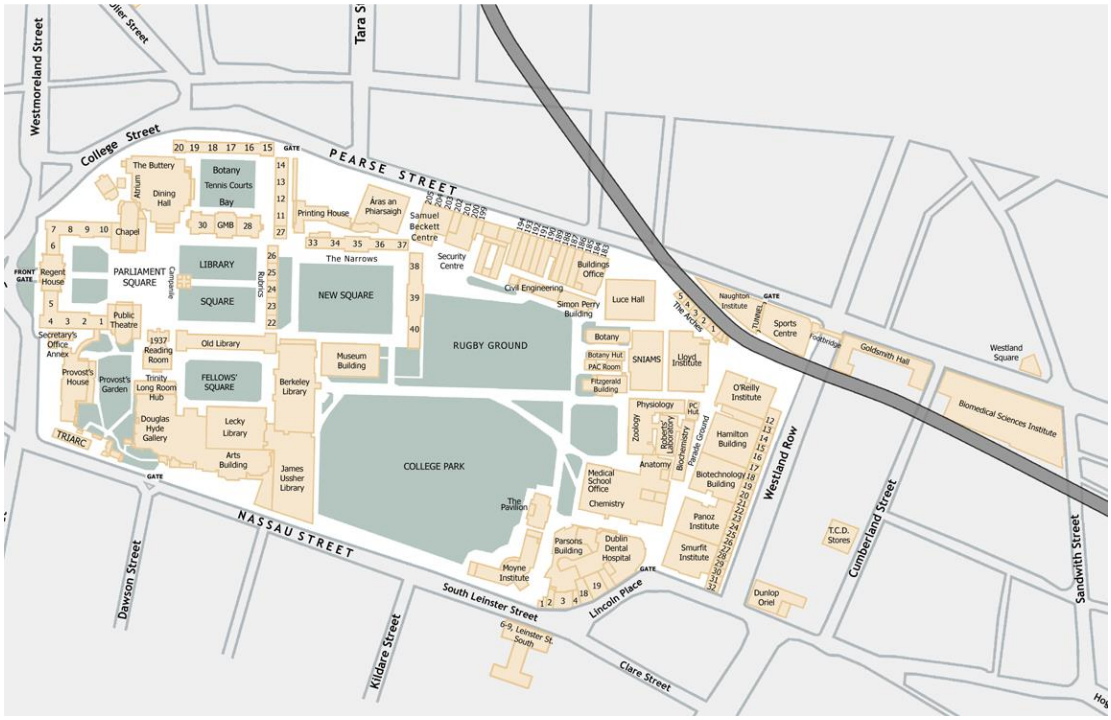
f) Progression
i) All students register on the Masters programme.
ii) Students who have successfully passed all the taught modules of the course and accumulated 60 ECTS, but who do not wish to proceed to the module IM7112 stage, or if they have submitted, but then failed the IM7112, will be considered for a Postgraduate Diploma in Immunology (exit award).
(iii) Students who have successfully passed all the taught modules and module IM7112 and accumulated 90 ECTS will be considered for a Masters degree. Students must achieve at least 50% in IM7112 and in all the taught modules (IM7101-IM7111) to fulfil criteria for the award of the M.Sc.
iv) The award of a Masters with Distinction shall require the achievement of at least 70% for module IM7112 and an average of at least 70% (which is weighted on the ECTS credits for each module) in all taught modules (IM7101-IM7111). A distinction cannot be awarded if a candidate has failed any module during the period of study.

Course Feedback

A Feedback Form will be given out at the end of each module. These anonymous forms are a mechanism whereby students can make comments and suggestions that will help us to maintain and indeed improve the quality of the teaching offered.

Please note that any aspects of this handbook and timetable are subject to change during the year.


TRINITY CENTRAL


Westmoreland Street
College Street
PEARSE STREET
Tara St
The Buttery
Botany Bay
Tennis Courts
Dining Hall
Atrium
Chapel
GMB
Printing House
Áras an Phiarsaigh
Samuel Beckett Centre
Security Centre
Buildings Office
Civil Engineering
Simon Perry Building
Luce Hall
Naughton Institute
Sports Centre
Goldsmith Hall
Westland Square
Biomedical Sciences Institute
PARLIAMENT SQUARE
LIBRARY
SQUARE
Regent House
Public Theatre
Secretary's Office Annex
Provost's House
Provost's Garden
1937 Reading Room
Old Library
Trinity Long Room Hub
FELLOWS' SQUARE
Douglas Hyde Gallery
Lecky Library
Arts Building
Berkeley Library
James Ussher Library
Museum Building
The Narrows
NEW SQUARE
RUGBY GROUND
COLLEGE PARK
Botany
Botany Hut
PAC Room
Fitzgerald Building
SNIAMS
Lloyd Institute
Physiology
Zoology
Biochemistry
Hamilton Building
O'Reilly Institute
Biotechnology Building
Anatomy
Medical School Office
Chemistry
The Pavilion
Panoz Institute
Smurfit Institute
Parsons Building
Dublin Dental Hospital
Moyne Institute
T.C.D. Stores
Dunlop Oriel
Westland Row
Cumberland Street
Sandwith Street
NASSAU STREET
South Leinster Street
Lincoln Place
Clare Street
Dawson Street
Kildare Street
TRIARC

The Class Representative

Within the first few days of term the class should elect a Class Rep. The role of the class rep is to act as a contact point for the class. The class rep can bring important issues to the attention of the Course Directors and can act as a contact point should the course Directors or Module Coordinators need to contact the whole class. The class rep may also lead in organisation of class social events.

The Biochemical Society

The student led Biochemical Society aims to stimulate interest in the fields of Biochemistry and Immunology amongst its members, which include postgraduates, undergraduates, postdocs and PI's. The society hosts weekly talks throughout the academic year. These are given by invited, high-profile speakers from Ireland and abroad. On a social level, the society organises table-quizzes, a December/Winter party and BBQs, which are an enjoyable way of meeting other members of the School.

Details of broader College social and sport activities are provided at: http://trinitysocieties.ie/

The Graduate Students Union

Trinity's Graduate Students' Union (GSU) is the main representative body for all postgraduate students in College (https://www.tcdgsu.ie/). Established in 1973, the GSU has supported members and advocated for improvements to the postgraduate experience here in Trinity. All postgraduate students of the College, including postgraduate research students and those on higher degree and higher diploma courses, automatically become members of the Union upon registering with the College. The GSU has two full-time sabbatical officers who represent postgraduates on every level of College, from class rep issues to structures and policy at Board. The GSU also provides advice on academic and welfare issues faced by postgrads, and offers three main facilities: dedicated postgrad study space in the 1937 Reading Room, the GSU Common Room on the first floor of House 7, and the GSU office in Room 28, House 6. Although the GSU works in partnership with the Students' Union, the GSU is the only postgraduate representative organisation recognised by College. The GSU also produce a Postgrad Handbook and also maintain an active Facebook page detailing events. International Students: GSU sabbatical officers have first-hand experience regarding the steps needed to settle down in Ireland as an international student. It is easy to become overwhelmed while adjusting to jetlag, a new country (sometimes even a new continent!), a second language and separation from family and friends. They can help you with a variety of supports including: dealing with

internal College issues regarding paying fees; registering for your course; the process of securing a visa; opening up a bank account or securing accommodation.

Postgraduate Advisory Service

The Postgraduate Advisory Service (PAS) was established in 2009 to extend Trinity's historic and unique tutorial service to the postgraduate community. We offer free, independent and confidential support, guidance and advocacy to registered postgraduate students at Trinity College Dublin.

How we can help:

We are here to provide support on any matter that may impact upon your time as a postgraduate at Trinity. Some of the most common issues students come to PAS to discuss include: study-related stress or worry; concerns about academic progress; supervisor-relationship concerns; extensions and going off-books; queries regarding regulations and academic appeals; bullying; plagiarism and disciplinary cases.

We support students by:

- Providing frontline confidential and free support, information, and referral via the Postgraduate Student Support Officer
- Providing, on referral, named academics to provide advice, advocacy, and assistance via the panel of Postgraduate Advisors
- Providing a suite of complementary supports including informal mediation, workshops and training to postgraduates
- Administering the Postgraduate Student Assistance Fund and other financial assistance to postgraduate students.

For more information please visit: https://www.tcd.ie/seniortutor/students/postgraduate/

Emergency Procedure

In the event of an emergency, dial Security Services on extension 1999. Security Services provide a 24-hour service to the college community, 365 days a year. They are the liaison to the Fire, Garda and Ambulance services and all staff and students are advised to always telephone extension 1999 (+353 1 896 1999) in case of an emergency. Should you require any emergency or rescue services on campus, you must contact Security Services. This includes chemical spills, personal injury or first aid assistance. It is recommended that all students save at least one emergency contact in their phone under ICE (In Case of Emergency).

SCS
Student Counselling Services

Managing Wellbeing in the Postgraduate Context

At some point throughout your academic career there will be a time where you are feeling challenged. You may be finding communication with your peers or supervisor difficult; your research is not going to plan; or you might be struggling to balance academic work alongside financial obligations, friends and family responsibilities. This is ***not unusual because postgraduate study is demanding***, and this challenge is heightened if you are feeling isolated, exhausted, unwell or unable to concentrate.

It can be helpful to avoid seeing postgraduate study as a general postponing of life, but rather an opportunity to learn how to best support yourself through what is going to be a challenging but hopefully rewarding phase in your life. We know that the academic environment plays a large part in this process, as does your ability to navigate this in a way that helps you best meet your needs. So here are some of our top tips:

STEP 1: Self-care is important not indulgent.

Get the balance right for you: Psychological health encompasses our capacity to work in a generative and meaningful way, our capacity to form and sustain authentic relationships and our capacity to play, be creative and get lost in the moment. Ensuring that you have time for each of these is incredibly important. So make time for those significant relationships in your life, and plan for some positive outlets throughout the academic year because this is will improve your energy levels and your ability to concentrate overall (see https://www.mentalhealthireland.ie/five-ways-to-wellbeing/ for more information).

Name the 'self-critic' instead of blaming yourself: There are many things we can do to proactively support our wellbeing going into this next academic year, however good plans often go to the wayside if we feel like: "I'm messing this up!", "I don't deserve to take a break", "I'm not able for this!". These are very common thoughts that tend to get louder the more overwhelmed we feel, and paradoxically, the more we listen to these the less effective we become. Often we rush to feeling self-critical and blaming ourselves for challenging circumstances when we could be more self-compassionate. (see http://wtm.thebreathproject.org/wp-content/uploads/2016/03/COMPASSION-HANDOUT.pdf for more information)

Take a regular step back from it all: Whether you take regular breaks from academic work or make the time to talk with friends, family and course mates about how you are getting on, it's important to reflect on the bigger reasons you have chosen to study. When we can reconnect with a sense of meaning and purpose in the work we are doing it can become a more enjoyable and rewarding process.

STEP 2: Build a Support Network

Many students feel a sense of being "an imposter" and think things like "Have they made a mistake letting me in?", "What if I'm not good enough?!", "They are going to find me out one of these days!". It is hard to believe that others are feeling similarly unless we reach out to them, but often this can feel more difficult in postgraduate courses due to the onus on independent study and the smaller class sizes.

Connect with peers: The Student Counselling Service in conjunction with the Postgraduate Advisory Service and the Graduate Student Union run a weekly drop in support group ("Grad Chats") during terms times. The Student Counselling Service also runs groups and workshops on general student issues, which can be a good opportunity to learn more about these and connect with other students (see https://www.tcd.ie/Student_Counselling/counselling/groups-workshops/ for more information).

Upskill if necessary: Postgraduate study is designed to be a step up from previous education and may require you linking in with our Student Learning and Development Team who run workshops and training throughout the year and also offer 1:1 appointments (http://student-learning.tcd.ie/).

Ensure you have the right level of support: If you are currently experiencing low mood or anxiety difficulties, or you want to learn more about managing stress you can sign up to our online support programmes at https://ie.silvercloudhealth.com/signup/tcd/.

Enlist the support of other services: see https://www.tcd.ie/students/supports-services/ for a full range of the student support services, clubs, societies available at TCD.

STEP 3: Ask for Help

Even with all of this in place there may come a time where you feel you would benefit from the chance to talk with someone objective about your situation. If you feel that your mental health and wellbeing is being negatively affected or you just need some space to talk through a difficult situation, a disappointment or a loss we would encourage you to book an appointment with us by calling 01 8961407. If you are having difficulty navigating academic processes and procedures, or want some advice about making an academic complaint or an appeal, you can contact the Postgraduate Advisory Service at: https://www.tcd.ie/seniortutor/students/postgraduate/

MyCareer from Careers Advisory Service

An online service that you can use to:

- Apply for opportunities which match your preferences - vacancies including research options
- Search opportunities- postgraduate courses and funding
- View and book onto employer and CAS events
- Submit your career queries to the CAS team
- Book an appointment with your Careers Consultant

Simply login to MyCareer using your Trinity username and password and personalise your profile.

Careers Advisory Service

Trinity College Dublin, 7-9 South Leinster Street, Dublin 2

01 896 1705/1721 | Submit a career query through MyCareer

MyCareer: mycareerconnect.tcd.ie

TCD.Careers.Service

TCDCareers

www.tcd.ie/Careers/students/postgraduate/

@TCDCareers

tinyurl.com/LinkedIn-TCD-Connecting

Opening Hours

During term: 9.30am - 5.00pm, Monday - Friday

Out of Term: 9.30am - 12.30pm & 2.15 - 5.00pm, Monday - Friday

Login. Only two steps - it's easy! Find us on tcd.ie/careers or MyDayApp

STEP 1 Login to MyCareer (using your Trinity username and password)

STEP 2 Update your profile with your email preferences, job and study areas of interest and your career readiness

Trinity College Dublin
Coláiste na Tríonóide, Baile Átha Cliath
The University of Dublin

Careers Advisory Service

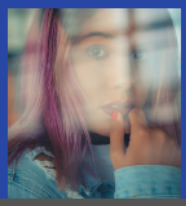
SUPPORTING STUDENTS

SCS Student Counselling Services | SLD Student Learning Development | S2S Student to Student

Tips and referral info for supporting students returning to University

COMMON STUDENT EXPERIENCES AND WORRIES :

- Wish for clear and prompt information and communication
- Feelings of uncertainty
- Anger / Frustration
- Feeling of agitation
- Anxiety and Stress
- Sleep disturbance
- Appetite disturbance
- Isolation
- Low mood
- Lack of motivation



WHAT TO DO?

- Listen - empathy / active listening skills
- Be curious - open questions
- Listen again - summarise / reflect
- Problem solve - referral options / agree on actions
- De-brief / Consult
- Follow up - when / if appropriate and agreed

SOURCES OF SUPPORT

College Health Centre:
Ph: 8961556/ 8961591
https://www.tcd.ie/collegehealth/

Students' Union: www.tcdsu.org

Graduate Students' Union
www.tcdgsu.ie

Senior Tutor:
Email: stosec@tcd.ie
For more info:
https://www.tcd.ie/seniortutor/

Accommodation:
accommodation@tcdsu.org

Education:
education@tcdsu.org

STUDENT COUNSELLING SERVICE:
www.tcd.ie/student-counselling
student-counselling@tcd.ie

Schedule needs assessments
- Daily Emergency appointments
- Staff consultation and training
- Groups & Workshops

http://student-learning.tcd.ie
student.learning@tcd.ie
1:1 consultations
Workshops
Writing Groups
Online Resources

Self-help packs:
http://cci.health.wa.gov.au

SilverCloud
SPACE FOR HEALTHY MINDS

Trinity Student Graduate Attributes