The Royal Society OF VICTORIA
Promoting science since 1854

PATRON: The Hon Linda Dessau AC
Governor of Victoria

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This Month's Events…

12th July: Arthur Lowery
2018 ATSE Joint Lecture
"Bionic Vision: The Brain-Machine Interface"

August 2018 Advance Notice:

9th August: Andrew Pask
"Beyond Extinction: the Power of Genomics"

11th – 19th August: National Science Week

July 2018 Newsletter

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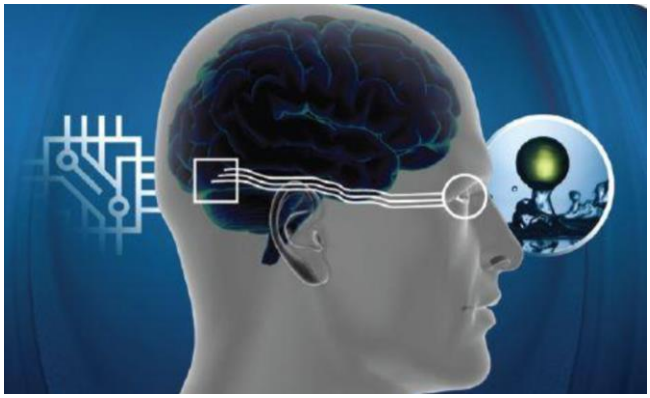
The Royal Society of Victoria Inc.
8 La Trobe Street,
Melbourne Victoria 3000
Tel. (03) 9663 5259
rsv.org.au

July Lecture

*2018 Joint Lecture with **ATSE Victorian Division***



Bionic Vision: The Brain-Machine Interface

Thursday, 12th July 2018 at 7:00pm

Speaker: Professor Arthur Lowery

Director, Monash Vision Group
Department of Electrical & Computer Systems Engineering,
Monash University

How are engineers and clinicians connecting specialised machines with our brains, and how far can we take this rapidly-evolving relationship?

The cortex – or cerebrum – is the largest part of the human brain, associated with higher brain function such as thought and action. Cortical implants are at the forefront of exciting new developments in bioengineering and neurosurgery, providing the human brain with new opportunities for direct interaction with the world outside the body, with particular application to overcoming the body's physical impairments.

The Monash Vision Group is a consortium of engineers and biomedical scientists, bringing together colleagues from Monash University, clinicians from the Alfred Hospital and two biofabrication companies (MiniFAB and Grey Innovation). This dynamic team is developing implants for the brain's cortex, along with a sophisticated electronic system and software, to provide patients with a new source of vision to aid in daily life.

Join Professor Arthur Lowery, an Electrical and Computer Systems Engineer leading the Monash Vision Group, to explore the challenges in interfacing with the brain via wireless connections, and the opportunities for brain-machine interfaces that may follow.

About the speaker:

Professor Arthur Lowery is a Professor of Electrical and Computer Systems Engineering at Monash University, Clayton. He is a past ATSE Clunies-Ross Award recipient and was inducted as an ATSE Fellow for his work developing design software for optical telecommunications devices and systems. He is currently an ARC Laureate Fellow working on the convergence of electronic and photonic technologies.

Places limited, bookings essential! Register online now at https://rsv.org.au/events/bionic-vision/ , call or email the RSV office to secure your place: 9663 5259, rsv@rsv.org.au

Nominations for RSV Membership

Nominations for membership of the Society have been received on behalf of:

Mr Christopher **QUINN**, Program Manager, Office of the Surveyor General
Mr Sina **KHATAMI**, PhD Candidate, The University of Melbourne

Young Scientist Research Prizes Applicants:

Miss Thy **NGUYEN**, PhD Student, The University of Melbourne
Ms Georgia May **PARKIN**, PhD Student, The University of Melbourne
Miss Michelle Carla **MAIER**, PhD Student, Federation University
Ms Wenyue **ZOU**, PhD Student, RMIT University
Mr Shaun **HOPPER**, PhD Student, The University of Melbourne
Mrs Anindita **SAMSU**, PhD Student, Monash University
Miss Sonia Louise **FIDDES**, PhD Student, The University of Melbourne
Mr Paul Thomas **BATTLAY**, PhD Student, The University of Melbourne
Mr Arooran **SUANI**, PhD Student, The University of Melbourne
Ms Marice **SOUNTHARARAJAH**, PhD Student, Monash University
Miss Jiry **SHARY**, PhD Student, The University of Melbourne
Miss Li **CONGYING**, PhD Student, The University of Melbourne

Mr Yang **WANG**, PhD Student, Monash University
Mr Araz **NASIRIAN**, PhD Student, RMIT University
Miss Vera **KORASIDIS**, PhD Student, The University of Melbourne
Mr Aidan James **KASHYAP**, PhD Student, Monash University
Mr Axel Harris **NEWTON**, PhD Student, The University of Melbourne
Miss Yilin **KANG**, PhD Student, The University of Melbourne
Mr Brett Joseph **KAGAN**, PhD Student, The University of Melbourne
Ms Georgia Kate **ATKIN-SMITH**, PhD Student, La Trobe University
Mr Hoang Tuong Nhu **NGUYEN**, PhD Student, Monash University
Mr Radhika Shehan **VIDANAGE DE SILVA**, PhD Student, Monash University
Ms Rochelle **TIXEIRA**, PhD Student, La Trobe University
Miss Victoria Elizabeth **COYLE**, PhD Student, RMIT University
Miss Emily Laura **GULLIVER**, PhD Student, Monash University
Ms Phoebe Ann **BURNS**, PhD Student, The University of Melbourne
Ms Kathryn Lesley **RUSSELL**, PhD Student, The University of Melbourne
Miss Remika **MITO**, PhD Student, The University of Melbourne
Miss Simone **PARK**, PhD Student, The University of Melbourne
Mr Mallawa Arachchi **SUDARAKA**, PhD Student, Monash University

Unless Members request a ballot, these will be considered for election by Council and if elected, will be announced at the Ordinary Meeting of the Royal Society of Victoria to be held on 9th August 2018. Recently elected members who have not yet signed the Society's membership book are warmly invited to attend the 12th July meeting to be formally welcomed as members. **Please inform the office if you plan to attend, so we can prepare your membership certificate for collection.**

A number of established members have indicated they have never had an occasion to 'sign in' – again, please let us know at the office if you'd like to rectify the situation, and we'll make sure you get the opportunity!

Outcomes of the 2018 Special General Meeting

Architect Dylan Brady presenting the "Magic" proposal to RSV Members

Following four "town hall" meetings over the past six weeks and a slew of project communications, the Society met for a Special General Meeting on the evening of 21 June for an historic vote on undertaking the "Magic" project - a new opportunity for the Society to sustainably fund science engagement and literacy programs in Victoria, and a new benchmark for sustainable, high-quality development in the CBD.

Following a lengthy room discussion, the vote was held, with the result in favour of moving ahead with the proposal. There were 97 votes in

favour of the motion, 24 against, and one abstaining.

Decompressing in the Burke and Wills Room over food and drink – the 21st June actually *was* the longest night of the year, being the winter solstice!

With this endorsement in hand from our members, our Council is now planning a careful process for further member involvement and consultation in the many aspects of the project, securing funding to appoint a suitably skilled project manager, and preparing a range of assessment materials to help the Society navigate a most ambitious undertaking - a fascinating exploration not just of the complexity of urban development, but of the boundaries of 21st century engineering and green tech. The biggest science project in our recent history is about to get started.

We will provide regular updates from our Council on the project, including opportunities to get involved, via our newsletters and regular meetings. Meanwhile, submissions and enquiries from our members are invited at ceo@rsv.org.au .

Fighting Superbugs: Biomimetic Nanotechnology

The article below follows an excellent presentation to the Society on the evening of Thursday, 26th April 2018 from ***Professor Elena Ivanova****, Professor of Nanobiotechnology at RMIT University.*

By Catriona Nguyen-Robertson and Scott Reddiex

"The future of humanity and microbes will evolve as episodes…of our wits versus their genes" – Nobel Laureate Joshua Lederberg

How do we fight bacteria when some "superbugs" can now resist all known antibiotics? As pathogens evolve to resist antibiotic drugs as fast as we can develop them, we need to start thinking about alternative approaches. Fortunately, an answer could potentially be found in nature.

Professor Elena Ivanova, 2017 Winner of the UNSW Eureka Prize for Scientific Research

Naturally occurring antibacterial surfaces exist, and we are able to replicate them using biomimetic nanotechnology – "bactericidal" structures on a nanometre scale that mimic those that exist biologically, which can be used to coat clinical instruments and medical environments to protect patients.

Bacteria are the oldest and most numerous life forms on the planet and, having undergone 3.8 billion years of evolution, are adaptable to almost every environment. Antimicrobial resistance is a major global health issue that imposes a significant financial burden to healthcare and commercial sectors, and has the potential to reverse the substantial progress made against infectious diseases in the past 90 years since the discovery of penicillin by Sir Alexander Fleming (1928). While antibiotics have reduced the burden of infectious disease in that time, antibiotics that were once regarded as miracle drugs are no longer working, and a recent report from the UK estimates that, by 2050, nearly 10 million people are likely to die from drug-resistant infections if the current trends persist[1]. In 2016, a 56-year-old man from rural Victoria with no history of hospital contact or international travel died from *Klebsiella pneumonia* infection, which was resistant to all antibiotics in the country[2]. These reports highlight the scale of the antimicrobial resistance crisis that is confronting the world.

To address this problem, RMIT University's **Professor Elena Ivanova** is taking a different approach that doesn't give bacteria the chance of survival: mimicking surfaces found in nature to develop self-sterilising materials that kill bacteria upon physical impact.

Professor Ivanova has always been interested in the biological sciences, originally wanting to become a marine biologist despite living far from the ocean. Instead, she was expected to become a doctor and started a medical degree, but switched streams into biochemistry and obtained her PhD. Her career has taken her from the Ukraine and Russia to Japan, the UK, France, and finally Australia. She worked at Swinburne University in Melbourne for 17 years, where she

was awarded the prestigious UNSW Eureka Prize for Scientific Research in 2017. In order to explore new opportunities, she moved to RMIT in 2018, setting up her own lab to investigate and develop nanosurfaces to be used in medical devices and implants that can prevent bacterial contamination.

Prof Elena Ivanova with RSV President David Zerman.

Designing a surface that can universally kill all bacteria types is no easy task, as bacteria are an exceedingly diverse group of organisms. Professor Ivanova produces antimicrobial surfaces that are both anti-biofouling (preventing bacterial attachment) and bactericidal (able to kill bacteria). The starting point for her work was to investigate the impact of surface topography (shape) on bacterial growth. She discovered that, in colonising surfaces, bacteria were far more susceptible to the 'roughness' of the surface on a nanometre (nm) scale than expected – to the extent that changing the height of nanopillar structures on a glass surface from 2.1nm to 1.2nm showed a difference in bacterial adhesion to the glass.

Professor Ivanova began investigating how self-cleaning surfaces in plants and insects maintain their clean surfaces. Due to the combination of their surface chemistry and topography, some insect wings and leaves can be "superhydrophobic" – extremely resistant to becoming wet – and all contaminants are removed when water washes over their surfaces. In collaboration with Lazer Zentrum Hannover, she wanted to recreate the surface of lotus leaves using titanium, a common metal used in medicine for orthopaedics, dental implants and surgical tools. After reproducing the grainy structure of lotus leaves on metal, she found that rod-shaped bacteria (bacilli) were unable to settle on the surface, but spherical bacteria (cocci) were still able to colonise the surface within an hour.

Undeterred, Professor Ivanova next looked to insect wings for the answer, starting with the very efficient bactericidal nature of cicada wings. In a collaboration with a soft matter theory group led by Vladimir Baulin at Universitat Rovira I Virgili, she modelled the bacteria-killing mechanism of cicada wings and it appeared that the physical structure of the surface was critical: any bacterial cell that came into contact with nanopillars on the wing (the miniscule peaks on the surface) was subject to high stress, leading to the membrane being sheared apart. The bactericidal nature of cicada wings, however, was limited to killing gram-negative bacteria but not gram-positive bacteria. All bacterial species can be classified as either gram-negative (e.g. *E. coli*) or gram-positive (e.g. *Staphylococcus aureus*) depending on the composition of their cell membrane, making this innate distinction in bactericidal ability intriguing.

A cicada's wing, providing the model for a bactericidal nanosurface for reproduction in clinical settings.

Professor Ivanova therefore next investigated the superhydrophobicity of dragonfly wings. Dragonfly wings are comprised of a disordered array of nanopillars, covered in fatty acids and alkane lipids, however there is remarkable difference in their killing efficiency between species due to their particular nanopattern variation. After studying the nano-topology of insect wings and lotus leaves, Professor Ivanova and her team exploited their structures to create biomimetic nanostructured surfaces that physically tear bacteria while leaving much larger eukaryotic human cells unscathed.

The nanopattern of the wings can be etched into black silicon wafers – a synthetic analogue of dragonfly wings – to kill bacteria to the same degree as the wings, or even better. She also attempted to recrystallise the fatty acids found in insect wings on graphite, and this scientific curiosity lead to the creation of another bactericidal surface.

Professor Ivanova presenting to the RSV audience.

Collectively, these surfaces that can specifically target bacteria provide an alternative to chemical agents and an exciting opportunity for the development of antibacterial materials for a wide range of industrial and biomedical applications.

Inspired by nature, Professor Ivanova and her team have generated bactericidal surfaces that rupture bacteria in a few hundred seconds. The rapidness at which they kill ensures that there is little opportunity for bacteria to adapt and become resistant. In the middle of a global antimicrobial resistance crisis, Professor Ivanova's work provides hope that we haven't yet lost the fight against superbugs!

References:

1. O'Neill, J. The review on antimicrobial resistance. Tackling drug-resistant infections globally: final report and recommendations. 2016.
2. Mandrawa, C.L. *et al.* Carbapenemase-producing Klebsiella pneumoniae: a major clinical challenge. *Med J Aust* 204, 277-278 (2016).

National Science Week – Call for RSV Volunteers

Help us Make Victoria's Science Week a Success!

National Science Week is coming up, officially spanning 11 to 19 August (with a bit of action either side). Already there are 63 events and 14 competitions registered for Victoria on the national site, and the Society is charged with getting everyone "kitted up" and ready to be a part the national effort.

We need your help getting materials out to event holders across the state. We've set aside the afternoon of Wednesday, 18th July from 1 to 5, transforming the Burke and Wills Room into the "**Science Week Dispatch Centre**!" We need all hands on deck to help us package up materials, label boxes and get all the Science Week gear out to libraries, community centres, schools, local governments and universities in metropolitan, regional and rural Victoria.

If you have some time you can spare to assist, we'd be grateful if you could register your name on our volunteer list at https://rsv.org.au/events/science-week-volunteers/ or call us during business hours on (03) 9663 5259.

Why is Australia the Food Allergy Capital of the World?

By Scott Reddiex and Catriona Nguyen-Robertson
RSV Science Communications

**This article follows a presentation to the Royal Society of Victoria by Professor Katie Allen titled "Why is Australia the Food Allergy Capital of the World?" on 10 May, 2018.*

Professor Katie Allen

If you are unable to remember many children having an allergy when you were young, and have thought that it seems as though these days every second child has some kind of allergy, you're not mistaken. The rate of food allergy in children has exploded over the last 30 years – from almost non-existence prior to the 1980s to >10% of infants tested in a Melbourne-based study having a verifiable food allergy in 2011[1].

With such a drastic increase in allergy, particularly in Australia, there are three questions that are typically raised: 'why is this happening?', 'how do we treat this?', and 'how can we stop this?' Professor Katie Allen is a clinician and medical researcher at the Royal Children's Hospital (RCH) and the Murdoch Children's Research Institute (MCRI), whose work for over a decade has focused on answering these questions with the ultimate goal of reducing the rate of allergies to zero.

Professor Allen comes from a long line of medical professionals: her father, grandfather and great aunt were doctors, and her mother and grandmother were nurses. Her father cared deeply about his profession and the community,

and would occasionally take her on ward rounds as she grew up, where she learned to check pulses, and fainted at the sight of leg splints. In what could have led to a different future, however, she very nearly became a journalist, making it down to the final six applicants out of 800 who applied to join *The Age*. In an incredibly fortunate turn of events for us, she was unsuccessful, and studied medicine instead.

Katie Allen with RSV audience

Professor Allen caught the bug for medical research during her fellowship in Chicago. While undertaking a month of pathology research training, examining countless paediatric liver transplant biopsies through a microscope, her professor suggested she ask a research question to make the tedious task more interesting. She rose to the challenge and researched centrilobular necrosis (CLN), a necrotic liver condition. During her first ward round after publishing a paper on CLN, she came across a patient who appeared to have the condition, however the senior doctors had thought to have ruled it out after an ultrasound revealed nothing. Dr Allen insisted that an angiogram be performed to confirm her suspicions, and the result showed that they were well founded – the child indeed had CLN, and received a new liver the following day. Her work has led to the reduction in mortality due to CLN from 30% to nearly zero. Professor Allen is dedicated to improving clinical practice, and considers herself more of a medical researcher than a scientist – her distinction being that she is driven by a focus on her patients.

In examining factors that affect our health, much has changed in the way we live over the past 50 years: better sanitation, lower rates of infection, and a decrease in tobacco usage have improved the average quality of life, while maternal age, urbanisation, and rates of obesity have also risen in this time. Professor Allen sought to identify whether any of these factors could be contributing to the increased rates of food allergy.

Having seen first-hand the increasing number of children with allergic reactions admitted to the RCH, Professor Allen and her group of researchers sought to identify the exact rate of food allergy in the population and devised the HealthNuts study. The study followed 5300 children from Melbourne aged 1 to 10 and assessed their reactions to specific foods known to commonly trigger allergic reactions (allergenic foods) – peanut, egg, cow's milk and sesame. It found that over 10% of children had 'challenge-proven allergy', which is when a child is observed to have an allergic reaction to a specific food and treated in a safe clinical setting.

From the data collected as part of the HealthNuts study, three hypotheses for the reasons behind the rise in allergy were developed, collectively known as the '5 D's'[2]:

1. **D**ry skin and **D**iet
2. Vitamin **D**
3. **D**ogs and **D**ribble

The 'Dry skin and Diet' hypothesis, relates to eczema occurrence and diet in the first years of life. The HealthNuts study revealed that children who experienced eczema within the first 12 months of life had increased risk of developing allergy, and the risk was further increased the more severe and earlier in life the eczema appeared. The study also found that introducing allergenic foods into the diet within the first year of life significantly reduced the risk of developing an allergy – even for those children classified as 'high risk'. In addition to studies by other research groups, these findings suggest that the route of allergen exposure is important in determining whether a child will develop allergy. When allergens eaten by the child are encountered by the immune system in the gut, the immune system becomes 'tolerant' towards them. In contrast, allergens encountered by the child through damaged skin in the case of eczema, skew the immune system towards an allergic response to the foreign compound, as it is perceived by the immune system as being more invasive. The Australasian Society of Clinical Immunology and Allergy (ASCIA) has developed guidelines for infant feeding and allergy informed by these findings (accessible from https://www.allergy.org.au/patients/allergy-prevention/ascia-guidelines-for-infant-feeding-and-allergy-prevention).

The 'Vitamin D' hypothesis stems from the finding that the rate of Australian children with peanut allergy increases the further south they live. The relationship between vitamin D deficiency and allergy development is particularly evident in Australia, one reason being the fortification of milk in the USA, UK and Europe with vitamin D, and vitamin D drops are recommended to European children early in life to supplement their comparatively lower sunshine exposure. This hypothesis is complemented by the HealthNuts study findings, which revealed that children who were vitamin D deficient were 11 times more likely to have peanut allergy, and studies that demonstrate that low levels of vitamin D skew the immune system towards activation rather than tolerance. Professor Allen's next step in testing this particular hypothesis is to perform clinical trials – with grants awarded by both the Australian and US governments, the study will assess whether vitamin D drop supplementation has a significant impact on allergy development in a cohort of 3000 infants.

RSV Vice-President Mrs Nicola Willams with Professor Katie Allen & RSV Councillor Professor David Walker (Vote of Thanks).

The third of the hypotheses, 'Dogs and Dribble', relates to microbial diversity in our gastrointestinal tract (the microbiome) and its relationship with our immune system. Allergy rates have risen faster than our genes can change, therefore suggesting that some environmental factors are also to blame. Interestingly, it has been found that owning a dog and having older siblings both appear to be protective against developing allergy, and this is thought to be due to a greater exposure to germs. Professor Allen's colleague at MCRI, Professor Mimi Tang, has developed a peanut allergy treatment that incorporates the introduction of a probiotic and doses of peanut simultaneously to induce tolerance, therefore strengthening the hypothesis that bacteria have a role to play.

While most studies Professor Allen discussed focus on peanut allergy, she is now looking beyond at other allergens. The allergy situation in Australia is dire and has reached the stage where parents have parked outside hospitals around Australia to feed their children peanuts and other allergenic foods for the first time, with the fear that their child could have a severe reaction requiring immediate hospital attention. Professor Allen's vision is to prevent food allergy in Australian children, and she aims to translate her research findings into clinical practice and public health policy to ensure the best outcomes for children both here and around the world.

More information on the HealthNuts study and the publications it has contributed to so far is available at the Murdoch Children's Research Institute website at https://www.mcri.edu.au/research/projects/healthnuts .

References:

1. Osborne, N.J. *et al.* Prevalence of challenge-proven IgE-mediated food allergy using population-based sampling and predetermined challenge criteria in infants. *J Allergy Clin Immunol* **127**, 668-676 e661-662 (2011).
2. Allen, K.J. & Koplin, J.J. Prospects for Prevention of Food Allergy. *J Allergy Clin Immunol Pract* **4**, 215-220 (2016).

Final Call for Nominations

The RSV Medal for Excellence in Scientific Research

Our distinguished Medal is currently open for nominations! Please consider the achievements of your colleagues in the biomedical and health sciences, and follow the link below to learn more.

The award of the Medal is based on demonstration of the candidate's excellence and leadership in scientific research. Nominations are invited in **Category II: Biomedical & Health Sciences. Nominations close at 5pm on 31 July, 2018.** Please see https://rsv.org.au/awards-and-prizes/research-medal/ for full details on making a submission.