LA TROBE UNIVERSITY

LA TROBE INSTITUTE FOR MOLECULAR SCIENCE

LIMS ANNUAL REPORT 2019

La Trobe Institute for Molecular Science

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TRANSLATABLE MOLECULAR DISCOVERIES

LAUNCHED BY LA TROBE UNIVERSITY IN 2009, THE LA TROBE INSTITUTE FOR MOLECULAR SCIENCE (LIMS) BRINGS TOGETHER THE UNIVERSITY'S LEADING RESEARCHERS TO WORK ON SOME OF THE MOST CRITICAL PROBLEMS AT THE INTERFACE OF HEALTH AND SCIENCE.

The La Trobe Institute for Molecular Science vision of excellence is achieved through four thematic areas of research strength: Cancer, Infection and Immunity, Molecular Design and Nanoscience.

The research agenda of LIMS is supported by a collaborative culture and modern facilities, where scientists in diverse disciplines work together to achieve remarkable outcomes that would not be possible in traditional academic settings.

Within LIMS are two embedded biotech companies. Hexima is a biotechnology company actively engaged in the research and development of plant-derived proteins and peptides for applications such as human therapeutics. AdAlta is an innovative, clinical stage biotech company developing a unique range of new drug treatments.

LIMS also has strong links with both the Australian Synchrotron and Melbourne Centre for Nanofabrication. A number of the Institute's researchers work with these facilities to develop new capabilities and to help translate their research.

And an important collaboration with the Olivia Newton-John Cancer Research Institute facilitates the sharing of knowledge, skills, training and facilities.

These mutually beneficial partnerships enhance the Institute's efforts to raise its research capabilities to new levels of national and international significance.

LIMS
AT A GLANCE

>400
ACADEMIC STAFF AND POSTGRADUATE STUDENTS

>60
LABORATORY HEADS

6
ARC FUTURE FELLOWS
2 DECRA FELLOWS

4
NHMRC FELLOWS

1
VCA MID-CAREER FELLOWSHIP

3
SIEF FELLOWSHIPS

202
WEB OF SCIENCE PUBLICATIONS (2019)

1.52
SCOPUS FIELD WEIGHTED CITATION IMPACT

ERA RANKINGS:

5
BIOCHEMISTRY AND CELL BIOLOGY; ANALYTICAL CHEMISTRY; OPTICAL PHYSICS; CONDENSED MATTER PHYSICS; GENETICS; MEDICAL AND BIOMOLECULAR CHEMISTRY

4
INORGANIC CHEMISTRY; PHYSICAL CHEMISTRY

>$41M
EQUIPMENT ACROSS 3 CAMPUSES

>900
INDIVIDUAL PIECES OF EQUIPMENT

LIMS RESEARCH THEMES:

CANCER
INFECTION AND IMMUNITY
MOLECULAR DESIGN
NANOSCIENCE

FACILITIES:

– HISTOLOGY
– COMPREHENSIVE PROTEOMICS PLATFORM
– BIOIMAGING PLATFORM
– PHYSICS WORKSHOP
– STORE

RESEARCH CENTRES:

– MATERIALS AND SURFACE SCIENCE
– MOLECULAR CANCER PREVENTION
– EXTRACELLULAR VESICLES
– BIOMEDICAL AND ENVIRONMENTAL SENSOR TECHNOLOGY

EMBEDDED BIOTECHNOLOGY COMPANIES:

HEXIMA LTD
ADALTA LTD

DIRECTOR'S REPORT

2019 WAS A YEAR OF CELEBRATION, A YEAR OF REFLECTION AND A YEAR OF CHANGE. LIMS REACHED A MAJOR MILESTONE – WE MARKED THE FIRST TEN YEARS IN THE LIFE OF OUR INSTITUTE. TEN YEARS OF OUTSTANDING ACHIEVEMENTS, OF SCIENTIFIC BREAKTHROUGHS, OF HARD WORK AND PERSEVERANCE, OF COLLABORATIONS AND PARTNERSHIPS.

To commemorate this milestone a symposium was held in December. "LIMS10" was celebrated in the Nicholas Hoogenraad Auditorium in the LIMS 1 building on La Trobe University's Melbourne campus. The room was filled to capacity, with over 200 guests who watched the opening address by La Trobe University's Vice-Chancellor, Professor John Dewar.

Presentations included our annual Max O'Connor Lecture (Chemistry) and Bruce Stone Lecture (Biochemistry), delivered by Dr Brad Sleebs and Professor Nick Hoogenraad AO, respectively. Many of our past Hoogenraad and Stone Fellows gave a brief overview of their research and discussed the impact the fellowship has had on their career.

LIMS10 offered the chance to reflect on the success of our fellowship scheme. Each of our Fellows has leveraged their LIMS appointment into other prestigious fellowships. Several of our young Fellows barely had time to take up their LIMS Fellowship before they moved onto their new funding. Our most recent Bruce Stone Fellow, Dr Donna Whelan, has been awarded an ARC DECRA – the first to a staff member from our Bendigo campus. Donna takes up this award in 2020.

Nick Reynolds is our newest recruit to a LIMS fellowship, a Hoogenraad Fellow. Nick commenced with LIMS in October 2019. He comes to us with a PhD from Sheffield in the UK and postdoctoral experience in Switzerland, the CSIRO and Swinburne University. He is a true cross-disciplinarian, deftly collaborating across the Physics, Chemistry and Biochemistry disciplines.

LIMS10 also provided us an occasion to launch our fundraising campaign. We believe wholeheartedly that our early career researchers – Nick, Donna and their colleagues – will achieve research outcomes that have meaningful and wide-ranging impact. We plan to establish a third fellowship and we are inviting contributions from staff, students and members of the public to help us make this happen.

The School of Molecular Sciences experienced its first School Review in 2019. In conjunction an internal review of LIMS was held. Both reviews endorsed a program of reimagining and strengthening LIMS, and this will be a focus for 2020 and beyond.

The year saw changes to the LIMS Advisory Board. We welcomed several new members: Professor Sue Dodds (replacing Professor Keith Nugent), Professor Megan Fisher, Professor Helen Irving, Mr Stephen May (replacing Dr Alan Watkinson) and Dr Fiona Cameron, who has agreed to take on the role of Chair of the Board. We thanked Dr Nick Samaras, who resigned from the Board after almost 10 years of service to LIMS.

And we farewelled Professor Andrew Hill towards the end of 2019. After steering LIMS through the 10-year anniversary celebrations and the School Review, Andy took up an opportunity in the University's College of Science, Health and Engineering to become Associate Provost (Research and Industry Engagement). Andy works closely with Professor Rob Pike (College Provost and a previous Director of LIMS) while his research team continues to work within LIMS. I give sincere thanks to Andy for his dedication to and leadership of the Institute.

It was with great pleasure and humility that I took on directorship of the La Trobe Institute for Molecular Science in 2019. Many of you will know I am also Head of the School of Molecular Sciences at La Trobe University. In that role I have been a member of the Advisory Board and a stalwart supporter of LIMS. I was also the inaugural LIMS Fellow in 2011 during the initial LIMS Fellowship scheme. My connection with LIMS runs deep.

As we move into 2020 we face research funding schemes where grants are becoming more difficult to obtain and a University looking to define itself against a backdrop of decreased federal funding and increased competition. The next few years will likely be challenging but I look forward to guiding the Institute and its staff to find ways to flourish and bring translatable molecular discoveries to the world.

Professor Brian Smith
Director

LEADERSHIP TEAM

LIMS IS LED BY AN EXPERIENCED TEAM THAT UNDERSTANDS THE IMPORTANCE OF SCIENTIFIC INNOVATION AND TRANSLATABLE RESEARCH OUTCOMES.

Professor Brian Smith

Professor Brian Smith is the Director of LIMS and Head of the School of Molecular Sciences.

Professor Smith obtained his PhD in Chemistry at the University of Melbourne. He held a postdoctoral position at the Research School of Chemistry in Canberra before returning to Melbourne in 1991 to join the Biomolecular Research Institute (BRI) as a research scientist. After the demise of the BRI in 2000, he moved to the Walter and Eliza Hall Institute of Medical Research as a founding member of the Structural Biology division. In 2011, he moved to La Trobe University, where he was appointed the inaugural LIMS Principal Research Fellow. In 2015, he became Head of the Department of Chemistry and Physics, and then Head of the School of Molecular Sciences in 2017.

Professor Smith is a Fellow of the Royal Australian Chemical Institute and a Fellow of the Royal Society of Chemistry. He is skilled in the determination of protein structure by X-ray crystallography, in the analysis of protein structure, and in the design of protein mimetics and small-molecule inhibitors of protein function. He has published over 150 research papers.

Professor Brian Abbey

Professor Brian Abbey, Deputy Director of La Trobe Institute for Molecular Science and the school's Research Director, is a mid-career researcher in the Chemistry and Physics Department and node leader of the ARC Centre of Excellence for Advanced Molecula Imaging. He holds Masters degrees in Physics (2002), Nanomaterials (2003) and Engineering (2010) from University College London, Imperial College of Science and Technology, and the University of Oxford, respectively, as well as a PhD in Chemistry (2007) from the University of Cambridge. Professor Abbey joined La Trobe University in 2011 and currently leads the only experimental X-ray Free Electron Laser (XFEL) group based in Australia. His research group focuses on the areas of Optics, Nanofabrication, and X-ray science. Professor Abbey has published over 100 papers with many first/senior author papers appearing in high-impact journals (e.g. Nature Physics, Nature Photonics, and Science Advances).

Dr Michael Angove

Dr Michael Angove is an Associate Professor and Head of the Department of Pharmacy and Biomedical Sciences, and Academic Director of Transnational Education for PSB Academy, a partner institution delivering La Trobe University courses in Singapore.

Dr Angove specialises in environmental chemistry, with a particular focus on soils impacted by human activity and bushfires.

Associate Professor Narelle Brack

Dr Narelle Brack is an Associate Professor and Head of the Department of Chemistry and Physics.

Associate Professor Brack specialises in materials and surface chemistry. She has developed surface modification strategies for a range of material systems including next generation aircraft materials, carbon nanomaterials and electrospun nanofibres.

Professor Robyn Murphy

Professor Murphy is Head of the Department of Biochemistry and Genetics.

Professor Murphy also serves on the Executive Committee of La Trobe University's Sport, Exercise and Rehabilitation Focus Area. She specialises in skeletal muscle in health and disease, with a particular focus on exercise and its effects on ageing and metabolic diseases.

LIMS **ADVISORY BOARD**

THE LIMS ADVISORY BOARD PROVIDES STRATEGIC ADVICE ON THE INSTITUTE'S RESEARCH AGENDA.

Professor Fiona Cameron (Chair)

Professor Cameron is a molecular geneticist with a PhD from Macquarie University. A 20 year career with the CSIRO encompassed gene regulation, gene delivery, drug formulation and gene therapy. Professor Cameron has held management roles with CSIRO Nanotechnology and the National Flagship for Food Futures, as well as running the Innovation and Consulting unit at the University of Western Sydney. Her subsequent role was Executive Director for Biological Sciences and Biotechnology at the Australian Research Council.

Professor Marilyn Anderson AO

Professor Anderson AO is Professor of Biochemistry at La Trobe University and the Chief Scientist of Hexima Limited. She is a Fellow of the Australian Academy of Science and the Australian Academy of Technological Sciences and Engineering. She was awarded the Lemberg Medal from the Australian Society of Biochemistry and Molecular Biology in 2014.

Professor Susan Dodds

Professor Dodds is the Deputy Vice-Chancellor (Research and Industry Engagement) and Professor of Philosophy at La Trobe University. She has held senior roles at multiple institutions including the University of New South Wales. She is recognised internationally for her leadership in research ethics and public policy development related to emerging medical technologies, and is an active researcher in applied ethics and political philosophy.

Professor Matthias Ernst

Professor Ernst is the Head of the School of Cancer Medicine at La Trobe University and the Director of the Olivia Newton-John Cancer Research Institute. He obtained his PhD from the ETH Zurich (Switzerland), is a member of the Ludwig Institute for Cancer Research and a Principal Research Fellow of the NHMRC.

Dr Megan Fisher

Dr Fisher is the Pro Vice-Chancellor (Industry Engagement) at La Trobe University. She has over 20 years' experience in executive management and leadership positions in higher education and research-based organisations in the public and private sector, most recently as Director of Research, Innovation and Commercial Engagement at the University of Melbourne. Dr Fisher has a PhD in Organic Chemistry and a Bachelor of Science (First Class Honours) from the University of Sydney, as well as qualifications in business and executive management. Megan has extensive experience in leading and advising on a broad range of commercial transactions.

Professor Andrew Hill

Professor Hill was Director of LIMS in 2019 before moving to Associate Provost Research and Industry Engagement for the College of Science Health and Engineering. Professor Hill obtained his PhD at Imperial College London in 1998. He held postdoctoral positions in the MRC Prion Unit (London) and the Department of Pathology at the University of Melbourne as a Wellcome Trust Prize Travelling Research Fellow. Professor Hill joined the Department of Biochemistry and Molecular Biology at the University of Melbourne in 2002 and moved his laboratory into the Bio21 Institute when it opened in 2005. He served as Biosciences Domain Coordinator (2011-14) and Associate Director (Structural and Cellular Biology) of the Bio21 Institute. In 2015, Professor Hill was appointed Head of the Department of Biochemistry and Genetics at La Trobe University and Director of the University's Research Focus Area, Understanding Disease. In 2016, he was elected President of the International Society for Extracellular Vesicles and established the La Trobe Research Centre for Extracellular Vesicles for which he was the inaugural Director. He has published over 180 research papers and edited three books.

LIMS **ADVISORY BOARD**

THE LIMS ADVISORY BOARD PROVIDES STRATEGIC ADVICE ON THE INSTITUTE'S RESEARCH AGENDA.

Professor Helen Irving

Professor Irving is the Director of the Understanding Disease Research Focus Area at La Trobe University. Professor Irving obtained her PhD in Biochemistry from the University of Melbourne and conducted post-doctoral work at Vanderbilt University (USA) and the University of Kentucky (USA) before returning to Australia to take up an ARC Post-Doctoral Fellowship at La Trobe University. For most of her career she has been a teaching/research academic based at the Faculty of Pharmacy and Pharmaceutical Sciences at Monash University. Helen moved to the La Trobe Institute for Molecular Sciences in 2017.

Mr Stephen May

Stephen May has more than 20 years' experience working in strategic marketing and development roles across the higher education, not for profit and healthcare sectors. He has an MBA from Mt Eliza/ Melbourne Business School and a Bachelor of Education from Deakin University and brings extensive expertise and knowledge around philanthropy and international alumni programs. Stephen is currently the Chief Advancement Officer at La Trobe University where he is responsible for delivering the $100M Make the Difference Campaign.

Professor Andrew Peele

Professor Peele is the Director of ANSTO's Australian Synchrotron. He is an adjunct Professor of Physics at La Trobe University and was seconded to the Australian Synchrotron from La Trobe University in 2011. He is a Fellow of the Australian Academy of Technological Sciences and Engineering and a past president of the Australian Institute of Physics. His research improves the versatility and quality of x-ray imaging and he has published over 100 research papers with applications ranging from improving advanced materials to cellular imaging.

Professor Robert Pike

Professor Pike is Provost of the College of Science, Health and Engineering at La Trobe University. He has extensive experience in academic and research leadership roles. Professor Pike is a biochemist specialising in enzymes. He has published over 100 research papers and supervised over 20 PhD students to completion.

Dr Tony Radford AO

Dr Radford AO is a Director of Ellume Limited and ASX listed Genetic Signatures Ltd. He was previously Director of Nucleus Networks and CEO of ASX listed Cellestis, from its founding until its acquisition by QIAGEN NV in 2011. For his contributions to tuberculosis diagnosis and enterprise, he received the Clunies Ross Award for the application of technology and is a Distinguished Alumnus of La Trobe University.

Professor Brian Smith

Professor Brian Smith is Director of LIMS and Head of the School of Molecular Sciences. After completing his PhD in Chemistry at the University of Melbourne he held various research positions before being appointed as La Trobe's inaugural LIMS Principal Research Fellow in 2011. Professor Smith is a Fellow of the Royal Australian Chemical Institute and a Fellow of the Royal Society of Chemistry. He is skilled in the determination of protein structure by X-ray crystallography and has published over 150 research papers.

LIMS **FELLOWS**

THE LIMS ENDOWMENT FUND WAS ESTABLISHED TO CREATE NEW AND SUSTAINABLE OPPORTUNITIES FOR SCIENTISTS WITH OUTSTANDING POTENTIAL.

The inaugural Bruce Stone Fellowship in Chemical Biology and the Nicholas Hoogenraad Fellowship in Molecular Sciences were awarded in 2015.

Both fellowships are named after two long-serving leaders: Professor Bruce Stone was the foundation professor of Biochemistry from 1972-1989, succeeded by Professor Nicholas Hoogenraad, who later became the first Director of LIMS. Professor Hoogenraad AO retired in 2014.

Bruce Stone Fellowship

Dr Donna Whelan

Dr Donna Whelan graduated with a PhD in Physical Chemistry in 2015 and completed her postdoctoral training at the New York University School of Medicine. Her research spans physics to biology, with a focus on applying advanced fluorescence techniques to understand the basis of disease.

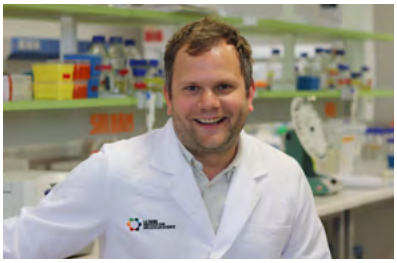
Dr Whelan has published 18 research papers (nine first author, one senior author, >400 citations) in high-impact interdisciplinary journals including *Nature Communications*, *Nucleic Acids Research* and *Physical Chemistry Letters*. She joined LIMS in 2018 and was awarded a large philanthropic donation to build a bespoke single molecule microscope for studying DNA damage and repair.

Dr Whelan has also been awarded an ARC DECRA for 2020 to investigate DNA replication stress.

Nicholas Hoogenraad Fellowship

Dr Nick Reynolds

Dr Nick Reynolds graduated with a PhD from the University of Sheffield in 2009 before undertaking postdoctoral fellowships and research positions at the University of Zurich, CSIRO and the ARC Training Centre for Biodevices (Swinburne University of Technology). His research focuses on the design, discovery and characterisation of self-assembled nanomaterials. These materials have applications in tissue engineering, biosensing, drug delivery and understanding the molecular origins of disease. Dr Reynolds works closely with biotech companies and hospitals to promote the translation of fundamental research into devices and commercial products that have real-world impact. Dr Reynolds has published 35 research papers (12 first, 10 corresponding author, > 940 citations) in high impact journals including *Nature Communications, Chemical Society Reviews, The Journal of the American Chemical Society* and *ACS Nano*. He joined LIMS in 2019.

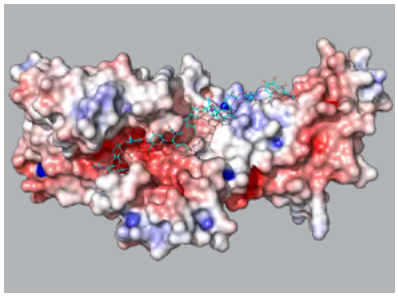


DISCOVERY **HIGHLIGHTS**

Chemotherapeutic drugs

5-Fluorouracil (5FU) is one of the most widely used chemotherapeutic drugs in the world for treating various types of cancers. Yet drug resistance is a large problem and the molecular mechanism of the drug resistance is not understood. Published in *PNAS*, Associate Professor. Hamsa Puthalakath and colleagues identified how BOK protein regulates chemosensitivity. This may lead to the development of better chemotherapeutic drugs.

LIMS RESEARCHERS PUBLISH IN HIGH IMPACT JOURNALS INCLUDING *JOURNAL OF EXTRACELLULAR VESICLES*, *NATURE COMMUNICATIONS*, *JOURNAL OF IMMUNOLOGY* AND *ELIFE*

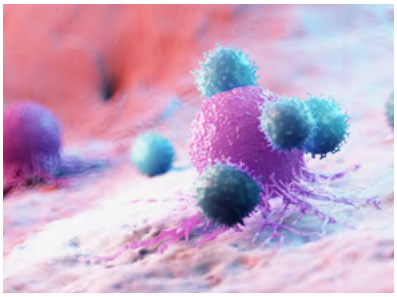


Salmonella attacks

PhD student Pramod Subedi, Dr Jason Paxman, Dr Geqing Wang, Dr Begoña Heras and collaborators have discovered a new mechanism used by the pathogen *Salmonella enterica* serovar Typhimurium that enables it to survive attacks from our immune system. Their findings, published in the *Journal of Biological Chemistry*, could lead to new strategies to combat *Salmonella* infections.

Gene mutation

Studying genes in model organisms can enhance understanding of their function in humans. Dr John La Marca, Dr Helena Richardson and collaborators have identified that mutations in specific genes of the vinegar fly, *Drosophila melanogaster*, can result in tumour growth. Published in *Development*, these findings could provide new insight into the role of these genes in human disease.

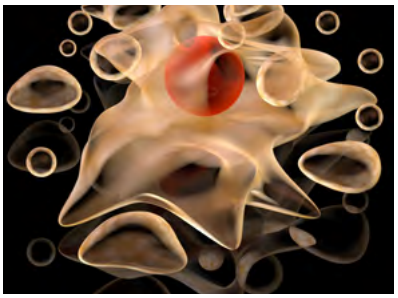


Machine learning

Understanding how proteins stick to surfaces is crucial in developing materials for industrial and medical applications. Professor David Winkler and collaborators have used machine learning to improve the ability to accurately predict how proteins and cells stick to surfaces. Findings, published in *Scientific Reports*, will aid the design of next-generation materials.

Immunity to influenza

Professor Weisan Chen and his collaborators have discovered that influenza virus infected cells make Defective Ribosomal Products (DRiPs), a type of short protein fragment, which could trigger anti-viral immunity and potentially explain virus-induced autoimmunity. Their findings, published in the *Journal of Immunology*, provide new insight into the interaction between host immune system and influenza virus.



Apoptotic characteristics

Apoptotic bodies are particles released by dying cells that play a role in intercellular communication. Dr Amy Baxter, Dr Ivan Poon and collaborators have, for the first time, defined the characteristics of apoptotic bodies. Their findings, published in the *Journal of Extracellular Vesicles*, will lead to better characterisation of these cell particles in future studies.

Venomous cone snails

Venomous sea-faring cone snails use insulin as a weapon to hunt prey. Professor Brian Smith and PhD student Nicholas Smith are part of an international collaboration that have used computational modelling to extend scientific understanding of cone snail insulin. Their findings, published in *eLife*, may lead to the development of new treatments for diabetes.

CELEBRATING 10 YEARS OF LIMS

THE YEAR 2019 SIGNIFIED A SUBSTANTIAL MILESTONE IN THE HISTORY OF THE LA TROBE INSTITUTE FOR MOLECULAR SCIENCE (LIMS). IT MARKED TEN YEARS SINCE EMERITUS PROFESSOR NICK HOOGENRAAD AO HAD THE COURAGE AND VISION TO CREATE AN INTERDISCIPLINARY SCIENTIFIC RESEARCH INSTITUTE.

In 2009 Professor Hoogenraad had been Head of the School of Molecular Sciences for over ten years, overseeing three high achieving yet distinctly separate departments. There was little cross over in research themes and resource sharing. But the landscape of teaching and research was changing and Professor Hoogenraad realised that an interdisciplinary, collaborative approach would be essential for research funding and critical for high impact research.

Taking advantage of government support for investment in education infrastructure, the School of Molecular Sciences secured funding to construct a new building – a fully-fledged scientific institute with teaching at its core. And LIMS was born.

The exterior of the LIMS building is recognised for its cutting-edge design but it's not until you work or learn within the building that its real innovation and intent becomes clear. The upper levels are research-focussed, flexible and collaborative. The lower levels accommodate undergraduate learning and teaching. Everything is linked by a central stairway, a symbol of the path from student to scientist.

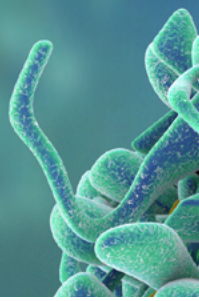
Lying between the two areas is a common room, where academics have opportunity to interact and share research ideas over lunch or a coffee. This cross-collaboration approach is at the heart of LIMS. Cooperation occurs within and across research themes rather than in silos of School designated departments. And this is how the vision of LIMS – to make translatable molecular discoveries – is realised.

Today the La Trobe Institute for Molecular Science focusses on four themes – Cancer, Molecular Design, Infection and Immunity, and Nanoscience – with researchers across multiple disciplines committed to solving global problems and improving the welfare of human societies.

The Institute sits neatly within La Trobe University's strategic vision – to be globally recognised for its excellence, creativity and innovation in relation to the big issues of our time. LIMS has achieved remarkable outcomes in the last ten years and we look forward to delivering another decade of translatable molecular discoveries.

CANCER

The cancer theme investigates the mechanisms of cancer initiation and progression, the crosstalk between cancer cells and the surrounding environment, and the discovery of new therapeutic approaches to combat the disease.



Theme leader

Erinna Lee
Senior Lecturer

Apoptosis, autophagy, cancer, drug discovery, cell biology, biochemistry, structural biology
Examines the mechanisms underlying cell survival/death dictated by apoptosis and autophagy using biochemistry, cell biology and structural biology. Uses this information to develop therapeutics targeting these pathways for cancer treatment.

Members

Suzanne Cutts
Senior Research Fellow

Cellular responses to anticancer drugs
Develops new therapeutic strategies for cancer treatment. Examines the mechanism of action in anticancer drugs doxorubicin and mitoxantrone. Works to restrict the killing properties of these drugs to cancerous cell types to minimise their toxic side effects.

Doug Fairlie
Associate Professor

Apoptosis, autophagy, cancer, drug development and peptides
Uses biochemical, cell biology, structural biology and medicinal chemistry approaches to understand the molecular mechanisms that control apoptosis. Develops new reagents, including drugs that could target and inhibit the actions of the key pro-survival proteins that keep cancers alive.

David Greening
Senior Research Fellow

Extracellular vesicles, exosomes, proteomics, cell reprogramming, nanotechnology
Uses a multi-disciplinary approach to understand the molecular function of extracellular vesicles incorporating proteomics, cell biology, molecular biology, nanomaterials, nanobiotechnology, regenerative cell biology and physiology. Identifies new deliverable therapeutic targets and facilitates effective engineered nanoparticles for next generation cell-free therapies.

Christine Hawkins
Associate Professor

Cell death regulation in cancer and viral infection
Studies apoptotic regulation in normal, cancerous and virally-infected cells. Explores the potential for molecularly targeted therapies to improve outcomes for patients with the bone cancer osteosarcoma.

Nick Hoogenraad AO
Emeritus Professor

Development of therapeutic antibodies against cachexia
Specialises in cancer cachexia, a serious wasting condition and a major complication of cancer. Investigates the molecular basis of this condition and a therapeutic intervention using monoclonal antibodies.

Patrick Humbert
Professor

Cancer biology, cell polarity and tissue architecture
Determines how cell asymmetry and tissue organisation can regulate cancer initiation, progression and metastasis. Examines how the cell polarity genetic program may be involved in tissue regeneration as well as developmental processes such as blood cell production and function.

Mihwa Lee
Tracey Banivanua Mar Fellow

Structural biology in gene regulation and DNA damage repair pathway
Uses a multidisciplinary approach (combining molecular biology, protein chemistry, cell biology and X-ray crystallography) to characterise the macromolecular complexes (protein-protein and protein-nucleic acid complexes) in the nucleus to understand their fundamental roles in gene regulation and the DNA damage repair pathway.

Suresh Mathivanan
Professor and ARC Future Fellow

Exosomes, secretome and systems biology
Explores the role of extracellular matrix components (soluble secreted proteins and extracellular vesicles) in cancer and intercellular communication using proteomic, genomic and bioinformatics methodologies. Undertakes basic science projects including the biogenesis of exosomes and the role of exosomes in intercellular communication.

Belinda Parker
Associate Professor

Cancer microenvironment and immunology
Determines the properties of tumour cells and interacting cells in the surrounding tissue that promote metastatic spread in clinically relevant models of breast and other cancers. Designs new anti-metastatic therapies that block the invasion and growth of cancer cells in distant tissues.

Helena Richardson
Associate Professor

Cell polarity, cell signalling and cancer lab
Uses the vinegar fly, *Drosophila*, to determine how regulators of cell shape (polarity) and the cell skeleton (actin cytoskeleton) impact on cell signalling and cancer initiation and progression, and to identify novel pathways that cooperate with the Ras oncogene in cancer.

Richard Simpson
Professor

Extracellular vesicles, exosomes and cancer biology
Uses an integrated proteomic, RNA profiling, bioinformatics and live-cell imaging strategy to understand the seminal role of extracellular vesicles in cell-cell communication in the extracellular environment during cancer progression and cancer plasticity.

Kaye Truscott
Senior Lecturer

Mitochondrial protein homeostasis
Studies the function of proteins engaged in the biogenesis and maintenance of mitochondria, the cell's power plant and manufacturer of essential biomolecules. At a molecular level investigates mitochondrial factors contributing to the development of human diseases including rare neuroendocrine tumours.

Donna Whelan
Bruce Stone Fellow in Chemical Biology

Biophysics, DNA damage, fluorescence, single molecule imaging
Applies state-of-the-art techniques to biological questions. Uses microscopic and spectroscopic methods to visualise the compositions and ultrastructures of individual cells and their subcomponents.

ADVANCES IN TREATMENT FOR MELANOMA CELL SURVIVAL

IT'S THE DIAGNOSIS NO ONE WANTS TO HEAR. THAT THE IRREGULARLY SHAPED MOLE ON THEIR SHOULDER IS A MALIGNANT MELANOMA. AS ONE OF THE MOST AGGRESSIVE AND DIFFICULT TYPES OF SKIN CANCERS TO TREAT, THE CONFIRMATION OF A MELANOMA CAN BE DEVASTATING NEWS.

Recent advances with targeted therapies and immunotherapy have led to improved treatment outcomes, but many patients remain unresponsive or develop resistance to available treatments. There is a clear need for new and more effective drug alternatives.

A partnership between the La Trobe Institute for Molecular Science (LIMS) and the Olivia Newton-John Cancer Research Institute (ONJCRI) has seen researchers, Dr Erinna Lee and Associate Professor Doug Fairlie, collaborate with scientists within ONJCRI, the University of Queensland and the Walter and Eliza Hall Institute of Medical Research to investigate which proteins from the BCL-2 family keep melanoma cells alive and how to potentially trigger death of these cancer cells.

BCL-2 proteins are essential for determining whether our cells live or die. The biological process that they control is known as apoptosis. Apoptosis is critical for the removal of damaged or unwanted cells in our body.

In many cancers the levels of proteins that enable cellular survival are often present at abnormally high levels. This gives cancer cells an unwanted survival advantage and enables them to resist chemotherapy that normally works by inducing apoptosis.

To effectively treat malignant melanomas the excess pro-survival proteins need to be reduced or inhibited. Until now, the specific combination of the pro-survival proteins that needs to be targeted to most effectively induce the killing of malignant melanoma cells was unknown.

Dr Lee and Associate Professor Fairlie noted that a class of drugs, known as BH3-mimetics, is a clinically proven and effective strategy for the treatment of some cancers, particularly blood cancers. Using this knowledge the research team was able to identify, for the first time, the most potent combination of BH3-mimetics required to eradicate malignant melanoma cells.

This discovery, published in *Cell Death & Disease*, has the potential to directly translate into a new treatment option for Australia's "national cancer" and is positive news for those susceptible to skin cancer.

For more information on this research or other cancer related discoveries please contact LIMS.

Associate Professor Doug Fairlie & Dr Erinna Lee

INFECTION AND IMMUNITY

The Infection and Immunity theme studies the molecules used by viruses, bacteria, parasites and fungi to infect humans, animals and plants, and the immune response associated with this.

Theme leader

Begoña Heras
Associate Professor

Structural Biology of Bacterial Pathogenesis
Studies the molecular mechanisms underlying Gram-negative bacterial infections. Uses a multidisciplinary approach combining X-ray crystallography, molecular biology and biochemistry to investigate the structure-function relationships in proteins involved in bacterial pathogenesis and develop antibacterial drugs with novel modes of action.

Members

Marilyn Anderson AO
Charles La Trobe Professor

Plant innate immunity proteins
Specialises in protection of humans and crops from pathogens by studying natural defences of plants and the biology of the pathogens themselves. Identifies insecticidal and antifungal molecules in Australian native plants for commercial applications in crop protection and human antifungal therapeutics. Chief Science Officer of the biotechnology company Hexima, which is embedded in LIMS and involved in the R&D of plant derived proteins and peptides.

Katrina Binger
Lecturer

Macrophage metabolism in biology and disease
Investigates the role of the physical and chemical composition of the tissue microenvironment on immune cell function. Focuses on innate immune cells, macrophages, and how metabolites and electrolytes modulate metabolic pathways to identify new targets for treating inflammatory diseases and infection.

Weisan Chen
Professor

Cellular immunity to Influenza A virus and transplant antigens
Specialises in CD8+ T cell biology and antigen processing and presentation in the development of cross-protective immune responses to the Influenza virus and the initiation of transplant immunity. Investigates interactions between T cells and antigen-presenting cells, such as dendritic cells, macrophages and monocytes.

David Dougan
Senior Research Fellow

Protein homeostasis in health and disease
Studies large ATP-dependent multi-subunit machines that are responsible for the regulated removal of unwanted proteins in bacterial cells and eukaryotic organelles. Identifies new components that control these machines and novel chemicals that dysregulate them.

Mick Foley
Professor

Use of single domain antibodies as therapeutics in fibrosis and other chronic diseases
Uses a library of single domain antibodies derived from sharks to identify antibodies that bind and block the function of proteins shown to be involved in human pathological conditions such as fibrosis of the lung, kidney and eye as potential therapies for these diseases. Chief Scientific Officer of AdAlta, a LIMS embedded company.

Andrew Hill
Professor

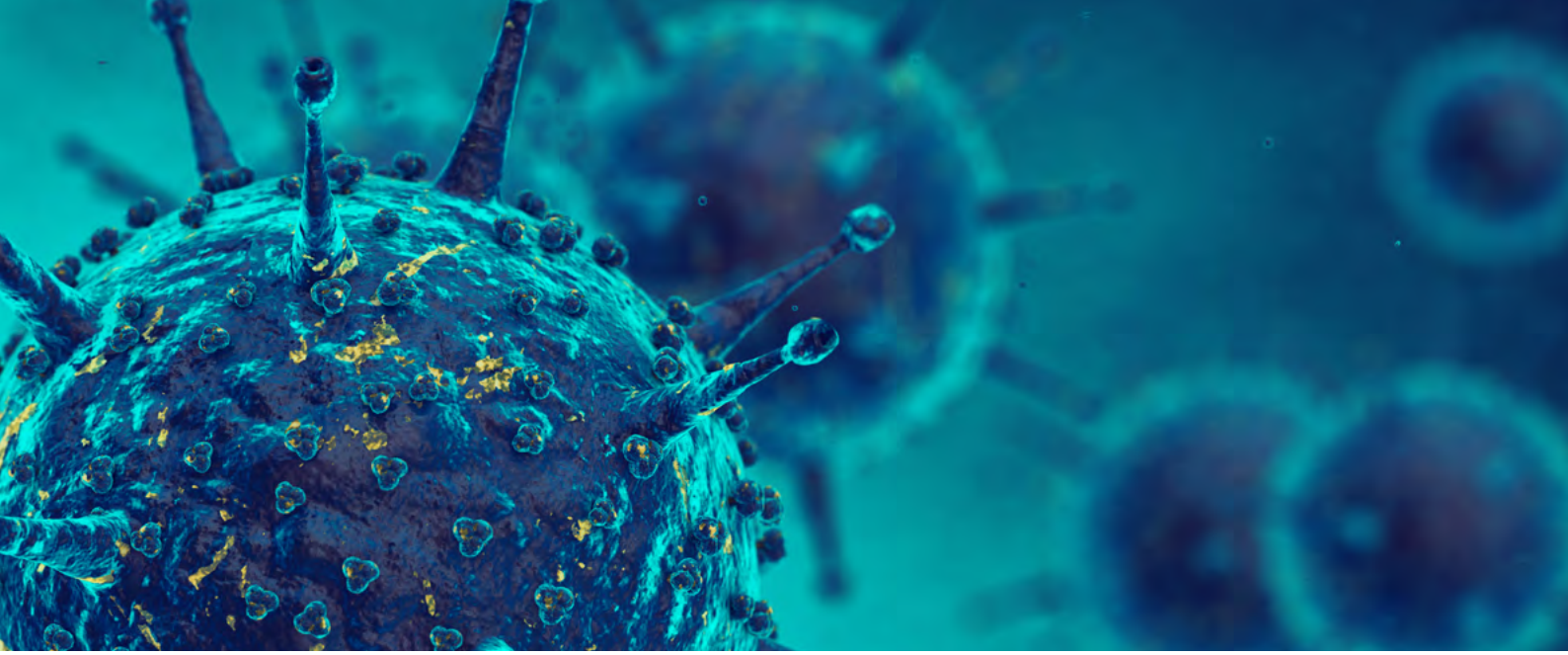
Neurodegenerative diseases, extracellular vesicles and noncoding RNA's
Uses *in vitro* and *in vivo* models to look at how abnormal proteins and RNA travel from cell to cell and are involved in neurodegenerative diseases. Studies the biology of extracellular vesicles and their potential use as diagnostics in neurological and infectious diseases.

Di Hughes
Lecturer

Oxidative stress, erythrocyte morphology and haemorheology
Researches peripheral oxidative stress in Parkinson's disease and rheumatoid arthritis. Studies erythrocyte morphology and haemorheology parameters to mark peripheral oxidative stress and whole blood antioxidant capacity.

Mark Hulett
Professor

Innate defence and inflammation
Investigates molecular mechanisms that drive inflammatory disease, innate immunity and tumour progression. Focuses on the function of innate defence peptides and the heparan sulphate-degrading enzyme heparanase in order to develop novel therapeutics to treat infection, inflammatory disease and cancer.



Helen Irving
Professor and Director of Understanding Disease Research Focus Area

Proteins in the innate immune system
Studies unusual mechanisms that proteins in the innate immune system use to signal processes in cells to control inflammatory responses. Uses a multidisciplinary approach involving protein molecular, cell biology and protein chemistry supplemented by bioinformatics and systems approaches.

Cristina Keightley
Senior Lecturer

Biomedical science
Seeks to discover and understand molecular pathways regulating blood cells in development and disease. Adopts a multi-disciplinary approach integrating molecular genetics, biochemistry, genomics and proteomics. Knowledge of these pathways can inform the design of pharmaceuticals, including stem cell therapies.

Christine Kettle
Lecturer

Autonomic and central nervous system regulation of metabolism
Examines the physiology of metabolism to find novel drug targets that activate brown adipose tissue (BAT) thermogenesis. Activation of BAT is a possible pathway to target obesity.

Marc Kvansakul
Professor

Structural biology of cell death and host pathogen interactions
Examines how viruses hijack cellular defence systems to ensure their own proliferation and survival. Understands the role of small proteins that act as a first line of defence against microbial targets and the mechanisms they use to destroy target cell membranes.

Megan Maher
Associate Professor

Metallobiology
Studies the mechanisms by which trace metals are regulated within biological systems. This regulation relies on proteins that fulfil specific roles within the cell. Examines the functions of these proteins by defining their three-dimensional architectures by X-ray crystallography.

Ronan O'Toole
Associate Professor

Infectious diseases and antimicrobial resistance
Applies genomic epidemiology to track the origin and spread of healthcare-associated pathogens such as *Enterococcus faecium*, to map the acquisition of antibiotic resistance by *Mycobacterium tuberculosis* in relation to treatment outcomes and to correlate genotypes of non-typeable *Haemophilus influenzae* strains with chronic obstructive pulmonary disease presentations.

Jacqueline Orian
Senior Research Fellow

Neurodegenerative diseases
Investigates mechanisms underlying blood brain barrier damage and neuronal loss in Multiple Sclerosis (MS). Uses the experimental autoimmune encephalomyelitis (EAE) MS model to generate proof of concept for pathological and molecular neurodegenerative mechanisms. The long-term view is to develop novel therapeutics that will delay entry into progressive MS.

Ivan Poon
NHMRC Career Development Fellow

Apoptotic cell disassembly and clearance
Studies the machinery that controls how dying cells can disassemble into smaller pieces. Specialises in the importance of cell disassembly in disease settings, such as influenza A infection and atherosclerosis to identify new drugs to control this process.

Hamsa Puthalakath
Associate Professor

Regulation of apoptosis by Bcl-2 family proteins
Studies apoptosis regulation by Bcl-2 family proteins in different patho-physiologies using *in vitro* and *in vivo* models. This includes death of immune cells during polymicrobial sepsis leading to immune paralysis, and the death of heart muscle cells leading to cardiomyopathy and heart failure.

Joseph Tucci
Associate Professor

Bacteriophage as alternatives to antibiotics, pharmacogenomics and pharmacy practice
Examines the personalisation of medicine to fit a patient's genetic profile, particularly in traditional and Indigenous populations. Studies the use of bacteriophage as an alternative to antibiotics and how these can be delivered clinically.

James Van Dyke
Senior Lecturer

Integrative Physiology
Studies how vertebrate physiology interacts with environment to determine reproductive success. Focuses in particular on the physiology and evolution of placentation, as a model for complex trait evolution. Also applies physiological approaches to solving environmental problems in the Murray-Darling catchment.

Lakshmi Wijeyewickrema
Lecturer

Proteases, inhibitors and receptors: relationship to disease states
Seeks to understand how the human body responds to infection and disease. Research aims to develop new ways to protect humans from different disease states by dissecting the activity of enzymes, called proteases, which are critical to the immune response.

THE STICKING POINT OF BACTERIA

ANTIBIOTIC RESISTANCE IS A GLOBAL HEALTHCARE CHALLENGE. IN AUSTRALIA ALONE, ANTIBIOTIC RESISTANCE ADDS $250 MILLION TO THE NATION'S HEALTHCARE BUDGET. THE WORLDWIDE NEED FOR NEW ANTIMICROBIALS IS BECOMING INCREASINGLY URGENT.

A possible target to develop new antimicrobials is identifying molecules that block the critical step by which bacteria "stick" to surfaces, beginning the establishment of infection and disease.

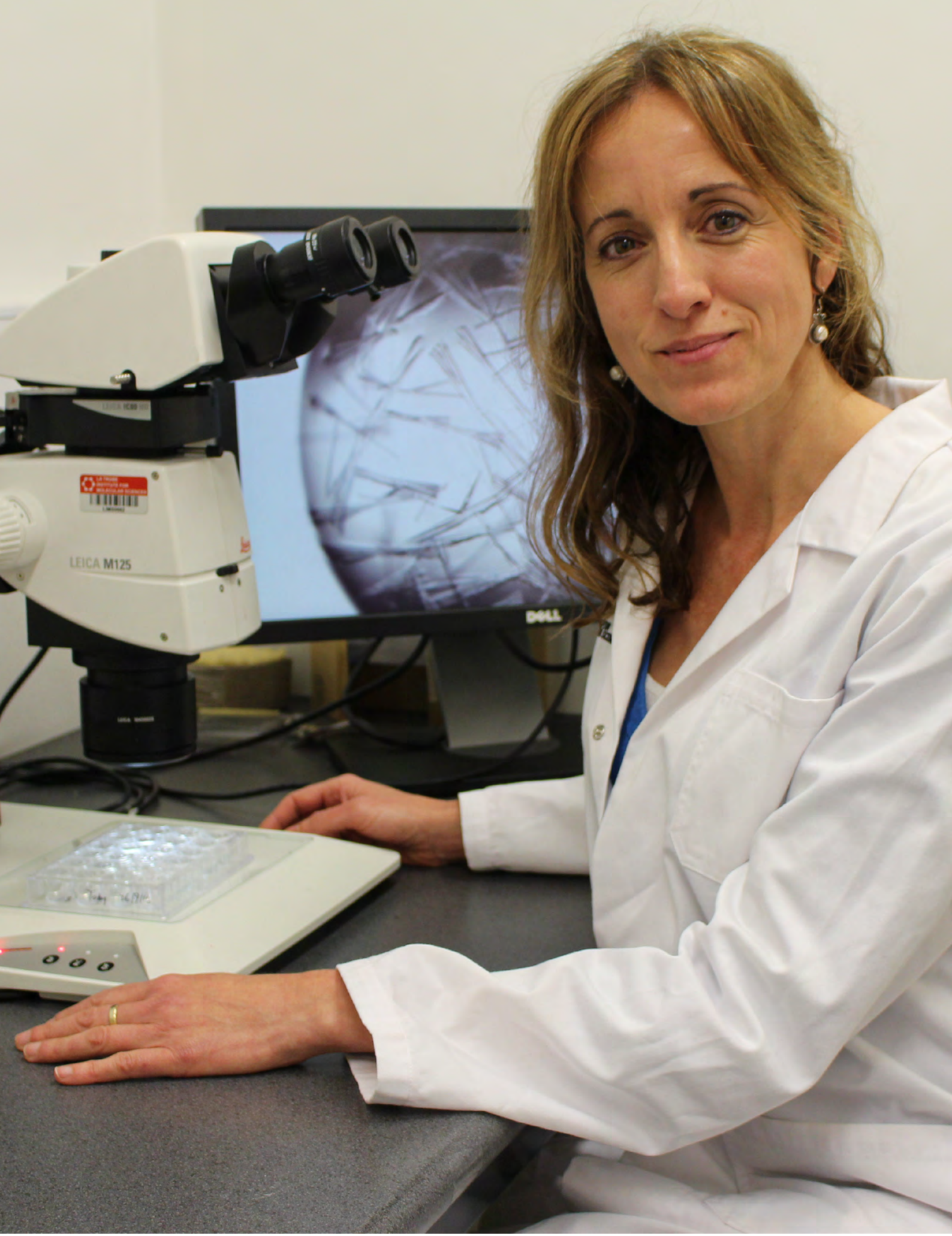
Research by Associate Professor Begoña Heras and Dr Jason Paxman from LIMS has revealed unprecedented molecular detail of how a widespread group of proteins that decorate the surface of bacteria, called autotransporters, allow bacteria to stick to surfaces – such as sites throughout the human body.

Their study focused on the autotransporter UpaB, a "superglue" protein of a pathogen known to cause urinary tract infections. Dr Paxman and Associate Professor Heras used the powerful light source of the Australian Synchrotron to determine the molecular structure of UpaB. Together with researchers from the University of Queensland they used the structure to reveal the mechanism by which UpaB binds to proteins and carbohydrates on the surface of epithelial cells, promoting bacterial colonisation and consequent infection.

The autotransporters are produced in bacteria listed by the World Health Organisation (WHO) as priority pathogens. As senior researcher Jason Paxman states, "These findings provide new insights into how autotransporters facilitate colonisation of widespread bacterial pathogens. Such information can be used to develop new types of therapeutics to prevent infections."

This discovery, published in *Nature Communications*, is a key milestone in the pathway to develop new drugs with novel mechanisms of action to treat bacterial infection and supports the Heras research group's recent PCT patent application for the development of Australia's first medical biofilm inhibitor.

For more information on this research, the patent and related themes please contact LIMS.



Associate Professor Begoña Heras

MOLECULAR **DESIGN**

The Molecular Design theme uses molecules to solve real world problems from computational studies on the interaction of drugs with proteins, to molecular synthesis, and surface and material science.

Theme leader

Belinda Abbott
Senior Lecturer

Medicinal chemistry and synthetic organic chemistry
Uses synthetic organic chemistry to make novel compounds for testing in biological assays in order to study the structure-activity relationships of how the compounds interact with the target. Develops treatments for bacterial infection, malaria, cardiomyopathy and motor neurone disease.

Members

Carmel Abrahams
Senior Lecturer

Supramolecular chemistry and single crystal X-ray diffraction characterisation of small molecules
Investigates the design, synthesis and characterisation of supramolecular systems. Studies the use of the biodegradable porous compound Zn saccharate and its ability to act as a host for molecules such as small aromatic hydrocarbons.

Jasim Al-Rawi
Senior Lecturer

Heterocyclic compounds such as PNA-PK, PI3K PDE3 inhibitors for cancer treatment
Synthesis of novel benzoxazines as DNA-PK, PI3K inhibitors for more effective treatment of cancer. Studies PI3K isoform selectivity as well as DNA-PK selectivity over PI3K. Uses molecular modelling to explain drug-receptor optimum interaction.

Peter Barnard
Senior Lecturer

Synthetic organic and inorganic chemistry
Synthesises coordination complexes for diagnostic imaging applications and sensor development. Specialises in small molecule organic and inorganic synthesis in combination with analytical techniques for the generation and characterisation of new compounds.

Jason Dutton
Associate Professor and ARC Future Fellow

Organic, organometallic and inorganic chemistry from synthetic and theoretical perspectives
Examines the fundamental chemistry of a wide variety of systems (literally spanning the periodic table from beryllium to iodine) using both synthetic and computational approaches. Discovers new structures, bonding and reactivity for a variety of elements.

Cathryn Hogarth
Senior Lecturer

Sperm development and maturation
Investigates the role that retinoic acid plays in the differentiation and maturation of sperm within the testis and epididymis. Focuses on how the production of retinoic acid is controlled within these organs and the downstream molecular targets of retinoic acid signalling. The ultimate goal is to develop new strategies for the treatment of male infertility and novel male contraceptives.

Yuning Hong
Senior Lecturer and ARC DECRA Fellow

Fluorescent probes, cell imaging, protein misfolding and neurodegenerative diseases
Develops fluorescence-based tools for understanding and manipulating fundamental biological processes. Designs and synthesises new luminescent molecules in combination with advanced fluorescence spectroscopy and microscopy for monitoring protein conformational transitions associated with neurodegenerative diseases.

John Moses
Professor and ARC Future Fellow

Design and synthesis of new functional molecular entities
Designs and synthesises new functional molecular entities and develops new methodologies for challenging and useful chemical reactions/transformations. Specialises in click chemistry, natural product synthesis and chemical biology.

Matthew Perugini
Associate Professor

Rational drug design targeting infection and age-related diseases
Studies the structure, function, regulation and inhibition of essential oligomeric enzymes such as dihydrodipicolinate synthase from the lysine biosynthesis pathway of bacteria. Characterises the role of apolipoprotein E in cardiovascular and Alzheimer's diseases.

Pallavi Sharma
Senior Lecturer

Synthetic organic chemistry
Develops new synthetic methodology that delivers structurally diverse and complex chemical entities via rapid fusion of short lived reactive species. Using under-represented reagents, explores their latent reactivity for heterocycles, spirocycles, natural products and analogue synthesis.

Brian Smith
Professor, Director of LIMS and Head of the School of Molecular Sciences

Modelling molecular interactions
Uses quantum-mechanical methods to understand enzyme mechanism, molecular mechanical methods to explore the dynamics of proteins, and a variety of tools to predict how molecules interact. Uses X-ray crystallography to determine the structures of complexes of proteins, polypeptides and small molecules.

Tatiana Soares da Costa
ARC DECRA Fellow

Examines the structure, function and regulation of essential proteins in bacteria and plants to guide the development of novel classes of antibiotics and herbicides. Focuses on targets involved in cell wall and amino acid syntheses and employs techniques encompassing biochemistry, bacteriology, biophysics, chemistry and plant biology.

David Wilson
Associate Professor

Computational chemistry and quantum chemistry
Uses computational quantum chemistry to model molecular structures, properties and spectroscopies, as well as the energetics of reactions. Focuses on understanding the fundamental properties of chemical bonding and electronic structure in the design of new chemistry and new materials.

David Winkler
Professor

Computational molecular design and AI
Uses computational methods to study the interaction of molecules and complex materials. Expertise in the application of AI, machine learning and evolutionary computational methods to design bespoke materials with novel properties. Designs small molecules and peptides as drug leads, novel 2D hybrid materials for energy applications, biomaterials and coatings to control immunity and cell behaviour, and advanced informatics methods for surface science.

TACKLING THE ANTIBIOTIC RESISTANCE CHALLENGE

THE DISCOVERY OF PENICILLIN AND THE SUBSEQUENT MASS PRODUCTION OF ANTIBIOTIC MEDICATION WAS HAILED AS ONE OF THE 20TH CENTURY'S GREATEST ACHIEVEMENTS.

Yet the current reliance on antibiotic drugs in modern medicine may lead to one of the greatest health challenges of the next 100 years, unless a solution is found soon.

In Australia – and throughout the world – there is an increasing demand for antibiotics, which has led to their overuse and frequent misuse. This ongoing exposure has enabled bacteria to develop ways of becoming resistant to drugs, which reduces their ability to effectively treat infection.

Due to increasing drug resistance, bacterial infections that could previously be treated with a course of antibiotics can potentially now be life-threatening.

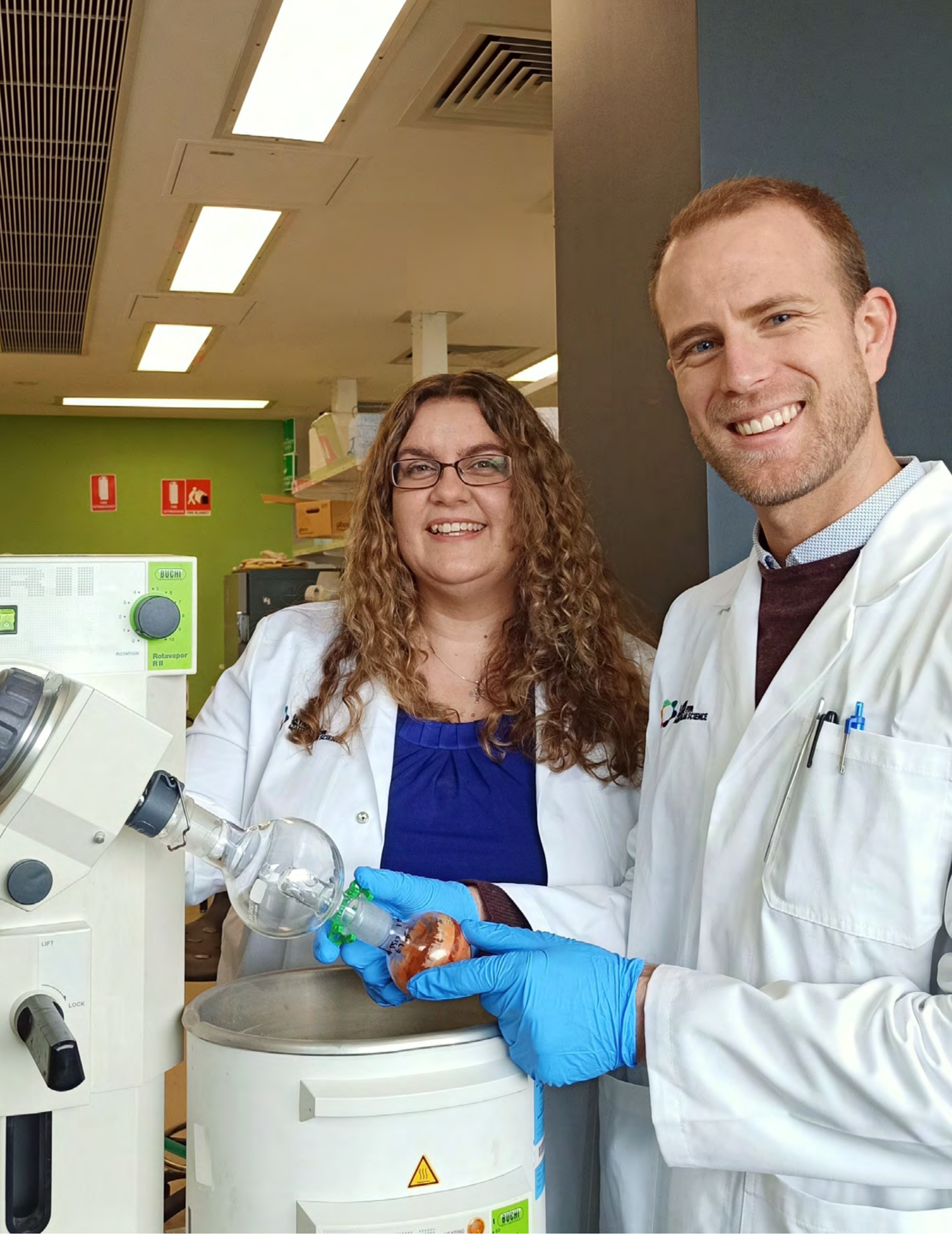
Dr Luke Duncan and Dr Belinda Abbott, collaborating with a multidisciplinary team including Dr Tony Wang and Dr Begoña Heras from LIMS, designed and synthesised small molecules that inhibit a protein that bacteria use to cause infection in human or animal hosts.

Starting with a small compound, known as a benzofuran, novel strategies for chemical synthesis were explored and developed to produce advanced molecules that could form stronger interactions with the bacterial protein being targeted. The team were then able to study where each molecule bound to the target protein and assess the strength of the interaction. This led to an informed understanding of which molecules could be selected for further study and development.

When asked about the motivation behind his involvement in this project, Dr Duncan, who was a PhD student at the time, replied – "Being able to synthesise a molecule in the lab that stops bacteria from being able to cause infection is a great example of bringing together the best of the chemical and biological sciences."

The findings from this work, published in *Molecules*, may lead to a new class of antibiotics that have greater ability to fight infection and help solve the critical issue of antibiotic drug resistance.

For more information on this research please contact LIMS.



Dr Belinda Abbott & Dr Luke Duncan

NANOSCIENCE

The Nanoscience theme uses a broad range of methods to characterise molecular structure and function, and to identify and quantitate key chemical and biochemical species in the environment and in the human body.

Theme leader

Russell Anderson
Senior Lecturer

Quantum enhanced sensing based on atom-light interactions
Develops next-generation quantum technologies with defence, medical and commercial applications. These include quantum-assured position, navigation and timing (PNT), and new perspectives on optical atomic magnetometry. Russell is also a leader in software control and automation of quantum technologies.

Members

Brian Abbey
Professor, Deputy Director of LIMS and Director of Research, School of Molecular Sciences

Coherent X-ray science and optics
Combines elements of optics, nanofabrication and X-ray free-electron lasers to develop new approaches to imaging materials and structures at the atomic, molecular and cellular level. Develops techniques for interpreting patterns of coherently scattered light.

Michael Angove
Associate Professor and Head of Pharmacy and Applied Science

Colloid, environmental and pharmaceutical science
Uses colloid chemistry to research environmental and agricultural soil systems so that we are better placed to manage soil environments and even rehabilitate damaged or contaminated soils. Studies pharmaceutical products that utilise colloidal particles and systems.

Narelle Brack
Associate Professor and Head of Chemistry and Physics

Surface modification and characterisation of advanced materials
Creates materials at the nanometer scale. Explores chemical and molecular properties and processes at surfaces and at interfaces. Develops surface modification strategies for material systems including next generation aircraft materials, carbon nanomaterials and electrospun nanofibres.

Conor Hogan
Associate Professor

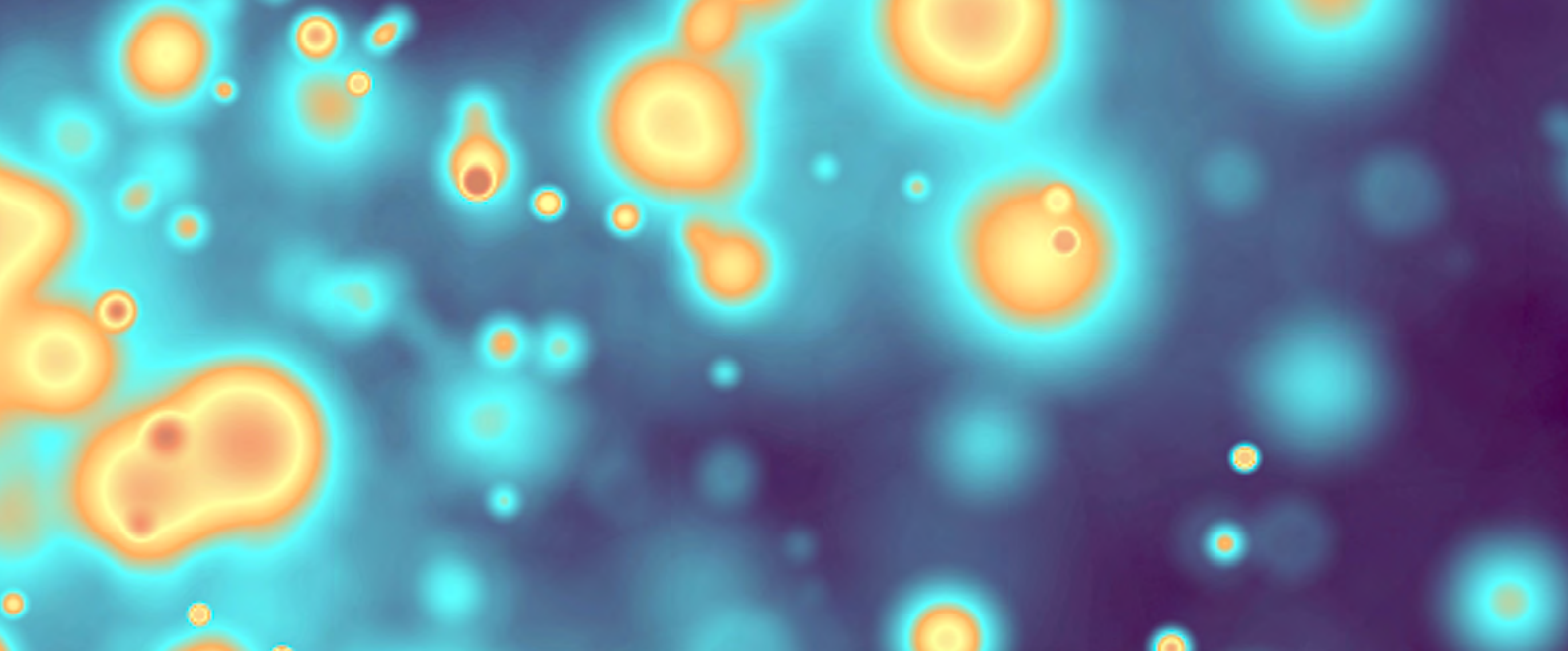
Electrochemistry, photochemistry, chemical sensing and biosensing
Conducts fundamental and applied multidisciplinary research with the aim of expanding the bounds of analytical science and translation for real-world applications. A world leader in ultrasensitive electrochemiluminescence (ECL) based detection and the use of mobile phones and other personal electronic devices for low-cost chemical / biochemical analysis.

David Hoxley
Lecturer

Biosensing applications of wide bandgap semiconductors
Studies the surfaces of semiconductor crystals, particularly diamond, and how they react to the world around and within us. Researches ways of making coaching possible in the tertiary education system, primarily through combining modern educational psychology with information technology.

Shanshan Kou
Lecturer

Bio-imaging and bio-photonics, optical micro- and nano-scopy, and biomedical instrumentation
Studies the interactions between light and biological matter to explore and discover the complex mechanisms behind cellular and sub-cellular events and processes. Develops novel bio-imaging modalities and instrumentation to be used in new diagnostic and therapeutic tools.



Adam Mechler
Associate Professor

Bioinspired self-assembling nanostructures
Studies the mechanism of antimicrobial peptide-membrane interactions, the formation of metallosupramolecular assemblies and the reaction pathways of antioxidant activity. Applies principles of self-assembly in the development of novel peptide antibiotics, antivirals and the design of oligoamide-based metamaterials.

Chris Pakes
Professor and Pro Vice-Chancellor (Graduate and Global Research)

Quantum materials for quantum computing, low-power spintronics and biosensing
Examines the functionalisation of diamond via chemical modification of the surface and surface transfer doping. Focuses on atom-scale engineering of diamond devices for next-generation digital technologies enabling low-power and secure information processing.

Paul Pigram
Associate Professor

Interactions at surfaces
Creates, understands and controls materials at the nanometer scale. Focuses on surface science, in particular exploring chemical and molecular properties and processes at surfaces and at interfaces, understanding molecular interactions at surfaces, and bio-surface characterisation.

Ian Potter
Senior Lecturer

Analytical and environmental chemistry
Prepares polymer inclusion membranes and polymer-based microspheres for use as small-scale chemical reactors and sensors for biological, environmental and industrial applications. Develops methods to analyse plant biomarkers. Develops forensic analysis methods to determine the production method and source of dangerous chemicals.

Nick Reynolds
Nicholas Hoogenraad Fellow

Self-assembled nanomaterials
Translational research into the design, discovery and characterisation of self-assembled nanomaterials with applications in fields including tissue engineering, drug delivery, antibacterial materials, biosensing and understanding disease.

Evan Robertson
Associate Professor

Optical spectroscopy of atmospheric and biological molecules
Uses powerful light sources, such as lasers and the Australian Synchrotron's infrared beamline, to study the shape of neurotransmitter molecules relevant to pharmaceuticals, greenhouse gas molecules, ice cloud particles and even molecules in the interstellar medium.

Chanh Tran
Lecturer

Interactions of X-rays with matter, optical coherence and X-ray imaging
Specialises in various forms of X-ray imaging, precision determination of the interaction cross-sections between X-rays and a range of elements and compounds. Developing phase spectroscopy and imaging of dynamic systems.

Grant van Riessen
Lecturer

Experimental condensed matter and materials physics, and coherent X-ray imaging development
Develops new ways of characterising and manipulating materials using coherent synchrotron light sources, with the aims of realising *in situ* imaging of nanoscale dynamics and enabling the next generation of lithographic patterning technology.

RAPID ONSITE TESTING FOR HEAVY METALS IN WATER

THE PRESENCE OF TOXIC HEAVY METALS IN WATER CAN BE DAMAGING TO THE ENVIRONMENT AND THE FLOW ON EFFECT OF IMPLICATIONS FOR HUMAN HEALTH AND THE ENVIRONMENT CAN BE DETRIMENTAL.

The need for timely and accurate detection of toxic heavy metals in water is paramount to ensure a healthy environment – for plant-life and animals, including humans.

Unfortunately, most available detection methods are slow, complicated and need to be performed in a laboratory. There is a huge demand for easy-to-use sensors that will allow rapid onsite testing of samples.

A team from LIMS, led by Associate Professor Conor Hogan, pioneered a fundamentally new approach to detecting heavy metal ion contamination using a phenomenon known as bipolar electrochemiluminescence – or bipolar ECL. In their novel sensing system, a mixture of luminescent molecules is made to glow under the influence of an electric field. The emission colour and voltage change depending on the quantity and identity of heavy metals present in the sample.

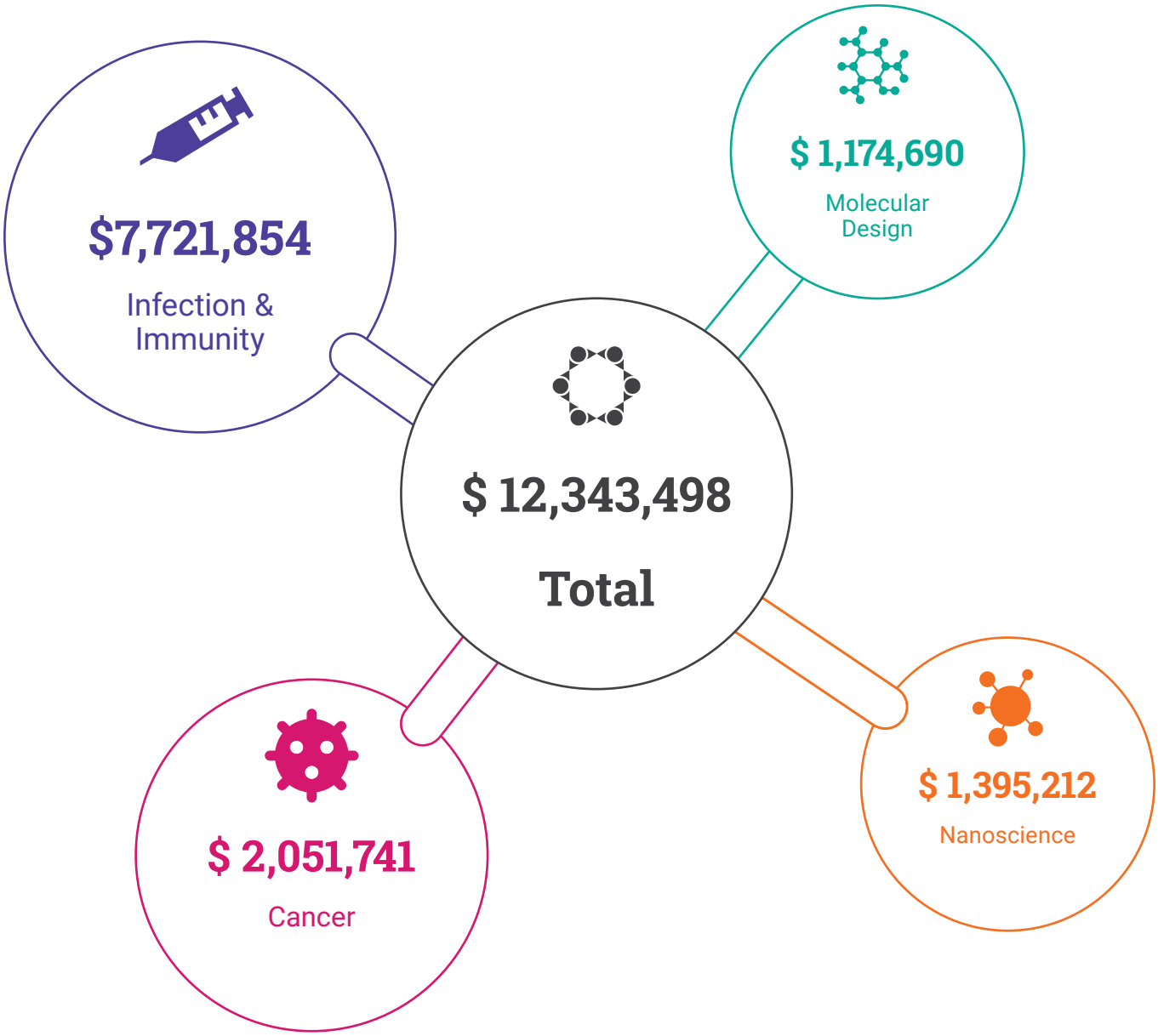
The findings, published in the prestigious journal *Chemical Communications*, are an important step towards simple yet highly sensitive heavy metal ion sensors for use in the field. Easy-to-use, portable sensors would enable anyone – with minimal training – to monitor the levels of pollution in waterways and drinking water supplies. If tests show hazardous levels of contamination a rapid response could be activated and harm minimised.

There is global need for accurate, low-cost sensors to assess water quality, particularly within developing countries and resource-poor settings where laboratory testing infrastructure may be limited. Having recently been funded by an ARC Discovery grant, further applications for this novel sensing concept will be extended into health testing and point-of-care medical diagnostics.

For more information on this research and further applications please contact LIMS.

Associate Professor Conor Hogan

EXTERNAL **FUNDING**



- Infection & Immunity
- Cancer
- Molecular Design
- Nanoscience

Project		2019 Revenue
AdAlta		**734,596.37**
Provision of research services for AdAlta Pty Ltd (Michael Foley)	●	734,596.37
Australian Research Council		**2,221,530.61**
Cell wall structure and dynamics in emerging fungal pathogens of crops (Marilyn Anderson)	●	14,736.00
Control of Cell Competition by Cell Shape Regulators in Tissue Development (Helena Richardson)	●	130,786.54
Crosstalk between cell survival and cell death pathways (Erinna Lee)	●	99,530.16
Determining the mechanism and function of dying cell disassembly (Ivan Poon)	●	147,868.86
Developing Next Generation Click Chemistry (John Moses)	●	246,702.71
Discovering New Organic Chemistry using an Inorganic Touch (Jason Dutton)	●	215,780.18
How autotransporter proteins mediate bacterial interactions (Begoña Heras)	●	161,564.02
How did the red blood cell lose its nucleus? (Patrick Humbert)	●	178,931.21
Laws of attraction and repulsion: a novel family of bacterial chemosensors (Brian Smith)	●	15,000.00
Mechanisms by which Beclin1 regulates intestinal homeostasis (Erinna Lee)	●	167,554.26
Molecular Mechanisms of Novel Bacterial Copper Defense Proteins (Begoña Heras)	●	47,499.75
Molecular reporters for measuring proteostasis capacity in cells (Yuning Hong)	●	132,388.00
The Structural Basis For Defensin-Mediated Membrane Attack (Marc Kvansakul)	●	143,765.53
Towards herbicide cocktails with a new mode of action to avert resistance (Tatiana Soares da Costa)	●	145,563.13
Understanding how protein and RNA cargo are sorted into exosomes (Andrew Hill)	●	146,801.22
Understanding the biogenesis of exosomes (Suresh Mathivanan)	●	227,059.04
Australian Research Council Centre of Excellence		**875,182.20**
ARC Centre of Excellence in Advanced Molecular Imaging (Brian Abbey)	●	875,182.20
Hexima		**2,616,299.76**
Antifungal activity implant defensins; discovery of novel insecticidal proteins; interaction between matriptase and proteinase inhibitors (Marilyn Anderson)	●	2,616,299.76
National Health and Medical Research Council		**2,341,109.73**
Activated platelets as unique targets for early imaging and site-directed therapy of cardiovascular and inflammatory diseases (Jacqueline Orian)	●	86,964.00
Biomarkers to aid clinical trials for neurodegenerative disease (Andrew Hill)	●	426,088.40
Broad Spectrum Inhibition of an Enzyme Antibiotic Target (Tatiana Soares da Costa)	●	13,825.06
Characterising the tumour suppressive function of myoepithelial cell stefin A in ductal carcinoma in situ (Belinda Parker)	●	83,461.62
Conologues: Ultra-fast-acting therapeutic insulins based on cone snail venom insulin principles (Brian Smith)	●	68,164.00
Defining molecular pathways for COX2 maturation in mitochondrial Complex IV (Megan Maher)	●	42,149.00
Defining the molecular regulators of apoptotic cell disassembly and their role in cell clearance and lupus-like autoimmune disease (Ivan Poon)	●	282,637.53
Disorderly conduct and disturbing the peace: how loss of cell polarity and tissue architecture drives cancer progression (Patrick Humbert)	●	131,782.30
Dissecting the pathogenic triad of enteric pathogens: Assembly, structure and function of autotransporter proteases (Robert Pike)	●	66,898.59

EXTERNAL **FUNDING**

Project		2019 Revenue
DsbA foldases from multidrug resistant pathogens as targets for new antimicrobials (Begoña Heras)		101,457.00
Elucidating the mechanism and function of cell disassembly during apoptosis (Ivan Poon)		110,897.04
Limiting the Impact of Influenza (Weisan Chen)		552,394.68
Mediator Kinase as a Therapeutic Target for Wnt/β-catenin Dependent Malignancies (Suresh Mathivanan)		20,000.00
Reappraisal of the mechanisms underlying implantation success or failure (David Greening)		58,169.00
Regulation of cell signalling and tumourigenesis by Lgl (Helena Richardson)		272,353.12
The metastability of proteome foldedness in neurodegenerative disease (Yuning Hong)		23,868.39
Other		**3,554,779.14**
A fast soft X-ray detector system for advanced biological and materials imaging (Grant van Riessen)		152,261.81
A Novel Cardioprotective Doxorubicin-based Treatment for Metastatic Breast Cancer (Suzanne Cutts)		131,236.00
Assessing the sensitivity of prion disease-associated exosomal miRNA profiles to therapeutic interventionin organotypic brain slices (Cathryn Ugalde)		12,560.00
Australia-China Centre for Personal Health Technologies (Yuning Hong)		230,000.00
Australian National Fabrication Facility (ANFF) - Victoria Node (Paul Pigram)		125,000.00
Barwon South West Pharmacist Early Intervention Pilot (Joseph Tucci)		5,000.00
Central neural circuits that regulate thermogenesis and lipolysis - target for anti-obesity pharmacology (Rodney Green)		15,000.00
Characterisation of Pineapple cysteine proteases with therapeutic potential (Lakshmi Wijeyewickrema)		288,306.00
CMSS Research Services for Monash University (Paul Pigram)		5,454.50
Comparing the in vivo mutagenicity and oncogenicity of Smac mimetic and chemotherapy treatment (Mark Miles)		76,798.00
Control of medically important Candidemias and Candida based Biofilms (Marilyn Anderson)		265,091.28
Controlling immune responses in blood cells (Helen Irving)		43,555.28
Development of herbicide cocktails with a novel mode of action for circumventing resistance mechanisms (Tatiana Soares da Costa)		11,899.00
Diagnosing Alzheimer's disease using miRNA from serum extracellular vesicles (Lesley (Sim) Cheng)		80,005.45
Dissecting the pathogenic triad of enteric pathogens: Assembly, structure and function of autotransporter proteases (Begoña Heras)		155,900.67
DNA damage by Idronoxil in Monotherapy and in Combination with Radiation (Paul Pigram)		68,883.74
Elucidating the mechanism and function of extracellular vesicle formation during cell death (Amy Baxter)		82,950.30
Elucidating the role of non-neuronal brain cells in the pathogenesis of prion disease (Cathryn Ugalde)		19,460.00
Enabling Exosome Therapy: Developing an Advanced Manufacturing Process (Andrew Hill)		441,341.09
Exploring better and safer treatments for osteosarcoma (Christine Hawkins)		95,678.00
F.graminearum cell wall (Marilyn Anderson)		47,050.00
Joint La Trobe Australian Synchrotron Fellowship (Brian Abbey)		130,705.04
Moving from preclinical trials into the clinic: Testing pathological and immunological response to intratumoral immune agents in triple negative breast cancer (Belinda Parker)		50,000.00
Novel insights into the molecular mechanisms of manganese recognition and acquisition by pathogenic bacteria (Megan Maher)		55,736.50
Novel therapeutics targeting neuronal transport pathways in MND (Belinda Abbott)		15,500.00

- Infection & Immunity
- Cancer
- Molecular Design
- Nanoscience

Project		2019 Revenue
Pre-clinical evaluation of IAP antagonists for osteosarcoma treatment (Christine Hawkins)	●	91,754.00
Preclinical testing of TLR agonists in triple negative breast cancer models: Critical timing, targets and combination strategies (Belinda Parker)	●	72,802.95
Profiling serum derived exosome-associated miRNA as a diagnostic tool for prion disease (Lesley (Sim) Cheng)	●	12,000.00
Proteasome inhibitors for canine osteosarcomas: modelling efficacy in mice (Christine Hawkins)	●	14,956.00
Regulation of Cell Polarity and Tumourigenesis by Tetraspanin 6 (Helena Richardson)	●	100,000.00
Research Services for Amcor AFAP Moorabbin (Paul Pigram)	●	30,900.00
Research Services for CSL Behring - SEM Analysis of Resin Beads (Paul Pigram)	●	900.00
Research Services for Mackay Rubber (Paul Pigram)	●	1,125.00
Research Services for Robert Bosch (Australia) Pty Ltd (Paul Pigram)	●	4,800.00
Screening of AdAlta's proprietary i-body library on a fibrosis related GPCR target (Christopher Hosking)	●	105,000.00
Seeking New Biomarkers for Early Diagnosis of Motor Neuron Disease and Huntington's Disease (Yuning Hong)	●	50,000.00
Specificity testing and cross-laboratory validation of a blood test for AD (Andrew Hill)	●	56,474.99
The origin and pathological contribution of intrathecal Ig in multiple sclerosis (Jacqueline Orian)	●	124,059.25
Towards herbicide cocktails with a new mode of action to avert resistance (Tatiana Soares da Costa)	●	6,000.00
Type I interferon regulators as prognostic markers and predictors of therapeutic response in triple negative breast cancer (Belinda Parker)	●	48,889.00
Understanding cellular metabolism to identify mechanisms underlying human disease (Katrina Binger)	●	100,000.00
Validation of brain specific exosomal miRNAs associated with Parkinson's disease (Andrew Hill)	●	60,644.29
When the dead speak: Boosting antibacterial immunity by inducing host cell death and disassembly (Thanh Phan)	●	69,101.00
Total		**12,343,497.81**

PUBLICATIONS

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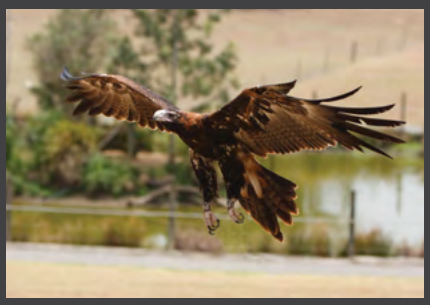

La Trobe University acknowledges that our campuses are located on the lands of many Traditional Custodians in Victoria and New South Wales. We recognise their ongoing connection to the land and value their unique contribution to the University and wider Australian society.

La Trobe University is committed to providing opportunities for Aboriginal and Torres Strait Islander people, both as individuals and communities, through teaching and learning, research and community partnerships across all our campuses.

The wedge-tailed eagle (Aquila audax) is one of the world's largest, and the Wurundjeri people – Traditional Owners of the land where our Melbourne campuses are located – know the wedge-tailed eagle as Bunjil, the creator spirit of the Kulin Nations.

There is a special synergy between Bunjil and the La Trobe University logo of an eagle. The symbolism and significance for both La Trobe and for Aboriginal people challenges us all to gamagoen yarrbat – to soar.

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