

TS SR

Trinity Student Scientific Review
Volume I

TS SR

Trinity Student Scientific Review

Volume I

Published by the Trinity Student Scientific Review
c/o Faculty of Engineering, Mathematics and Science,
Trinity College, Dublin 2
Republic of Ireland.

All rights reserved.
Copyright © contributors to the
Trinity Student Scientific Review 2015

All views expressed herein are those of the authors and do not
necessarily reflect the views of the editors or sponsors.

This journal claims no special rights or privileges.

Printed by Brunswick Press Ltd.

Cover by David Corish
Photography by Gearóid Gibbs and Benedict Shegog.

The TSSR logo was created by Ger Walsh at Magnet Design in 2014.

The Trinity Student Scientific Review is also available online at
<http://trinityssr.com/>

TS SR

**The Trinity Student Scientific Review
is kindly sponsored by the**

Dr Patrick Prendergast,
Provost of Trinity College Dublin

The Faculty of Engineering, Mathematics and Science
Trinity College Dublin

THE TRINITY STUDENT SCIENTIFIC REVIEW COMMITTEE 2015

General Managers:	Johnny Deane Georgia O'Sullivan
Biology Editor:	Dan McDermott
Chemistry Editor:	Elaine Kelly
Physics Editor:	Dylan Scully
Production Manager:	David Corish
Launch Manager:	Luke McGuinness



Back Row (L to R): Dylan Scully, Dan McDermott, Luke McGuinness,
David Corish

Front Row (L to R): Johnny Deane, Georgia O'Sullivan, Elaine Kelly

Prize-Winning Essays of The Trinity Student Scientific Review 2015

Best Overall Essay:

A Quantam Model of Olfactory Reception

Oskar Ronan

Best Biology Essay:

A Fourth Dimension in the Bacterial Defence
Against Bacteriophage Infections

Matthew Dorman

Best Chemistry Essay:

Targeting ligands and Nanovehicles:
A Novel Approach to Lung Cancer Therapy

Shelley Stafford

Best Physics Essay:

Graphene-Sulfur Composites: A Novel Method in
Developing Advanced Lithium-Sulfur Batteries

Andrew Selkirk

Best Freshman Essay:

The Uses and Limitations of Absorption Spectroscopy
in the Development of Non Invasive Blood Glucose
Monitoring Systems

Kate Reidy

“As Dean of the Faculty of Engineering, Mathematics and Science, it is my pleasure to support the Trinity Student Scientific Review (TSSR), a challenging and innovative initiative by our Science Undergraduate Students. Trinity College is committed to the enhancement of the learning experience of each of its students and TSSR provides a platform in the Faculty for our students to develop the critical academic and literary skills of modern day scientists. TSSR showcases undergraduate academic talent and encourages the recognition of this talent among peers and staff.

This review journal demonstrates the ability of the Editorial Board to collaborate effectively with both academics and industry to reach a successful conclusion and gain invaluable insights into scientific publishing and editing. The production of TSSR demonstrates a combination of enthusiasm, inspiration and organisation that Trinity College actively encourages among its student body.

Science progresses through publication, and TSSR has the potential to stimulate students to pursue further research that ignites their curiosity.”

Prof. Clive Williams
Dean of the Faculty of Engineering, Mathematics and Science
Trinity College Dublin

“I would like to strongly endorse this concept of an undergraduate produced student review journal. It is great that undergraduate students get the opportunity to write scientifically in a serious way at an early stage in their career. It can only help them progress academically and this early exercise of technical writing will be of immense benefit for the rest of their careers.

We should remember that a professional scientist should not only be technically competent and be widely knowledgeable about their chosen subject, but should also aim to be a professional writer. First class written communication is essential for success in getting Grant funding and getting papers published and, more importantly, cited. Writing does not come easy to many. Practice makes it easier.

So in short, TSSR is a great idea which has arrived on the scene at an

appropriate time. The editorial Committee are to be commended for bringing this all together”

*Professor Mike Lyons
Associate Professor, Physical Chemistry and SFI Principal
Investigator in the School of Chemistry, Trinity College Dublin*

“The TSSR is an exciting initiative run by a talented bunch of enthusiastic third-year science undergraduates for the benefits of their fellow students. It provides participants with the invaluable opportunity to experience the peer review process. Students who are successful in getting their original work published at this stage in their career will be at a distinct advantage when it comes to applying for future PhD positions, which is a process that is becoming more and more competitive.”

*Dr Rachel McLoughlin
Assistant Professor in Immunology
Trinity Biomedical Sciences Institute*

“I’m delighted to be involved with the Trinity Scientific Review. The publication is a great opportunity for students to hone their writing and share their ideas with the world. It’s also a brilliant way for students on the editorial board to gain organisational skills that will be invaluable throughout their future careers.”

*Dr Natalie Cooper
Assistant Professor
Macroecology and Macroevolution Research Group
Trinity College Dublin*

“This is a great idea, highlighting exciting developments in science from the students’ point of view”

*Professor John McGilp
Professor of Surface and Interface Optics
Trinity College Dublin*

“I am very happy to support the Trinity Scientific Review. The more we can communicate the science we do the better - for our colleagues, students and the broader community. I look forward to reading the interesting reviews that will appear.”

*Professor Luke O'Neill
Chair of Biochemistry
Trinity College Dublin*

“The Trinity Student Scientific Review is a great idea for helping students to research and write up topics they are interested in. In this way they can experience the pleasure of sharing with others their enthusiasm for science. For over 40 years I’ve shared with Trinity students my own enthusiasm for physics, and encourage all students to give this initiative their support. I wish the Review and all those involved every success”

*Dr. Eric Finch
Fellow Emeritus and Senior lecturer in Physics
Trinity College Dublin*

The Trinity Student Scientific Review was kindly supported and endorsed by the Science Gallery, Trinity College Dublin.





TRINITY COLLEGE DUBLIN
COLÁISTE NA TRÍONÓIDE, BAILE ÁTHA CLIATH

THE
UNIVERSITY
OF DUBLIN

M.SC. IN IMMUNOLOGY

SCHOOL OF BIOCHEMISTRY & IMMUNOLOGY, TCD

Commences September



Modules (1 year full time)

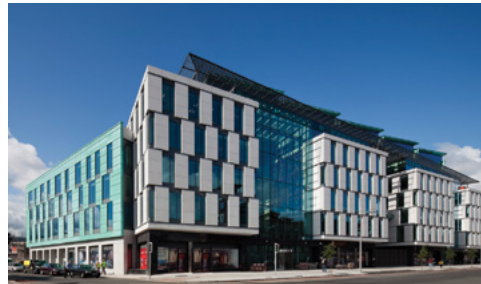
- Basic Immunology
- Immunological Techniques
- Communicating Science & Critical Analysis
- Immunogenetics
- Microbe Detection and Evasion
- Clinical Immunology
- Parasite Immunology
- Tumour Immunology
- Global Infectious disease
- Immunotherapeutics & Product Development
- 12 week Immunology Research Project

Application Website

www.tcd.ie/apply/mscimmunology

Contact

Director: Cliona O'Farrelly
Co-ordinator: Nigel Stevenson
Email: N.Stevenson@TCD.ie
Web: <http://www.tcd.ie/Biochemistry>



Admission

This M.Sc. is designed for graduates aiming to pursue careers in academic research, medicine or the pharmaceutical industry, for which a thorough grounding in immunology, immune-mediated pathogenic mechanisms and immunotherapy is required. Applicants are required to hold at least an Upper Second Class Honours degree (2.1) in Medicine, Veterinary Science, Dentistry, Molecular Biology, Genetics, Immunology, Biochemistry or any Biological Science.



Trinity Student Scientific Review

TS
SR

Prelude

Welcome Message

Johnny Deane & Georgia O'Sullivan, General Managers

xiv

Biology

Letter from the Editor

Dan McDermott

2

Best Biology Essay:

A Fourth Dimension in the Bacterial Defence Against Bacteriophage Infections

Matthew Dorman, Junior Sophister

4

Lysine Methylation of the p53 Tumour Suppressor: Analogies with Histone Biology

Hayley Porter, Junior Sophister

20

DNA Vaccines

Jeremy Dover, Junior Sophister

34

Thromboxan A2 Receptor (TPR α): A Potential Human Drug Target

Judy Conmey, Senior Sophister

48

Man's best friend? Human-Canid Conflict in the 21st century*Holly English, Senior Sophister*

66

Immunoglobulin Binding Proteins of *Staphylococcus Aureus**Kelly Murray, Junior Sophister*

76

Natural Killer Cells - More than Meets the Eye*Karen Slattery, Junior Sophister*

90

First Line Treatment of Chronic Lymphocytic Leukaemia and the Impact of Genetic Abberations in Chemotherapy*Tristan Kwan, Junior Sophister*

104

Chemistry

Letter from the Editor*Elaine Kelly*

118

Best Chemistry Essay:**Targeting ligands and Nanovehicles:
A Novel Approach to Lung Cancer Therapy***Shelley Stafford, Junior Sophister*

120

Best Freshman Essay:

**The Uses and Limitations of Absorption Spectroscopy
in the Development of Non Invasive Blood Glucose
Monitoring Systems**

Kate Reidy, Senior Freshman

134

**Production of Hydrogen and its Role in the Transition
to a Clean Energy Economy**

David Madden, Senior Freshman

148

Minor DNA Groove Binding Agent Optimisation

Rory Scanlon, Senior Freshman

162

**Developments in Metal Organic Frameworks for
Utilisation in Catalysis**

Joseph Eiffe, Junior Sophister

176

Physics

Letter from the Editor

Dylan Scully

192

Best Overall Essay:

A Quantam Model of Olfactory Reception

Oskar Ronan, Junior Sophister

194

Best Physics Essay:

Graphene-Sulfur Composites: A Novel Method in Developing Advanced Lithium-Sulfur Batteries

Andrew Selkirk, Junior Sophister

206

Enceladus: Plume Composition and Interactions in the Saturnian System

Jessica Erkel, Junior Sophister

222

Metamaterials - Future of Cloaking

Katarzyna Siewierska, Junior Sophister

234

Implications of a 125 GeV Higgs Boson for the Minimal and Next-To Minimal Supersymmetric Standard Model

Brian Ó Fearraigh, Junior Sophister

250

Welcome

On behalf of the Editorial Board and the Committee, we would like to welcome you to the first ever edition of the Trinity Student Scientific Review.

It has been a pleasure working with our dedicated team of students and academics over the past few months in producing this publication, and we are so pleased to be able to showcase such a high standard of academic talent from our fellow students. This standard meant our editorial teams had their work cut out for them when it came to choosing the best articles, and the following pages are a testament to the quality and talent of Trinity students.

Our aim for the TSSR was to provide Trinity science undergraduates with an opportunity to bridge the gap between their degree and the research-driven world of science by engaging in an area of particular interest to them. In writing this it is important to acknowledge the Student Economic Review here in the University as a source of inspiration for the TSSR. Professor John O'Hagan and his team of students from the Department of Economics succeed in producing a wonderful journal every year, providing their students with the opportunity to be published as undergrads. The SER has become part of the fabric of academic and student life in the department, which is something we hope for the TSSR to achieve.

The establishment of the TSSR this year would have been impossible without the overwhelming encouragement and enthusiasm of the academics we initially approached, and we are very grateful to Dr Andrew Jackson of the Department of Zoology, Professor Werner Blau of the Department of Physics, and Dr Mike Southern of the School of Chemistry. Without them, we would not have accomplished half of what we did. The Trinity Student Scientific Review will grow and develop with them as continuing academic advisors. To the postgraduate students and academics who made the editorial process run smoothly, efficiently and fairly, we are grateful for your time and your invaluable contributions.

None of what we have achieved this year would have been possible without the generous sponsorship we received from the University itself. We would like to sincerely thank Dr Patrick Prendergast, Provost of Trinity College Dublin, for recognising the potential of the TSSR and ensuring we went to print this year. To Professor Clive Williams, Dean of the Faculty of Engineering, Maths and Science, we are extremely grateful for your immediate and full support from the very start. To the wonderful staff in the Faculty office, we are indebted to you and your patience when we were running up and down the stairs to knock on your door.

If we were to list everyone who has gone out of their way to offer invaluable advice these past few months we would have a publication twice the size it is now, so to keep this as short and as sweet as possible know that we are indebted to every single one of you.

Our fellow founding members of this publication deserve our biggest thank yous; Dan McDermott, Dylan Scully, Elaine Kelly, Luke McGuinness and David Corish, you made our jobs easier by being so good at yours. It was a pleasure, a privilege and a lot of fun working with you.

We are looking forward to seeing the TSSR grow to become a firm fixture in the undergraduate academic calendar. We hope that the work we have done these past few months has laid the foundations for the Trinity Student Scientific Review to go on and become a platform for Trinity science students to explore their own research interests, and we know these exceptional students that come through Trinity College Dublin will ensure the success of the TSSR for years to come.

Johnny Deane & Georgia O'Sullivan
General Managers
Trinity Student Scientific Review 2015

Biology

TS

SR