THE UNIVERSITY OF QUEENSLAND
AUSTRALIA

AIBN

Australian Institute for Bioengineering and Nanotechnology

Annual Report 2017

Contents

Cover image: Rattle-type magnetic non-porous hollow carbon particles.
Image on this page: SEM image of a di-block copolymer (PS-b-PMMA) thin film, phase separated on a surface energy modifying underlayer (PS-r-PMMA) on a Silicon substrate.

Vice-Chancellor and President's Message

Vice-Chancellor and President
Professor Peter Hoj

It is my pleasure to introduce the 2017 annual report of the Australian Institute for Bioengineering and Nanotechnology.
AIBN has been part of The University of Queensland for 15 years, contributing to our objectives and success regarding research excellence, innovation, sustainable outcomes for society, and industry-linked solutions to global problems.

> In 2017, AIBN underwent a seven-year review of its performance in research output, governance, engagement, teaching and learning, and equity and diversity. The outcome was pleasing, with AIBN receiving positive feedback on a range of important matters, including the environment created by and for AIBN staff.

An emphasis on equity and inclusiveness is part of AIBN's ongoing commitment to fostering future leaders in research and innovation. Career development initiatives in 2017 included a panel aimed at early-mid career researchers (EMCRs) and students, a postgraduate careers evening organised by the AIBN Student Association, and a new communicating science seminar series to help students and EMCRs develop science communication skills.

Reflecting the importance of opportunities for researchers to network, exchange ideas and initiate collaborations with national and international peers, AIBN hosted the International Conference on BioNano Innovation. Over 130 talks were presented, including a plenary lecture by Australian-born Nobel Laureate Professor Elizabeth Blackburn.

The conference gave AIBN students and EMCRs a forum for presenting their research to an international audience. These talks garnered much interest, as AIBN research continues to earn a place at the cutting edge of bioengineering, nanotechnology and the nexus of the two. The calibre of AIBN's research is also demonstrated through the achievements of a former Group Leader Professor Max Lu and inaugural Institute Director Professor Peter Gray, who were each made Officers of the Order of Australia.

I reiterate the University's congratulations to these knowledge leaders, who were instrumental in establishing AIBN.
AIBN continues to be ahead of the curve in areas of bioengineering and nanotechnology, and has firmly established itself as a key scientific innovator and exemplar of industry-linked research.

> I extend the University's appreciation and congratulations to all those who contributed to AIBN's success in 2017, including staff, students, alumni, industry partners, the Board, the Scientific Advisory Committee, and philanthropists.

Director's Message

AIBN Director
Professor Alan Rowan

2017 was a remarkable year of growth and scientific advancement for AIBN. Such progress was a wonderful way to mark 15 years since our Institute's foundation. AIBN has come a long way during this time, with over $134 million in grant funding secured, 161 PhD graduates earning their degrees, and seven spin-out facilities based on AIBN technology developed. These achievements highlight how well we continue to work together as we evolve.

2017 also provided a critical opportunity for reflection and planning, with a septennial review of our scientific discoveries and innovations, our facilities and research centres, and our researchers and education programmes. The overwhelmingly positive outcome of the review is due entirely to the hard work of AIBN staff and students over the last seven years, and is something of which we should all be immensely proud.

I am also delighted to say that 2017 was a year in which several of our research staff received wide recognition for their expertise. In particular, Professor Debra Bernhardt was awarded the 2017 Association of Molecular Modellers of Australasia (AMMA) Medal. Professor Mark Kendall was elected as a Fellow of the Australian Academy of Technological Sciences and Engineering (ATSE), following in the footsteps of other AIBN Fellows. Associate Professor Jessica Mar was awarded the Metcalf Prize from the National Stem Cell Foundation of Australia in recognition of her leadership in stem cell research. Moreover, Professor Justin Cooper-White became the Editor-in-Chief of the new scientific journal, *APL Bioengineering*.

> These achievements serve as inspiration to all of us, and further distinguish AIBN as a world-class Institute that both attracts and fosters scientific leadership.

Indeed, sustained advancement in scientific research relies on an environment that promotes career opportunities, while encouraging curiosity, innovation, and equality. In line with this, 2017 involved a special focus on career development and growth at AIBN, with several major events organised in and around the Institute designed to support and inspire our researchers, students and staff.
In particular, we launched the new Group Leader and Senior Group Leader structure at AIBN. This revised approach to scientific leadership enables the Institute to better support emerging group leaders.

> Throughout the year, AIBN continued its steadfast support of gender equity, with the Gender Equity Committee expanding to facilitate AIBN's participation in UQ's SAGE Pilot of the Athena SWAN program.

Meanwhile, our researchers continued to make great strides in their respective areas of expertise. Accordingly, 2017 was a year of exceptional science.

In Stem Cells and Ageing, AIBN researchers found that neurons affected by the rare neurodegenerative disease ataxia-telangiectasia (A-T) can be grown in the lab using stem cells derived from the skin cells of A-T patients. This work is now advancing research into A-T.

In Industrial Biotechnology, AIBN researchers developed a computer model that harnesses ancient biology for carbon-capture biotechnology. This identifies the best way to modify a microbe so that it can capture carbon from industrial waste gases and convert that carbon into useful products like ethanol.

In Precision Nanomedicine, our researchers have designed a virus-like nanoparticle (VNP) that could deliver drugs directly to the cells where they are needed.

In Agricultural Nanotechnology, AIBN researchers and their collaborators announced the development of a nanoscale clay matrix that protects double stranded RNA so that it can be sprayed onto crops to control plant viruses. This technology circumvents key problems caused by traditional pesticides as there are no toxic compounds or breakdown products associated with it.

In Advanced Materials, AIBN researchers are developing aluminium-based printed, flexible batteries. A key advantage of this technology is that it can be adapted to take almost any shape, yielding a wide range of potential applications from wearable electronics to large scale energy storage.

These represent just a glimpse of the wonderful discoveries and innovations this year brought, with further highlights covered in this annual report.

We anticipate many more remarkable discoveries in the year ahead and look forward to sharing them with you.

AIBN Board

Board responsibilities

- Assist in defining strategic goals and progress against goals
- Assist in defining levels of funding required to support ongoing operations and strategic initiatives
- Provide advice on funding opportunities, commercialisation paths, extension activities and growth strategies for the Institute
- Review progress of the Institute in the areas of research, internationalisation, commercialisation, governance and management
- Provide advice on matters such as raising the international profile of the Institute to maximise the benefits to Queensland and Australia
- Maintain the high visibility and reputation of AIBN in the research, industry, government and public domains.

The AIBN Board was established to provide interdisciplinary expertise to guide the development and strategic planning of the Institute. Its membership includes leaders from industrial, corporate, research, government and academic sectors. AIBN is fortunate to draw on the collective experience of these individuals to assist in shaping the Institute's future.

Dr Susan Pond AM (Chair)

Adjunct Professor in the Dow Sustainability Program at the United States Study Centre at the University of Sydney, Dr Susan Pond has a strong scientific and commercial background. She has held executive positions in the biotechnology and pharmaceutical industry for 12 years, including as Chair and Managing Director of Johnson & Johnson Research Pty Ltd. Her board positions include the Australian Nuclear Science and Technology Organisation, Commercialisation Australia, the Academy of Technological Sciences and Engineering (as Vice-President), Biotron Ltd and the Centenary Institute.

Professor Alan Rowan

Professor Alan Rowan serves as Institute Director of AIBN. As a world-leading researcher, he has published more than 300 peer-reviewed articles and books, garnering more than 14,000 citations (h-index 63). His work developing a biomimetic hydrogel is being commercialised through start-up companies for applications in wound dressings, drug therapeutics and cell growth. In 2016, Professor Rowan was awarded an Australian Laureate Fellowship to support his goal to establish a world-class research initiative centred on the interaction of cells with nanostructured materials and surfaces.

Kathy Hirschfeld

Non-executive director of InterOil Corp, Transfield Services Limited, and Toxfree Solutions; a Senator of The University of Queensland; and a member of the Board of UN Women in Australia. A chemical engineer, Ms Kathy Hirschfeld's 20-year career with BP included oil refining, logistics and exploration, located in Australia, the UK and Turkey. Her last executive role was as Managing Director of BP Bulwer Island Refinery in Brisbane, with responsibility for all aspects of the business.

Professor Max Lu AO FAA FTSE

Professor Max Lu is the President and Vice-Chancellor of University of Surrey. He is currently a Board director of the National Physical Laboratory and member of Leadership Council of the National Centre for Universities and Business in the UK. He has received numerous awards including Top 100 Most Influential Engineers in Australia. He has served on numerous boards including as Chairman of IChemE Australia, Australian Synchrotron; Uniseed; National Emerging Technologies Forum; Research Data Storage Infrastructure and Stem Cells Australia.

Professor Wilhelm Huck

A Professor of Physical Organic Chemistry at Radbound University, Professor Huck's group focuses on the physical organic chemistry of the cell and aims to elucidate, using model systems, the influence of the special nature of the cellular environment on complex reaction networks in cells. He was elected to the Royal Netherlands Academy of Arts and Sciences (KNAW) in 2012 and elected to the Royal Society of Chemistry. He has published around 250 papers and supervised ~20 PhD students. For his work in Nijmegen he received an ERC advanced grant (2010), a VICI award (2011), and the Spinoza prize (2016).

Dr Kym Baker

Dr Kym Baker is General Manager of Patheon Biologics Australia. Dr Baker has a strong academic and commercial background, holding a variety of positions in the biotechnology and biopharmaceutical industry for more than 20 years in the UK. Dr Baker is passionate about science education and the development of future scientific and engineering talent to help grow the Biotechnology industry in Australia through improved collaboration between industry and academia.

Bob McCarthy AM

With more than three decades of experience in senior positions in both the public and private sectors, Mr Bob McCarthy has been Director General of several Queensland Government departments, including the Department of Natural Resources and Mines, and the Department of State Development and Innovation. He has been at the forefront of efforts to diversify the Queensland economy and develop new industries, based on science and innovation.

Professor Aidan Byrne

As Provost, Professor Aidan Byrne is the Vice-Chancellor's senior deputy and a critical contributor to the general management of the University. His research interests involve the use of gamma-rays as probes to determine the structure of heavy nuclei and the examination of the atomic level structure of materials (especially semiconductors). He has published over 200 papers.

Scientific Advisory Committee

The Scientific Advisory Committee is tasked with advising the AIBN Board and Director on scientific direction and research strategies. Comprised of domestic and international researchers who are recognised as multidisciplinary leaders in their field, the Committee provides a wealth of knowledge.

The group's members are at the forefront of scientific research, and bring with them diverse professional networks and experience to assist in the translation of AIBN's scientific endeavours. The Committee is a vital component in providing strategic leadership and ensuring AIBN maintains its position as a world-class research institute engaging in relevant, needs-based science for the benefit of society.

Committee Members

Emeritus Professor Chris Lowe OBE (Chair)
Professor of Biotechnology, University of Cambridge

Professor Chunli Bai
President, Chinese Academy of Sciences

Professor Harvey W Blanch
The Merck Professor of Biochemical Engineering, University of California (Berkeley)

Professor Barry Buckland
Visiting Professor, Department of Biochemical Engineering, Faculty of Engineering Science, University College London; CEO of BioLogicB LLC

Professor Thomas W Healy AO
Particulate Fluids Processing Centre, University of Melbourne

Dr Anita Hill
Chief of Process Science and Engineering, CSIRO

Professor Andrew Holmes
University Laureate Professor of Chemistry, CSIRO Fellow and Distinguished Research Fellow (Imperial), University of Melbourne

Professor Martin Lavin
Centre for Clinical Research, The University of Queensland

Professor Martin Pera
Chair of Stem Cell Sciences, University of Melbourne, Florey Neuroscience and Mental Health Institute and Walter and Eliza Hall Institute of Medical Research

Professor Virgil Percec
P. Roy Vagelos Chair and Professor of Chemistry, University of Pennsylvania

Professor Colin Raston
South Australian Premier's Professorial Research Fellow in Clean Technology, Flinders University

Professor Laura Poole-Warren
Pro Vice-Chancellor Research Training and Dean Graduate Research School, University of New South Wales

Committee responsibilities

- Identify future strategic opportunities for fields of research, collaboration and cross-disciplinary foci
- Recommend research strategies and goals to the AIBN Board
- Identify unique funding opportunities for AIBN's activities
- Assist in providing global visibility for AIBN's activities
- Propose strategies for training and developing researchers and research students to build scientific capacity and capability in a multi-disciplinary, global environment.

Gender Equity Commission

The Gender Equity Commission (GEC) was established in 2016 to promote gender diversity by integrating gender equity into AIBN's strategic plans and practices. The GEC aims to create an inclusive academic culture and workplace that supports women in science. Besides implementing the best practice for senior leader recruitment in the Institute, GEC initiated seminars and workshops focused on career development, leadership, and training. These forums provide opportunities for early- to mid-career researchers to discuss and exchange ideas on navigating academic career challenges. The GEC plans to support AIBN's participation in the UQ SAGE Pilot of the Athena SWAN program. This program is designed to address and improve gender equity and diversity in Science, Technology, Engineering, Mathematics and Medicine and currently has 45 Australian organisations, universities, medical research institutions, and government research institutions involved. To assist with AIBN's aim towards an Athena SWAN Departmental Award, the GEC has encouraged the participation of 8 AIBN members across UQ SAGE Working Parties.

The GEC aims to create an inclusive academic culture to harness the power of diversity for enhanced organisational performance.

Family friendly workplace

- Dedicated child-friendly workspace
- Financial support for caregivers
- Parental leave information brochures

Communication and Engagement

- Cross institute awareness
- Career advancement brochures
- Resource page on website

Advancing Women's Career

- Financial initiatives to support women in science
- Career development workshop series
- Targeted career mentorship for ECMRs

Eradicate Unconscious Bias

- Gender equity seminars
- 50/50 pledge seminar speakers and committee memberships
- 42% of speakers at ICBNI were female

Address Historic Imbalance

- Strategy for recruitment of senior leaders
- Targeted hiring of very high quality senior or mid-career female researchers
- Inclusive job advertisement and position description

SAGE Pilot Athena SWAN

- 8 AIBN members participating in UQ SAGE, across most working parties
- Aim towards Athena SWAN Departmental Award

Research

Alexandrov Group

Synthetic biology and protein design

Professor Kirill Alexandrov

The Molecular Engineering group, led by Senior Group Leader Kirill Alexandrov, is working in the area of synthetic biology and protein design. The main objective of the group's work is to construct biological signalling systems using standardised protein-based building blocks.

> One of the main aims of this work is to create a seamless interface between biochemistry and electronics. While the initial practical application is in the point-of-care diagnostics, in the long term this work paves the way to the first bio-electronic hybrids.

"The idea of combining man-made and natural systems has fascinated humans for centuries; however, the integration of electronic and biological systems remains a woefully underdeveloped field of study. By expanding the genetic code and engineering proteins with novel functions, we can create molecular switches that enable seamless communication between electronic and biochemical processes." Professor Alexandrov said.

The group is currently focused is on developing biosensors based on glucose dehydrogenase enzyme. This enzyme is a principle component of glucose monitors that are the most widely used kind of diagnostic tests. Using synthetic biology Alexandrov's group reengineered this enzyme into an artificial sensing platform that can be used potentially for any analyte. In 2017, The Alexandrov Group filed a patent for this work bringing the total number of biosensor patents to five.

Another important line of the group's research is genetic code reassignment. As proteins are composed of twenty standard amino acids, their chemical diversity is limited. Alexandrov's group developed an approach for replacing natural amino acids with their chemically modified versions at the chosen positions of a polypeptide chain. This allows selective addition of new functionalities to create novel protein probes, sensors and drugs. This work pairs with the group's cell-free protein expression system based on the *Leishmania* parasite to allow researchers to label proteins site selectively in any way they want. The Alexandrov group published this work in the journal *ACS Synthetic Biology* in 2017. The unique approach developed by Alexandrov's group is the subject of two patent applications.

In 2017, the Alexandrov Group published or contributed to 11 research papers. One paper of note, published in the *Journal of Biotechnology,* was titled "Cell-free pipeline for discovery of thermotolerant xylanases and endo-1,4-β-glucanases." This work by Alexandrov group postdoc Dr Dejan Gagoski describes a streamlined pipeline based on the group's cell-free protein expression system that enables the rapid discovery of new biotechnologically useful enzymes.

The Alexandrov group received two grants in 2017, one through the Australian Cancer Research Foundation (ACRF) Cancer Ultrastructure and Function Facility and the other through the ARC Training Centre for Biopharmaceutical Innovation (CBI). The group also began a new collaboration with the Chemical Pathology department of Queensland Health.

> In 2017, the Alexandrov Group had two successful PhD graduates: Zhenling Cui , who went on to start a postdoc with the group, and Dejan Gagoski.

www.aibn.uq.edu.au/alexandrov

Bernhardt Group

Professor Debra Bernhardt

Theoretical and computational chemistry

The Bernhardt Group, led by Senior Group Leader Professor Debra Bernhardt, engages in research focused on the development of theoretical and computational methods for studying molecular systems, as well as their application in the fields of nanotechnology, environmental science, and nonequilibrium systems.

> "We're really interested in fluids that flow at such a high rate that it actually changes the properties of the fluid, and modelling that type of behaviour at the molecular level" Professor Bernhardt said.

The group utilises quantum electronic structure methods, classical and quantum molecular dynamics, statistical mechanics, and dynamics systems theory to characterise physical, chemical, kinetic, transport, material, and catalytic properties of complex systems in targeted application areas. Operating in an excellent computational laboratory within AIBN, the group has access to an in-house computational cluster, as well as access to UQ and national computation facilities.

One of the group's major projects, in collaboration with AIBN's Wang Group, is on developing new materials for better batteries. They are looking at the interactions of lithium with different anode materials to design better, more efficient electrolytes, anodes, and cathodes for rechargeable batteries.

In collaboration with the Wang Group and the Institute of Process Engineering in Beijing, in 2017 the Bernhardt Group was awarded a Queensland-Chinese Academy of Sciences (Q-CAS) Collaborative Science Fund grant for energy storage research to develop next generation lithium ion batteries.

The research aims at developing a cost-effective battery, with improved off-grid electricity storage capability and a longer lifespan, by looking to lithium-rich cathode materials, which offer greater energy density than traditional cathode materials.

In an ARC Discovery Project grant received last year, the group has been looking into improving nanostructured materials for supercapacitors. The project aims to understand the mechanism of charge and discharge using molecular modelling of the structure and diffusion coefficients in supercapacitors, to guide in the development of better energy storage systems.

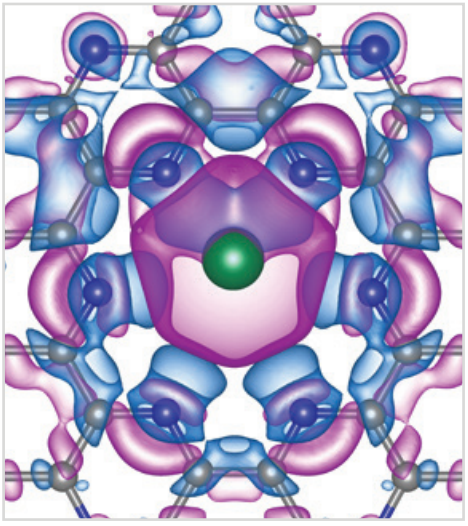
The group also received a grant from the Asian Office of Aerospace Research and Development for modelling polymers for 3D printing using non-equilibrium molecular dynamics simulations.

"We're looking at calculating the viscosity of the polymers to try and see what sort of material we can design that might perform well in 3D printing."

During 2017 the Bernhardt Group had 18 publications. Of note was a publication in the *Journal of Power Sources*, which examined using sodium as an alternative to lithium in metal-ion batteries.

The group looked at modelling sodium storage and mobility on different carbon materials. By removing some of the atoms from graphene, the group was able to model a carbon material with triangular pores which would enable diffusion of the sodium through the carbon layers, making for a cheaper battery material.

The group had two PhD students, Daniel Han and Yuan Su, graduate in 2017. In 2017 Professor Bernhardt was a Plenary speaker at the 25th Thermodynamics conference in Edinburgh. She was also awarded the 2017 Association of Molecular Modellers of Australasia (AMMA) Medal for the significant impact her work has had on the field of molecular modelling.



www.aibn.uq.edu.au/bernhardt

Cooper-White Group

Professor Justin Cooper-White

Microfluidics, stem cell biology, polymer chemistry and biomaterials

The Cooper-White Group, led by Senior Group Leader Professor Justin Cooper-White, is a group of highly motivated researchers with expertise in the areas of biomaterials, microfluidics, adult and pluripotent stem cell biology, and tissue engineering, passionate about applying an interdisciplinary bioengineering-based approach to generating novel solutions to improving tissue repair and overcoming age-related diseases.

"Our approach relies on developing novel diagnostic materials and cell-based microdevices to probe stem cell behaviour and understand their roles in tissue development, maintenance and age-related diseases. We then use this knowledge to generate in the lab human tissues/organs-in-a-dish for drug screening and discovery or to regenerate tissues in the body that are lost due to injury or disease." Said Professor Cooper-White.

During 2017, the group had several major publications; two papers of particular note were published in *Nature Communications*. One of the papers details the discovery of a small panel of *mechanosensitive* microRNAs that are secreted by mesenchymal stem cells when grown on a stiff substrate (mimicking bone tissue). The team then showed that by adding these microRNAs to these same types of stem cells when they are growing on a soft substrate (mimicking fat tissue), on which their natural tendency is to make fat, they could instead drive them to make bone, opening up previously unexplored avenues of using soft biomaterials to repair bone defects.

"Injectable, soft hydrogels represent one of the most effective delivery methods for stem cells, since they can easily be injected to fill spaces left by lost tissue and hold the stem cells in place, maximising their reparative potential; however, they normally inhibit osteogenesis because stem cells are driven, through mechanosensing, to forming soft tissues, such as fat."

By using these, and other similarly mechanosensitive microRNAs, it is now possible to direct the fate of the stem cells in a highly tuneable manner, opening up new avenues for manipulating stem cell differentiation and overcoming some of the major challenges faced in translation to the clinic.

In collaboration with the Queensland Brain Institute (QBI), the group's second publication in *Nature Communications* focused on the development of a novel microdevice that allows researchers to understand how neurons interact with proteins or endocytose material from a soluble environment. The design of the device enables the use of super resolution microscopy to directly observe and study that activity. This allowed the researchers to look at uptake and transport kinetics in neuronal cells at levels previously unexplored. This work resulted in a follow-up paper in *Nature Protocols* detailing the method and approach.

The group also published work in *Biomacromolecules* on a new nanoparticle system that allows targeted delivery of genetic material for direct reprogramming of one cell type to another, for example, a cardiac fibroblast to a cardiomyocyte, to improve recovery from an life-threatening injury (e.g. a heart attack!). These nanoparticles rapidly self-assemble from three pre-made, off-the-shelf components, carrying large amounts of genetic material (DNA, RNA) at their core, and can be targeted for uptake by presenting peptides that ligate to specific antigens on cell surfaces. Most recently, in a significant achievement, these nanoparticles have been used within *in vivo* small animal models, showing that they are not only non-immunogenic, but that they also enable a high transfection efficiency, critical steps to their translation into the clinic in the future.

With translation of their science high on their list of priorities, in early 2017, the Cooper-White group spun out a start-up company in the USA and Australia called *Scaled Biolabs Inc.* to commercialise microdevice technology that rapidly surveys 1000's of cellular microenvironments to define optimal media and culture conditions for the growth and differentiation of pluripotent stem cells. Professor Cooper-White holds a pro-bono position in the company as the Chief Scientific Officer. Around the size of a credit card, several versions of the chip have been developed, including the Microbioreactor Array (270 culture chambers) and High Density Microbioreactor Array (8,100 culture chambers).

Scaled Biolabs was awarded a grant from the California Institute of Regenerative Medicine (CIRM) in 2017 to work in the area of dopaminergic neuron generation for Parkinson's disease. Specifically, the company seeks to develop a medium and protocol for use in near-future clinical trials. In the past year the company has generated $1.5 million USD in income and is working with cell therapy companies in the US and Europe to reduce their cost of goods and improve product quality, removing critical roadblocks to making cell therapy cost effective and clinically translatable.

Professor Cooper-White holds a number of other roles, including Co-Director of the newly established UQ Centre in Stem Cell Ageing and Regenerative Engineering (UQ StemCARE), Office of the Chief Executive Science Leader in CSIRO, Professor of Bioengineering in the School of Chemical Engineering (UQ), Director of the NCRIS-funded Australian National Fabrication Facility – Queensland Node, based in the AIBN, and serves as Editor-in-Chief for *APL Bioengineering*, published by the American Institute of Physics Publishing. This open access peer-reviewed journal publishes high-impact manuscripts specific to the understanding and advancement of physics and engineering of biological systems, in perfect alignment with the focus of the Cooper-White group and many other groups in the AIBN.

www.aibn.uq.edu.au/cooper-white

Gray Group

Professor Peter Gray AO

Mammalian cell Lines and stem cell bioprocesses

The Gray Group, led by Professor Peter Gray, has a research focus on developing scalable methods for the production and differentiation of stem cells, and on bioengineering aspects of mammalian cell production of complex proteins.

> In 2017 Professor Grey received an Order of Australia medal in recognition of distinguished service to science in the field of bioengineering and nanotechnology as an academic and researcher, and to professional biotechnology associations.

The Gray Group collaborates broadly with several AIBN research groups, including Professors Stephen Mahler, Michael Monteiro, Lars Nielsen, and Chengzhong (Michael) Yu, on aspects of mammalian and stem cell bioengineering.

In ongoing grant support from Stem Cells Australia (ARC Special Research Initiative), the Merchant Charitable Foundation and the JEM Foundation, the group studies the thermo-responsive PNIPAM 'Nanobridge' stem cell propagation system.

The PNIPAM 'Nanobridge' system has been shown to be able to support enzyme-free propagation and sub-culturing of pluripotent stem cells (PSC) as cell aggregates without requiring small molecule inhibitors. The system has been tested in stirred bioreactors, which are more amenable to scalability and automation to generate large amounts of clinical grade cells for therapeutic systems, resulting in some of the highest cell concentrations of pluripotent cells reported to date. Imaging techniques have been developed on the GE InCell Analyzer which show that there is an even distribution of the viable, pluripotent cells throughout the aggregates.

It has been shown that the PSC aggregates produced by the PNIPAM 'Nanobridge' system are suitable for subsequent differentiation to a required cell lineage. Established protocols were used to induce neuronal differentiation of PNIPAM aggregates of PSCs. Downregulation of pluripotency markers (OCT 4, Nanog, DNMTB3) was observed during the first five days of dual SMAD inhibition, followed by induction of neuronal markers (PAX 6, NCAM, OTX2) by day 10 onwards. The PNIPAM allowed the aggregates to be dissociated by decreasing the temperature and the application of shear forces.

Four of the leading global groups in the field of stem cell bioengineering have requested, under a material transfer agreement, to obtain samples of the PNIPAM 'Nanobridge' stem cell propagation system to evaluate in their fields of interest.

During 2017 Professor Gray published work in collaboration with the Marcellin and Nielsen groups in the journal *Biotechnology and Bioengineering* titled 'Overexpression of the regulatory subunit of glutamate cysteine ligase enhances monoclonal antibody production in CHO cells'. The paper investigated the involvement of glutathione (GSH) in monoclonal antibody production, by generating stable Chinese hamster ovary (CHO) cell lines overexpressing genes involved in the first step of GSH synthesis.

> The group demonstrated that glutathione cannot be linked to higher productivity and that the glutamate cysteine ligase modifier subunit (Gclm) may be controlling cellular processes involved in monoclonal antibody production yet to be elucidated.

www.aibn.uq.edu.au/peter-gray

Kendall Group

Professor Mark Kendall

Targeting the skin for needle-free, minimally invasive vaccine delivery and diagnostics for disease

The Kendall Group, led by Senior Group Leader Professor Mark Kendall, focuses on physical methods for delivering biomolecules and stimuli to key immune response-inducing cells located in the skin and extracting important biomolecules for diagnostics purposes.

The ultimate goal of the group's research is to dramatically improve the cost and efficiency of vaccination and treatment of major diseases. This multidisciplinary research spans biomedical engineering, diagnostics, dermatology and vaccinology.

The group is known for the development of the Nanopatch device, a small patch which has thousands of small projections designed to deliver the vaccine to abundant immune cells in the skin.

During 2017, the Kendal Group published work funded by the World Health Organisation on a trivalent polio vaccine which demonstrated that the Nanopatch has a 40-fold dose baring, compared to the needle and syringe with the classic 3 strain polio vaccine.

"This is an exciting development which lays a key step for the next project, which is clinical utility of the Nanopatch." Said Professor Kendall.

PhD student Jonathon Wei was first author on a paper published in *Scientific Reports* that made fundamental discoveries into how the mechanical properties of skin change in different species of animals. This was done in collaboration with AIBN's Professor Darren Martin.

The paper establishes a firm understanding of correlations through species that are classically used in medical device work. This work allows not only for improved fundamental knowledge of dermatology but also a smarter way to test medical device interventions on the skin in the animal model, enabling translation to humans far more quickly and at a lower cost.

The group also published work in *Experimental Dermatology* with Professor Ian Frazer, which examined how damage-associated molecular patterns regulate the immune response to non-self-antigens presented at the site of a physical injury. Dr Jacob Coffey, a postdoctoral research fellow in the group who is currently working at MIT with Professor Robert Langar — one of the world's top biomedical engineers — was the recipient of an NHMRC travel fellowship in 2017. Also, Dr Michael Crichton, who has been working with the Kendall group at AIBN for a decade, received an Associate Professor appointment at Heriot-Watt University in Edinburgh.

> "Both of these postdocs have gone on to do great things, and these appointments speak to the quality of training and experience received at AIBN."

As part of his work with the Global Future Council on Entrepreneurship and Innovation, Professor Kendall also published work in the *World Economic Forum* about the 4th industrial revolution in education. "The 4th industrial revolution is changing everything, so we're looking at how we're going to need to change research and universities to meet that."

Professor Kendall was also elected as a Fellow of the Australian Academy of Technological Sciences and Engineering (ATSE) an independent body of more than 800 Australian scientists and engineers seeking to enhance Australia's prosperity through technological innovation.

www.aibn.uq.edu.au/kendall

Mahler Group

Professor Stephen Mahler

Research and development of biologic medicines

The Mahler Group, led by Senior Group Leader Professor Stephen Mahler, is working in biopharmaceutical discovery, research and development, focusing on biological medicines and antibody-targeted nanomedicines for the treatment of human diseases.

The group's research has a focus on the discovery of new therapeutic proteins, as well as developing drug delivery platforms to precisely target cancer cells.

The group uses monoclonal antibody discovery platforms, some of which have been created by the group, for isolating antibodies that target receptors involved in the initiation and progression of various types of cancers. Other disease indications targeted are various infectious diseases and graft versus host disease An antibody that binds the dendritic cell antigen CD83, previously isolated by the Group, is now in clinical development in collaboration with an Australian biotechnology company.

The group also utilises antibody fragments for targeting drug-loaded nanoparticles to tumour cells. The targeted drug delivery system allows for a potentially greater uptake of the therapeutic agent by tumour cells at a lower overall dosage, which results in reduced systematic toxicity, reduced side effects and improved treatment efficacy. The Mahler and Thurecht Groups work in collaboration in this research area of antibody-targeted nanoparticle delivery, and through patented technology have developed a new platform for drug delivery. The collaboration with the Thurecht Group facilitates the deployment of state-of-the-art imaging tools required to investigate the distribution of these nanoparticles in living systems.

"Imaging allows the group to see how effective the antibody-targeted nanoparticle delivery is as well as if the therapy is effective in tumour regression", Professor Mahler said.

Professor Mahler is also the Director of the ARC Industrial Transformation Training Centre for Biopharmaceutical Innovation (CBI). CBI is a $10 million biopharmaceutical initiative with strong industry support that launched in 2017. CBI's research focus is divided into three thematic research areas: discovery of new biopharmaceuticals, engineering cells for production of protein-based biopharmaceuticals, and advanced manufacturing for industrial production.

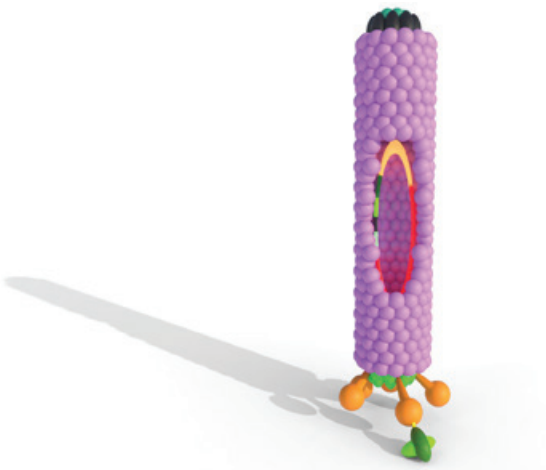
"We have a high throughput screening system where we isolate the antibodies from large immuno-globin gene libraries. After in vitro and in vivo testing, we discover if they could be candidates for a pre-clinical trial with the ultimate aim of becoming a new therapeutic agent." Professor Mahler said.

In work published in the journal *Antibodies,* the group reviewed different cell-based phage panning strategies for antibody selection. The review identifies a new methodology and system to isolate potential new anti-cancer drugs.

CBI works in strong collaboration with its four major partners: Patheon Biologics, CSL limited, the Australian Red Cross Blood Service, and GE Healthcare to deliver high-calibre training to students through industry-driven research projects, with a goal of contributing to the transformation of the biopharmaceutical industry. The centre currently has 16 PhD students.

Professor Mahler has also created a continuing professional development (CPD) program in the area of biopharmaceuticals. The CPD program is being further developed in partnership with MTPConnect and industry partners, and will be made available to stakeholders in the industry, both in Australia and internationally.

Through CBI and the CPD Program in Biopharmaceuticals, the Mahler Group continues to work with stakeholders to ensure a vibrant future for the biopharmaceutical and biomedical sciences industry in Australia.



www.aibn.uq.edu.au/mahler

Mar Group

Associate Professor Jessica Mar

Bioinformatics methods to understand how regulatory processes go awry in human diseases

Associate Professor Jessica Mar started with AIBN in July 2016 under a joint appointment with the Albert Einstein College of Medicine in New York City. Professor Mar's work is in computational biology, bioinformatics, and quantitative genetics. The group focuses on data modelling of gene expression and understanding the regulatory control of the transcriptome.

> "Computational biologists help make sense of the data. We complement the technologists and experimentalists as well as clinicians" Professor Mar said.

This quantitative approach to biological systems allows the Mar Group to drive science forward and answer specific questions about gene expression, both in a population and all the way down to the single cell level. The Mar Group's current focus is on variability, or heterogeneity, in gene expression and how it can relate to phenotype or clinical output.

"People are all quite different, and the genetic make-up of how a system works can also be quite different."

Bioinformatics methods typically focus on the average differences in the genome, such as if a gene is more highly or lowly expressed between patients and control groups. But variability is also an important component, for instance a gene might be expressed in a noisy way from patient to patient but more stably expressed in a control group. The Mar Group uses tools and develops new methods for looking at changes in this variability. In particular, the group looks at single cell populations and studies the variability in a population of cells to identify the parts of the genome that are important to disease, which could lead to better focused drug design. Working with large populations of single cells also improves the statistical power of this work.

"Statisticians have always been hindered by small sample sizes — if you have low n-values there's only so much you can do with that statistically — but now, with some of these single cell techniques, you're profiling thousands of cells individually and there's a lot you can do with that — it's an exciting new way to look at cell biology."

2017 was a successful year for the Mar Group in terms of research grants. Associate Professor Mar secured an ARC Future Fellowship grant and is part of an NHMRC project grant in collaboration with the Wolvetang Group. Associate Professor Mar was also the recipient of a 2017 Metcalf Prize.

In 2017 the group published work in the journal *PeerJ*, describing a computational method for identifying pathways that have different degrees of variability that can be applied to a variety of data sets.

> "Our group has a dual focus – doing work on the science side, but then also producing methods for genetic analysis."

Along with her impressive scientific output, Associate Professor Mar is also a member of the AIBN Gender Equity Committee, developing initiatives to address the gender imbalance at the Institute.

Associate Professor Mar supervises four HDR students in her role at the Albert Einstein College of Medicine and is looking to recruit new HDR students in 2018 for her group at AIBN.

www.aibn.uq.edu.au/mar

Marcellin Group

Dr Esteban Marcellin

Systems metabolic engineering for industrial biotechnology

The Marcellin Group, led by Dr Esteban Marcellin, focuses on using bioprocessing and systems metabolic engineering for the production of chemicals. By using genome-wide analyses alongside mathematical modelling, the group is able to characterise and better predict cellular behaviour.

> "We use systems biology and synthetic biology to engineer the 'cell factory' to provide a sustainable and green approach to the production of chemicals."

Using metabolic engineering to optimise the cell's metabolic performance, microorganisms and cells can be modified by installing and removing genes from other cells or synthetic sources and deliberately deregulating or removing competing pathways for efficient production and yield of high-value chemicals. Using cells to produce these chemicals from renewable feed stocks, such as natural gas or gasified waste, as opposed to burning fossil fuels is environmentally favourable. This novel approach to chemical production could help combat climate change by consuming greenhouse gases, which would otherwise be released, in a process called gas fermentation.

"The advantage of using gas fermentation is that you can gasify pretty much anything, such as municipal or agricultural waste. The bacteria we work with are able to capture the greenhouse gases released from this process and convert them into useful chemicals."

This process of gas fermentation formed the basis for a publication in *Cell Systems* titled "Maintenance of ATP Homeostasis Triggers Metabolic Shifts in Gas-Fermenting Acetogens". This work was done in close collaboration with Lanzatech, a US based leader in the field of gas fermentation, as part of an ongoing ARC Linkage grant.

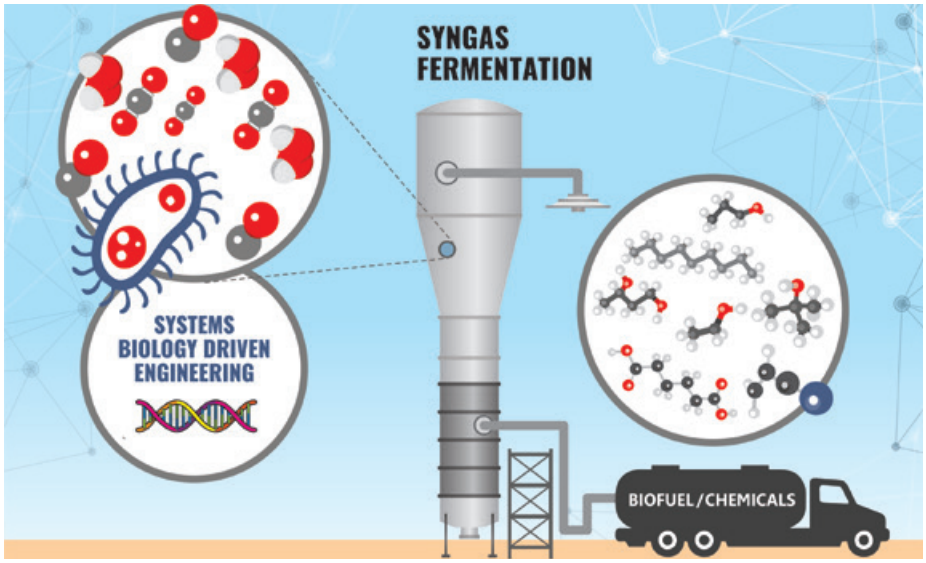
The group has also collaborated extensively with Zoetis as part of another ARC Linkage grant to increase production of tetanus toxoids for vaccines and for the production of active secondary metabolites to treat livestock from diseases. Other collaborations in the same field included a collaboration with Cornell University and The University of Tübingen, which also resulted in a paper published in *Current Opinion in Chemical Biology*.

The Marcellin Group published or contributed to a total of nine research papers in 2017. The Marcellin Group also filed two patents in 2017: The first in partnership with Lanzatech in producing biopolymers and the second with UniQuest.

Dr Marcellin also contributes to work carried out at the ARC Training Centre for Biopharmaceutical Innovation (CBI), applying the group's 'cell factory' technology to the production of proteins that can be used to treat certain diseases in collaboration with Patheon and CSL.

2017 was also a successful year for three of the Marcellin group's HDR students, with one student being awarded his PhD and two others submitting their thesis for review.

Dr Marcellin is also a member of the Gender Equity and HDR Committees at AIBN.



www.aibn.uq.edu.au/marcellin

Martin Group

Polymer nanocomposites, renewable nanomaterials and nanotoxicology

Professor Darren Martin

The Martin Group, led by Senior Group Leader Professor Darren Martin, is investigating ways to replace everyday materials, such as plastics, rubbers, packaging, insulation foams and carbon materials — many of which are unsustainably sourced from petrochemical-derived materials, with sustainable alternatives. In developing these new products, the group also seeks to enhance their mechanical properties and performance compared to existing versions of these products.

> As one of the most commercially focused groups at AIBN, the group takes fundamental discoveries in materials science and biology, and progresses the engineering, regulation, and translation of these technologies.

A major focus of the group is their work with nanocellulose derived from spinifex, a genus of grass indigenous to Australia. The group has developed a method of extracting the nanocellulose from spinifex to be used as an additive to improve the strength, durability, and rigidity of a range of products, including latex, paper, and building materials.

"Spinifex is endemic to Australia and in 2012 we discovered that when converted to nanocellulose, it's made up of long, thin, super-tough fibres that are unlike anything else on the planet"

The group works closely with the Dugalunji Aboriginal Corporation, who signed a landmark agreement with UQ in 2015 ensuring that their remote Indigenous community will have ongoing equity and involvement in the project. The project has the potential to provide training, jobs, and education in regional Australia.

One example of the successful application of the spinifex nanocellulose is in the group's recycled cardboard project. One of the challenges facing the recycled paper industry is the decreased structural integrity of recycled paper fibres. However, the addition of spinifex nanocellulose in small percentages can increase the rigidity of corrugated cardboard packaging. Additionally, the nanocellulose fibres are sustainable and biomass based, as well as having a high hemicellulose content which makes the fibres "self-adhesive".

In an ongoing Advance Queensland Project, led by Dr Pratheep Kumar Annamalai, the group is modifying spinifex and getting the best out of it as a cement and concrete additive. The group also works on latex re-enforcement through another ongoing Advance Queensland Project led by Dr Nasim Amiralian. In tests run on a commercial dipping line in the United States, latex with the spinifex additive showed a performance increase of 20% in pressure and 40% in volume compared to the commercial latex control sample. Currently, the project is looking towards running further trials with manufacturers in South East Asia.

During 2017, the group published work in the journal *Industrial Crops and Products* on their work to develop sustainable rigid polyurethane foam used in insulation. The group replaced the petrochemical building blocks in the foam with sustainable materials, such as lignin and plant-based materials, resulting in a significant reduction in thermal conductivity, which equates to energy savings.

To support the advancement of their work, the group received a major Advance Queensland Biofutures Commercialisation grant to upgrade the current spinifex Nanocellulose downstream pilot facility at Long Pocket into a commercial demonstration plant. The upgrade will improve the infrastructure, quality systems, and technology development associated with taking the spinifex platform technology closer to market.

The facility will enable the group to work with a range of commercial partners to produce cellulose nanofibers tailored to perform across the elastomer, paper and packaging, cement and concrete, and other anticipated future addressable markets. The group also plans to move all their research work to the upgraded facility in 2018.

www.aibn.uq.edu.au/martin

Monteiro Group

Professor Michael Monteiro

Polymer Chemistry: Synthesis of designer polymers

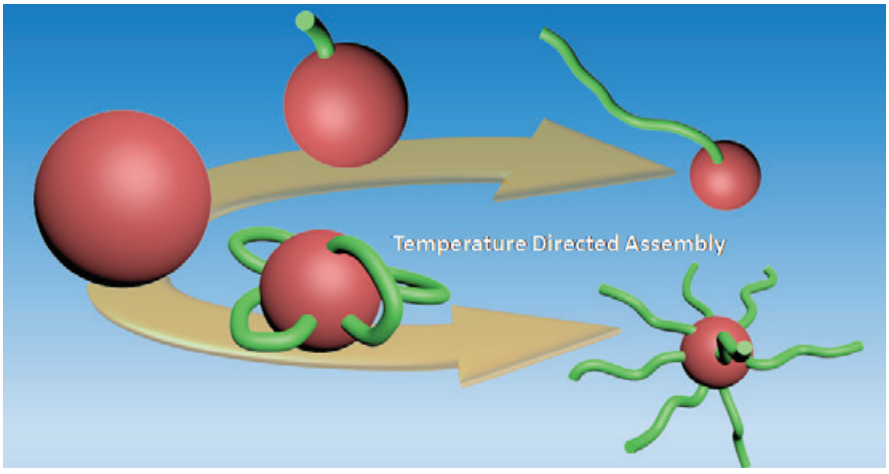
The Monteiro Group, led by Professor Michael Monteiro, has a research focus on polymer science, and in particular polymer chemistry, from synthesis of sequence controlled polymers to polymer nanostructures. These polymer structures are designed for many applications.

The group's goal is to utilise multidisciplinary teams with complementary expertise to develop a fundamental understanding between the relationship of designer polymer architectures and biological molecules with the aim of enabling the synthesis of advanced products.

Polymers are amoung the most versatile and diverse materials ever created by humans or nature. Professor Monterio's contribution to living radical polymerisation (LRP) is the development of new and useful LRP techniques through the in depth study and understanding of their mechanisms. His group has recently developed new methods to carry out SET-LRP in water to produce water-soluble polymers with controlled distributions and end-group functionality. His insights into the mechanism of LRP has led to improved engineered materials, now being used by industry.

The Monteiro Group has previously designed and synthesised unprecedented complex macromolecular dendrimers through the coupling of well-defined and functional building blocks generated via LRP and 'click'-chemistry work funded by an ARC Discovery Project grant. The group has now expanded its expertise to make polymer rings (cyclics) using the group's own nitroxide and well-established 'click' reactions.

Professor Monteiro's work in making nanostructures via emulsion polymerization is internationally recognised. The group's recent work used thermoresponsive polymers to drive 3D structures directly in water and on scales for potential use in industry. With this, the group could create a wide range of structures and more importantly have diverse surface orthogonal functionality on nanoworm and tadpole nanostructures. These functional structures are now being trialled as drug delivery vehicles.



> The group has now made the unique toroidal nanorattles (*ACS MacroLetters 2017*), and building similar systems through fueled self-assembly.

During 2017 the Monteiro Group collaborated with Professor Virgil Percec from the University of Pennsylvania on the ultrafast SET-LRP of water soluble monomers to form polymers with high chain-end functionality. The SET-LRP method has had direct impact in industry, now producing commercial products from this process. The group's work on soil remediation could impact on rehabilitation of toxic mining wastelands. More recently, technology to expand stem cells in biocultures has the potential to impact not only laboratory practices but allow expansion of pluripotent stem cells for tissue generation.

The group has also developed a new strategy to produce iterative sequence and exponential growth of macromers with well defined chemical compositions.

www.aibn.uq.edu.au/monteiro

Ngo Group

Neurometabolism

Dr Shyuan Ngo

The Ngo Group, led by Group Leader Dr Shyuan Ngo, moved to AIBN in July 2017 after being established at the UQ Faculty of Medicine. The group is interested in understanding how metabolic homeostasis at the systemic and cellular level can impact upon neurodegenerative processes. Overall, the group's research program has a strong focus on Motor Neurone Disease (MND).

> The group has a strong research foundation that centres on patient-directed research.

Body composition and metabolic rate, as well as dietary intake, appetite regulation, gut dynamics, and physical activity are assessed to understand the impact of altered whole body metabolism and human physiology on the clinical features of disease and patient outcome.

"It's important to give patients the opportunity to get involved in the research so they can become more aware of what we are trying to achieve in our studies; it gives them a lot of hope to know that they can make a difference. That way, even if it may not change their personal outcome, they're contributing to something bigger." Dr Ngo said.

During 2017, the group published six papers spanning the fields of MND, ageing, and growth hormone. In work published in Nature Communications, the group was involved in a large collaboration that describes the discovery of a novel risk locus, which significantly advances our understanding of some of the causes of MND.

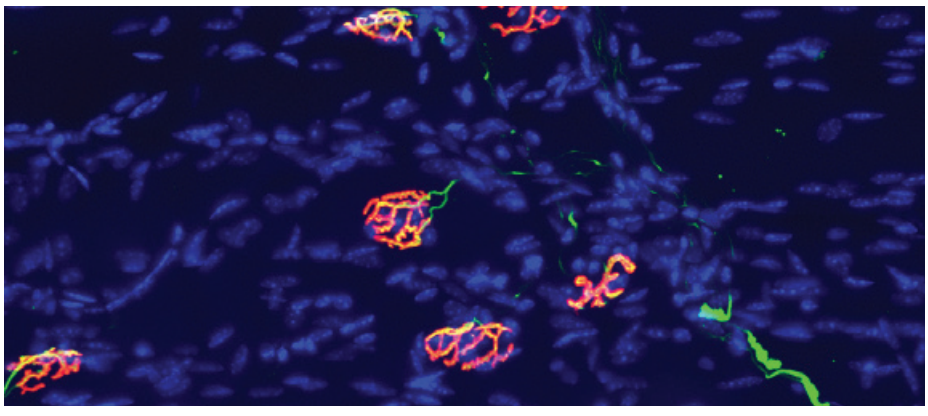
The group received a grant from the Motor Neurone Disease Research Institute of Australia (MNDRIA) in 2017 to take muscle biopsies from their patients and non-affected individuals. These samples will enable the group to do high throughput screening for compounds that keep muscle cells alive in vitro, with the ultimate goal of translating these treatments back into an individual and gaining an understanding of the heterogeneous nature of the disease.

PhD student Timothy Tracey was also the recipient of the MNDRIA PhD student top up grant. This grant is only awarded to one PhD student a year. His project looks at using induced pluripotent stem cell-derived neurons to understand how changes in the way these cells use energy might increase their susceptibility to death in MND, and to identify potential therapeutic compounds.

"One of the reasons we moved to AIBN was to advance towards the goal of personalised medicine, because no patient is the same, and if we can tease apart the disease mechanisms we can better stratify patients for clinical trials in the future."

In collaboration with researchers from The Florey Institute and University of Strasbourg, the Ngo Group received a $1 million grant from FightMND (formerly Cure for MND). This collaboration focuses on targeting the metabolism of complex fatty acids as a therapeutic approach for MND.

Dr Ngo also participated in the Brisbane Health Hack, an event designed to help medical researchers, health professionals, and students find innovative solutions to important problems. In collaboration with researchers from the Institute of Molecular Bioscience (IMB) and the Queensland Brain Institute (QBI), Dr Ngo's pitch was to develop an app titled "Show Me MND" that allows a patient to track their own progress in areas such as muscle symptoms and mood, to generate a report for their neurologist. This app could eventually be linked to their clinician, enabling them to be notified of any changes that are of concern to the patient.



www.aibn.uq.edu.au/ngo

Nielsen Group

Systems and synthetic biology

Professor Lars Nielsen

The Nielsen Group, led by Senior Group Leader Professor Lars Nielsen, uses systems biology — that is, systems science, modelling and simulation — to integrate data streams and generate knowledge. As applied systems biologists or biotechnologists, they do more than just develop tools for better understanding (analysis); they also use these tools to design products and processes for human benefit (synthesis). The science is moving forward from the crude retrofitting of living systems with a small number of genes using genetic engineering, toward purposeful reengineering of living systems using systems and synthetic biology.

> "We're increasingly looking at industrialised biotechnology — looking for ways to accelerate the development and discovery process" Professor Nielsen said.

Drawing on a common core of expertise in genome scale metabolic modelling and the full range of "-omics" technologies, the group studies a diverse range of biological systems, including model and industrial microbes, animal cells, plants, and increasingly complex ecosystems.

"One of the things we consider is how to use modelling and analytic tools to come up with better designs for chemicals, proteins, and cells — we focus on the mathematical modelling required to address that question."

During 2017, the Nielsen Group received renewal of both a Bio-Platforms Australia grant and a Stem Cells Australia grant, allowing them to continue with ongoing research into both of these projects. Professor Nielsen has a joint position with the Novo Nordisk Foundation Centre for Biosustainability at the Technical University of Denmark (DTU) in Copenhagen, which has created collaborative opportunities between DTU and AIBN. An international collaborative development grant has been secured for partnering between several groups involved in industrial biotechnology at AIBN and DTU.

The group also collaborates under a memorandum of understanding with leading American synthetic biotechnology company, *Amyris Inc.* The collaboration is working to identify target products of interest to the Queensland region and develop the required production and scale-up technology in collaboration with the $2-billion Queensland sugar industry. The collaboration gives the group access to *Amyris*' Automated Strain Engineering (ASE) platform, which can generate and screen more than 1,000 strains per month. The group then characterises these strains to identify and produce ones with commercial viability.

During 2017, the group published 25 papers. One paper of note, published in the journal *ACS Synthetic Biology* titled "Toward Synthetic biology strategies for adipic acid production: An in silico tool for combined thermodynamics and stoichiometric analysis of metabolic networks", evaluated 16 different production routes for making adipic acid, a novel nylon-6,6 precursor that has recently gained popularity in synthetic biology. Another paper published in *Biotechnology Advances* titled "Formulation, construction and analysis of kinetic models of metabolism: A review of modelling frameworks" reviewed, evaluated, and discussed kinetic models, which are critical in predicting the dynamic behaviours of metabolic networks.

> The group also contributed to a paper published in *PNAS* titled "Functional screening in human cardiac organoids reveals a metabolic mechanism for cardiomyocyte cell cycle arrest".

The Nielsen Group has two PhD completions in 2017, with Pedro Andres E. Saa Higuera being awarded his degree for his project titled "A Bayesian framework for sampling the feasible kinetic behaviour of metabolic reaction networks' and Tim McCubbin submitting his PhD thesis titled "Exploring the metabolism of propionibacteria using genome-scale modelling".

www.aibn.uq.edu.au/nielsen

Rowan Group

Professor Alan Rowan

Bio- and nano-mimickry of human systems

The Rowan Group, led by AIBN Director and Senior Group Leader Professor Alan Rowan, focuses on the interaction of live cells and synthetic materials which closely mimic the physical properties of materials found in nature.

The group was established at AIBN in July 2017 and continues on from Professor Rowan's 22 years of work in supramolecular chemistry at the University of Nijmegen. Alan's passion for science translates to his role as Institute Director in that he aims to inspire HDR students and early career researches to think and grow as academics.

"I absolutely love science: I love the challenge of it, I love the creativeness of it. Science is about taking an idea which never existed and then developing a series of questions to answer it; it's a wonderful job in that context." Professor Rowan said.

With the support of ongoing funding received by Professor Rowan in an ARC Laureate Fellowship grant, the group continued their work on understanding how soft materials in the human body can be modelled to produce sophisticated and responsive materials, and then translate this knowledge into products for use in diverse applications such as tissue engineering, wound healing, and immunology through to responsive soft matter and robotics.

The Rowan Group has recently invested in a confocal rheometer, the first of its kind in Australia, a unique piece of lab equipment which allows them to apply a force, such as stretching or compressing, to a cell and monitor in real time which proteins are expressed or upregulated in response to that stimuli.

This work will lead to a better understanding of how cells interact with their environments by answering questions like "How does a cell interact with the extra cellular matrix? How does the cell sense its environment? That was the hypothesis; how do we design experiments to understand that?"

Professor Rowan says that the research has some interesting potential applications.

"It turns out that astronauts have exactly the same problem: In zero gravity the forces on their cells are different, so things like bone density start to degrade."

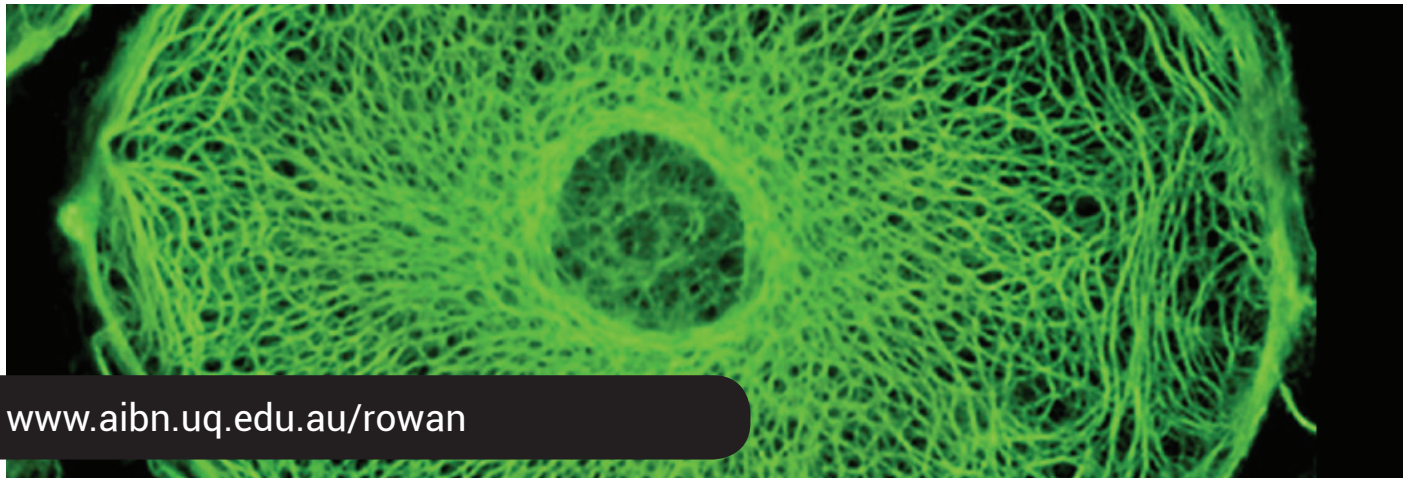
Professor Rowan's research has demonstrated that cells need this force to be activated and that the amount of force applied to the cells can influence how they are activated.

> "This whole idea that we call 'mechanobiology' is essential to life."

During 2017 the group contributed to seven publications. Including one in *Nature Communications* which showed how the mechanics of fibrous networks change in the presence of a second network component, using a synthetic biopolymer mimic.

Professor Rowan is continuing to supervise a number of students in his lab in Nijmegen with the aim of recruiting new students to join his group at AIBN.

The group also launched a number of collaborations with groups at the Institute for Molecular Biosciences (IMB) and Queensland University of Technology (QUT).



www.aibn.uq.edu.au/rowan

Thurecht Group

Associate Professor Kristofer Thurecht

Molecular imaging, polymer chemistry, multimodal imaging, theranostics, nanomedicine, drug delivery

The Thurecht Group, led by Group Leader Associate Professor Kristofer Thurecht, focuses on the development of polymer and nanoparticle-based devices for nanomedicine. In particular, they are interested in the design, synthesis, and preclinical evaluation of nanomaterials for molecular imaging and drug delivery.

> "My group uses imaging to try and understand how the fundamental properties of nanomaterials affects their behaviour in biological systems" Associate Professor Thurecht said

For polymers to be truly effective in nanomedicine, they must incorporate new therapies while maintaining their physical and chemical integrity. This can only be achieved by developing a strong understanding of the fundamental properties of the nanomaterial-delivery system, in addition to identifying and successfully delivering new therapies. Central to the development of these future therapeutic platforms is the field of theranostics, where molecular imaging plays a key role in understanding the dynamics of polymeric nanomedicines.

The group is involved with numerous collaborations, locally and nationally, including Monash University, the University of Melbourne, and the University of New South Wales. Many of these collaborations are driven by Associate Professor Thurecht's affiliation with the ARC Centre of Excellence in Convergent Bio Nano Sciences and Technology (CBNS).

As part of their collaborative network, the group also heavily engages with industry and has been working with an industry partner to develop an antibody imaging agent, which the partner has now moved into clinical trials in Sydney. The group is continuing that work to further develop it into a therapeutic agent with the partner.

"We work with a number of different companies in developing new imaging agents and drug delivery technology as well as enhancing the training of students in the science and methodology required to advance that technology."

Associate Professor Thurecht was one of 12 Chief Investigators involved in a successful ARC Industrial Transformation Training Centre grant for the establishment of the ARC Training Centre for Innovation in Biomedical Imaging Technology. The centre will collaborate with industry partners to train sixteen HDR students and three postdocs over the next four years. Associate Professor Thurecht will lead the nanomedicine theme at the centre.

The Thurecht Group had 14 publications in 2017. Of note, the group collaborated with researchers from the University of Melbourne to publish a perspective article in ACS Nano. The paper examined and highlighted ways to improve the next-generation of nanomedicines and explored new directions for the field of cancer nanomedicine. Associate Professor Thurecht was invited to present at the Engineering and Physical Sciences Research Council (EPSRC) focus project in the United Kingdom on the topic of closed loop therapeutics. He was also invited to present the group's work at the Royal Australian Chemical Institute (RACI) National Congress in Melbourne.

In 2017 the group was also involved in developing a new advanced chemistry course for high school students. The course was developed for a school in rural Queensland, and researchers spent 3 days at the school working with students to develop their fundamental understanding of chemistry. The group then hosted the students at various laboratories at UQ where they had some hands-on experience in materials characterisation.

> "The main aim of the course was to give students an opportunity to see what it's like in a real lab; for them to be able to use some of the instruments and see the practical applications of the theory they were learning."

The group is continuing to work with the school to improve the course and was successfully awarded an educational infrastructure grant for the school to improve their facilities for students.

Associate Professor Thurecht is also part of the AIBN Gender Equity Committee, and participates in the UQ SAGE Athena SWAN Pilot program communications working party.

www.aibn.uq.edu.au/thurecht

Trau Group

Nanoscience, nanotechnology, molecular diagnostics

Professor Matt Trau

The Trau group, led by Senior Group Leader Professor Matt Trau, is focused on nano-bioscience research, technology development, and clinical translation. Professor Trau has a joint position with the School of Chemistry and Molecular Biosciences and is the Director for the Centre for Personalised Nanomedicine (CPN). The CPN brings together research from the fields of Nanotechnology, Molecular Biology, Clinical Research and Health Economics.

> The group is dedicated to developing improved point-of-care diagnostics from the benchtop to bedside, with the goal of significantly enhancing patient outcomes and helping to transition the medical system towards early disease detection and personalised treatment.

By combining innovations in nanotechnology with chemistry, engineering and molecular biology, the group's research aims to create highly innovative point-of-care diagnostic technologies targeted at the health care sector.

"It's a very exciting time right now; molecular technologies are increasingly being used to guide treatment in cancer, so there's an opportunity to invent and utilise new DNA, protein, or cell-based technologies and trial them in the clinic. Our group is very active on all those fronts." Professor Trau said.

Work published in 2017 by Kevin Koo, a PhD graduate in the Trau Group, was featured on the front cover of the journal *Lab on a Chip*. In this work, Koo highlights the group's research advancements in the development of miniaturised lab-in-a-drop biosensors, and the role AIBN research is playing in moving the field forward.

Lab-on-a-chip systems are personalised diagnostic systems that seek to perform the entire sample-to-outcome detection of disease biomarkers on a single, miniaturised platform. Building on from this, Koo describes the latest advances in these miniaturised solution-based disease detection technologies, collectively termed as the "lab-in-a-drop" system, and how they can be extremely useful for the detection of disease nucleic acid biomarkers.

"Kevin's work is able to detect fusion RNA genes, which act as a marker for prostate cancer, down to 100 copies in urine samples. This technology can easily be run at home with minimal user input." Professor Trau said.

Another research highlight from 2017 was work by Jing Wang on circulating tumour cells (CTCs). CTCs are a promising biomarker for monitoring cancer metastasis and therapy response; however, the rarity and fragility of CTCs make detecting them challenging. Currently, CTC detection requires advanced instruments that might be inaccessible in most hospitals or labs. To allow simple and rapid CTC detection, the group developed a sensor based on magnetic nanoparticles.

"We developed barcoded nanoparticles that are designed to bind to receptors on the surface of potentially dangerous CTCs that allow us to image them. Using this, we're able to monitor cancer progression in real time." Professor Trau said.

As well as these two highlights, the group published 16 research papers in 2017. The group also had two HDR student graduations and one thesis submission in 2017.

In 2017, the Trau group secured for five new research grants, including a philanthropic donation from *So Brave*, Australia's young women's breast cancer charity. The Trau group, as part of the CPN, hosted this charity in 2017 at a fundraising event and is a strong supporter of their work.

www.aibn.uq.edu.au/trau

Vickers Group

Associate Professor Claudia Vickers

Synthetic biology

The Vickers Group, led by Group Leader Associate Professor Claudia Vickers, has a research focus on using synthetic biology approaches to answer key fundamental biological questions and to improve industrial bioprocesses. In particular, the group is interested in using biology to replace current industrial practices — largely based on finite petrochemical resources — with sustainable, environmentally friendly processes.

> "We use yeast, cyanobacteria, and *E. coli* as whole-cell catalysts to convert carbon from a sustainable feedstock, such as carbon dioxide or sugar, into an industrial product that has an interesting or useful application" Associate Professor Vickers said.

The group's specific focus is on a set of natural products called isoprenoids, which have industrial applications including pharmaceuticals, fragrances, flavourings, agricultural and industrial chemicals, and biofuels and fuel additives. The group is interested in understanding the fundamental science behind the metabolic regulation and control of the pathways that produce isoprenoids, as well as using that scientific information to develop new engineering techniques that are effective in increasing the flux of carbon from the feedstock to the product of interest.

In 2017, the Vickers Group was awarded a Fellowship for Dr Konstantinos Vavitsas through the CSIRO Synthetic Biology Future Science Platform and established three new research collaborations through three other CSIRO Synthetic Biology Future Science Platform grants. These projects cover work into next generation biosensors with the Alexandrov Group at AIBN, synthetic diatom engineering with collaborators from the University of Sydney, a microbial sensing-and-killing platform with collaborators at the CSIRO, and a platform for high-throughput strain engineering in cyanobacteria with international collaborators from the University of Copenhagen.

The Vickers Group published or contributed to five papers in 2017, including an invited paper published in the journal *Current Opinion in Chemical Biology* titled 'Recent advances in synthetic biology for engineering isoprenoid production in yeast'.

Associate Professor Vickers was an invited speaker at seven national and international conferences in 2017, and was keynote or plenary speaker at five of them. Associate Professor Vickers was also Plenary Speaker for Australia and session chair at the 13th Australia-China Symposium - Synthetic Biology. She was also on the organising committee for Synthetic Biology Australasia 2017 in Sydney, and on the Scientific Advisory Committee for the Yeast Products and Discovery 2017 meeting in Ballarat and the international TERPNET 2017 conference in Dalian, China. In addition, she took up editorial roles for *ACS Synthetic Biology* and *Microbial Cell Factories*.

In 2017, the Vickers Group had one PhD thesis submission, one PhD graduation, and one First Class Honours student graduation.

Associate Professor Vickers has a joint appointment with the CSIRO as the director of the Future Science Platform in Synthetic Biology, a $30 million research and development program launched in 2017 that aims to increase Australia's capability in synthetic biology and develop a synthetic biology based industry in Australia.

www.aibn.uq.edu.au/vickers

Wang Group

Professor Lianzhou Wang

Characterisation and application of functional nanomaterials

The Wang Group, led by Senior Group Leader Professor Lianzhou Wang, is focused on the clean energy sector, developing new functional materials for solar energy conversion and storage systems.

The group's research focuses on the design and development of semiconducting nanomaterials, which underpin important applications in photo-electrochemical solar energy conversion and storage such as solar fuel and electricity generation, and their subsequent storage in batteries.

Aluminium-ion batteries are part of a new generation of battery technology that have some unique advantages, including a fast charge and discharge rate and longer term cyclability. The raw materials are also cheaper than lithium-ion batteries.

> "While lithium is commonly used in rechargeable batteries, aluminium is safer, more abundant, and more affordable." Professor Wang said.

One of the challenges facing the progress of aluminium-ion batteries is the formation of a passive oxide film and intrinsic hydrogenation over the aluminium metal. To address this, the group designed a new cathode structure using graphene instead of graphite. Graphene is a sheet of repeating carbon molecules and, under the right conditions, the researchers were able to create a three-dimensional matrix of criss-crossing graphene sheets.

The group published two papers during 2017 in *Advanced Materials* on the development of aluminium-ion batteries.

The Wang Group has several collaborative projects with AIBN's Bernhardt Group on the development of improved battery materials with the financial support from a Queensland-Chinese Academy of Sciences grant and Baosteel Australia Joint Research and Development Centre grant. The Bernhardt Group provides computational simulations to explain the mechanics of the materials in depth, enabling researchers to predict new materials and new functions of existing materials for batteries.

In 2017, the group was awarded $2 million in project funding by the Australian Government through the Collaborative Research Centres Programme, in collaboration with researchers in academia and industry, to develop printed flexible batteries. This technology could be adapted to take almost any shape, yielding a wide range of potential applications from wearable electronics to large scale energy storage.

"We are very pleased to have this opportunity to work with leading printing technology industry partners on this exciting program to address some critical energy storage challenges." Professor Wang said.
Dr Bin Luo, Dr Jung-Ho Yun and Dr Wuqiang Wu from the group secured ARC DECRA fellowships in 2017. Dr Bin Luo also won an ARC Discovery Project in collaboration with Griffith University. Another postdoc, Dr Yang Bai, also received a UQ Development Fellowship.

The group had four PhD students graduating in 2017, one PhD student, Miaoqiang Lyu, was awarded the "Chinese government award for outstanding self financed students abroad". This award is considered one of the highest awards given by the Chinese government to graduate students who study outside of China.

In 2017, Professor Wang hosted the 2017 International Symposium on Energy Conversion and Storage Materials in Brisbane, which attracted over 200 top scientists from various countries to discuss the latest advances in functional materials for sustainable energy conversion and storage technologies. The main objective of the symposium was to promote international cooperation and partnerships between world leaders in the fields of nanomaterials and nanotechnology for clean energy applications.

www.aibn.uq.edu.au/wang

Whittaker Group

Professor Andrew Whittaker

Polymer chemistry, nanotechnology, photolithography, biomaterials science, magnetic resonance

The Whittaker group, led by Senior Group Leader Professor Andrew Whittaker, specialises in physical polymer chemistry, with research programs in polymers for medicine, energy materials, nuclear magnetic resonance (NMR) and magnetic resonance imaging (MRI). The group applies synthetic methods to develop technologies for health and energy applications. These include advanced next generation molecular imaging agents for disease detection, and polymers to be used in advanced lithography for the fabrication of integrated circuits. The group's broad research field, polymer chemistry, is the underpinning science of modern materials and biomaterials. The group is building and studying new materials to solve practical problems facing society.

"As a physical chemist, my desire, scientifically, is to understand the relationship between the structure of a material and how it performs; that is, I try to build an understanding of how materials behave and relate that to chemical structure. This knowledge is used to design new materials for a range of important applications in energy and health."

In 2017, the Whittaker group contributed to 18 research articles, including papers published in the journals *Nature Biomedical Engineering and Biomaterials* titled "Nanoparticle-mediated local depletion of tumour-associated platelets disrupts vascular barriers and augments drug accumulation in tumours" and "Molecular imaging of activated platelets via antibody-targeted ultra-small iron oxide nanoparticles displaying unique dual MRI contrast" respectively.

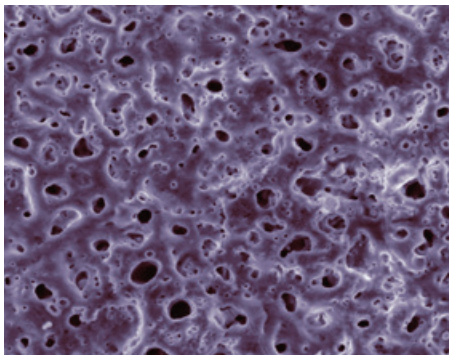
This work describes a novel method to deliver chemotherapeutic drugs into tumour tissues, and the development of nanoparticles for targeted MRI of atherothrombosis using a combination of chemical and biological conjugation techniques to improve detection accuracy.

> The Whittaker group collaborates with a large number of other research groups, both locally and internationally, as well as a number of industry partners.

Of note is the Group's partnership and collaboration with the Dow Chemical Company, specifically with corporate fellow Peter Trefonas, with whom they successfully applied for an ARC Discovery grant to develop a method to produce a higher density of circuits on computer chips — a project that not only has a direct technical application, but will greatly expand our knowledge of the interfacial science of polymers. Also of note is a new collaboration started in 2017 with the National Center for Nanoscience and Technology, a subsidiary of the Chinese Academy of Science. The Group filed four patents in 2017 in collaboration with Dow Electronic Materials.

Professor Whittaker chaired or co-chaired a number of international conferences in 2017, including the ICBNI conference, hosted by AIBN and attended by over 400 delegates with the Plenary lecture by Nobel Laureate Prof Elizabeth Blackburn, the European-Australian polymer workshop in Lyon, the Tianjin University – University of Queensland Workshop on Advanced Materials, held in Tianjin, and the China-Australia Polymer Meeting, held in Brisbane and featuring 20 leading Chinese polymer scientists. The Group was invited to present their work at international meetings, including the ACS National Meeting in San Francisco, the Soft Matter Materials Symposium, EP 2017 in Xi'An, the Emerging Polymer Technologies Summit in Melbourne, and the Pacific Polymer Conference in Xiamen. Professor Whittaker also serves as Deputy Director International of AIBN. His role is to assist the Director to coordinate international collaboration by the AIBN.

In 2017, Mr Ao Chen was awarded his PhD, and four students, Qinglan Zhao, Ari Golbaz Hagh, Elizabeth De Lisle, and Minze Zhu, successfully passed their confirmation milestones. The Whittaker group is a major supporter of the undergraduate intern programme at AIBN, with 15 undergraduate students hosted in 2017.



www.aibn.uq.edu.au/whittaker

Wolvetang Group

Professor Ernst Wolvetang

Induced pluripotent stem cells, in vitro disease models, novel regenerative medicine approaches

The Stem Cell Engineering Group (SCEG), led by Senior Group Leader Professor Ernst Wolvetang, aims to understand the molecular and cellular processes that underlie childhood neurological diseases as well as ageing-related neurodegenerative diseases. The Wolvetang group establishes induced pluripotent stem cells from skin or blood cells donated by patients with various brain diseases, creating an inexhaustible supply of cells that can generate each cell type of the human body. By manipulating the genome make-up and expression of genes in brain cell types derived from these human stem cells, they can not only understand the relationships between gene function and human disease, but also use these cells to discover and test novel therapeutics.

To better model the 3D architecture and connectivity of the brain the group employs brain organoids, and optogenetic tools for stimulating and visualizing neuronal activity, and single cell transcriptome analysis to interrogate the gene regulatory networks that govern the behaviour of brain cells.

"These human mini-brains resemble small sections of the human cortex, and this allows us to examine how this biological computer is built and to understand how things go awry in neurological diseases and ageing" Professor Wolvetang said.

Currently these brain organoids are used to investigate the progression of neurological diseases such as Alzheimer's disease, childhood myelination diseases and schizophrenia.

As Co-Director of the UQ Centre in Stem Cell Ageing and Regenerative Engineering (UQ-StemCARE), Prof Wolvetang has embarked on a number of new collaborations focused in the area of aging and regenerative medicine. Of note is a project in collaboration with the European Research Institute for the Biology of Aging (ERIBA), which involves looking at a new class of proteins that may be involved in the development of plaques in the brains of Alzheimer's patients.

In a joint project with Professor Martin Pera from the University of Melbourne, the group published work in *Elife*, reporting the discovery of new inhibitors of the kinase DYRK1A that resides on chromosome 21, and likely plays a role in early onset Alzheimers disease and craniofacial abnormalities in Down Syndrome. In work published in *Frontiers in Cellular Neuroscience*, the group reported on gene regulatory pathways involved in Ataxia-Telangiectasia (A-T). A-T is characterised by degeneration of the cerebellum, cancer and a weakened immune system because children lack the ability to repair broken DNA.

"Most sufferers of Ataxia-Telangiectasia die before they are 20, because their hind brain degenerates, and we still don't exactly know why this happens, but using our stem cell models we are now not only getting closer to solving this riddle but also to screening drugs that can help these patients." said Professor Wolvetang.

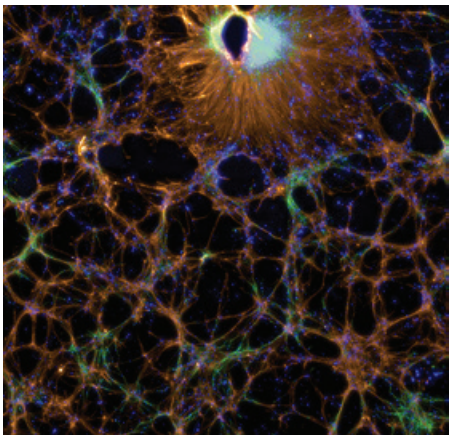
Supported by philanthropic funding from patient and parent support group BrAshA-T, the Wolvetang group used patient samples to develop IPSCs, generate hindbrain organoids and performed the first gene expression study on human A-T brain cells. Using CRISPR genome editing they have now corrected the defective gene in A-T iPSC.

Professor Wolvetang is also heavily involved in outreach activities for A-T and childhood leukodystrophies, including engaging with school students and encouraging them to participate in fundraising.

"It's important to engage younger people in medical research — to convey how exciting science is and explain its real world impacts."

In 2017, Prof Wolvetang was awarded two NHMRC grants (CIA and CIB) related to work on A-T and Schizophrenia. The group further received an ARC Linkage Infrastructure, Equipment, and Facilities grant together with UQ-StemCARE Co-Director Professor Justin Cooper-White, to support the establishment of an automated stem cell bioengineering ("AutoStem") facility that will enable critical insights into the molecular mechanisms that underlie the loss in stem cell function and tissue homeostasis as we age.

The functional genomics strategies and discovery platforms developed in the Wolvetang group will enable the development of patient-specific personalised medicine approaches for rare diseases affecting children as well as ageing related diseases that touch us all.



www.aibn.uq.edu.au/wolvetang

Xu Group

Clay nanomaterials for drug delivery, vaccines and agricultural science

Professor Zhi ping (Gordon) Xu

The Xu Group, led by Senior Group Leader Professor Zhi Ping (Gordon) Xu, is a multidisciplinary research team with strengths in the controlled preparation of various nanomaterials, including clay nanomaterials, calcium phosphate nanoparticles, fluorescence nanoparticle, liposomes and soli-lipid emulsion nanoparticles for diverse applications for cancer therapies and diagnosis through efficient delivery of drug, gene, protein/peptide and relevant therapeutic agents.

The group is developing a fundamental understanding of the interactions of clay-drug nanoparticles with proteins in serum and target cells, while also building knowledge of the subsequent biological effects. This understanding enables the design and synthesis of improved nanomaterials for a range of applications, including anti-restenotic drug delivery, siRNA delivery, vaccine delivery, photothermal therapy and disease diagnosis.

> During 2017 the group expanded their focus to employ their nanoparticle technology in agricultural science.

"In the past, our focus was on cancer and other disease treatment, but we have more recently shifted focus to work on animal health, plant health, crop protection, and crop productivity." Professor Xu said.

In collaboration with the Queensland Alliance for Agriculture and Food Innovation (QAAFI), the group developed BioClay: an agricultural nanotechnology innovation that could help reduce food production losses due to pests and pathogens without the toxic environmental impacts of current chemical sprays.

BioClay has been used to deliver double-stranded RNA (dsRNA) molecules to crops, which then trigger a plant defence mechanism known as RNAi gene silencing. This is delivered as a non-genetically modified, non-toxic spray by partnering it with the Xu Group's clay nanoparticles. This process is as an alternative to genetically modified, or transgenic, disease-resistant crops.

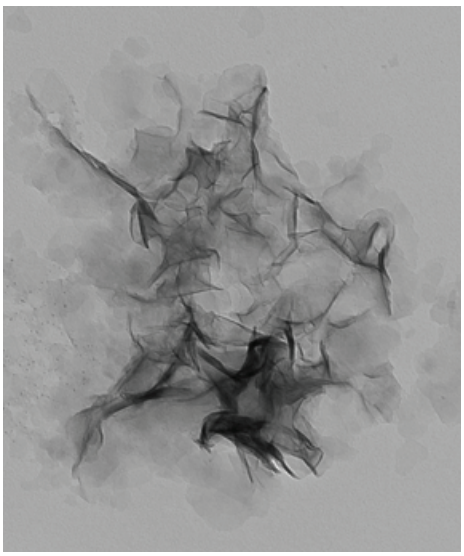
The biggest challenge in applying RNAi technology to agriculture is the short lifespan of the dsRNA in ambient conditions. To work around this, the particles have a nanoscale clay matrix that is ideally suited to protect dsRNA once it is sprayed onto a crop. The specially designed matrix forms minuscule, stacked layers that can be compared to puff pastry. These layers degrade naturally, but in the process they dramatically extend the dsRNA's protection period.

The Xu group published 20 papers in 2017, with 10 of those papers appearing in high impact journals, including a paper on the BioClay technology published in the journal *Nature Plants*. Also of note was work published in *Advanced Materials* that focused on novel manganese-based layered double hydroxide nanoparticles. Together with an already demonstrated capacity for drug and gene delivery, these nanoparticles are a very promising agent for cancer diagnosis and treatment, vaccination and plant protection.

The group also does work in collaboration with the Chinese Academy of Sciences using clay nanoparticles for cancer therapy.

"Our partners at the Chinese Academy of Science are experts in identifying, manufacturing and using peptide therapeutics against cancer and neurodegenerative diseases."

In an ARC Discovery Project awarded in 2017, the group will examine how the properties of nanomaterials determine their disposal by liver cells. A key outcome of the project will be to determine how the attributes of nanomaterials direct pathways for liver cell disposal. This work will build a novel paradigm that describes nanomaterial and liver interactions at the cellular level.



www.aibn.uq.edu.au/xu

Yamauchi Group

Nanoarchitectured inorganic materials

Professor Yusuke Yamauchi

The Yamauchi Group recently moved to AIBN and is led by Senior Group Leader Yusuke Yamauchi. The group has a research focus on the nanoarchitectured design of nanocrystals and nanoporous materials with controlled compositions and morphologies. Specifically, nanoporous metals with metallic frameworks that can be produced by using surfactant-based synthesis with electrochemical methods.

Owing to their metallic frameworks, nanoporous metals with high electroconductivity and high surface areas hold promise for a wide range of electrochemical applications, including batteries, fuel cells, solar cells, chemical sensors, field emitters, and photonic devices.

The group is currently working on developing improved materials for supercapacitors using nanoporous carbon. The nanopores increase the surface areas which can store more charge in the materials.

> "Our nanoporous materials are multi-functional. They're useful not only for energy applications, but also for agricultural science" Professor Yamauchi said.

The group has also developed porous catalysts that can maintain the freshness of fruit and vegetables for longer. Using Queensland bananas as an example, the group have completed tests that show that their catalyst can maintain the fruit's original freshness for up to 15 days.

In 2017, Professor Yamauchi contributed to more than 20 papers (including top journals such as *Angewandte Chemie International Edition*) during his three months at AIBN, on top of an additional 80 papers in his previous position at the University of Wollongong. Of particular note was his publication in the journal *Scientific Reports*,describing a cost-effective method of converting agricultural waste biomass into commercially valuable chemicals for food production, pharmaceuticals, agriculture, and other industries.

While some biomass can be used as feedstock or biofuels, as in the case of bioethanol, these avenues aren't suitable for all forms of biomass. A great deal of biomass, such as bagasse or jute waste contains high levels of commercially valuable molecules; the only problem is that they are extremely difficult and costly to extract and to convert.

To address this issue, the group developed a new procedure using a recyclable ionic catalyst — 1-methyl-3(3-sulfopropyl)-imidazolium hydrogen sulphate, dubbed 'BAIL' for short — to effectively convert hemicellulose to C5 sugars or even to furfural.

The group is also working on developing a catalyst for CO_2 oxidation with a view to rolling it out for the Tokyo 2020 Olympic Games smoking rooms. Current catalysts for CO_2 oxidation require a high amount of heat to achieve 50% conversion rate, meaning a lot of energy is wasted in the conversion process.

The group's current technology has a 40% conversion rate at room temperature, with the goal being to achieve a 60% conversion rate.

Professor Yamauchi has strong collaborations nationally and internationally. For example, the group works with researchers at the University of Wollongong to use their technology in solar cells, with Griffith University in the development on biosensors, and with the National Institute for Materials Science (NIMS) in the development on electrocatalysts.

> "My research direction is to develop new nanoarchitectured inorganic materials that have never been achieved, which then enables other research groups to use those materials for their own research purposes."

www.aibn.uq.edu.au/yamauchi

Yu Group

Professor Chengzong (Michael) Yu

Novel nanoporous and nano-materials for biotechnology, clean energy & environmental protection

The Yu Group, led by Senior Group Leader Professor Chengzhong (Michael) Yu, has a research focus on the design and synthesis of advanced functional materials and their applications in drug delivery, bio-analysis, environmental protection, and energy storage. Additionally, the group works with a number of collaborative partners to explore the commercial viability of their work through innovation in nanomaterials in a range of applications.

> "Over the years our research has moved towards agriculture nanotechnology but this is just one of the many areas we are looking into." Professor Yu said.

During 2017, the group published 19 research papers, including work highlighted on a back cover of *Angewandte Chemie*, which discussed how selected metal nitrate solutions can be used to dissolve various types of nanostructured resoles through an oxidative dissolution process. This project could enable the development of a variety of nanostructured materials with unprecedented architectures and bioapplication potential.

Also in 2017, the group developed a new approach to delivering DNA into cells using spikey silica nanoparticles, which was published in the *Journal of the American Chemical Society (JACS)* and also highlighted as a supplementary cover. The spikey surface of the nanoparticle provides extra surface area for DNA binding and enhances the cellular delivery. Additionally, the spikes protect the DNA molecules from degradation by physically preventing enzymes from reaching it.

When the group compared their spikey nanoparticles with a commercial vector commonly used to transport DNA into cells, they found that the new nanoparticles were equally effective at transport in the absence of degrading enzymes, but when degrading enzymes were present, the spikey nanoparticles were substantially better at delivering DNA into cells. The technology is currently licenced to an industry partner who is in the process of using it in the development of vaccines.

In another publication in *JACS,* the group patented work on a strategy to prepare asymmetrical nanoparticles. These nanoparticles exhibited a higher level of uptake and *in vitro* maturation of immune cells and could be used in the development of a vaccine adjuvant.

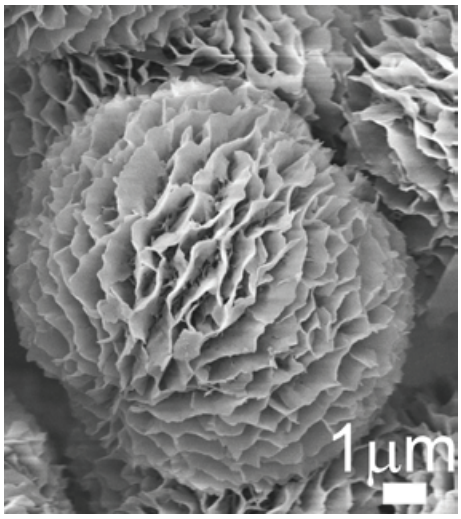
Through an Advance Queensland Innovation Partnership Project, the group is using nanomaterials to develop a better formulation for temiticides, resulting in better in termite control. This project will develop two revolutionary termiticide products, providing far-reaching benefits for Queensland and Australia.

The Yu Group is involved in a number of partnerships across academia and industry, including an ARC Linkage Project on the development of a nano-platform for affordable and ultra-sensitive bio-marker detection.

"The main principle is to use one nanoparticle conjugated with as many quantum dots as possible that give you strong fluorescence, which you can then use to detect viruses such as influenza."

The advantage is bio-detection with improved sensitivity, so that one can easily detect the source of the infection, such as whether it is from a virus or bacteria.

Through an ARC LIEF grant obtained in 2017, the group received funding to establish a new Small Angle X-Ray Scattering Facility (SAXF) for Queensland. Developed in partnership with several other universities, the facility will be based at the University of Queensland with open access for all the universities involved. By enabling the study of nanostructures and their interactions with different environments *in situ*, the facility has strong potential to advance Australia's research capability.



www.aibn.uq.edu.au/yu

Zhao Group

Biomimetic engineering, microfluidic technology, tissue chips

Associate Professor Chunxia Zhao

The Zhao Group, led by Group Leader Associate Professor Chunxia Zhao, focuses on the discovery and development of new knowledge and approaches to making "bio-inspired" functional nanomaterials based on biomimetic engineering and microfluidic technology for drug delivery and controlled release.

> "Bio-inspired means we use what we learn from nature and turn it into something smart or useful" Associate Professor Zhao said.

For example, the group uses naturally occurring processes to create different biomolecules in a more controlled way, allowing them to be designed with multiple specific functions.

One such bioinspired nanomaterial is a nanocapsule made from peptides or recombinant, catalytic, and modular proteins that can facilitate the formation of oil droplets encased with silica at room temperature, neutral pH and without any toxic agents. This design creates a core-shell structure that protects the cargo and provides control over the rate at which the cargo is released into the surrounding environment. In addition, the group has also developed facile microfluidic processes for assembling liposomes and polymeric nanoparticles for cancer therapy.

The translation of these nanosystems into clinical trials has been slow; one of the challenges is the expensive and slow screening process of new drugs. In response the group has expanded their work into the design and building of biomimetic chips for faster nanomedicine screening and evaluation.

"We are developing "*in vivo* mimicking" biochips, with critical cell types that resemble tumours, onto small chips that allow tests to occur very quickly and at lower cost." Associate Professor Zhao said.

The chips are the size of a five-cent coin and contain chambers that mimic blood vessels and tumors, allowing the direct observation of how nanoparticles accumulate at the tumor. The chips are then used to evaluate and screen the nanomedicines the group has developed.

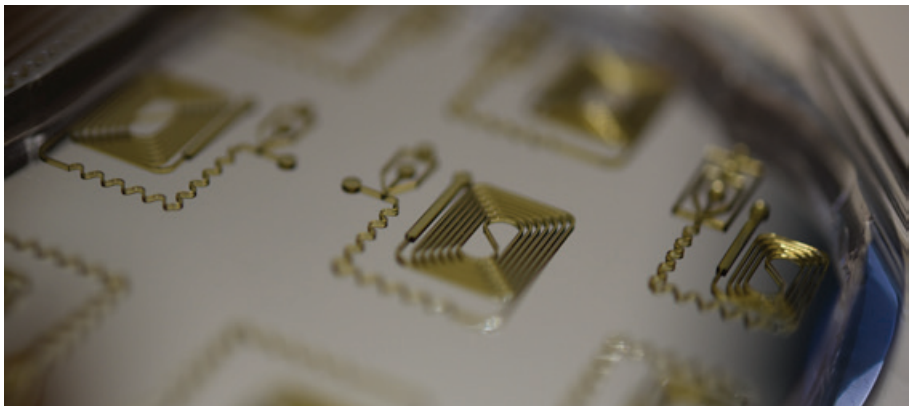
The group collaborates with several industry partners, including work with vaccine companies to develop vaccine adjuvant or new vaccine formulations. The group also works with other industry partners to apply the nanocapsules for agricultural applications.

"This takes us one step close to transferring our technology into something really useful." Associate Professor Zhao said.

Additionally, the Zhao group has collaborations with major universities, locally, nationally, and internationally, including Fudan University and Zhejiang University in China, as well as Brown University and Cornell University in the USA. Associate Professor Zhao has collaborated with Professor David Weitz at Harvard University, which resulted in several publications.

During 2017 the group published 14 papers in journals such as *ACS Nano*, *Langmuir, Biotechnology and Bioengineering, Journal of Materials Chemistry B.*

Associate Professor Zhao gave several invited or keynote presentations at a number of international conferences including the 2017 Nano Delivery Conference in Japan, the Advanced Materials conference in China, and the AIBN hosted International Conference on BioNano Innovation (ICBNI).



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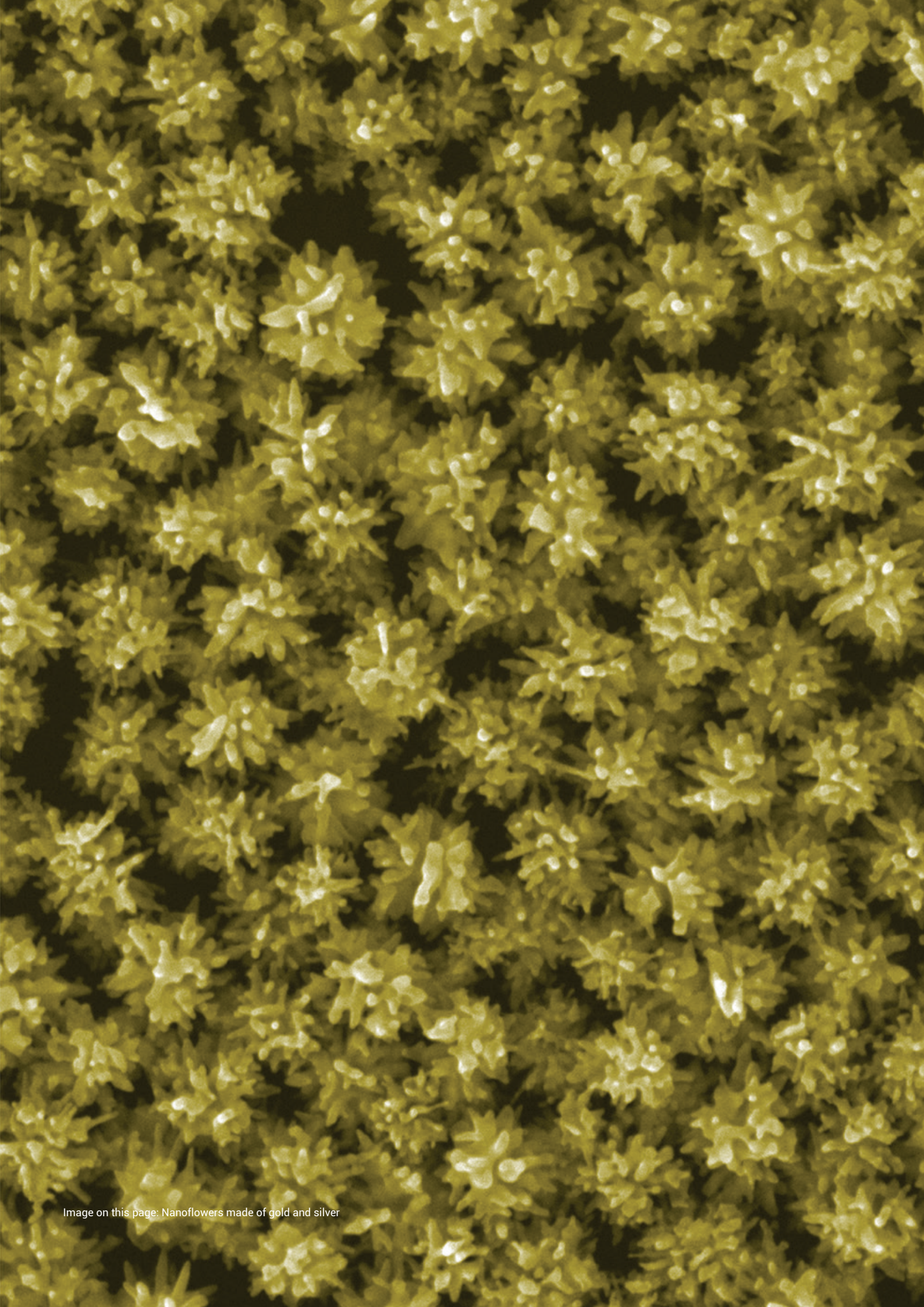


Image on this page: Nanoflowers made of gold and silver

Funding & Recognition

Funding & Recognition

Fellowships and Funding

Research fellowships are awarded through highly competitive funding schemes and provide support for researchers recognised for their exceptional talent.

During 2017 the strength of innovation and output demonstrated by AIBN researchers resulted in another sucessful year of fellowship funding.

Dr Han Hu

ARC DECRA Research Fellow

Wang Group

Dr Hu's project aims to design and synthesize compressible hybrid supercapacitors using graphene aerogels as substrates through novel structural design and surface modification. High-performance compressible energy storage devices are expected to be developed.

Dr Run Zhang

ARC DECRA Research Fellow

Xu Group

Dr Zhang's project aims to develop a nanoprobe using an X-ray excited luminescence "nanolaser" as the local light source to activate coupled responsive photoacoustic sensors.

Dr Qinghong Yuan

ARC DECRA Research Fellow

Bernhardt Group

Dr Yuan's project aims to use computational methods to address a crucial scientific problem in the synthesis of two dimensional materials: determination of the optimal catalyst for growth of high quality, continuous films.

Dr Meihua Yu

NHMRC Early Career Fellow

Yu Group

Dr Yu's project aims to generate a novel immune adjuvant with excellent safety to promote antigen immunity by rationally designing the surface structure of nanomaterials. Successful completion of this project has great potential to develop new, safe and potent vaccines for some infectious disease and cancer. Dr Yu is based at Diamantina Institute.

Dr Mohammed D Hossain

Advance Queensland Research Fellow

Monteiro Group

Dr Hossain's project aims to develop an innovative antimicrobial surface using the next generation of adaptive polymers that will effectively kill microbes (more specifically viruses) on diverse aircraft interior surfaces and be self-cleaning. This antimicrobial technology will play an important role in reducing aircraft disease transmission, and will supersede current expensive and ineffective technologies (e.g. UV light).

Dr Chang Lei

Advance Queensland Research Fellow

Yu Group

Dr Lei's project will use purpose-designed mesoporous silica nanoparticles with tuneable structures and surface chemistry, which will be loaded with quantum dots to enhance fluorescence intensity. The optimised nanoparticles will be incorporated with the lateral flow assay (LFA) device developed by partner Ellume Pty Ltd for the rapid detection of influenza.

Dr Zhongfan Jia

Advance Queensland Research Fellow

Monteiro Group

Dr Jia's project aims to develop new polymer materials for the next-generation of scalable, safer and cheaper aqueous redox flow batteries (AFRB). The project will be undertaken in close collaboration with industrial partner, Redflow Ltd., a Queensland based advanced energy storage company with extensive experience in developing and commercializing large-scale energy storage batteries in Australian and overseas markets.

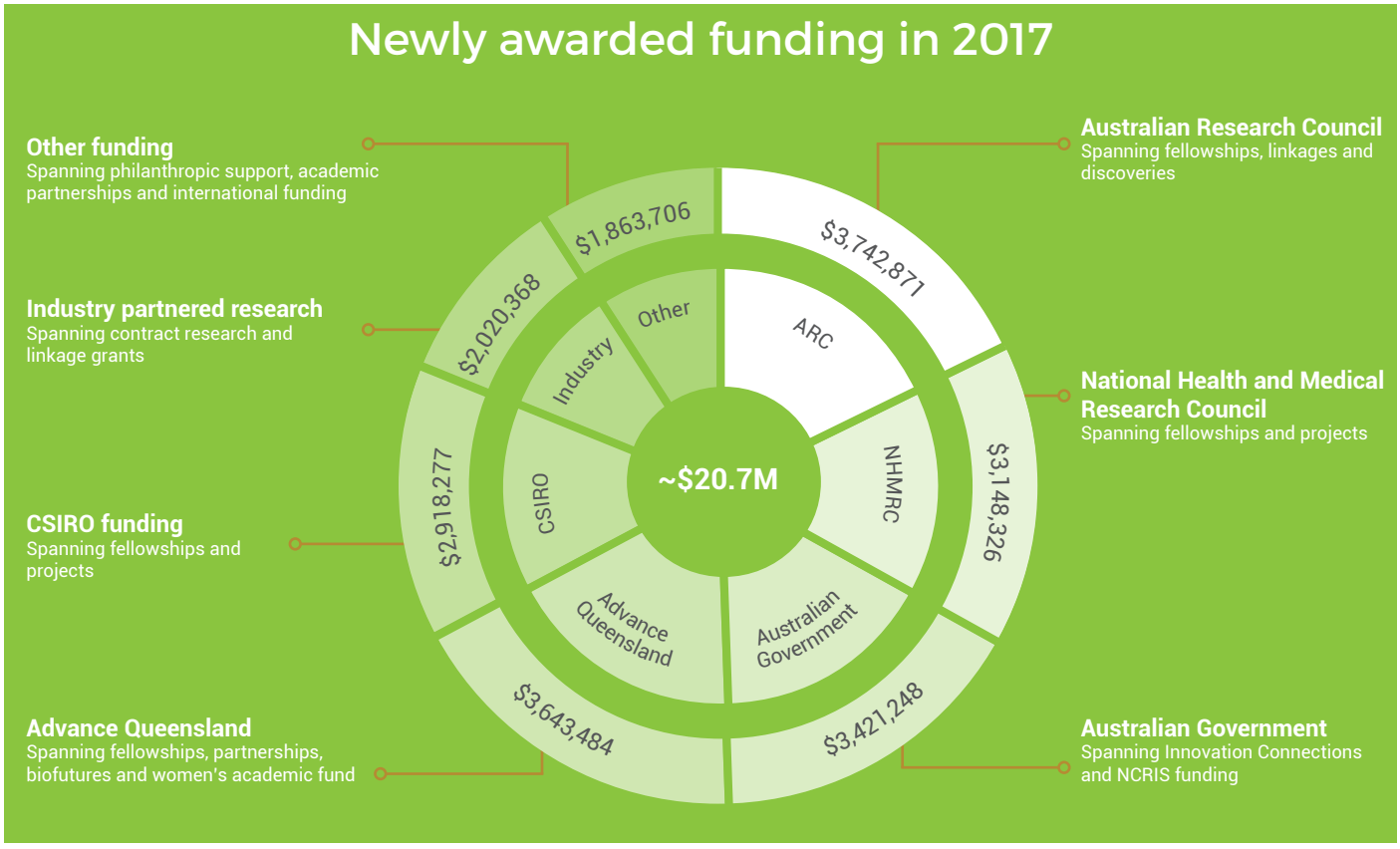
Dr Konstantinos Vavitsas

CSIRO Synthetic Biology Fellow

Vickers Group

Dr Vavitsas's project aims to fully explore the potential of cyanobacteria for the renewable production of high-value chemicals by creating a modular, high-throughput genetic engineering toolbox.

Newly awarded funding in 2017



Prizes and Awards

2017 was a prolific year for prizes and awards at AIBN.

Professor Debra Bernhardt was awarded the 2017 Association of Molecular Modellers of Australasia (AMMA) Medal. Professor Bernhardt said that it was an honour to receive the award, and a pleasant surprise, too. She is the fourth recipient of the medal, which was presented to her at the 2017 AMMA conference in Margaret River, Western Australia.

Associate Professor Jessica Mar won a Metcalf Prize from the National Stem Cell Foundation of Australia in recognition of her leadership in stem cell research. Australia's Chief Scientist Dr Alan Finkel AO presented the 2017 Metcalf Prizes for Stem Cell Research at a special event in Melbourne.

Dr Nasim Amiralian won the Queensland Women in STEM competition in recognition of her work paving the way for young women to embark on a career in science. Dr Amiralian won the Judge's Choice Award for her work using spinifex grass nanofibres to create strong, durable, extra-thin latex for products such as surgical gloves. The awards were presented at the World Science Festival in March.

Professor Peter Gray, founding Director of AIBN, and **Professor Max Lu**, former AIBN Group Leader, were recognised in the Australia Day 2017 Honours List and named as Officers of the Order of Australia (AO). Professor Gray was recognised for distinguished service to science in the field of bioengineering and nanotechnology as an academic and researcher, and to professional biotechnology associations. Professor Lu was recognised for distinguished service to education, to national and international research in the fields of materials chemistry and nanotechnology, to engineering, and to Australia-China relations.

Professor Mark Kendall was elected as a Fellow of the Australian Academy of Technological Sciences and Engineering (ATSE). ATSE is an independent body of more than 800 Australian scientists and engineers seeking to enhance Australia's prosperity through technological innovation. These Fellows — who are drawn from academia, government, industry and research — are some of Australia's leading figures in their fields.

Dr Shyuan Ngo won the silver medal at the Brisbane Health Hack competition for her Motor Neuron Disease (MND) symptom tracking app "SHOWmndME". MND is a rare and fatal neurodegenerative disease with no available cure. Quality of life, however, can be extended through appropriate, individualised multi-disciplinary care. Dr Ngo's app avoids the typical hurdles that impact regular disease tracking and enables appropriate support to be accessed at the right time.

The **AIBN IT team** received recognition for their hard work and expertise at the 2017 UQ Awards for Excellence. The team was awarded a Commendation in the category "Excellence in Service" following nomination by AIBN researchers, who described our IT experts as "exemplars of service and competence, and continually delivering service which exceeds all expectations". The "excellence in service category" had over 50 nominees, so the competition was fierce. The Commendation reflects the high quality of support this team provides to AIBN.

Advance Queensland Women in STEM Prize awards. including Minister Leanne Enoch (centre) and AIBN's Dr Nasim Amiralian (right of centre).

Early-and-Mid Career Researcher Committee

Following its formation in 2014, the Early-Mid Career Researcher (EMCR) Committee enjoyed a successful year of expanding its program of support and educational initiatives to the strong cohort of EMCR researchers within the Institute.

> The EMCR Committee ran a number of initiatives to address some of the challenges facing EMCRs in career advancement.

One such initiative was the development of a grant writing program called "GrantReady", a comprehensive program run over three days to support AIBN researchers to produce high quality grant applications. In collaboration with the AIBN Executive, the committee developed a funding structure to support the award of an AIBN EMCR Professional Development Award which will be launched in mid-2018.

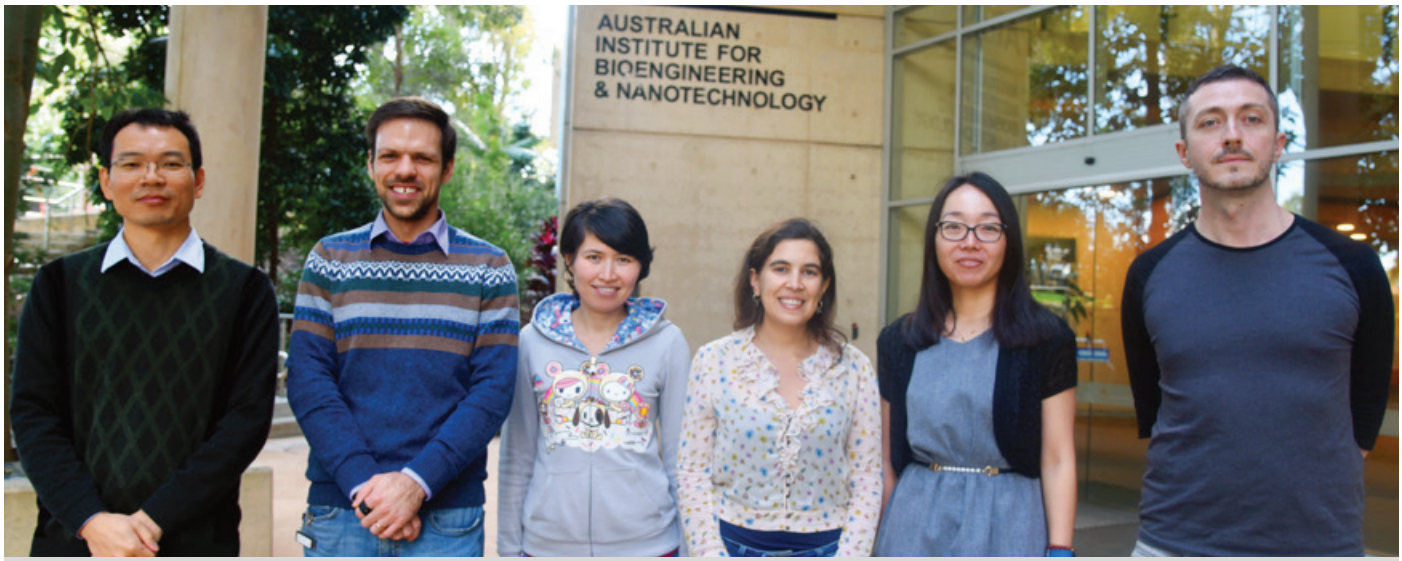
Recognising that networking and professional development are critical elements to advance a research career the committee organised a series of networking events, professional development seminars and courses intended to help EMCRs identify strategic research opportunities.

The committee also performed a thorough review of teaching opportunities for EMCRs within UQ with the view to strategically develop new opportunities that integrate with the university's current course structure.

The EMCR committee continues to work hard to deliver resources and structured professional development material to support the growth of our emerging academics.

Committee Objectives

- Develop EMCR leadership skills and practices and to foster the next generation of research leaders of international standing.
- Build capacity amongst Level A-C researchers as appropriate to position/ potential, according to identified needs:
  - As research managers (project management skills)
  - As laboratory managers (compliance management skills)
  - As potential future independent research leaders (skills in attracting grant and commercialisation funding)
  - As skilled individual for industrial roles
- Assist in career planning and development, through mentoring, sponsorship and professional skills programs.



AIBN EMCR Committee (from left to right): Dr Zhongfan Jia, Dr Simon Puttick, Dr Muxina Konorova, Dr Veronica Martinez Salazar, A/Prof Chunxia Zhao and Dr Darren Korbie. Absent: Dr Ilaria Stefani.

Facilities & Infrastructure

Facilities and centres

The ability of the AIBN to develop and intertwine the two transformative technology areas of nanotechnology and bioengineering, is underpinned by significant and unrivalled world-class, co-located infrastructure. Expertise in nanofabrication, metabolomics and biologics play an important part in progressing cutting-edge research in medicines, vaccine delivery and antibody production. Expertise in protein expression, stem cells and microscopy and microanalysis all offer unique opportunities to undertake industrially-relevant research and development activities and bring high-tech industry into AIBN as end users of those facilities.

Expertise and equipment is made available to the broader Australian research community which includes academia, industry and private organisations.

AIBN Centres

UQ Centre in Stem Cell Ageing and Regenerative Engineering (StemCARE)

UQ-StemCARE aims to understand how the decline in stem cell function affects the ageing process. UQ-StemCARE's goal is to engineer clinically translatable solutions for increasing health span and healthy ageing.

Centre for Theoretical and Computational Molecular Science

CTCMS brings together leading researchers developing and using theories and computational techniques for molecular science from across UQ. The CTCMS has a computational facility installed in the AIBN. It consists of 260 DELL CPU cores with approximately 6GB RAM per core, 240 Intel Xeon Phi co-processor cores, an InfiniBand network and 130 TB disk space.

ARC Training Centre for Biopharmaceutical Innovation

The CBI brings together research, development, and manufacturing expertise and capabilities of our AIBN researchers and key industry partners: CSL, Patheon, Australian Red Cross Blood Service and GE Healthcare. Industry-driven research projects ensures industry-ready graduates to drive growth in the sector.

Centre for Personalised Nanomedicine

By bringing together cutting edge research from the fields of nanotechnology, molecular biology, clinical research and health economics, the vision of the Centre for Personalised Nanomedicine (CPN) is to become a world leader in this field as well as a catalyst for change in the local and international medical system.

NCRIS Supported & UQ Facilities

Protein Expression Facility

PEF is internationally-recognised as a specialist in recombinant protein production for academic and industry researchers. PEF serves a diverse client base across UQ and more broadly, with a portfolio of national and international users from diverse sectors. PEF incorporates sophisticated facilities to support high-throughput scale-down screening and scale-up bioreactor production. Offering protein production in a broad range of cellular and non-cellular translation systems, PEF enables cutting-edge research through comprehensive services in recombinant protein production.

Centre for Microscopy and Microanalysis

CMM promotes, supports, and initiates research and teaching in microscopy and microanalysis, as well as developing the disciplines themselves. CMM is dedicated to understanding the structure and composition of all materials at the atomic, molecular, cellular and macromolecular scales. This understanding arises from the application of optical and electron-optical techniques to biological and non-biological materials and also includes the use of x-rays, ions, and surface signals. Purpose-built laboratories at AIBN house some of CMM's microscopes and a range of sample preparation facilities catering for both materials and biological applications.

StemCore

StemCore was created by UQ and Monash University as a joint continuation of The Australian Stem Cell Centre (ASCC) to ensure that the next generation of Australian researchers can access pluripotent stem cell expertise and services. Specific services include custom generation of patient-specific induced pluripotent stem cell lines, multiple stem cell products and training in exemplar methodological approaches to stem cell biology.

Australian National Fabrication Facility – Queensland Node

ANFF-Q is a micro/nano-fabrication facility providing access to cutting-edge equipment with support from expert staff specialising in microfluidics, organic electronics, biomaterials, novel semiconductor materials, and characterisation. ANFF comprises a network of eight nodes including 21 institutions throughout Australia.

National Biologics Facility – Queensland Node

NBF boasts a specially designed suite of laboratories, clean rooms and state-of-the-art equipment designed to assist Australian academic and industrial researchers wishing to bridge the gap between research discoveries and the bioprocesses required to produce material for pre-clinical and clinical trials.

Queensland Proteomics Node

PA-Q provides high throughput proteomics and protein biochemistry using mass spectrometry and high pressure liquid chromatography. Services are offered in protein characterisation, quantification and identification, protein sequencing, protein separation, post translational modifications, biomarker discovery, screening and multiplexing assays, amino acid analysis and N-terminal sequencing.

Metabolomics Australia – Queensland Node

MA-Q provides expertise in targeted and untargeted metabolomics as well as in metabolic engineering, directed to understanding and manipulating cellular behaviour at a system level. MA-Q's facilities provide support for projects requiring the characterisation of biochemical metabolites and develop fluxomic models that are used to analyse and engineer fermentation systems and optimise product development.

UQ-StemCARE's High Throughput Robotic Facility

OHS Report

AIBN's health and safety systems complement UQ's health and safety structure.

> These systems are designed to achieve a high level of occupational health and safety for our staff, students, visitors, contractors and volunteers throughout all areas of AIBN's activities.

AIBN follows and enforces the University's OH&S policies, achieving compliance with the 10 OH&S goals. Compliance is achieved by following a structured safety management system (SMS) led by the OH&S Manager and supported by the Infrastructure Manager and team of Floor Managers.

These individuals deliver induction, training and support programs to the AIBN community. These and other programs allow AIBN to communicate and implement the relevant policies and procedures.

Within AIBN's SMS there are Health and Safety Representatives (HSR) who assist in the implementation of health and safety procedures such as the monthly inspection program. This program is driven by the OH&S Manager who completes every inspection with the Floor Managers' and HSRs' assistance.

During 2017, a sponsored prize was awarded monthly to a research wing for meritorious efforts on safety and compliance.

An integral part of AIBN's SMS is the OH&S Committee, with representatives of all participant groups within AIBN. This committee meets to address health and safety issues, changes to the work environment, preparation of new policies, modification of existing policies, and communication to AIBN through announcements and AIBN's intranet. The AIBN's OH&S Manager collaborated with the Central UQ OHS Division on the revision of online induction modules, polices and guidelines that are implemented across UQ, as well as contributing to create the new Health, Safety and Wellness Strategy to be implemented in 2018.

> Overall AIBN aims to maintain a safe and healthy environment for all members of our community. This is achieved through maintaining a safe physical environment, and inducting, training and educating individuals to enable day-to-day research and innovation.

Incidents

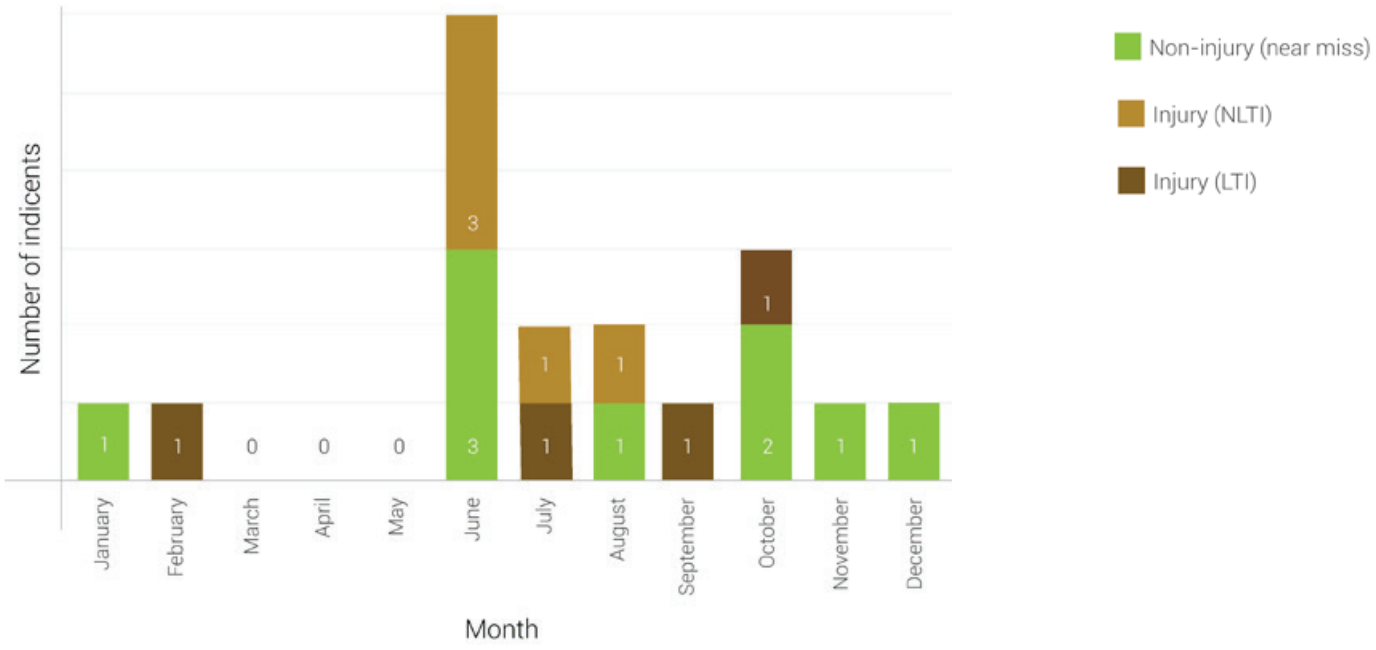
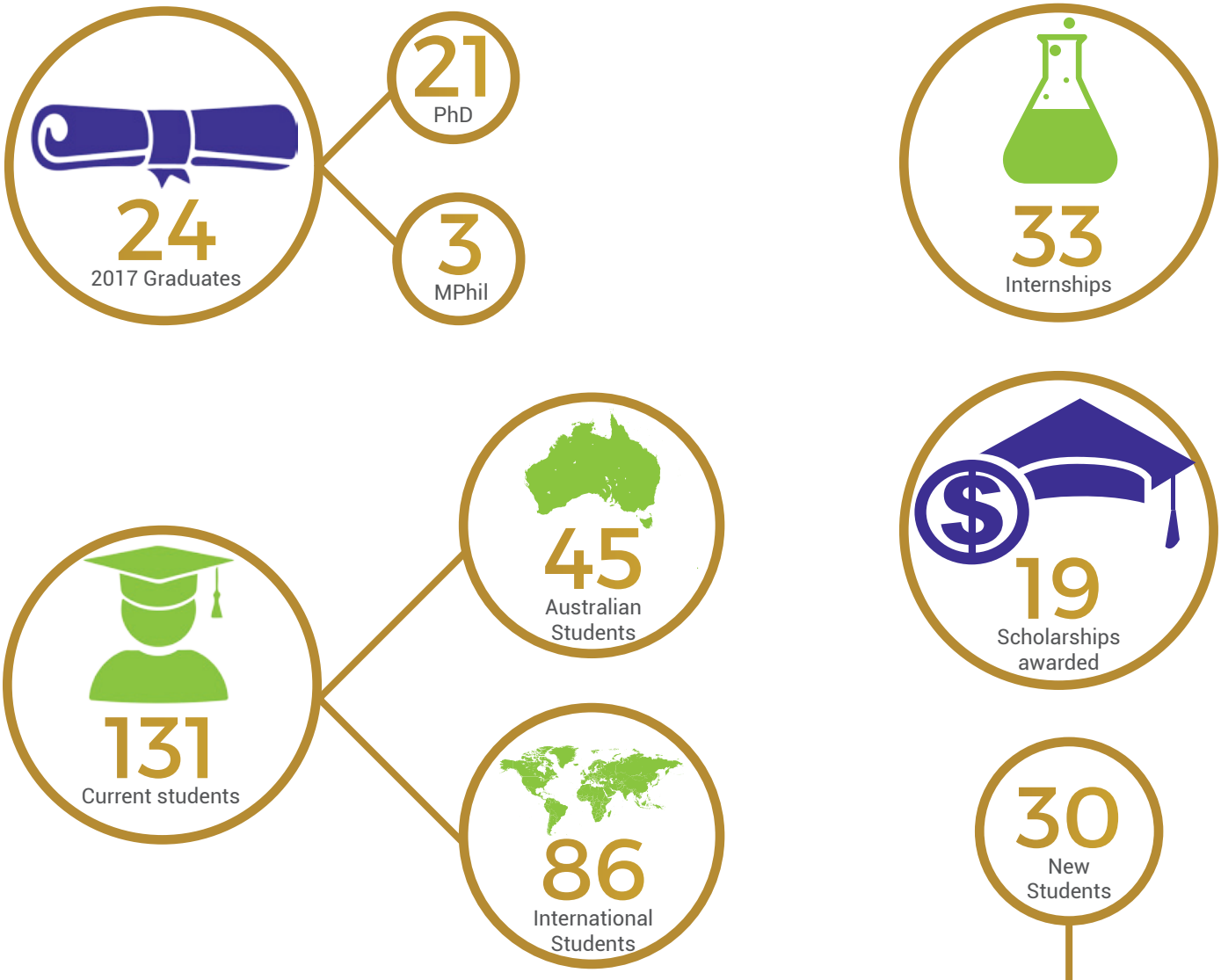


Image on this page: Reaction between ethanol and a super-suturation of VOPO4/Water

Students

Higher Degree by Research



New Higher Degress by Research Students in 2017

Roche Recinos Dinora
Baktash Ardeshir
Pleitt Kristina
Wu Yuao
Sun Bing
Xie Yuan
Kong Yueqi
Hamborg Vinde Marcos
Lu Jennifer
MacDonald Michael
Liu Jianping
Pelingon Ruby
Sowah Sandra
Tang Jiayong
Ekman Serena
Panagides Nadya
Liu Jie
Wang Zhao
Gao Yuan
Denman Paul
Balaji Arunpandian
McGowan Eunike
Mahamkali Vishnuvardhan
Wang Haofei
Brighi Caterina
Cao Pei
Yang Yang
Wilson Russell
Wang Yue

Student Association Report

The AIBN Student Association (ASA) was established to provide a support network for students and to promote co-operation and networking between research groups at the AIBN.

The 2017 team, led by Nick Hong Seng Lee (President), Lewis Chambers (Vice President), Kanupriya Tiwari (Treasurer), Matthew Henry (Secretary), Rebecca Wood (Academic Representative), Irene Reto (OH&S Representative), Edward Jiang (Student Engagement Officer) and Mark Mathew (Social Media Officer), delivered over 20 initiatives focussed on social engagement, academic support and career development, that benefited not only students at the AIBN, but also postgraduate communities around the university.

"This year, in addition to continuing our role to provide social and academic support, we also focused heavily on developing programs to help students explore and develop careers after their research degrees," said the ASA president Mr Nick Hong Seng Lee.

For their efforts, the ASA was awarded the 2017 Postgraduate Club of the Year at the UQ Union Clubs and Societies Gala.

Among highlights was the inaugural UQ STEM Postgraduate Careers Evening, in collaboration with student associations from the Institute for Molecular Bioscience (IMB) and the School of Biomedical Sciences (SBMS). The event saw attendance by more than 150 graduate students and staff, who had the opportunity to network with industry partners such as Cook Medical, CSIRO, Patheon and Vaxxas.

Esteemed guests, including Dr Christine Williams, Acting Chief Scientist of Queensland, who shared her career journey post-PhD. An exclusive interview with the Chief Scientist of Australia, Dr Alan Finkel, was also featured, in which he discussed his views on non-academic careers for PhD graduates.

"We identified that the STEM postgraduate experience at UQ lacks formal and tailored opportunities for students to explore careers post-PhD. This event was a way to address the gap," said Mr Lee.

Further career development support was provided through the PhD Employability Workshop, organised in partnership with the Student Employability Centre, aimed at teaching students ways to highlight their research and professional skills and to present themselves as competitive candidates for roles in academia and industry.

In the academic space, the ASA started the weekly AIBN Writing Group and helped organise a Photoshop and Illustrator Workshop with the AIBN Communications Team. Working with the HDR and internship team, the ASA ran several intern welcome and farewell events, as well as a Forum to allow students to raise their research degree problems with the management. Additionally, many students also had the opportunity to be involved in the day-to-day organisation of the International Conference on BioNano Innovation (ICBNI), hosted by the AIBN.

Throughout 2017, the ASA also ran social and sporting events to promote interactions between various postgraduate communities. These include cricket with the School of Chemistry and Molecular Biosciences (SCMB), frisbee and badminton with the Centre of Advanced Imaging (CAI) and the annual soccer tournament with 10 other schools and research institutes. Also on the calendar were the annual trivia night with IMB and the inaugural UQ Postgraduate Masquerade Party, held in collaboration with four other postgraduate bodies.

Overall, activities in 2017 helped the ASA achieve greater impact in terms of fostering connections between students and ensuring a balanced student experience at the AIBN and UQ.

2017 ASA Committe (from left to right): Nick Hong Seng Lee, Rebecca Wood, Kanupriya Tiwari, Edward Jiang, Irene Reto, Mark Mathew, Lewis Chambers and Matthew Henry

2017 Graduates

Prasanna Lakshmi Abbaraju

Qualifications: PhD
Project Title: Mesoporous silica nanoparticles for biomedical application
Abstract: Mesoporous silica nanoparticles (MSNs) with defined pore size and morphology, have been prepared. The synthesised MSNs were, 1) used in the preparation of floating tablet, 2) examined for hemocompatibility and adjuvanticity in relation to particle morphology, 3) and studied for anti-cancer combination therapy. The main achievements of this thesis are, 1) novel floating tablets prepared with MSN enhanced the performance of drug release for both hydrophilic and hydrophobic drug, 2) asymmetric dendritic MSN exhibit a higher level of uptake and in vitro maturation of immune cells, 3) and combination of photodynamic therapy and antibody therapeutics significantly inhibits the cancer cell growth.

Teera Butburee

Qualifications: PhD
Project Title: Nanoarchitectural Designs of Titanium Dioxide for Efficient Solar Energy Conversion
Abstract: Titanium dioxide (TiO2) has been one of the most important metal-oxide photocatalysts because of its excellent photo- and chemical stability, low cost, non-toxicity, and respectable photocatalytic reactivity. However, the performance of TiO2 in photocatalysis is still limited by 1) its large band gap, and 2) high recombination rate of photogenerated electrons and holes. This thesis aims to address these key limitations by the strategic nanoarchitectural designs. The rational designs of TiO2 nanostructures newly developed in this thesis significantly enhance solar conversion efficiency in various energy and environmental applications.

Ao Chen

Qualifications: PhD
Project Title: Exploring Novel Polymer Coatings for Antimicrobial Applications
Abstract: The ideal remedy to resist bacterial contamination on surfaces is to avoid initial attachments of bacteria, which can be effectively achieved by antimicrobial polymer coatings through biocidal or antibiofouling functions. This thesis explored the antimicrobial performance of three novel polymer coating systems: antibiofouling fluorinated polymer coatings, biocidal polymers with anilinium functional groups, and honeycomb-patterned polymer films combining both functionalities. The research is expected to broaden the current selection of effective materials and designs to improve antimicrobial performance. Furthermore, the relationship between the polymer structures, the surface properties and the antimicrobial behaviour can be better understood for future optimisations and applications.

Valentin Bobrin

Qualifications: PhD
Project Title: Temperature-Directed Morphology Transformation Method to Produce Well-Defined Complex Multifunctional Polymer Particles
Abstract: Polymer nanoparticles have attracted considerable attention due to their fascinating features such as stimuli-responsive properties or variability of chemical functionality. The main focus of this thesis was to develop a rapid and reproducible method to generate well-defined multifunctional polymer nanoparticles with complex geometries at high solids, such as tadpoles. Polymeric tadpoles are multicompartment nanoparticles with a head and tail. The ability to have such subdivided structures might be attractive for a wide range of applications; for example, nanocatalysis or synthetic nanomotors.
The findings in this thesis elaborated the synthetic strategies for the generation of novel well-defined multifunctional polymeric tadpole nanoparticles.

Donna Capararo

Qualifications: PhD
Project Title: Towards service life prediction of aircraft coatings: Mechanical and chemical studies into weathering and mechanisms of crack initiation
Abstract: This doctoral thesis identified key factors contributing to the weathering of aircraft paint which result in the eventual cracking of the coating. The first stage was a loss of leachates, shrinkage and change of physical properties. The second stage was a loss of surface polymer/increase of pigments at the surface, changes in the visual appearance and changes in mechanical properties. Cracking in the field is likely the exceeding of material properties at cold temperatures. Newer topcoats should perform as well or better than the Legacy paint. Techniques were developed to monitor paint through ATR-FTIR Spectroscopy and solvent extraction of leachates.

Mikhail Gavrilov

Qualifications: PhD
Project Title: New Insights into Copper-Mediated Polymerization and Polymer Topologies
Abstract: The thesis first develops the theory for the analysis of size exclusion chromatography data, and provides a methodology to fit polymer molecular weight distributions (MWDs) with a log-normal distribution (LND) model based on a Gaussian function. The LND model was then used to analyse polymers made by a new variant of copper-mediated 'living' radical polymerization in water, allowing hydrophilic polymers with both narrow MWDs and high chain-end functionality for further 'click' reactions. In the final stage of this thesis, the versatility of the LND model was demonstrated by determining the polymer coil conformation of multicyclic polystyrene structures.

Hadi Hezaveh

Qualifications: PhD
Project Title: Selective Capture of Native Extracellular Matrix by Protein Binding Peptides for Directed Differentiation of Human Mesenchymal Stem Cells
Abstract: The extracellular matrix (ECM) is a highly dynamic system that creates a supportive microenvironment for cells within the tissue. The ECM surrounding cells is continuously remodeled by cells throughout their secretome. Providing a scalable, degradable synthetic hydrogel platform that enables stem cells to remodel their microenvironment that allows the recruitment of cell-secreted ECM proteins would represent a significant step forward in the field of tissue engineering. Here, the concept of remodeling hydrogels was developed and validated. A detailed investigation of protein binding peptides ability to recruit secreted ECM proteins to encourage stem cells to remodel their local microenvironment was presented.

Carlos Luna Flores

Qualifications: PhD
Project Title: Understanding high propionic acid production in Propionibacterium
Abstract: Propionic acid (PA) is a three-carbon compound traditionally derived from petrochemical extraction used as a preservative. Biological production of PA has gained interest in recent years. Propionibacterium spp. produce PA along with acetate. Current biological conversion of PA suffers slow growth and low yields. Overcoming limitations for rational designs, I used genome shuffling to generate a new strain capable of generating PA yields above the commercial standards. Genomics, metabolomics, transcriptomics, and proteomics revealed upregulation of sucrose and amino acid transporters and unreported mechanisms in Propionibacterium which included the methylglyoxal pathway, the pentose and glucuronate interconversion pathway, and the GABA shunt.

Swathi Mukundan

Qualifications: PhD
Project Title: Sustainable Biorefinery of Lignin: Fundamental studies on catalytic hydrodeoxygenation of lignin using model compounds for chemicals and fuel production using molybdenum disulphide based catalysts
Abstract: This project aims at catalytic conversion of lignin which is a major renewable aromatic source found mainly in the waste streams of the paper and pulp industry. Carbon supported molybdenum disulphide based catalyst synthesised by microemulsion technique incorporates specific active sites that is selective for the hydrotreatment reactions of lignin and model compounds to produce vital chemicals and fuel additives such as phenol and cyclohexane. The outcome of this study is towards the advancement of hydrotreatment catalysts for lignin valorisation.

Jennifer Lu

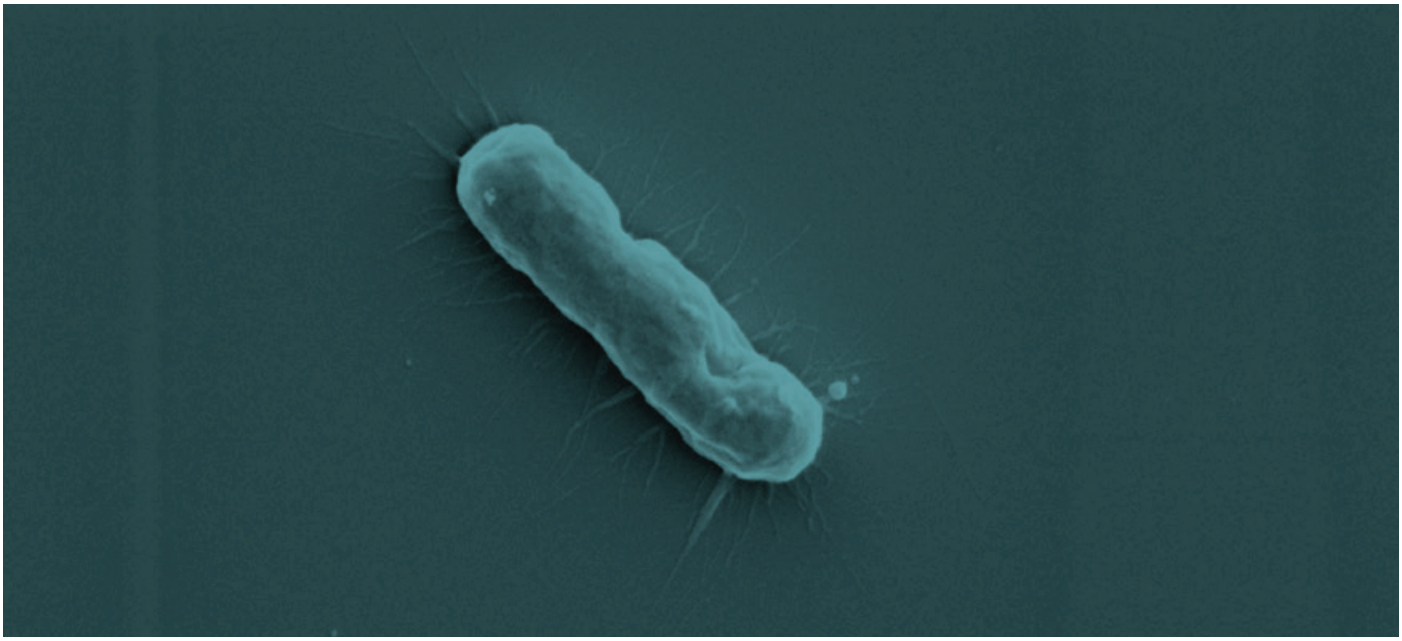
Qualifications: MPhil
Project Title: Bioinformatic Tools and Applications for Analysis of DNA Methylation
Abstract: Cytosine methylation of CpG sites is one of the most-studied epigenetic biomarkers of cancers and diseases. Bisulfite-modified DNA is a requisite need of DNA detection, where the unmethylated cytosines of genomic DNA is selectively deaminated into uracils allowing the identification of methylated cytosines post-modification. A major limitation is the need for specialised oligonucleotides in subsequent amplifications. This thesis explores the development and empirical validations of a high-throughput bioinformatics portal for designing and pooling of primers for DNA methylation detection, as well as the optimisation of primers using base modifications to minimize PCR bias and improve amplification efficiency.

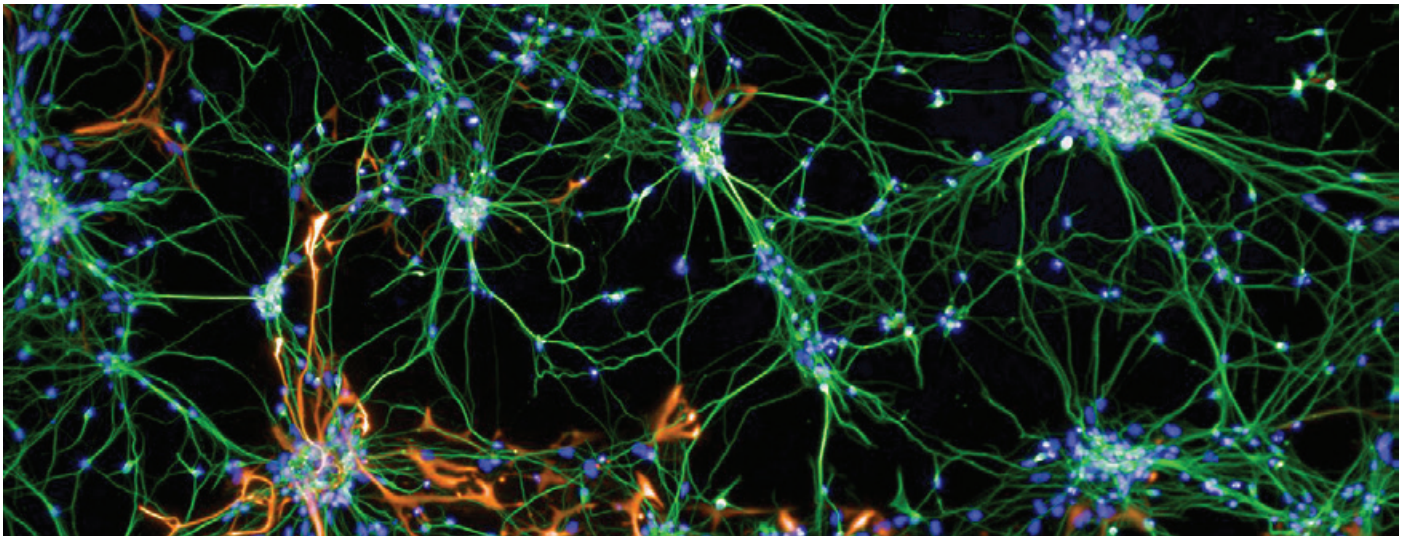
Anand Kumar Meka

Qualifications: PhD
Project Title: Functionalized Large-Pore Mesoporous Silica Nanoparticles for Bio-Applications
Abstract: Majority of biotherapeutics such as proteins and genes possess drawback of low permeability across the cell membrane and remains a significant challenge. To address this issue, functionalised large pore mesoporous silica nanoparticles- KIT-6-MSNs, AHDMSN, and HP-DDMSN have been developed for efficient delivery of biomolecules. Our findings demonstrated that fine tuning of the reaction mechanism lead to development of unique self-assembled silica nanoparticles. The synthesized nanoparticles with their unique structural features enhances therapeutic potential and delivery of biomolecules. These novel silica nano constructs offer a plethora of opportunities for developing clinically useful next generation nanoparticles for biotherapeutics delivery and diagnostic agents.

Hwee Ing Ng

Qualifications: PhD
Project Title: Systems Vaccinology studies on the biomolecular basis of physical adjuvantation in skin when vaccinated with a high density microprojection array
Abstract: Skin delivery technologies are shifting the vaccination paradigm designed to exploit the many beneficial traits of the skin, such as accessibility and the abundance of immune cells. One of which, the Nanopatch, has demonstrated improved immunogenicity compared to the conventional needle and syringe vaccination to muscle. Using a systems vaccinology approach, I investigated key molecular mechanisms behind this high immunogenicity. Examination of RNA-sequencing datasets with differential expression and pathway analysis uncovered that Nanopatch application to skin exhibits a physically-induced adjuvant effect. This study could help advance the field of vaccines through shifting from empirical to more informed vaccine design.





Ellen Otte

Qualifications: PhD
Project Title: A microfluidic device for co-culture: investigating the role of cell-cell interactions in Mesenchymal Stem Cell behaviour
Abstract: In this thesis a microfluidic device (interactome device, or i-device) was designed, validated and used to investigate the role of co-culture in mesenchymal stem cell differentiation. The device allows direct contact and paracrine signalling to be investigated both separately and simultaneously to highlight the effects of each. Particularly, direct contact was revealed to be essential both for osteoblasts driving osteogenesis in MSCs and for endothelial cells maintaining a perivascular niche in experiments that were only possible due to the ability of the i-device to isolate communication modes. One mechanism for cell-cell contact, tunnelling nanotubes, were investigated using super resolution microscopy.

Lyndon Raftery

Qualifications: PhD
Project Title: Development and Application of Novel Biosensor Technologies
Abstract: This thesis reports the application of nanobiotechnology towards the development of novel biosensors. Simultaneously, these biosensing principles were applied to an antibody drug discovery platform, known as phage display. Specifically, antibodies were isolated, engineered and incorporated into two Dengue virus diagnostic tests: a clinical, nanoparticle-based immunoassay and a point-of-care, label-free electrochemical assay. Ultimately, this research highlights the power of applying state-of-the-art scientific technologies in order to probe biological problems. Given the rapid rate of progress within this field, it is likely that diagnostic devices - as well as various screening methodologies - will continue to benefit from nanobiotechnological innovations.

Pedro Andres Eduardo Saa Higuera

Qualifications: PhD
Project Title: A Bayesian framework for sampling the feasible kinetic behavior of metabolic reaction networks
Abstract: Kinetic models are critical to predict the dynamic behaviour of metabolic networks. Despite their virtues, mechanistic kinetic models of metabolism remain uncommon due to the difficulty of fitting their parameters. To tackle this limitation, this work presents a computational framework for parameterizing and sampling thermodynamically feasible reaction kinetics using a statistically sound approach rooted in Bayesian statistics. The capabilities of the approach are illustrated for describing complex kinetics, constructing detailed kinetic models of metabolism, and identifying key regulatory interactions. Owing to its Bayesian character, the framework readily supports advanced modeling tasks like model selection and experimental design not covered previously.

Swasmi Purwajanti

Qualifications: PhD
Project Title: Development of Magnesium Oxide-Based Functional Nanomaterials for Water Remediation
Abstract: MgO nanomaterials have recently been identified as a new class of arsenite adsorbents. In addition, MgO nanomaterials have also been reported to have antibacterial activity and produces no harmful disinfection by-product. The focus of this thesis is the development of magnesium oxide-based functional nanomaterials for water remediation with high performance towards arsenite (As(III)) adsorption also for microbial disinfection in water remediation process. The relationship between the nanostructures and functions of the synthesized MgO has been systematically studied for the fabrication of functional MgO-based materials and composites with enhanced performance towards arsenic removal and microbial disinfection.

Tim Ruder

Qualifications: MPhil
Project Title: Development of anti-PEG bispecific antibodies for targeting PEGylated nanoparticles to tumour cells
Abstract: In this thesis, we explore the design of bispecific antibodies targeting both a PEG chain on a nanoparticle and cancer-associated cell surface targets. Our initial antibody designs yielded one bispecific antibody that successfully binds both the PEG nanoparticle and the epidermal growth factor receptor (EGFR) antigen on cancer cells. Capture ELISA showed the affinity of the anti-PEG component to be comparable to the parent monoclonal antibody. We further show that these bispecific antibodies bind to EGFR overexpressing MDA MB 468 cells both in vitro and in vivo and evaluate 3 further bispecific antibodies targeting CD171, CD200 and CD223 for their efficacy.

Athanasia Amanda Septevani

Qualifications: PhD
Awarded: July
Project Title: Sustainable Rigid Polyurethane Foams Incorporating Natural Oil Polyol and Nanocellulose
Abstract: The current innovation of rigid polyurethane foam (RPUF) is largely being driven towards more sustainable insulation materials. Hence, this thesis provides clever and robust ways to significantly enhance the insulation performance of a model RPUF based on petroleum based polyol (PbP) without compromising other desired physical and mechanical properties by either the replacement of PbP with bio-sourced polyol and/or enhancing the insulation performance by incorporating nanocellulose as nucleating agent. Comprehensive analysis of the processing-structure-property relationship of the modified RPUF and the feasibility of preparing high quality nanocellulose/polyol dispersion in a commercially scalable manner are examined and explored in this project.

Arjun Seth

Qualifications: PhD
Project Title: Development of nanovaccines against Influenza A and Group A Streptococcus
Abstract: This thesis aims to improve the immunogenicity and protective efficacy of microbially-produced modular virus-like particles (VLPs) and their subunit capsomeres targeting Group A Streptococcus (GAS) and Influenza A, respectively. Silica nanoparticles as non-carrier adjuvant enhance the immunogenicity of modular capsomeres presenting influenza M2e antigen despite their independent trafficking as observed by fluorescence imaging. Sublingually administered modular VLPs presenting GAS J8 antigen induced strong mucosal and systemic responses in mice, which was supported by observed draining of VLPs into submandibular lymph nodes and the induced salivary antibodies showed in vitro opsonization activity. This highly productive vaccine manufacturing technology aided by nanotechnology allows low-cost, rapid and potent response to current vaccine requirements.

Abu Ali Ibn Sina

Qualifications: PhD
Project Title: Detecting DNA methylation at the gold interface: A gateway towards next generation cancer diagnostics
Abstract: This thesis is focused on the interfacial chemistry of DNA which explores the physicochemical properties of DNA in solution and when they interact with metal surfaces such as gold. The key innovation in this thesis is that changes in the DNA composition due to the methylation based chemical conversion of DNA bases or due to the different distribution of methyl groups affect the physicochemical properties of DNA in solution and when they adsorbs onto the gold surface. These observations are exploited to develop nanotechnology based diagnostic platforms for detecting DNA methylation based cancer biomarkers providing high potential for clinical application.

Faheem Amir Solangi

Qualifications: PhD
Project Title: Synthesis of Well-defined Complex Polymer Architectures by Iterative Growth
Abstract: Chemists have long sought to mimic the structural complexity found in biological molecules. It is now established that 'precision' is the key to attain this goal. Currently, a wide variety of precisely defined complex architectures could be synthesized by combining 'Living' radical polymerization (LRP), standard small-molecule organic synthesis and quantitative 'click' reactions. The aim of this thesis was to develop synthetic strategies for the construction of well-defined complex polymer architectures by combining LRP and the copper catalyzed azide-alkyne cycloaddition (CuAAC) 'click' reaction. Our work has provided the fundamental basis for the synthesis of sequence controlled macromolecules.

Qi David Sun

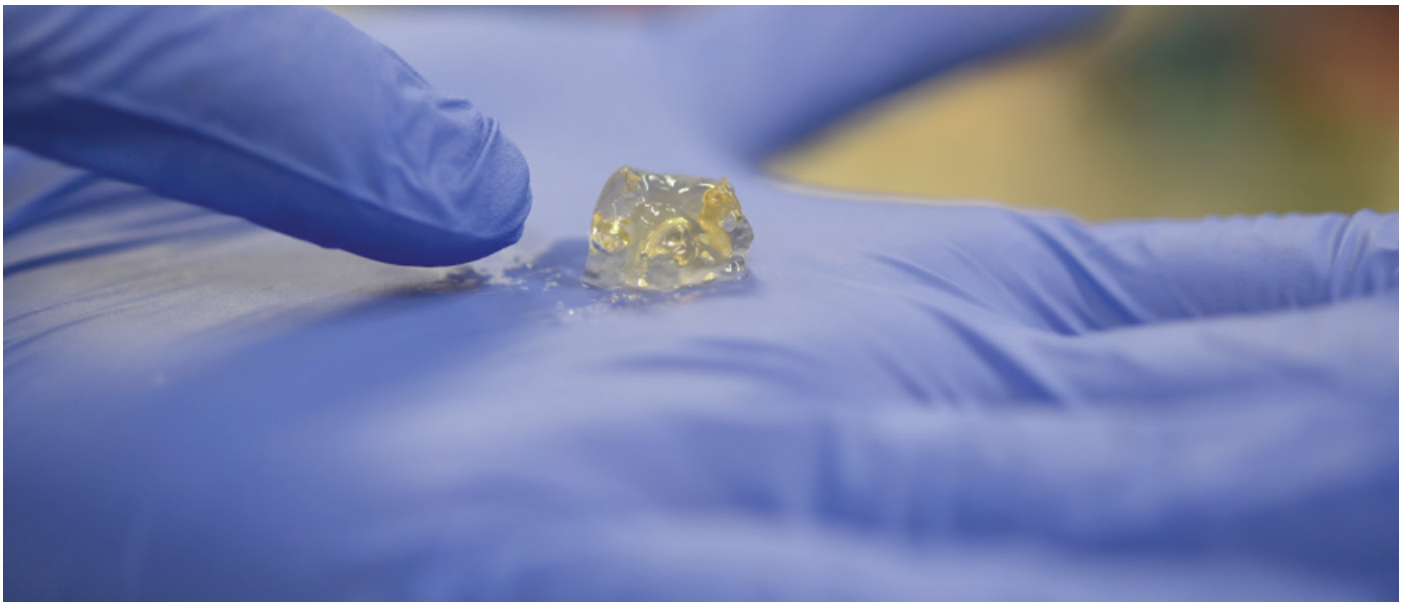
Qualifications: MPhil
Awarded: December
Project Title: Development of three-dimensional microfluidic models for therapeutic testing
Abstract: I proposed a mirofluidic device to fabricate core-shell alginate particles and use these particles to form tumor spheroids. The tumor spheroids were generated with MCF-7 cells in the core and fibroblast in the shell. These tumor spheroids were then used to evaluate the cytotoxicity of paclitaxel and curcumin. The result showed that 3D models were more resistant to drugs than 2D models. Besides, the multicellular tumor spheroids showed even higher cell viability when treated with the two drugs than unicellular spheroids. This microfluidic approach allows the high-throughput production of tumor spheroids thus making it feasible to achieve high-throughput screening in future.

Yingdong Zhu

Qualifications: PhD
Project Title: Controlled-aspect-ratio Synthetic Layered Silicates, Their Characterization and Application
Abstract: This thesis examines, in detail, the reduction of aspect ratio of both pristine and organo-modified semi-synthetic fluoromica (Somasif ME100) using high-energy milling. Different size fractions were obtained using differential centrifugal separation for further characterization and application. An improved advanced microscopy approach provided the most efficient and reliable measurement of the reduced aspect ratio fluoromica series. An in-vitro toxicity study was performed and demostrated that smaller fluoromica nanoparticles indicated reduced cytotoxicity levels. The influence of controlled aspect ratio layered clay nanofillers on the structure and properties of polymer/clay nanocomposites (artificial nacres) was also investigated. Some optimized artificial nacres exhibited attractive property profiles possessing a unique combination of strength and toughness.

Huali Zuo

Qualifications: PhD
Project Title: Modifying layered double hydroxide nanoparticles with peptide to penetrate blood brain barrier for gene delivery.
Abstract: Novel engineered inorganic layered double hydroxide (LDH) nanoparticles delivery system with enhanced suspension stability, redispersion capability and brain targeting ability based on the bovine serum albumin (BSA) coating strategies were developed. Angiopep2 (Ang2) and rabies virus glycoprotein peptide (RVG) are selected as targeting ligands towards brain tumours and the endothelial cells which form the Blood-brain barrier (BBB), respectively. Moreover, the manganese ions are incorporated into the LDHs system to form bifunctional magnetic LDHs (Mn-LDHs) for brain cancer theranostics. This newly designed Mn-LDHs can act as the potential theranostic agent for simultaneous brain imaging and delivery.



Engagement

Scientific Engagement

Each year AIBN researchers are involved in local, national and international professional engagement and outreach activities. Their efforts raise the scientific profile and awareness of the work undertaken at AIBN, and help establish valuable research collaborations.

AIBN Director, Professor Alan Rowan, attended The Australian's Research Luncheon to discuss the need for companies and universities to come together and promote research as an investment:

"We all here have a responsibility for driving the research in Australia. The evidence is absolutely out [that] the more you put in, the better it is for the economy ... and also for inspirational young people. It's for talent in the future. It's for new products in the future. We need to keep on investing, not withdrawing money."

Throughout 2017 AIBN hosted a number of delegations, with national and international guests from both academia and industry. Delegates from Badan Pengkajian dan Penerapan Teknologi (BPPT) visited to meet with the Rowan, Yu, and Wolvetang Groups.

Three large undergraduate tour groups also visited AIBN: 12 students from INJE University in South Korea toured the Whittaker and Bernhardt labs, 40 students enrolled in the Advanced Study Program in Science (ASPinS) toured the Whittaker and Nielsen labs, and 16 students enrolled in ENGG1600 toured the Nielsen and ANFF labs.

Delegates from the Technical University of Munich, Xi'an Jiao Tong University; and Taiwanese Delegates, including representatives from Trade and Investment Queensland also toured the Institute.

A large delegation that included the Honourable Arthur Sinodinos AO; Scott Emerson MP; representatives from Printed Energy, UNSW, StBEI, and SAS Group toured the Wang Group lab. In March, Queensland's chief scientist, Suzanne Miller, paid AIBN a visit to meet with Director Alan Rowan. In November, QLD Assistant Chief Scientist, Dr Christine Williams, visited with Project Officer Dr Morocco and Information Technology and Innovation scientist Dr Olsen.

> A number of high-profile events were organised by AIBN researchers in 2017.

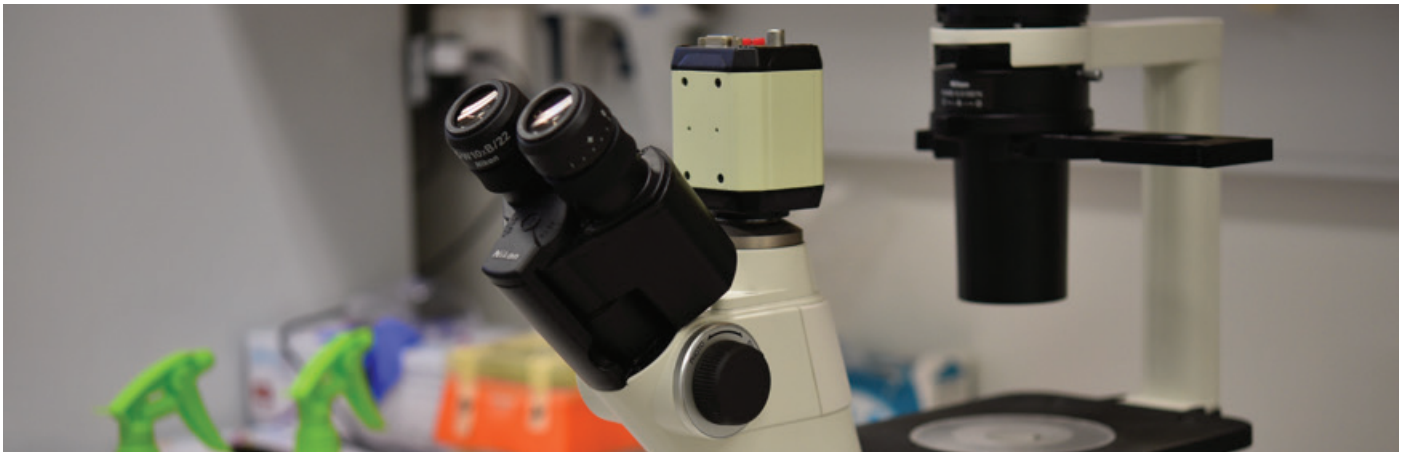
Professors Lianzhou Wang and Alan Rowan, with collaborators from the Chinese Academy of Sciences chaired the 2017 International Symposium on Energy Conversion and Storage Materials.

AIBN hosted the International Conference on BioNano Innovation (ICBNI) with over 400 registrants attending more than 130 presentations over three days, as well as a number of satellite events that promoted scientific excellence and gender equity in STEMM.

To promote Gender Equity in STEMM AIBN and UQ hosted ICBNI satellite events such as the Dinner In conversation with Nobel Laureate Professor Elizabeth Blackburn AC as well as a public lecture by Professor Geraldine Richmond on "The Importance of Diversity and Inclusion in Science".

The 4th China-Australia Polymer Meeting (CAPM-4), chaired by Professor Andrew Whittaker was also a satellite event to ICBNI, as well as The National Workshop on Biomedical Applications of Engineered Antibodies and Proteins hosted by the Centre for Biopharmaceutical Innovation. Also held around ICBNI was the International Symposium on Stem Cell Ageing and Regenerative Engineering, hosted by UQ-StemCARE.

Even AIBN students engaged in scientific engagement activities with ASA President Nick Hong Seng Lee interviewing Australia's Chief Scientist as part of STEM Postgraduate Careers Evening, hosted by the ASA in partnership with students from the Institute for Molecular Bioscience and School of Biomedical Sciences.The event gave students the opportunity to hear from expert panellists and learn about different career pathways post-PhD.



Community Engagement

AIBN staff and students actively participate in broad community engagement activities to raise awareness of their work and promote the importance of scientific advances.

A great example of AIBN's effort to raise public awareness during 2017 was the participation of a number of Group Leaders in science-based television programmes. Associate Professors Chunxia Zhao and Claudia Vickers appeared on episodes of the UQ produced Food Lab by Ben Milbourne Associate Professor Zhao discussed her work with nanoemulsions and Associate Professor Vickers discussed the fermentation process. Professor Ernst Wolvetang appeared on Network 10's *Scope* presenting a segment on stem cell therapy.

AIBN engaged in a number of philanthropic activities throughout 2017, including a fundraiser run by Dr Colette Godfrey for Frocktober, raising money for the Ovarian Cancer Research Foundation.

The Trau Group hosted guests from the National Breast Cancer Foundation in May, followed up by the 'Celebrating So Brave' event in December, an informational and networking evening with researchers, clinicians and breast cancer suvivors to hear key speakers discuss how breast cancer research in Queensland is making an impact.

> In November, the Whittaker Group hosted six Children's Hospital Foundation Donors to discuss the research the group was doing.

During the year AIBN hosted a total of nine tour groups from a range of backgrounds. The science experience tour in January kicked the year off with groups of year 10 students learning about 3D printing, stem cell differentiation, and the HDMA chip. UQ-StemCARE hosted an Alumni tour in March, with guests commenting that the science was very well communicated and easy to understand. The Kendall Group hosted a class of year four students from Graceville State School in June.

Also in June, year 12 students, some from regional centres, toured the Wang and Zhao Groups' labs. July saw AIBN host a group of indigenous students as part of the UQ inspireU Health Sciences programme. The students toured the UQ-StemCARE and ANFF facilities. Primary school students from Lawnton State School also toured the Kendall, Vickers, and CMM labs in July.

Throughout the year AIBN researchers also made media appearances across television, radio, newspaper and online platforms.

Media coverage provides an opportunity for researchers to inform and educate the broader community about their own discoveries and findings as well as provide commentary on their fields of expertise.

International Conference on BioNano Innovation

The International Conference on BioNano Innovation (ICBNI) 2017 provided an avenue for networking and presentation of the latest advances in the most exciting and commercially-promising areas of science and engineering: the interface between the biological and physical sciences at the nanoscale.

The conference featured nine plenary speakers, including Nobel Laureate Professor Elizabeth Blackburn, who shared her research journey on the cellular mechanisms of ageing and how recent advancements in microfluidics engineering are enabling her and colleagues to observe cellular ageing at the individual cell level.

Also present was US National Medal of Science recipient Professor Geraldine Richmond, as well as current and former Australians of the Year, Professor Alan Mackay-Sim and Professor Ian Frazer.

The conference included more than forty-five international and Australian keynote speakers covering the latest advances in microelectronics, biologics and other therapeutics, stem cell therapies, drug delivery, advanced diagnostics tools, nanocomposites, and more. Conference convenors, AIBN Professors Andrew Whittaker and Stephen Mahler, were extremely pleased with the turnout. 420 delegates from Australia and around the world attended to network and learn about the latest scientific trends.

For Professor Whittaker, a particular highlight was observing how well these major themes blended together.

"To me that indicates that many of these fields are converging," he said.

"For example, there's a greater recognition that systems biology works with nanotechnology, and energy devices are coming across into the biological sphere."

Professor Heather Maynard's Keynote was an excellent example of this. She provided an overview of the recent advancements being made by her research group at the University of California, including the development of protein-polymer conjugates to improve the stability of drugs like insulin, to the use of electron beam lithography to create nanopatterns and shape-shifting materials that could be used in the design of nanomachines, new drug delivery vehicles, and nano-scale sensors.

The development of novel materials for use in a clinical setting was a significant theme at the conference. Professor Sheila McNeil from Sheffield University, for example, described her work on tissue engineering approaches that stimulate healing in chronic ulcers and burns.

Another highlight was AIBN alumnus Dr Trent Munro, now Team Leader of Cell Line Development at AMGEN in the US, who spoke about his own research journey from AIBN to a world class pharmaceutical company.

> "Everyone thoroughly enjoyed themselves and we had a real saturation of great science," said AIBN Director, Professor Alan Rowan.

"We had some wonderful speakers from across Australia and internationally, including a Nobel Laureate. This was an inspiration to the young people, and that's what this is about: inspiring young researchers."

AIBN's hosting of this premier international conference reflects the Institute's commitment to incubate translational science, by bringing the brightest minds together to exchange ideas and foster scientific collaborations.

AIBN Seminar Series

January

27 Jan: **Prof Helmuth Moehwald**, *Max-Planck-Institute of Colloids and Interfaces, Potsdam*
Light Stimulated Interactions In Organic/Inorganic Hybrids For Sensing And Cell Stimulations

February

16 Feb: **Prof Petr Kral**, *Department of Chemistry, University of Illinois*
Modeling Of Nanoparticles Self-assembly And Coupling With Biomolecular Complexes

April

20 April: **Prof Alan Rowan**, *Director, AIBN*
The Path To Nature

May

4 May: **Prof Qinghong Yuan**, *Department of Physics, East China Normal University*
The Growth Mechanism Of Low Dimensional Carbon Materials

June

8 June: **A/Prof Joanne MacDonald**, *Molecular Engineering; University of the Sunshine Coast*
Molecular Engineering For Next-generation Devices With Embedded Biomolecular Computers

15 June: **A/Prof Colin Jackson**, *The Australian National University*
A Orthogonal Cofactor For Biocatalysis

29 June: **Prof Ed Rybicki**, *Professor of Microbiology, University of Cape Town*
Molecular Farming: Production Of Protein-based Reagents And Particulate Vaccines In Plants

August

2 Aug: **Prof Gilles J. Guillemin**, *Professor of Neurosciences, Center for MND Research, Faculty of Medicine and Health Sciences, Department of Biomedical Sciences, Macquarie University*
Understanding Progression of Neuroinflammatory Diseases Via The Tryptophan Metabolism

10 Aug: **Prof Colin Raston**, *Centre for NanoScale Science and Technology, College of Science and Technology, Flinders University*
Vortex Driven Thin Film Processing Under Flow

17 Aug: **Prof Gang Liu**, *Shenyang National Laboratory for Materials Science, Institute of Metal Research, Chinese Academy of Sciences. School of Materials Science and Engineering, University of Science and Technology of China*
Constructing Solar-Friven Photocatalysts For Solar Fuels

September

28 Sept: **Prof Yi-Chin Toh**, *Department of Biomedical Engineering, National University of Singapore, Biomedical Institute for Global Health Research & Technology (BIGHEART), Singapore Institute for Neurotechnology (SINAPSE), NUS Tissue Engineering Program*
Microtechnologies For Controlling And Probing Multicellular Interaction Heterogeneity In Human Diseases

October

12 Oct: **Dr Jazmina Gonzalez-Cruz**, *UQ Fellow, Diamantina Institute*
Peripheral CD4+CD8+ T Cells Arise From Tissue Specific CD4+ T Cells And Regulate CD8+ Single-Positive T Cell Function In The Skin

12 Oct: **Dr Kelvin Tuong**, *Advance Qld Early Career Fellow, Diamantina Institute*
Breaking Down The Immune Transcriptome In Chronic HPV16 E7 Oncoprotein Expressing Skin

19 Oct: **Dr Hang Ta**, *NHMRC ECR Fellow, AIBN*
Novel Bionano-Solutions For Diagnosis And Treatment Of Cardiovascular Disease

19 Oct: **Dr Cheng Zhang**, Postdoctoral Researcher, AIBN
^{19}F MRI Agents: From Fundamental Designs To Biological Applications

26 Oct: **Dr Barbara Rolfe,** *Senior Research Fellow, AIBN*
Targeting The Complement System: A Novel Immunotherapeutic Strategy For Solid Tumours

November

2 Nov: **Prof Xingyu Jiang**, *National Center for NanoScience and Technology, University of Chinese Academy of Sciences*
Microfluidics For Bio-nanotechnology

2 Nov: **Dr George Adamson**, *Uniquest*
Introduction To Commercialisation

9 Nov: **Prof Ingrid Winkler,** *NHMRC Senior Research Fellow, Mater Research Institute*
Endothelial Niche Regulation Of Normal And Malignant Haematopoietic Stem Cells

16 Nov: **Prof Kirill Alexandrov**, *Group Leader, Institute for Molcular Biosciences & AIBN*
Toolbox of Protein-Based Signal Detectors and Amplifiers

Publications

Publications

Book Chapters

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Journal Articles

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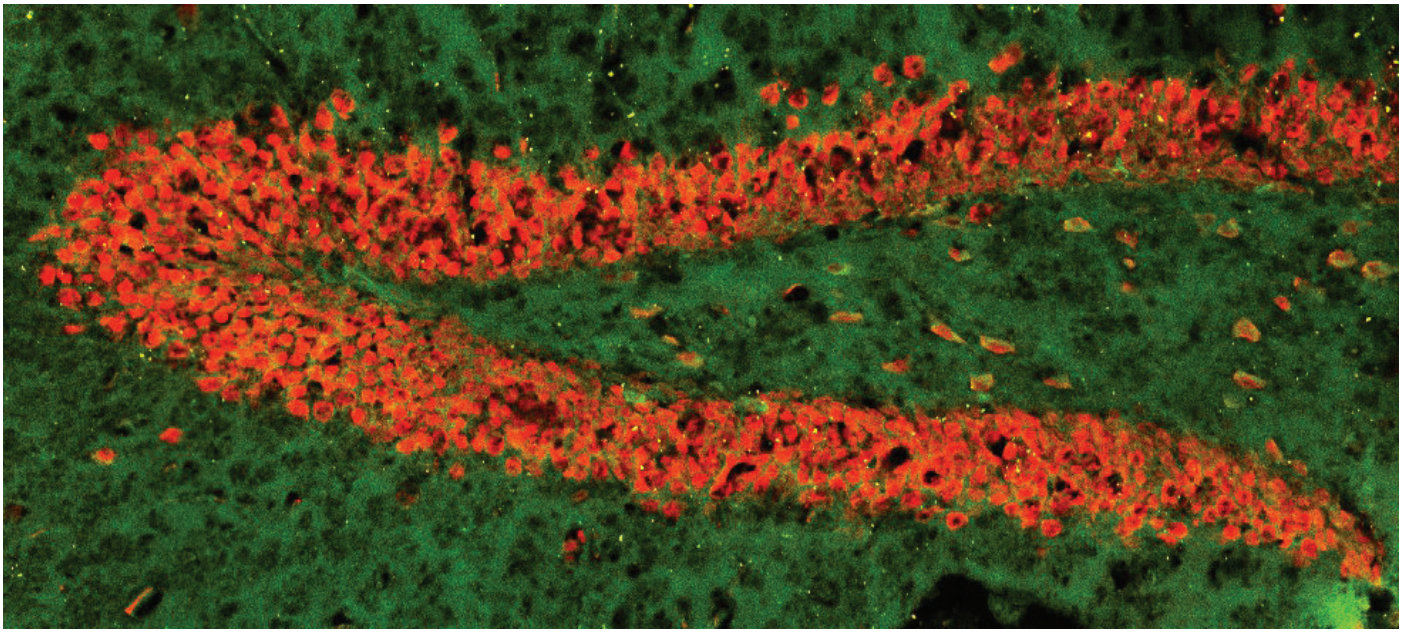

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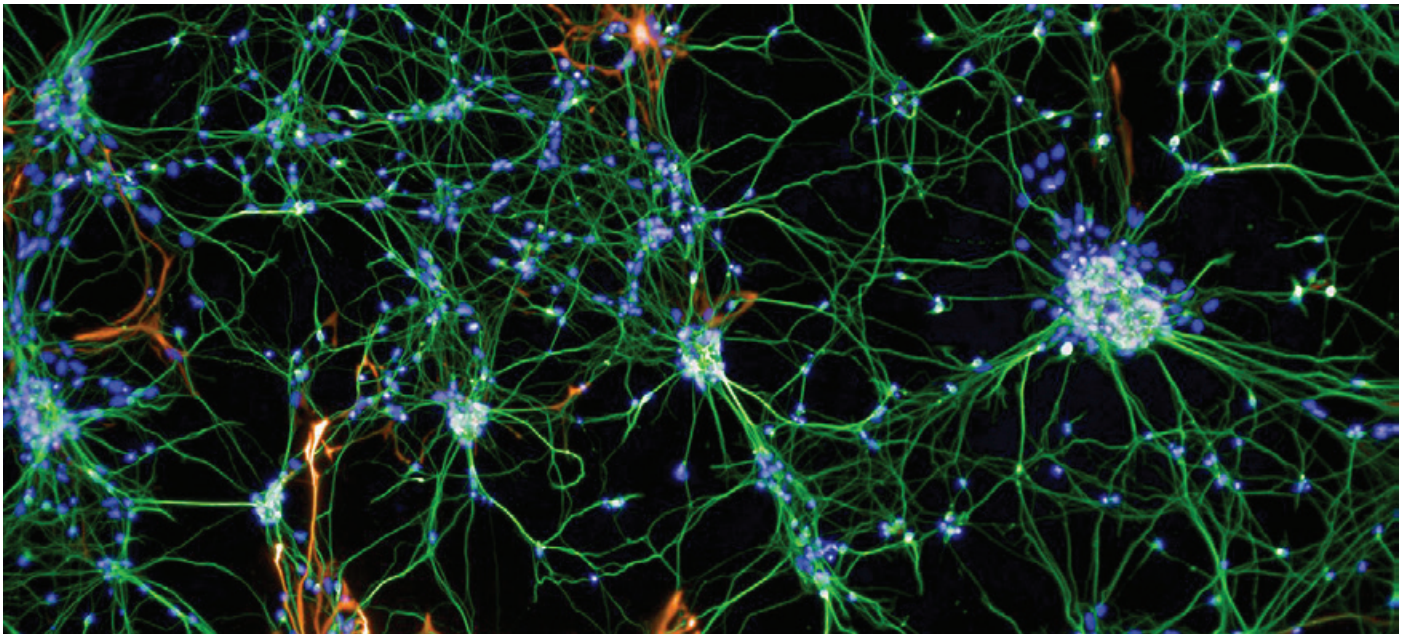

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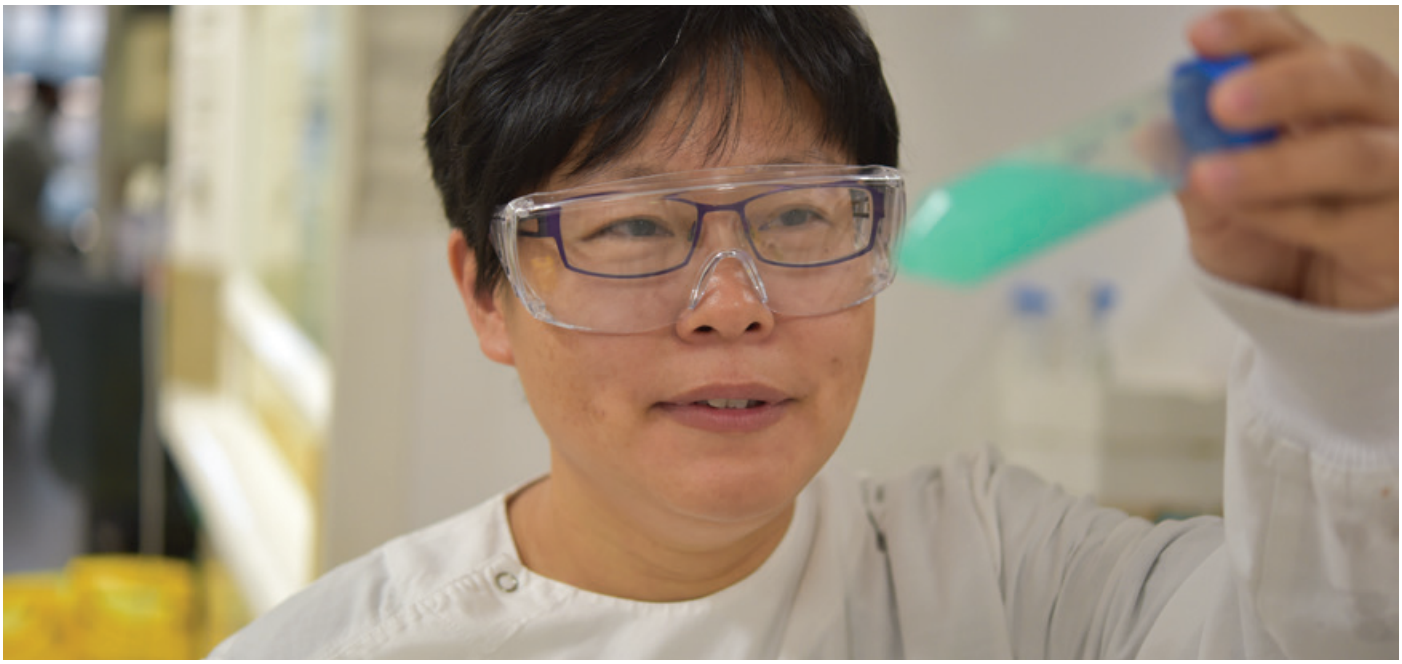

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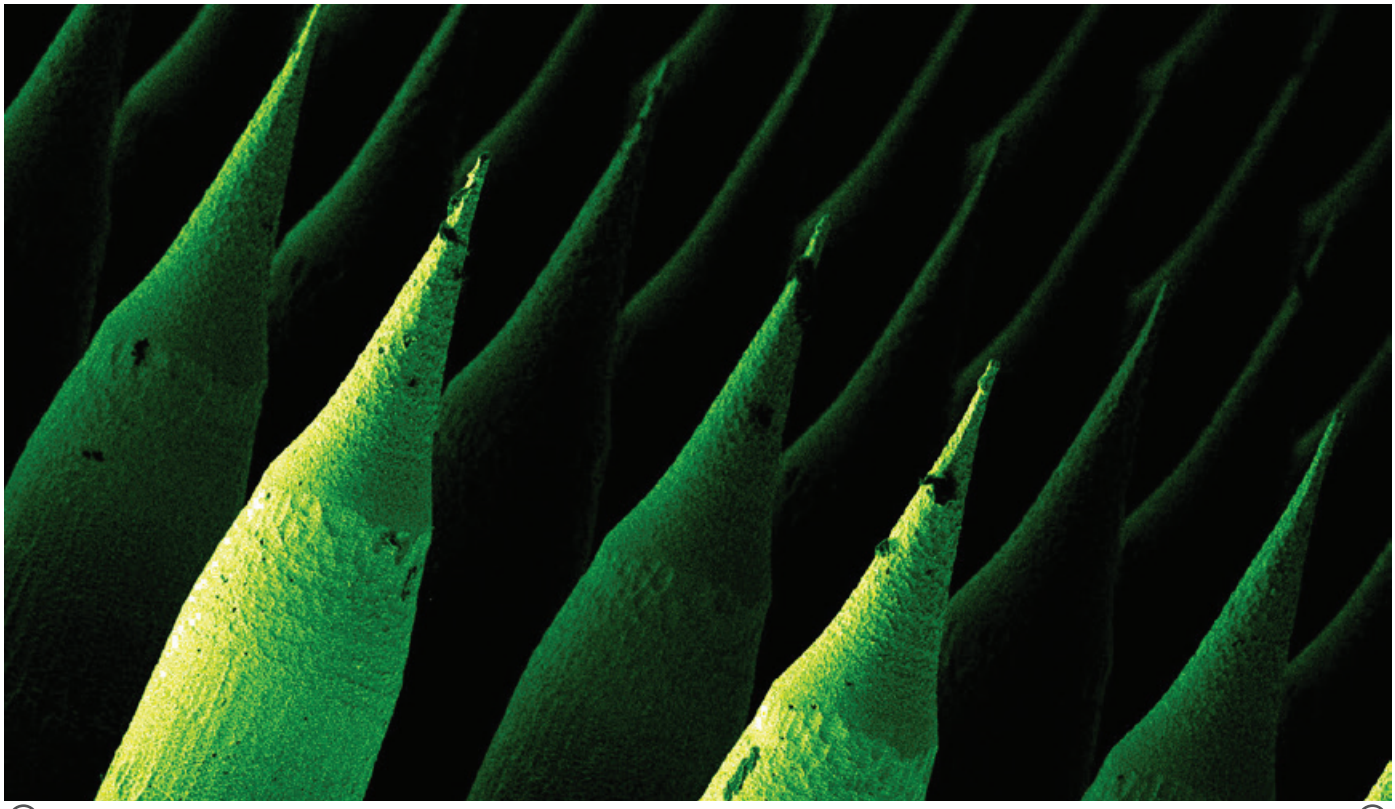

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