The University Of Queensland
AUSTRALIA

AIBN

Australian Institute for Bioengineering and Nanotechnology

Annual Report 2016

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Vice-Chancellor and President's Message

It is my pleasure to introduce the 2016 annual report of The University of Queensland's Australian Institute for Bioengineering and Nanotechnology.

The AIBN entered 2016 in fit shape to contribute to global knowledge and progress in our age of disruption. It started the year with the promise to augment its track record for high-quality research and industry engagement – and it has delivered on that promise.

Under the new leadership of Professor Alan Rowan and the guidance of a strong Board, the Institute has developed a strategic approach that enunciates the Institute's strengths, and how they can be channelled optimally to enhance human health, sustainable industrial processes, energy storage, and agriculture and food production.

A number of significant developments of 2016 reflect not only the wisdom of having a tight institute-specific strategy, but also the advantages of being part of a comprehensively excellent university.

For instance, the new UQ Centre in Stem Cell Ageing and Regenerative Engineering (UQStemCare) is led by AIBN, but pools expertise from a number of other UQ institutes and faculties. It will tackle a major issue: stem cell depletion and the associated reduction in bodily functions that occur as we age.

As well, AIBN's Professor Stephen Mahler (a joint School of Chemical Engineering appointment) leads an impressive group of researchers in the new Australian Research Council (ARC) Industrial Transformation Training Centre for Biopharmaceutical Innovation. It has won the confidence of the ARC and industry, which together will provide almost $10 million in cash and in kind.

Recognising that an organisation's culture is symbiotic with its performance, AIBN is equally focussed on becoming a more diverse and welcoming workplace.

New initiatives to enhance culture and performance include: setting a target for the number of associate and full professorships to be shared 50/50 by women and men by 2021; budgeting to ensure research projects continue uninterrupted if a team member takes parental leave; budgeting to provide care for small children of staff who need to travel in the interests of their projects; and demonstrating to early and mid-career researchers that they have a range of options, including teaching in cognate UQ schools.

Indeed, a return on the Institute's investments in early- and mid-career staff was embodied in the results of the 2016 round of Advance Queensland Research Fellowships. AIBN achieved five of UQ's total 20 fellowships; four of the AIBN Fellowship recipients are women.

Students and staff who reach for excellence have many AIBN role models. They include: the aforementioned Alan Rowan, who in 2016 received a prestigious ARC Australian Laureate Fellowship (one of only 16 awarded nationally); Professor Justin Cooper-White, who won a Research Excellence Award from the National Health and Medical Research Council; Dr Linda Lua, a co-inventor of a rotavirus vaccine candidate and Director of the UQ Protein Expression Facility (which received the annual UQ Team Award for Excellence in Service); and Professor Darren Martin, who has worked with partners including an Aboriginal corporation to investigate and patent a technique for extracting nanocellulose from native spinifex.

AIBN was ahead of the curve when it launched more than a decade ago as Australia's only fully-integrated institution grouping science and engineering at the interface of biological and nanoscale structures. Staff, students, partners, alumni and other supporters have enabled it to remain in the vanguard of industry-linked research and translation, and 2016 augurs very well for its future.

I extend the University's appreciation and congratulations to everyone who contributed to AIBN's efforts for Queensland, Australian, and global society. Thank you.

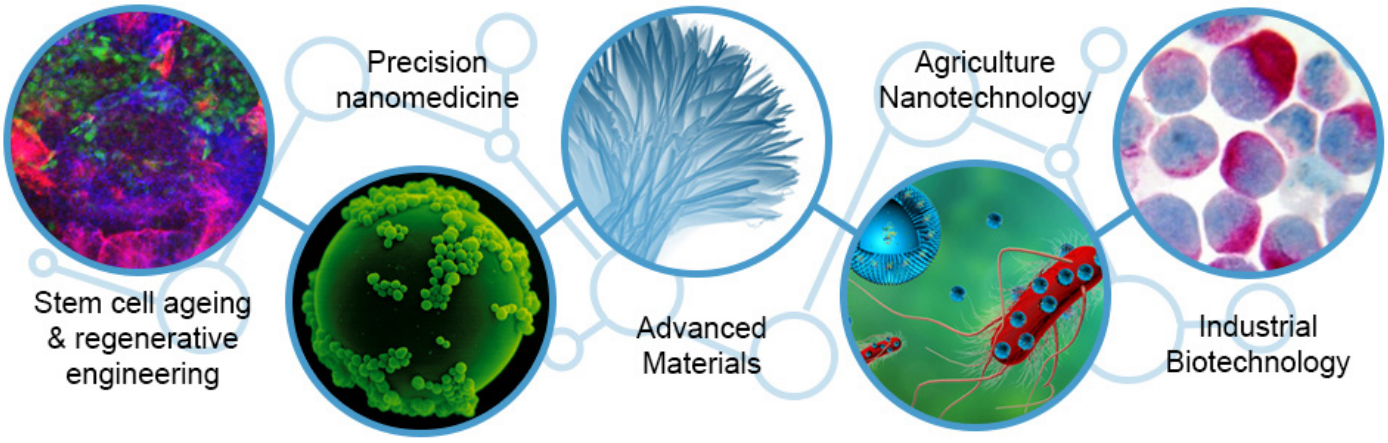
Director's Message

2016 was a time of reflection and exciting change for AIBN. It was an opportunity to take stock of the remarkable things AIBN has accomplished since its inception more than 10 years ago, and to decide where we want to go from here.

Throughout the year, AIBN's Executive worked closely with Group Leaders and the AIBN Advisory Board to identify our strength in generating solutions to challenges in health, energy and sustainability. Our goal was to establish a clear plan to leverage these strengths. This will be achieved by fostering an environment for top science to occur and facilitating translation pathways so that the outcomes of our research can reach industry and end consumers as quickly as possible. Our hard work and deliberation paid off: the new AIBN strategy was endorsed by the Advisory Board in December 2016.

The primary feature of the new AIBN strategy was concentrating many of our research programs into five key areas of focus:

- Stem Cell Ageing and Regenerative Engineering
- Precision Nanomedicine
- Advanced Materials
- Agriculture Nanotechnology, and
- Industrial Biotechnology.



Another significant aspect of the new AIBN strategy is the expansion of AIBN supported by these core pillars. In 2016, this endeavour began in earnest with the October 2016 launch of the $7 million UQ Centre in Stem Cell Ageing and Regenerative Engineering (UQ-StemCARE). UQ-StemCARE aims to profoundly improve our understanding of the ageing process and engineer clinically translatable solutions for increasing health spans. The new centre is a highly collaborative venture, and is poised to quickly achieve international renown as a place of excellence in scientific research and training. The successful launch of UQ-StemCARE now leads the way for more centre launches planned for 2017.

The development of these new, highly focussed, synergistic centres will not only enable us to deliver translatable research outcomes, but will also bolster our efforts to attract high calibre researchers and students from Australia and around the world. In 2016, we commenced a recruitment drive to build our knowledge base and research capacity. New researchers joined AIBN in 2016, and our recruitment efforts will continue well into 2017 with the ultimate goal of 21 Group Leaders.

I am extremely excited about the new direction of AIBN, and delighted that these collective efforts are taking place in an environment of enthusiasm and collegiality. This, along with AIBN's new dedication to gender equity, is something of which we can all be proud and will be a key factor in our success.

In 2016, AIBN established the Gender Equity Commission (GEC) to address gender imbalance in scientific research. The GEC is comprised of AIBN staff, chaired by Associate Professor Linda Lua, and aims to develop and monitor gender equity initiatives as well as providing a forum for communication relating to gender issues in our workplace.

A range of practical initiatives have already been implemented by the GEC, including a commitment that 50% of all new senior academic leadership roles will be female, and improved parental leave support to facilitate research, grant writing and conference attendance. The establishment of a child friendly workspace also represents a positive, family-friendly step forward for AIBN.

The GEC also hosts presentations that address important gender-related issues associated with career advancement, and has developed a range of brochures to promote funding opportunities for female academics and educate supervisors on parental leave support. In 2017, the GEC will expand on these efforts to facilitate AIBN's participation in UQ's SAGE Pilot of Athena SWAN program.

These GEC initiatives are an essential part of AIBN's dedication to advancing the careers of all our researchers. Indeed, our new strategy ensures that career development for early and mid-career researchers is a priority at AIBN. We have taken steps to formalise this in our internal structure while continuing to offer broader and more sustainable career options for our internationally emerging researchers. These initiatives include access to teaching opportunities and mentoring programs, as well as continued career development support from the professional staff of AIBN.

In short, our collective efforts in 2016 have set us up well for a bright future. The range of awards received by AIBN staff in 2016 further confirm this. Dr Nasim Amiralian won the 2016 Women in Technology (WiT) Life Sciences and/or Infotech Rising Star Award for her research on nanofibres derived from Australian native spinifex grass. She was also awarded a Queensland State Government Advance Queensland Fellowship, along with Dr Muxina Konarova, Dr Pratheep Kumar Annamali, Dr Li Li, and Dr Meihua Yu.

We recognise Professor Mark Kendall, whose success continues with the award of the prestigious 2016 CSL Young Florey Medal by the Australian Institute of Policy and Science (AIPS). In addition, AIBN researchers were recognised by the NHMRC for their top ranking grant proposals, with Professor Cooper-White receiving the Marshall and Warren Award, and Professor Kirill Alexandrov (joint appointee with IMB) acknowledged for the highest ranked Development Grant application.

On a personal note, I was also delighted to receive the Australian Research Council award of Australian Laureate Fellow, which would not have been possible without the hard work of my own group in recent years. These accolades are just a glimpse of what we at AIBN can accomplish together. With the new strategy in place, I look forward to an exciting 2018.

AIBN Board

The AIBN Board was established to provide interdisciplinary expertise to guide the development and strategic planning of the Institute. Its membership includes leaders from the 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.

The Institute would like to acknowledge and thank the inaugural AIBN Board Chair Mr Euan Murdoch, who was instrumental in the formation and running of the Board until 2016.

2016 Board Members

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 commenced as Director of AIBN in February 2016. Professor Rowan joined AIBN from Radboud University's Institute of Molecules and Materials in the Netherlands. As a world-leading researcher, he has published more than 300 peer-reviewed articles and books, garnering more than 13,000 citations (h-index 57). His work developing a biomimetic hydrogel is being commercialised through start-up companies for applications in wound dressings, drug therapeutics and cell growth.

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.

Emeritus Professor Chris Lowe OBE

Situated at the Institute of Biotechnology at the Department of Chemical Engineering and Biotechnology at the University of Cambridge, Emeritus Professor Chris Lowe is a fellow of the Royal Academy of Engineering, the Institute of Physics and the Royal Society of Chemistry. He has been the driving force for the establishment of 11 spin-out companies and fosters entrepreneurship within the University. Professor Lowe is also the 2016 Chair of the Cambridge Scientific Advisory Committee.

Bob McCarthy AM

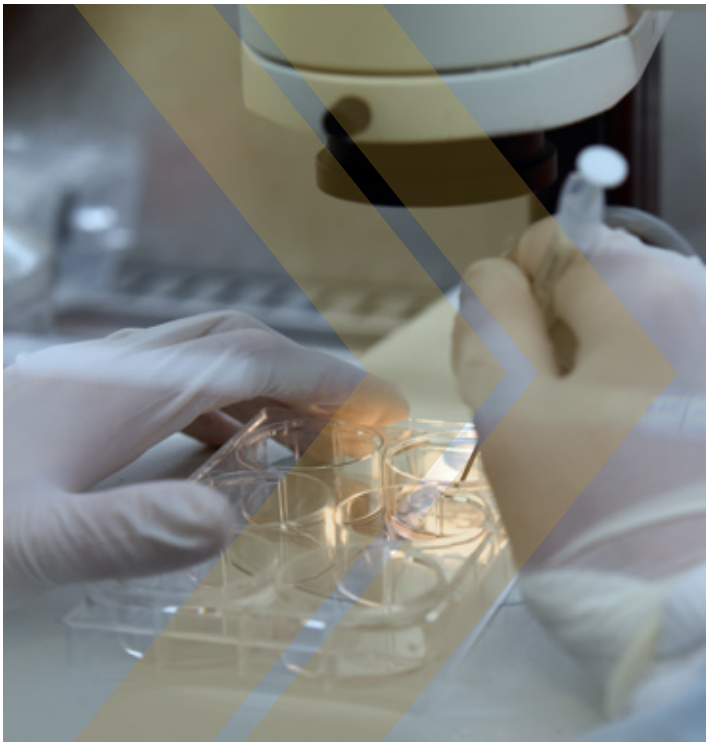
With more than three decades of experience in senior positions in both the public and private sectors, Mr Bob McCarthy has been Director General of several Queensland Government departments, including the Department of Natural Resources and Mines, and the Department of State Development and Innovation.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

Professor Robyn Ward AM

Deputy Vice Chancellor (Research) at UQ, Professor Robyn Ward has held roles that include Director of the Prince of Wales Cancer Centre, and Clinical Associate Dean at University of New South Wales. She remains Director of the Translational Cancer Research Network, a multi-institutional group based in NSW and supported by the Cancer Institute NSW, chairs the Medical Services Advisory Committee, and is a long standing member of the Pharmaceutical Benefits Advisory Committee.

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.



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 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 Membership

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.

RESEARCH HIGHLIGHTS


17
group leaders
400+
researchers and support personnel

ALEXANDROV GROUP

Molecular engineering of protein signalling systems

The research of Professor Kirill Alexandrov's group is focused on application of Synthetic Biology to protein engineering and synthetic signalling.

During 2016, the Alexandrov Group collaborated with a number of academic and industry partners. Molecular Warehouse Inc. and University of Zurich partnered with Professor Alexandrov's group on the development of a new class of biosensors and novel ligand binding domains based on DARPins (designed ankyrin repeat proteins). The group also collaborated with Phylogica LLC and The University of New South Wales on the development and optimization of *in vitro* protein expression systems focusing on the expression of macrocyclic peptides.

Between 2016 and early 2017, the Alexandrov Group published nine peer reviewed publications, including one that establishes a universal platform for protein biosensor design and construction based on an engineered PQQ-glucose dehydrogenase. This work was published in *Journal of the American Chemistry Society (JACS)* and the article presented a novel biosensor architecture based on analyte-driven intermolecular recombination and activity reconstitution of a re-engineered component of glucometers: PQQ-glucose dehydrogenase. In this paper the Alexandrov Group demonstrated that the proposed sensor architecture can be rapidly adopted for the detection of immunosuppressant drugs, α-amylase protein, or protease activity of thrombin and Factor Xa. It represents a platform for the construction of protein-based biosensors with direct electron output, being suitable for integration with portable electronic devices such as smartphones. The paper further showed that ligand-induced activity of the developed biosensors could be directly monitored by chronoamperometry, enabling construction of disposable sensory electrodes. It is expected that this architecture could be expanded to the detection of other biochemical activities, post-translational modifications, nucleic acids, and inorganic molecules.

The Alexandrov Group received a number of grants in 2016, including a Bill and Melinda Gates Foundation grant to repurpose glucose monitoring technologies for DNA detection. In this project the Alexandrov Group is aiming to create a two component biosensor architecture, intended to be used as an inexpensive DNA biosensor that can be "trained" to recognize DNA of pathogenic species in biological samples. The two component glucose dehydrogenase (GDH) -based sensors will be combined with DNA binding proteins that can be engineered to specifically recognize desired sequences. Recognition of the desired sequence by TALEN transcription activator-like effector nucleases) domains fused to GDH fragments will lead to reconstitution of the active enzyme and generate electron current that will be captured by a sensory electrode.

Also in 2016 the Alexandrov Group was granted a Linkage Project grant by the ARC to work in collaboration with industry partner Phylogica on the development of an *in vitro* system for the expression of macrocyclic peptides.

The research of the Alexandrov Group was recognised in 2016 through an NHMRC Research Excellence Award relating to the top-ranked development grant application for a project with Molecular Warehouse Inc., titled "Point-of-care test for immunosuppressant drugs."

The Alexandrov Group also filed two patents including one on a novel electrochemical biosensor.

Alexandrov Group

www.aibn.uq.edu.au/kirill-alexandrov

BERNHARDT GROUP

Theoretical and computational molecular science: Nonequilibrium systems, fluids and materials

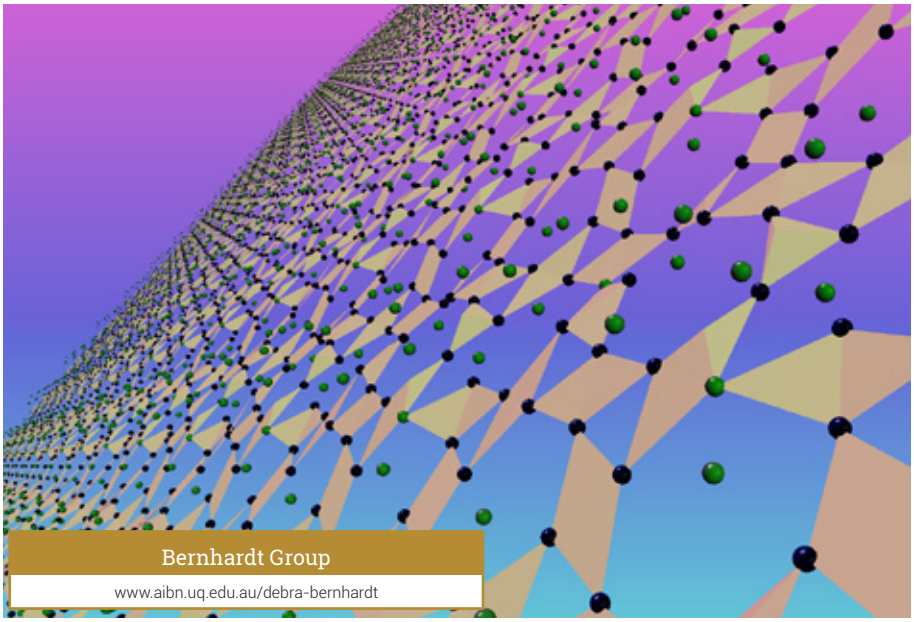
The research focus of the Bernhardt Group, led by Professor Debra Bernhardt, is the development of theory and computational methods for study of molecular systems as well as their application in the fields of nanotechnology, environmental science and nonequilibrium systems. The group utilises quantum electronic structure methods, classical and quantum molecular dynamics, statistical mechanics and dynamics systems theory to characterise photophysical, kinetic, transport, material and catalytic properties of complex systems in targeted application areas.

During 2016, the Bernhardt Group collaborated with researchers at the Australian National University, Monash University, NASA Langley Research Labs, US National Institute for Aerospace, University of Turin, Max Planck Institute for Polymer Research, Hokkaido University, Soochow University and Uppsala University.

These collaborations included demonstration of how fluctuation theorems could be used to determine equilibrium binding energies from force spectroscopy simulations (E Hodges, BM Cooke, EM Sevick, DJ Searles (Bernhardt), B Dünweg, JR Prakash, Soft Matter, 12, 9803-9820 (2016)), hydrogen storage on heterogeneous materials (T Hussain, DJ Searles (Bernhardt), K Takahashi, J. Phys. Chem. A, 120 2009-2013 (2016)) and the reinforcement of metal matrix composites by boron nitride nanotubes (C Rohmann, Q Sun and DJ Searles (Bernhardt)).

In 2016 the group also published 19 peer reviewed publications, and co-authored a book with Denis Evans and Stephen Williams (ANU) titled *Fundamentals of Classical Statistical Thermodynamics: Dissipation, Relaxation, and Fluctuation Theorems.*

The book shows how thermodynamic relationships can be derived from microscopic dynamics and that this also leads to generalisation of the subject to apply to small systems that are arbitrarily far or close to equilibrium. It demonstrates that for nonequilibrium systems, the dissipation can be used to characterise the behaviour of the system in a somewhat similar way that entropy describes equilibrium systems.



A paper investigating the utility of some two-dimensional materials for lithium ion battery electrodes by Marlies Hankel and Debra Bernhardt "Lithium Storage on Carbon Nitride, Graphenylene and Inorganic Graphenylene" was highlighted as an inside cover of *The Journal of Physical Chemistry Chemical Physics.*

The Bernhardt Group's research was funded by grants from the ARC and the Asian Office of Aerospace Research and Development (AOARD). These grants supported research on properties of nonequilibrium steady states, transport in superionic conductors and boron nitride nanotube metal matrix composites.

In addition, Dr Qinghong Yuan was awarded an ARC DECRA on "Alloy catalyst design for synthesis of graphene and boron nitride sheets". In this project she will use computational methods to determine optimal catalysts for growth of high quality, continuous two-dimensional materials using chemical vapour deposition. She will take up this award in mid 2017.

Dr Marlies Hankel was CI on an ARC Discovery Project grant "Functionalizing sustainable natural binders for energy storage devices " with Delai Ye (AIBN), Professor Shanqing Zhang (Griffith University) and Dr Gao Liu, (Lawrence Berkeley National Lab).

Professor Bernhardt is the director of the AIBN Centre for Theoretical and Computational Molecular Science, which hosted a Symposium on Computational Methods and Applications in November, which brought together top researchers and students from the region.

COOPER-WHITE GROUP

Biomaterial scaffolds and microdevices to direct stem cell differentiation

The Tissue Engineering and Microfluidics Group, led by Professor Justin Cooper-White, focuses its research on stem cell biology, materials engineering science and microfluidics to look at the basic signals and stimuli needed to repair and regenerate diseased or damaged tissues. Including researchers with different backgrounds, ranging from developmental biology to mechanical engineering, the TE&M lab aim to discover optimal cues and stimuli to drive stem cell differentiations to produce, in a simple and effective way, cells expressing the correct phenotype for the targeted organ.

During 2016 the TE&M Group collaborated with several international institutions, including the Politecnico di Milano on *ex vivo* vascular regeneration. The effort of both parties to create valuable insight in the regenerative medicine field, produced published data on the development of a valuable, mechanically compliant, three-dimensional support for perivascular cell attachment, growth and differentiation into mature vascular cell types.

In 2016 the TE&M Group published 14 peer reviewed publications, including "Induction of human iPSC-derived cardiomyocyte proliferation revealed by combinatorial screening in high density microbioreactor arrays" in *Nature Scientific Reports*.

The paper focused on the optimisation of pluripotent stem cell differentiation into beating cardiomyocyte and screening the candidate biologicals or factors driving relevant molecular pathways in an high-throughput combinatorial micro-bioreactor array. The research group was able to test 81 different media combinations of 4 factors, within one single device, allowing the generation of new insights in the field heart regeneration in a fast and reliable manner.

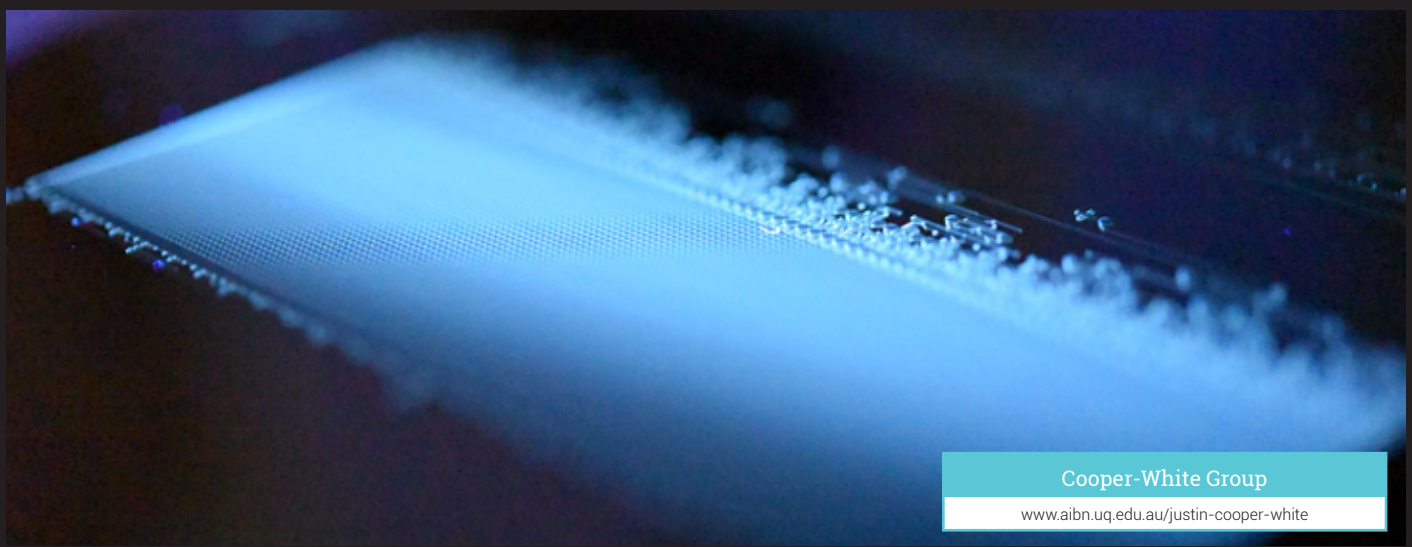
Professor Cooper-White was also successful in National Health and Medical Research Council (NHMRC) grant rounds in 2016. The group received two grants in 2016, to study "Wiring stem cells: The molecular mechanism underpinning lineage propensity" in collaboration with the Children's Medical Research Institute (Sydney), and "Unravelling the mechanism coupling synaptic activity with neurotrophin signalling in the nervous system" in collaboration with The Queensland Brain Institute.

Professor Cooper-White was awarded the NHMRC Marshall and Warren Award, for the most innovative and potentially transformative Project grant application.

The grant was entitled "Targeted direct reprogramming of adult cardiac fibroblasts to functional cardiomyocytes", and focuses on ischemic adult heart tissue regeneration. Based on a non-viral reprogramming approach, this project targets cardiac fibroblasts with the aim to optimise promoters and factor stoichiometry in order to allow differentiation into functional myocardial tissue.

In collaboration with former AIBN PhD student Dr. Drew Titmarsh, Professor Cooper-White launched Scaled Biolabs, a start-up company commercializing their patented lab-on-a-chip system, that allows an increase in throughput, precision, economy, and insight. This can lead to dramatic innovations in organogenesis, fermentation condition optimization and therapeutic production.

Finally, in collaboration with Professor Ernst Wolvetang, Professor Cooper-White and Professor Rowan opened The UQ Centre in Stem Cell Ageing and Regenerative Engineering (StemCARE) as co-directors.



Cooper-White Group

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

GRAY GROUP

Mammalian cell lines and stem cell bioprocesses

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.

During 2016 the Gray Group collaborated with the AIBN research groups of: Professors Stephen Mahler, Michael Monteiro, Lars Nielsen, and; Chengzhong (Michael) Yu, and Professor Martin Pera from the University of Melbourne on aspects of mammalian and stem cell bioengineering.

The group received a number of grants in 2016, including support from 'Stem Cells Australia' (ARC Special Research Initiative), the Merchant Charitable Foundation and the JEM Foundation to study the thermo-responsive PNIPAM 'Nanobridge' stem cell propagation system.

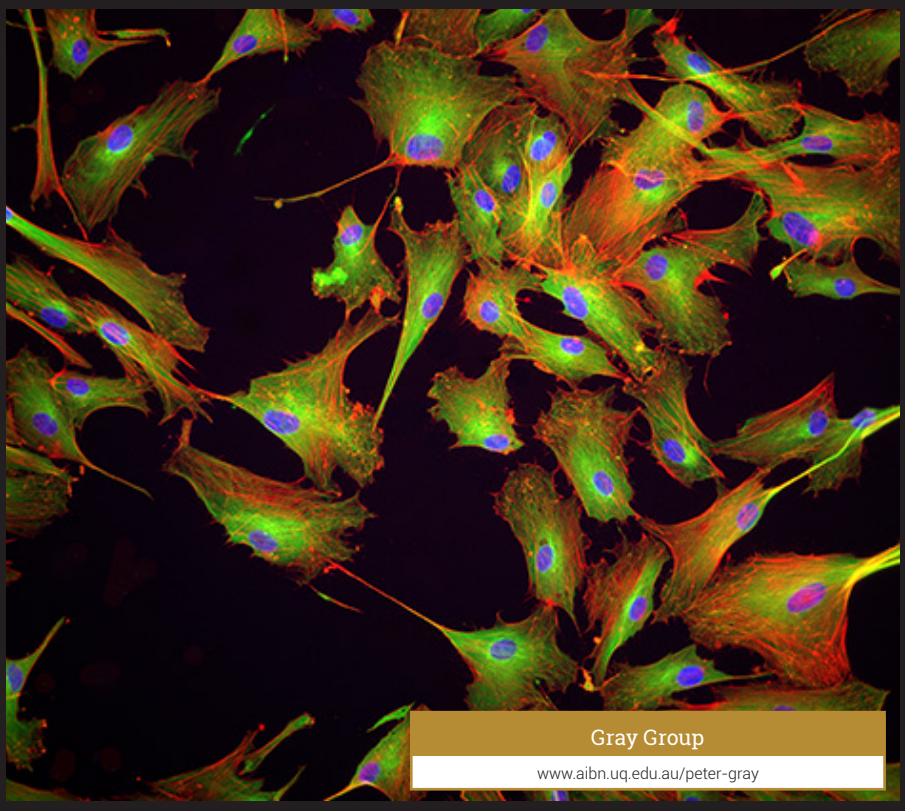
The PNIPAM 'Nanobridge' system has been shown to be able to support enzyme-free propagation and sub-culturing of Pluripotent stem cells (PSCs) as cell aggregates without requiring small molecule inhibitors. The system has been tested in stirred bioreactors, which are more amenable to scalability and 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 5 days of dual SMAD inhibition, followed by induction of neuronal markers (PAX6, NCAM, OTX2) by day 10 onwards. The PNIPAM allowed the aggregates to be dissociated by decreasing the temperature and the application of shear forces.

The research of the Gray Group was recognised in 2016 by Dr. Xiaoli Chen receiving an Ian Potter Foundation travel grant.

In 2016, the patent application 'Release Media' PCT/AU2013/000610 which covers the PNIPAM 'Nanobridge' system progressed smoothly through the national phase in USA, Europe, China, Singapore and the patent recently issued in Australia. The UQ/UNSW spin-off company ACYTE Biotech P/L is covering the patent costs for three patent families in the fields of stable and transient protein expression by CHO cells.

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



Gray Group

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

KENDALL GROUP

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

The Delivery of Drugs and Genes Group, led by Professor Mark Kendall, focusses on fundamental research and applied techniques for needle-free vaccination delivery systems and wearable diagnostics for disease.

During 2016 the Delivery of Drugs and Genes Group continued their collaboration with the ARC Centre of Excellence in Convergent Bio-Nano Science and Technology, innovating in bio-nano science and incubating the expertise and technological excellence required to develop next generation bio-responsive nanomaterials.

In 2016, the Delivery of Drugs and Genes Group published nine peer-reviewed journal articles. Three of these articles were published in Nature Scientific Reports, including "The changing shape of vaccination: improving immune responses through geometrical variations of a microdevice for immunization", by Crichton et al.

In this paper, we explore a way to more effectively use energy for skin penetration and vaccination – extending beyond Nanopatch prototypes for needle-free vaccine delivery. We show that advancing this design results in more efficient surface crack initiations, allowing the energy to be more efficiently be deployed through the projections into the skin, with a significant overall increase in penetration depth (50%). Furthermore, we measured a significant increase in localized skin cell death (>2 fold), and resultant infiltrate of cells (monocytes and neutrophils). Using a commercial seasonal trivalent human influenza vaccine our new patch design resulted in an immune response equivalent to intramuscular injection with approximately 1000 fold less dose, while also being a practical device conceptually suited to widespread vaccination.

The group continued work as part of the ARC Centre of Excellence in Convergent Bio-Nano Science and Technology, an ARC Discovery Project, an ARC Linkage Project, two NHMRC Development Projects and a Queensland Government Accelerate Fellowship.

The research of the Delivery of Drugs and Genes Group was recognised in 2016 with Dr Jacob Coffey being awarded an American Australian Association Fellowship, Jonathan Wei receiving a UQ Graduate School International Travel Award, Dr Alexandra Depelsenaire receiving a Queensland Government Advance Queensland Women's Academic Fund Award, Nick Hong Seng Lee winning the UQ three minute thesis competition at the Institute level. Also, Group Leader Mark Kendall won two national awards: (1) the CSL Young Florey Medal from the Australian Institute of Policy and Science. This award is presented to an outstanding scientist for significant early career achievements in biomedical science and/or human health advancement (2) Dr John Dixon Hughes Medal for Medical Research Innovation, for outstanding contribution towards the development and advancement of a biomedical innovation related to the nature, prevention, diagnosis, treatment and incidence of disease and other health problems that have a significant impact on the health of humans.

2016 held success for the Delivery of Drugs and Genes Group, with the granting of two patents including: (a) Coating Method (Publication number US20160058697 A1) and (b) Analyte detection using a needle projection patch. (Publication number US9387000 B2).

Mark Kendall was elected onto the World Economic Forum Global Future Council for Entrepreneurship and Innovation, serving a three year term (2016-2018).

Kendall Group

www.aibn.uq.edu.au/mark-kendall

MAHLER GROUP

Biologic medicines, targeted nanomedicines and theranostics

The Mahler Group focuses on the research and development of biologic medicines, targeted nanomedicines and theranostics for the diagnosis and treatment of diseases including cancer, inflammatory diseases and infectious diseases. The group has a particular interest in monoclonal antibodies (mAbs), which have potential as a cure for various types of cancers. The group engages in technology development, and has been successful in developing several platform technologies in areas including mAb discovery and drug delivery. Members of the Mahler Group have successfully engaged and collaborated with industry and academic research groups throughout 2016 and have achieved exceptional translational research outcomes.

For mAb discovery, the group has created "in-house" immunoglobulin gene libraries for the isolation of mAbs with diagnostic and therapeutic potential. Success stories include isolation and development of a mAb that binds CD83 on dendritic cells, with a longer term therapeutic application in the treatment of graft versus host disease. Other antibodies that bind cell surface receptors including EGFR, PSMA and EphA2 are in development for applications ranging from targeting drug-loaded nanoparticles to tumours through to development of theranostic agents. The group in collaboration with the Thurecht Group has generated a method of targeting nanoparticles to tumours using antibodies, which is now undergoing testing in collaboration with industry partners.

One of the highlights of 2016 was the successful application for an ARC Industrial Transformation Training Centre, with funding and support of $13 million over a five year period.

The centre, named the ARC Training Centre for Biopharmaceutical Innovation (CBI), works closely with industry partners CSL Ltd, GE Healthcare, the Australian Red Cross Blood Service and Patheon Biologics Australia Pty Ltd in areas that range from biologic medicine discovery and development of blood diagnostic reagents through to advanced manufacturing capabilities and technologies for biologic medicines. A range of outcomes is envisioned including potential new products and bioprocesses through to licensing of technology and spinout companies. CBI will train a cohort of highly skilled, industry-ready graduates that will help drive economic output within the industry, in Australia.

In 2016, the Mahler Group published two book chapters and eight peer reviewed journal publications. These publications describe development of new biologic medicines and innovations in antibody-targeted drug delivery systems. One paper describes a technology for the isolation of antibodies that bind membrane biomarkers, which has great significance for the discovery of novel antibodies for cancer diagnosis and therapy.

Mahler Group

www.aibn.uq.edu.au/stephen-mahler

MARTIN GROUP

Renewable nanomaterials and polymer nanocomposites

The Martin Group has a research focus on renewable nanomaterials and polymer nanocomposites, with a proven track record in "end-to-end innovation". The group takes fundamental discoveries and learnings in materials science and biology and progresses the science, engineering, regulation and translation of these technologies for the benefit of Queensland and Australia. Current active platforms include the unique cellulose nanofibres from Australian spinifex arid grasses, and organosilicate nano additives being commercialised by the AIBN spin-out company TenasiTech Pty Ltd.

During 2016 the Martin Group collaborated with Dr Warren Batchelor (Monash University), Prof Paul Memmott (UQ Architecture) and Dr Gleb Yakubov (UQ Chemical Engineering) on the Indigenous traditional knowledge and fundamentals of spinifex cellulose nanofibers. This collaboration produced some excellent joint publications and prepares the group well for ongoing projects such as understanding the fundamentals of ultra-tough "nanopaper" materials formed from spinifex nanofibres.

The Martin Group published two book chapters and nine peer reviewed journal publications in 2016, including one paper which communicates the scalable processing of thermoplastic polyurethane nanocomposites toughened with spinifex nanocellulose, which appeared in the *Chemical Engineering Journal*.

This paper demonstrates that the incorporation of only 0.5% spinifex nanocellulose by weight showed a remarkable improvement (up to 43%) in elastomer tensile strength, without compromising the elastic properties including elongation, creep and hysteresis. This was achieved using, for the first time, a commercially-scalable, organic, solvent-free, reactive extrusion process. This technology is protected by a PCT patent (PCT/AU2015/050773).

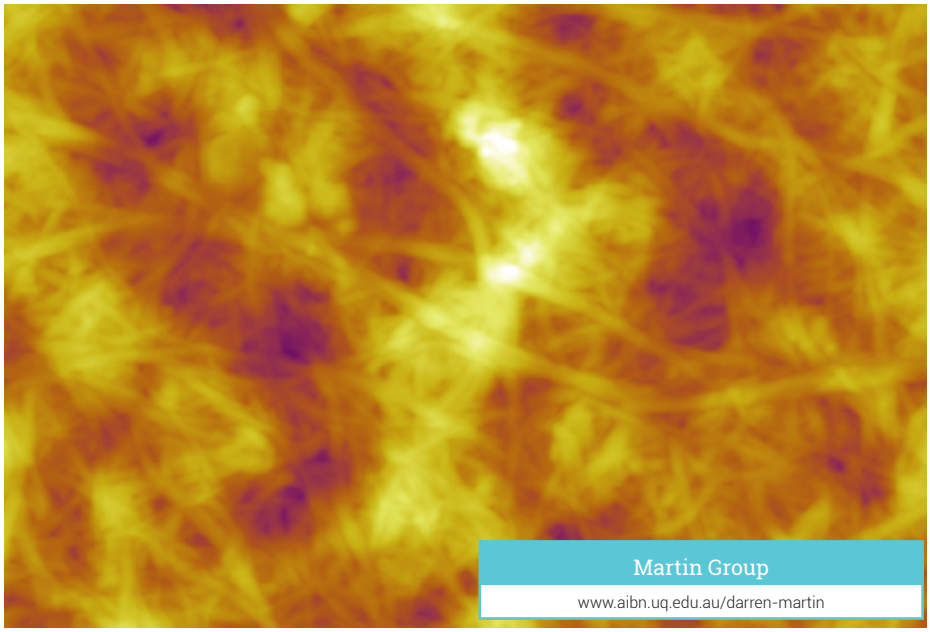
A landmark umbrella agreement and commercial partnership between UQ and The Indjalandji-Dhidhanu traditional owner group (though the Dugalunji Aboriginal Corporation) was signed in 2016. This provides a framework for the vision of shared future commercial benefits and Indigenous economic development from the generated spinifex nanocellulose IP. The technology was highlighted in Prime Minister Turnbull's 2016 release of the "Closing the Gap" Report, as one new technology with the potential to redress Indigenous disadvantage. In 2015-16 the project received $1 million in funding from Minister Nigel Scullion's Indigenous Advancement Strategy (IAS) for the group's 5kg per day nanocellulose pilot plant – the first time this fund has supported a nanotechnology-based R&D project.

Also in 2016, the group was successful in winning two Advance Queensland Fellowships to support targeted projects in spinifex-reinforced natural latex and compounded rubber products (condoms, gloves, minerals handling equipment) and spinifex-stabilised civil infrastructure (bitumen and concrete).

Following on from this research sucess, Professor Martin recently won a 2016 UQ Partners in Research Excellence Award for ongoing engagement, co-development and commercialisation activities in working with the spinifex nanocellulose technology with the Dugalunji Aboriginal Corporation. Dr Nasim Amiralian won the 2016 Women in Technology (WiT) Rising Star Award for her tremendous ongoing basic and applied research on spinifex nanomaterials.

2016 also held success for members of the Martin Group (Professor Darren Martin, Dr Grant Edwards and Dr Celine Chaleat) with the granting of patent WO/2014/194380, which protects a formula which gives scratch resistance performance for our TenasiTech nano additives in a range of rigid thermoplastic materials including PET, plexiglass, polycarbonate and nylon thermoplastics.

Progress was also made in establishing the Long Pocket pilot manufacturing facility, with the transfer of materials processing equipment, and the successful installation and commissioning of Australia's first pilot scale nanocellulose plant. This plant can produce 5 kg per day of a range of spinifex nanocellulose grades for ongoing commercial trials with a growing list of industry partners.



Martin Group

www.aibn.uq.edu.au/darren-martin

MIDDELBERG GROUP
Biomolecular engineering

The Middelberg Group, led by Professor Anton Middelberg, Dr Chun-Xia Zhao (Associate Group Leader and ARC Future Fellow) and Dr. Frank Sainsbury (Associate Group Leader and ARC DECRA Fellow), has an application focus on vaccine engineering, and bio-inspired nanomaterials for drug delivery and controlled release. These outcomes are underpinned by fundamental research into biomacromolecular self-assembly and condensed soft matter.

Dr Zhao leads the Middelberg Group's research on bio-inspired engineering of nano and micromaterials for drug delivery and controlled release. This work develops the group's background in manipulating the interfacial properties of designer peptides and proteins, as well as extensive expertise in microfluidics. In addition, this work has expanded into the design and building of biomimetic chips for faster nanomedicine screening and evaluation.

Dr Sainsbury leads the Middelberg Group's research on the self-assembly of virus-like nanoparticles and tailorable nano-scale emulsions. This work aims to understand the processes that drive assembly and the resulting structures with molecular level precision. With this information on bioengineered building blocks, the group is enabling the rational design of novel bio-derived nanomaterials for designer vaccines and therapeutic delivery.

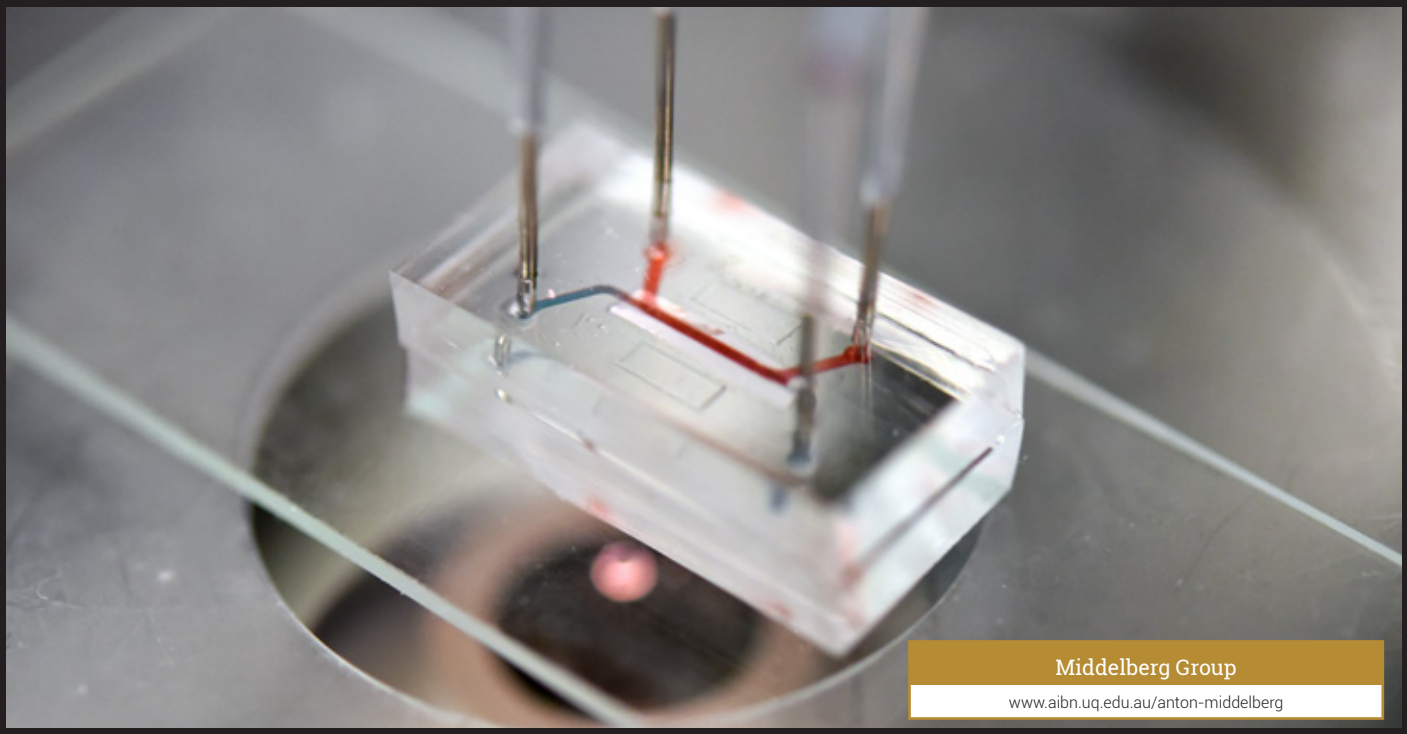
During 2016, Dr Zhao and Prof. Middelberg collaborated with Professor David Weitz at Harvard University on making complex emulsions for controlled release, which produced three papers.

In 2016 the Middelberg Group published 15 peer reviewed publications in leading journals including *Advances in Colloid and Interface Science, Scientific Report, Langmuir* and *Vaccine*.

The Middelberg Group received ARC Discovery project and UQ CIEF grants in 2016.

The research of Dr Chun-Xia Zhao in the Middelberg group was recognised in 2016 through winning a UQ Foundation Research Excellence Award.

A bio-inspired nanocapsule technology developed in the Middelberg Group has been patented and entered national phase in 2016 covering Australia, US, Europe and Canada.



Middelberg Group

www.aibn.uq.edu.au/anton-middelberg

MONTEIRO GROUP

Designer polymers: Synthesis of complex polymer architectures

The Monteiro Group, led by Professor Michael Monteiro, has a research focus on polymer science, 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 the most versatile and diverse materials ever created by humans or nature. Professor Monterio's contribution to living radical polymerisation (LRP) is developing kinetic simulations supported by experiments of RAFT (a highly cited paper co-authored by all RAFT experts in the field), ATRP and SET-LRP to determine the controlling mechanism in bulk and solution. This has led to insights into the mechanism of LRP that were non-intuitive and improved engineered materials.

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. The group has now expanded its expertise to make polymer rings (cyclics) using the group's own nitroxide and well-established 'click' reactions.

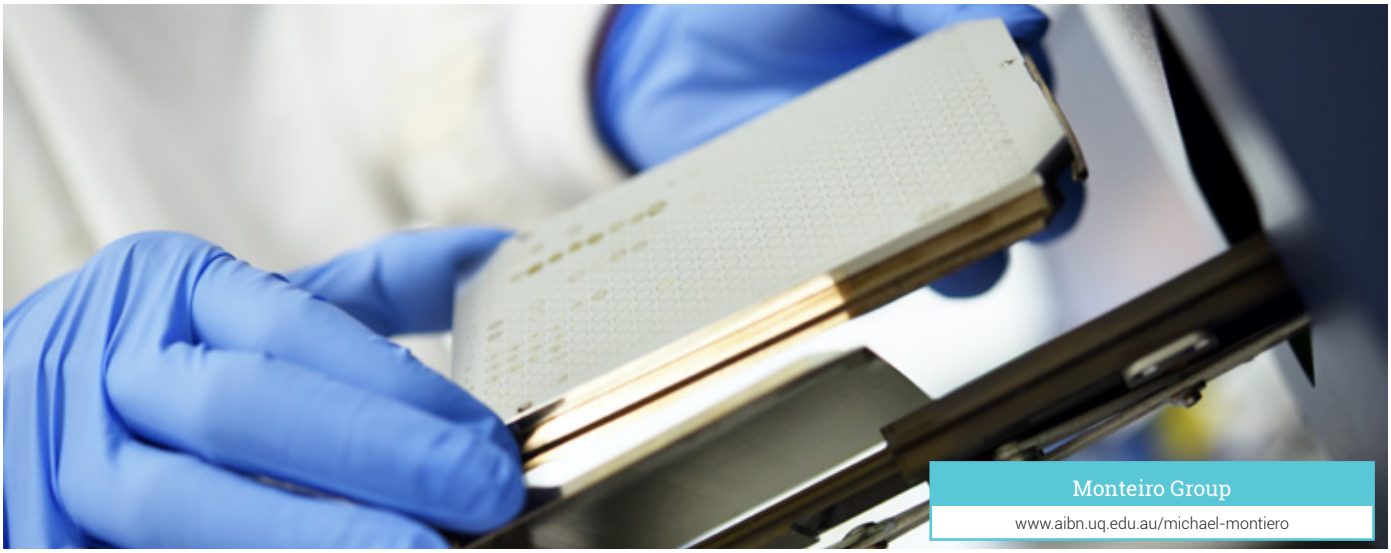
Professor Monteiro's work in making nanostructures via emulsion polymerization is internationally recognised. The Group's recent work using thermoresponsive polymers to drive 3D structures directly in water and on scales for potential use in industry (Angew Chemie 2011). With this, the group could create a wide range of structures and more importantly have diverse surface orthogonal functionality on nanoworm (J. Am. Chem. Soc. 2014) and tadpole nanostructures (J. Am. Chem. Soc. 2015). These functional structures are now being trialled as drug delivery vehicles. The same types of orthogonal chemical functionality will be used in a new project.

During 2016 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. This work was published in Polymer Chemistry, along with 8 other publications from the Monteiro Group this year.

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 cell 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. This work was published in the *Journal of the American Chemical Society* in 2016.

The research of the Monteiro Group was recognised in 2016 with Professor Monteiro being awarded a UQ Vice Chancellor's Strategic Fellowship (2016-2019).



Monteiro Group

www.aibn.uq.edu.au/michael-montiero

NIELSEN GROUP

Systems and synthetic biology

The Systems and Synthetic Biology Group (SSBG) is led by Professor Lars Keld Nielsen supported by two Associate Group Leaders (Drs Claudia Vickers and Esteban Marcellin) and the manager of Metabolomics Australia's Queensland Node (Dr Mark Hodson). Two affiliated staff from the School of Chemistry and Molecular Biosciences (Dr Steve Reid) and the School of Chemical Engineering (Dr Cristiana Dal'Molin) completes the leadership team.

SSBG has an international outlook with student and staff representing 20 nations across six continents. The group has many global research partners in academia and industry, and last year saw us extend a contract with Zoetis (US) under the ARC Linkage scheme and sign a new direct commercial contract with Samyang (Korea).

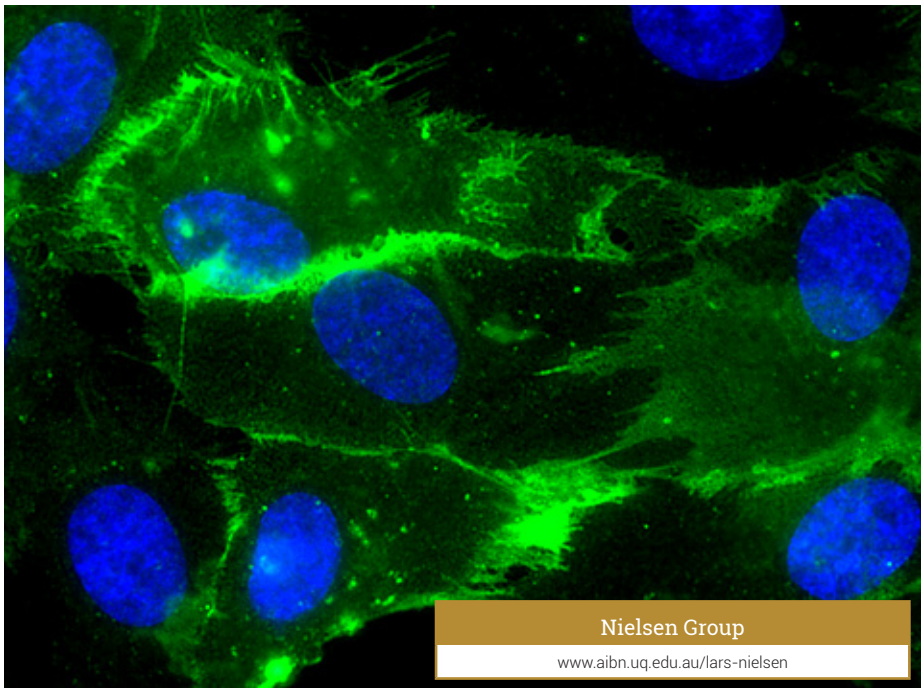
Collaboration with leading synthetic biology commercialiser, Amyris (US) also expanded through a Memorandum-of-Understanding. This gives the group access to Amyris' expertise and facilities for automated strain engineering. The collaboration underpins a renewed push by SSBG working with colleagues and Queensland Government to help realise the potential of a $1 billion industrial biotechnology sector by 2025. This push is helped by additional funding from Bioplatforms Australia (BPA), who contributed additional funding to expand the BPA facility with proteomics. Dr Vickers was invited to write a commentary on advances in synthetic biology leading to the engineering of minimal genomes (*Nature Biotechnology* 34: 623–624, 2016).

Gas fermentation is another technology coming of age. SSBG has worked with LanzaTech, the leading company in the field for a few years, and this year published the first comprehensive systems biology study of acetogens (*Green Chemistry* 18: 3020-28, 2016). Dr Marcellin was awarded a UQ Strategic Research Fellowship to advance a centre in this field, having organised the first international C1 fermentation workshop on Heron Island in June. The workshop was attended by 40 people, including several world leaders from academia and industry. Several new projects have emerged from this workshop.

Locally, the formation of the ARC Training Centre for Biopharmaceutical Innovation will see several group members (including Drs Dal'Molin, Martinez and Marcellin) involved doing research on CHO systems biology and bioprocess engineering. This research will build on the consensus, genome scale model of CHO metabolism, developed with colleagues across the world (*Cell Systems* 3: 434-443, 2016).

SSBG filed several patents in 2016 and our patent on large-scale production of neutrophils from blood stem cells was licensed to the Centre for Commercialisation of Regenerative Medicine in Toronto. The blood stem cell team has recently been focusing on new RNA sequencing technologies and contributed to two papers on novel synthetic genome standards (*Nature Methods* 13:784-91 and 13:792-8, 2016).

Towards the end of 2016, Professor Nielsen started his joint position with the Novo Nordisk Foundation Center for Biosustainability at DTU in Denmark. Supported by an $8m NNF Research Laureate Research Grant, he will build on seminal work on kinetic modelling of cell metabolism recently developed in the group (*Science Report* 6:29635).



Nielsen Group

www.aibn.uq.edu.au/lars-nielsen

ROWAN GROUP

Bio- and nano-mimickry of human systems

The newly established Biomechanics Group, led by Professor Alan Rowan, has a focus on the interaction of cells and biomimetic materials which closely mimic the physical properties of materials found in nature.

During 2016, the Rowan Group continued collaboration with the Institute for Molecules and Materials, Radboud University on a novel hydrogel materials project which produced several high impact publications

As a result of this ongoing collaboration, in 2016 the Rowan Group published 14 peer reviewed publications, including one on "Stress-stiffening-mediated stem-cell commitment switch in soft responsive hydrogels" in *Nature Materials*.

The paper demonstrated for the first time, that mesenchymal stem cell differentiation can be controlled by the mechano-transduction between the cell and the matrix. This intriguing observation challenges current cell culturing approaches, which state that cell fate is partly determined by the stiffness of the extracellular matrix, with bone cells forming on stiff materials and neurons on soft materials. The group proved that the standard theory is too simple and demonstrated that the onset of strain stiffening (the size of force the cell exerts on the matrix before it stiffens) plays a role in cell outcome.

The Rowan Group received a number of grants in 2016, including an ARC Laureate fellowship to study strain stiffening as a key to cell control.

The Laureate project aims to unravel the highly complex mechanical behaviour of the extracellular matrix (ECM), and in doing so, develop a whole new class of sophisticated and responsive ECM materials. Outcomes will include a blueprint for synthetic ECMs, pushing the boundaries of materials development in the biological and life sciences.

In 2016, on top of establishing the group itself, and a new research laboratory at the AIBN, the Rowan Group started to build a state of the art piece of equipment, the confocal rheometer. The first of its kind in Australia, which will allow for detailed visualisation of interaction of the extracellular matrix and cell when external force is applied.

Rowan Group

www.aibn.uq.edu.au/alan-rowan

TRAU GROUP

Nanoscience, nanotechnology and molecular diagnostics

The Trau group led by Professor Matt Trau is focused on developing nano-scaled biosensors for genomics, proteomics, epigenetic, drug screening and diagnostics, with the goal of enabling early detection of disease and personalised treatment.

The Group is supported by funding from the ARC, philanthropic donations, commercial contracts and a $5M multidisciplinary collaborative grant from the National Breast Cancer Foundation (NBCF). The NBCF project brings together nanotechnologists, breast cancer clinicians, pathologists and world-leading geneticists to discover new genetic 'biomarkers' of breast cancer, as well as developing innovative nanotechnology to read such information from blood or tissues. Participating organisations include: the Garvan Institute (Sydney), the Peter MacCallum Centre (Melbourne), the Olivia Newton John Cancer Research Centre (Melbourne) and the University of Newcastle.

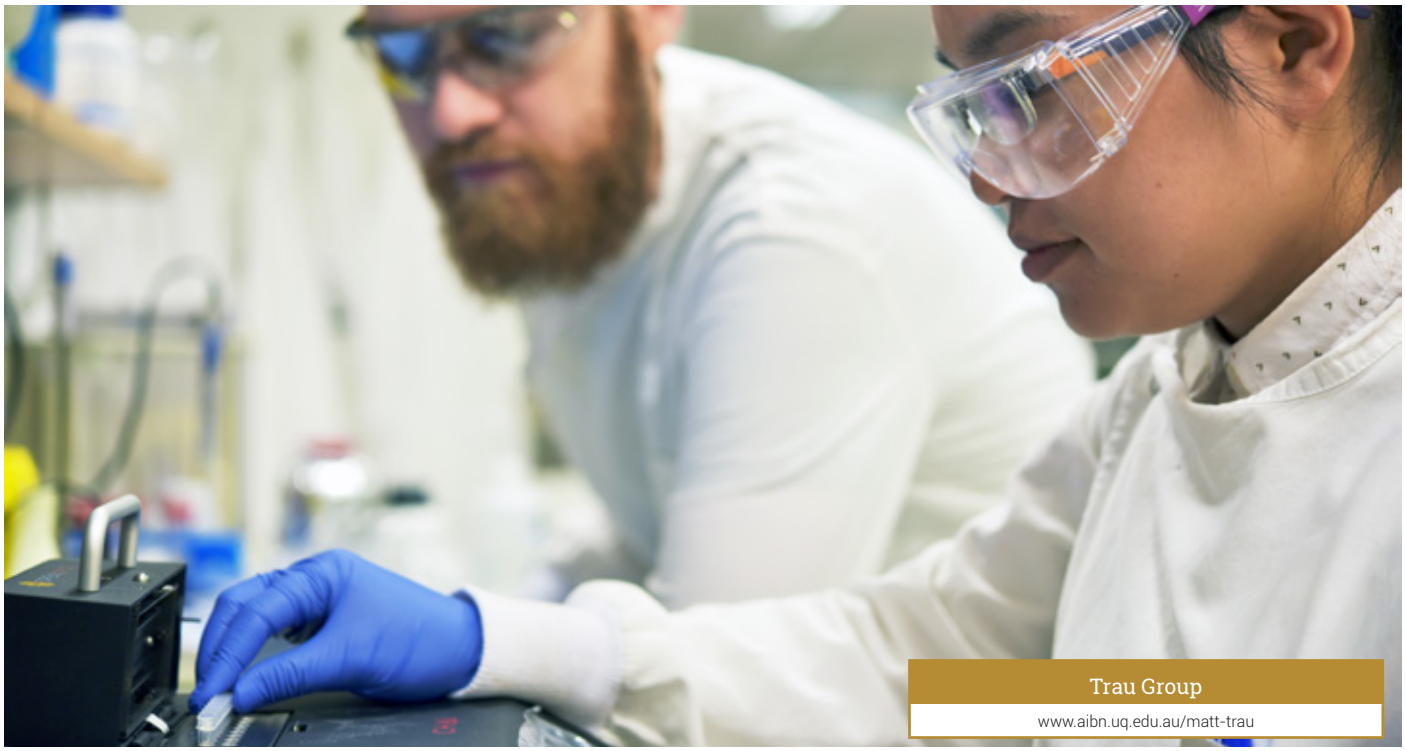
Professor Trau also leads an ARC Discovery Project Grant in the area of nanoparticle characterisation within nanopores.

Professor Trau also engages with breast cancer patients and survivors and in 2016 worked with the So Brave breast cancer calendar organization (http://sobrave.com.au/), who produce an arts-based calendar to promote breast cancer awareness and research.

In 2016, Professor Trau was invited to present a TEDx talk, "Engineering and End to Cancer Mortality with Nanodiagnostics" where he described emerging nanotechnologies to enable early cancer detection, personalised treatment/monitoring, as well as personalised cancer vaccines. (released on the internet by TED in Sept 2016). Professor Trau was also invited to present one of the five plenary lectures at the 6th International NanoBio Conference held in Nanjing, China, a major international nanobiotechnology conference.

2016 was a very productive year with the Trau Group publishing 23 peer reviewed journal articles which included publications in leading journals Scientific Reports (4), Chemical Communications (2) and Small (2).

The Group has extensive laboratory infrastructure and equipment including microscopy, potentiostat, flow cytometry, cell, protein/particle characterization/analysis, and "Next-Generation" DNA Sequencing. In 2016, supported by an UQ Major Equipment & Infrastructure Grant, the Group established an state of the art Exosome and Bio/Nanoparticle Characterisation Facility which will allow high throughput analysis of complex bio/nanoparticle samples, enabling enable novel insights into the properties of bio/nanoparticles.



Trau Group

www.aibn.uq.edu.au/matt-trau

WANG GROUP

Characterisation and application of functional nanomaterials

The Wang Group, led by Professor Lianzhou Wang, has a research focus on the design and development of functional semiconductor materials for clean energy conversion and storage applications, including photocatalysis, low cost solar cells and rechargeable batteries.

During 2016 the Wang Group collaborated with Baosteel and Chang'an Leling Group on a rechargeable batteries project which produced high energy density cathode materials for lithium ion batteries.

The Wang Group published over 30 peer reviewed publications in 2016, including a paper on hematite based thin films for solar hydrogen fuel in *Advanced Materials*. The paper discussed the development of low cost hematite based nanosheets as photoelectrodes, which are able to perform a solar driven water splitting process with high performance and good stability, addressing a key challenging issue of solar fuel generation processes.

The Wang Group received a number of grants in 2016, including: an ARC Discovery Project (2017-2019) on "Perovskite Materials: exploring new properties beyond solar cells", and an ARC Linkage Project (2016-2019) on the "Design of new two-dimensional materials for lithium sulfur batteries."

The research of the Wang Group was also recognised in 2016 by the award of a number of competitive research fellowships.

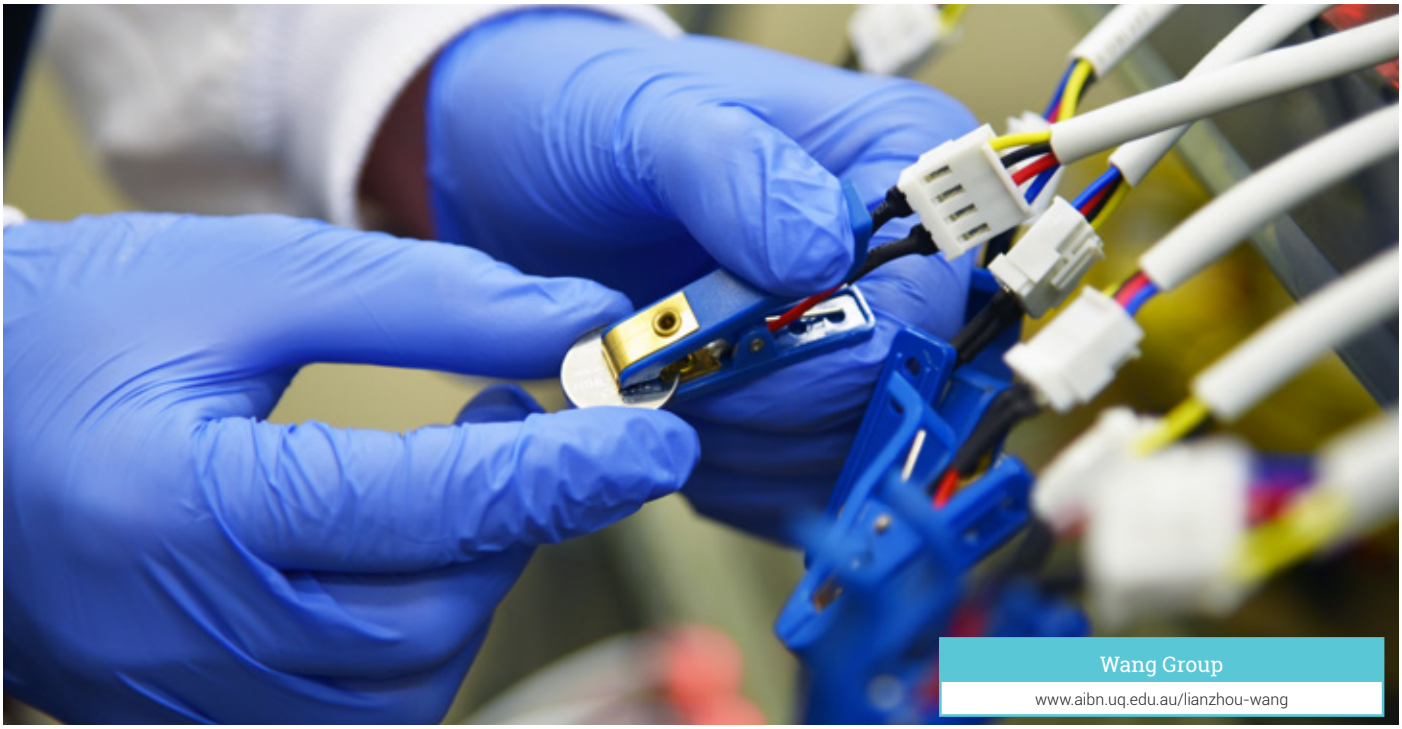
Professor Lianzhou Wang was awarded a UQ Strategic Research Fellowship for his project, Development of new electrode materials for next generation rechargeable batteries (2017-2020).

Dr Yang Bai also received a UQ Development Fellowship for his project, Development of efficient and stable solution-processed thin film solar cells (2017-2019).

Dr Muxina Konarova was awarded an Advance Queensland Research Fellowship for her project, on Sustainable production of ethanol from bio-syngas (2016-2019).

Dr Han Hu received an ARC DECRA Fellowship for his project, Designing compressible hybrid supercapacitors from graphene aerogels (2017-2019).

2016 held success for the Wang Group with the generation of intellectual property in new electrode materials for high performance sodium ion batteries.



Wang Group

www.aibn.uq.edu.au/lianzhou-wang

WHITTAKER GROUP

Innovative polymer chemistry for health and energy

The Whittaker Group, led by Professor Andrew Whittaker, develops novel polymeric nanomaterials for health and energy. Specifically, his group has research programs on 1) MRI agents for interrogation of the tumour environment, 2) functional polymer surfaces for tissue regeneration and anti-bacterial agents, and 3) new approaches to the manufacture of integrated circuits.

Professor Whittaker and his group tackle complex scientific problems which require broad expertise. Much of this resides within his group, however he has built a series of national and international networks to support his research programs. Notably he is Theme Leader of Imaging Technologies within the ARC Centre of Excellence in Convergent Bio-Nano Science and Technology (CBNS). The CBNS is a national network of leading scientists working in the fields of spanning the bio- and nano-sciences.

An example of novel MRI agents is the group's development of ion-responsive MRI contrast agents capable of detection of cancer cells. This study led by Dr Cheng Zhang and published in the leading journal *ACS Sensors*, describes in detail the chemistry and application of these new MRI agents capable of measuring ionic strength *in vivo*. Cancer cells have perturbed ionic composition, and the imaging agents are able to report on these changed conditions.

In another important study, Dr Kewei Wang, a member of the Whittaker Group, developed new nanoparticles based on hyperbranched polymers for combined x-ray CT and 19F MRI bimodal molecular imaging. This is the first report of combined CT and 19F MRI agents, and offers the prospects of improved diesease diagnosis.

Amongst the other papers published is a collaborative study with Professor Afang Zhang and his group at Shanghai University, and Professor Debra Bernhardt of AIBN, in which Dr Cheng Zhang examined the mechanism of the remarkable thermal properties of a series of dendronised polymers dissolved in water. The detailed study was an outstanding example of the power of combining advanced NMR and computational methods to gain a unique insight into polymer properties.

Professor Whittaker's group also works in the field of materials for the manufacture of integrated circuits. These studies have been done in partnership with leading manufacturers of chemicals and computer chips. Most recently he and his partner in this work, Associate Professor Idriss Blakey, have been working with Dow Electronic Materials. Their research supported by an ARC Linkage Project grant, developed new materials to support the latest technology in the field, for example 193nm immersion lithography and EUV lithography.

These studies resulted in the publication in 2016 of three patents jointly with Dow EM. In addition, Dow EM has licensed technology developed by the Whittaker Group for the improvement of the regularity of nanometre-scale features on circuits with an aim to commercially release a product.

Professor Whittaker and his group are active in developing new materials with antimicrobial properties. The polymers will ultimately be applied in the form of paints in medical settings, to reduce the burden of microbes in those environments. As part of these activities he is collaborating as Senior Scientific Advisor to the Biocide Toolbox, a consortium of scientists based in Auckland, working in allied fields. So far this work has led to several innovations, for example low fouling surfaces, and novel microbe-killing polymers.

The excellence of research of the Whittaker Group was recognised in 2016 by numerous invitations to present at major international conferences including keynote talks by Professor Whittaker in Australia, UK and Korea. Also, in his role as the AIBN Deputy Director (International), Professor Whittaker co-chaired two joint meetings with leading materials scientists from China (July 2016 in Brisbane) and Korea (October 2016 in Daegu).

Finally, and most importantly Professor Whittaker's group celebrated the graduation of three PhD students, Dr Cheng Zhang, Dr Amanda Pearce and Dr Adit Ardana. All three have gone on to secure excellent postdoctoral positions.

Whittaker Group

www.aibn.uq.edu.au/andrew-whittaker

WOLVETANG GROUP

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

The Stem Cell Engineering Group, led by Professor Ernst Wolvetang, has a research focus on human functional genomics, stem cell based disease modelling and ageing.

During 2016 the SCEG Group collaborated with Professor Gerald Schumann on the mobility of DNA elements during the generation of human induced pluripotent stem cells (2016 *Nature Comm)* and with Professor Lavin (UQCCR) on Ataxia taliengectasia, a debilitating disease in children.

In 2016 the SCEG Group published 10 peer reviewed publications, including one on the long non-coding RNA NEAT1 that is responsive to neuronal activity and is associated with hyperexcitability states (Guy Barry, James A. Briggs,et al. Dong Soo Lee, Jeffrey A. Loeb, Seth Blackshaw, John S. Mattick, and Ernst J. Wolvetang).

The paper identifies a role for the LncRNA NEAT1 in modulating human neuronal activity and suggests a novel mechanistic link between this activity-dependent long non-coding RNA and epilepsy.

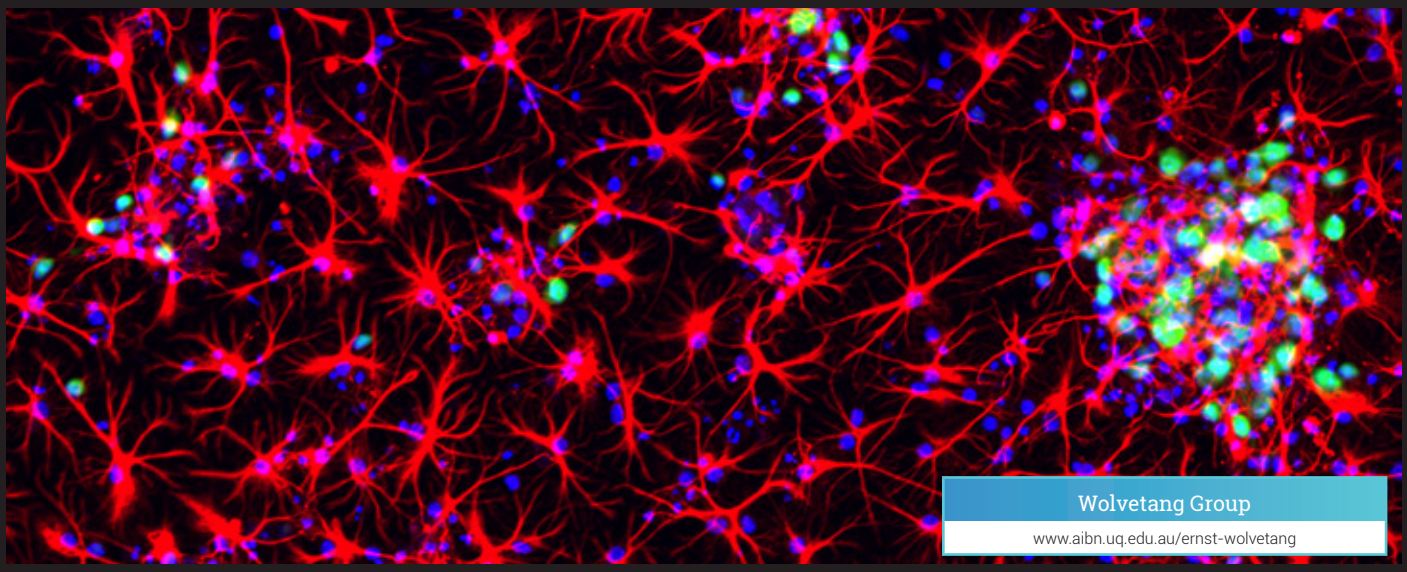
Despite their abundance, the molecular functions of long non-coding RNAs in mammalian nervous systems remain poorly understood. The group showed that the long non-coding RNA, NEAT1, directly modulates neuronal excitability and is associated with pathological seizure states. Specifically, NEAT1 is dynamically regulated by neuronal activity *in vitro* and *in vivo*, binds epilepsy-associated potassium channel-interacting proteins including KCNAB2 and KCNIP1, and induces a neuronal hyper-potentiation phenotype in iPSC-derived human cortical neurons following antisense oligonucleotide knockdown.

The Wolvetang Group received two NHMRC grants in 2016 (APP1127976) "Re-wiring a stem cell: Deciphering the molecular mechanism underpinning lineage propensity" and (APP1130168) "Leveraging genomics strategies to generate adult neurons from iPSCs and somatic cells."

The latter project aims to overcome the neoteny of human induced pluripotent stem cells (iPSC) derived cell types (IAW reprogramming leads to rejuvenation of somatic cells and therefore iPSC produce fetal cells upon their differentiation. Furthermore timing of development appears to be temporally hardwired in each species, making experimentation on human iPSC derived adult-like cells difficult, particularly in the study of ageing related diseases. In this project CRISPR-based approaches are used to identify combinations of genes that can achieve this.

The group's research as part of the international research consortium, FANTOM5, was recognised in 2016 by winning 2016 Scopus Eureka Prize for Excellence in International Scientific Collaboration.

This year marked the establishment of the UQ Centre for Stem Cell Ageing and Regenerative Engineering (UQ-StemCARE), co-directed by Professors Wolvetang, Cooper-White and Rowan. The centre, which was opened by Premier Palaszczuk aims to understand the role of stem cells, their niches and blood borne soluble factors that collectively and collaboratively govern tissue homeostasis and declines with ageing. The aim is to discover molecules and strategies that can enhance or maintain stem cell function with age and thus promote healthy ageing outcomes.



XU GROUP

Clay nanomaterials for delivery of drug, gene and vaccine

The Xu Group, led by Professor Zhi Ping (Gordon) Xu, has a research focus on the controlled preparation of inorganic/organic hybrid nanoparticles and their applications in drug/gene/protein delivery and diagnostic imaging for enhanced health of humans, animals and plants.

During 2016 the Xu Group collaborated with Professor Roberts in the Translational Research Institute on a project exploring toxicity of nanomaterials, to animal organs and an imaging project using nanomaterials, which produced four high-quality papers. A collaboration with Associate Professors Mahony and Mitter from the Queensland Alliance for Agriculture and Food Innovation (QAAFI) on vaccine and dsRNA delivery for animal and plant health, produced two high-quality papers. In addition, the Xu Group collaborated with Professors Whittaker and Monterio from the AIBN, and Professor Qian in Shanghai University and Dr Li in Hubei University on drug delivery, imaging and environmental protection.

In 2016 the Xu Group published 12 peer reviewed publications, including one on "Efficient and durable vaccine against intimin β of diarrheagenic E. coli induced by clay nanoparticles" in *Small* and another on "Short- and long-term tracking of anionic ultra-small nanoparticles in kidney" in *ACS Nano*.

The first paper reported the group's new findings that clay nanoparticles induce strong antibody and cell-mediated immune responses to a specific antigen, and these immune responses are maintained for at least four months in the mouse model, during which there are no changes in histopathology of the animal organs.

This demonstrates that clay nanoparticles are useful adjuvants in new-generation vaccine formulations to control various infectious diseases.

The second paper reported the group's new findings that the surface charge also determines renal clearance of ultra-small nanoparticles. This study also provides a framework for characterising and predicting subcellular disposition in organs and long-term targeting, with a physiologically-based kinetic model being subsequently developed for the first time to describe the sub-organ kinetics of anionic ultra-small nanoparticles.

The Xu Group received a number of grants including ARC DP170104643 titled "What are key physicochemical properties of nanomaterials determining their disposal by liver cells?" and NHMRC APP1126091 "Physiologically-based pharmacokinetics and pharmacodynamics of therapeutic cells for liver disease". Dr Run Zhang received an ARC DECRA Fellowship for a project titled "X-ray induced photoacoustic nanoprobe: break depth dependency of bioimaging".

Xu Group

www.aibn.uq.edu.au/zhi-ping-xu

YU GROUP

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

Professor Michael Yu is an internationally recognized expert on designed synthesis and application of functional nano-materials. He is leading a research group of more than 20 researchers and students with wide research interests on smart nano-materials for water treatment, energy storage, sustainable agriculture and biological applications.

During 2016 the Yu Group collaborated with Elanco Animal Health together with Professor Neena Mitter from UQ's Queensland Alliance for Agriculture and Food Innovation on an ARC Linkage Project. In the first year collaboration of "Novel Nano-Pesticides for Animal Health", a novel nano-Spinosad formulation has been developed with much enhanced efficacy in simulated field conditions than current commercial products.

Successful collaborations were established with N4 Pharma and Anpario to investigate smart nano-materials for DNA vaccines and animal feed.

The Yu Group, published 29 peer reviewed publications during 2016, including two journal papers in *Advanced Functional Materials* as cover stories. In one cover story, a facile, template-free synthetic strategy of novel yolk-shell Sn@C nanoboxes with tunable shell thickness is investigated as an advantageous anode material in lithium ion batteries. Another inside back cover story describes engineering of iron oxide hollow nanospheres that successfully combine high antimicrobial activity with an excellent safety profile towards mammalian cells.

Additional work published in the *Journal of the American Chemical Society* introduces a facile new approach to fabricate silica nanopollens with enhanced adhesion toward bacteria surfaces. Potent antimicrobial activity of lysozyme-loaded silica nanopollens is demonstrated both in *in vitro* and ex vivo models. This interesting finding drew extensive attention from both academia and industry, and was reported by C&E News as "Nanopollens pack a sticky antibacterial punch".

The Yu Group received a number of grants in 2016, including an ARC Linkage Project, a LIEF grant to purchase a Small Angle X-Ray Scattering Facility for Queensland, and research grants from industry partners N4 Pharma and Anpario for smart nanomaterials development.

Funding was also provided by Diabetes Australia for research on a small-sized nano-implant that aims to remove the need for daily insulin injections. The nano-implant will be based on nanoparticle technology with enzymes and polymer coatings that act as a barrier to release insulin only when the blood glucose level is higher than normal, and then closes once glucose levels return to safe levels. The successful development of this technology was reported by 7 News and online.

In the Yu Group, five research higher degree students completed their study and were awarded PhD or MPhil degrees during the year, and Dr Chang Lei was awarded the 2016 Distinguished International Students Scholarship by the China Scholarship Council.

2016 also held success for the Yu Group with the filing of three patents, including an International (PCT) Patent (Application No. PCT/AU2016/050283). In this patent the particulate material comprising rough mesoporous hollow nanoparticles is described. Another two Australian Provisional Patent applications have also been filed ("Nanoparticle Composition", Application No. PAT-02256-AU-01 and "Detecting an Analyte", Application No. PAT-02252-AU-01).

Professor Yu co-chaired the 8th International Symposium on Nano and Supramolecular Chemistry (8th ISNSC) and Inaugural China-CSIRO-Queensland Workshop on Advanced Materials, which were held in Brisbane during July.

Yu Group

www.aibn.uq.edu.au/michael-yu

ASSOCIATE GROUP LEADERS

Dr Frank Sainsbury
ARC DECRA Fellow

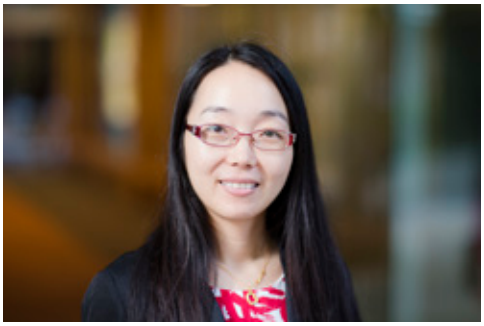
Dr Frank Sainsbury's research uses biomolecular engineering of virus-like particles (VLPs) and peptide-stabilised nano-scale emulsions to create protein-based nanoparticles with sophisticated properties for intracellular protein delivery, designer vaccines and cell-specific targeting of imaging agents.

These advanced applications are underpinned by fundamental research in the molecular self-assembly of VLPs and the interfacial properties of peptide-stabilised emulsions. He is collaborating with researchers at SCMB to determine the high-resolution structure of VLPs and with researchers at ANSTO on the molecular-level characterisation of emulsion surfaces.

Elucidating the assembly pathways and structure-function relationship of protein-based nanoparticles provides the insight and means to design and build functional nanoparticles on first principles.

Dr Sainsbury is an inventor on 5 patents relating to VLP assembly and engineering, and to high-yield protein production in plants. Some of these currently support the manufacture of influenza vaccines in late stage clinical trials.

To date his research has been supported by an Australian Research Council (DECRA), a UQ ECR Grant, UniQuest Pathfinder and Contract Research grants, and the Australian Nuclear Science and Technology Organisation.



Dr Chun-Xia Zhao
ARC Future Fellow

Dr Chun-Xia Zhao's research program is focused on developing novel nanomaterials for drug and vaccine delivery and controlled release, and designing biomimetic chips for faster screening and evaluation of promising nanomedicine candidates.

Nanomedicine has so far failed to live up to high expectations. Two key challenges remain: difficulty in producing nanomaterials with well controlled properties in a reproducible way and lack of reliable and fast platforms to evaluate and optimize the large libraries of nanomaterials with different properties.

"To address these fundamental issues, we have developed facile one-step approaches for the two most widely used nanosystems. We have also invented a novel biomimetic process for making nanocapsules for controlled release and drug delivery." Dr Zhao said.

"Developing *in-vivo* mimicking chips such as tumor-on-a-chip, which allows the fast screening of big libraries of nanomaterials with systematic changed properties in a quicker and cheaper way."

2016 was a productive year for Dr Zhao, leading a group of 14 members working on three ARC projects. Her research excellence was recognized by a 2016 UQ Foundation Research Excellence Award. Additionally, she received a UQ CIEF grant to support building collaborations with industry partners.

Dr Zhongfan Jia
ARC Future Fellow

Dr Zhongfan Jia is working to understand the basic properties of polymers and applying them in areas as broad as biomedicine and energy storage.

"The applications of polymer materials are very broad and can be completely different, but as polymer chemists, our aim is to be able to precisely design and synthesise the polymer materials with desired properties for specific applications" he said.

His work under an existing ARC Future Fellowship also saw him utilising polymers in a project that aims to generate large quantities of undifferentiated stem cells for the first time. He is using polymer nanostructures that are decorated with growth factors to facilitate the generation of stem cells in a 3-D model, providng a new source of stems cells that could be applied in regenerative medicine.

In 2015, he won a UQ Foundation Research Excellence Award to provide one year of funding to develop a battery made entirely of plastic. His work in this area has resulted in an invited review article in 2016 with journal cover art and a research article in 2017 both published in *Polymer Chemistry*. His vision sees a fully completed product where the waste battery could be disposed of into a recycling bin, without the environmental concerns of heavy metals used in current batteries.

Associate Group Leaders

Associate Professor Claudia Vickers
Queensland Government Accelerate Fellow

Associate Professor Claudia Vickers uses synthetic biology to redesign microbial cells for production of industrially useful bio-chemicals.

She focuses on a group of natural organic compounds called terpenoids. This group includes compounds that can be used as biofuels and rubbers, as well as specialty chemicals that can be used to improve crop yield and make industrial fragrances.

"A lot of the products we are looking at are replacements for petrochemicals, to make more sustainable and environmentally friendly chemicals," Associate Professor Vickers said.

Associate Professor Vickers is looking to understand the fundamental biology of how terpenoid metabolic pathways behave, so that she can modify them effectively.

"It's not trivial to try to make cells do something that they haven't spent millions of years evolving to do," she said.

Synthetic biology is the construction of new biological parts and devices, and their application for useful purposes. Associate Professor Vickers uses these new parts to engineer cells to convert cheap feedstocks into valuable products.

She focuses on sucrose from sugarcane as a feedstock because it is a large economic generator locally in Queensland. Converting it into value-added products represents a substantial benefit over selling it as a cheap commodity product.

In further research, Associate Professor Vickers applies systems biology tools to examine the 7,000-year-old bioprocess of beer making. She aims to better understand how each of the three different organisms that go into making beer – barley, hops, and yeast – impact the quality of beer.

Dr Esteban Marcellin
Queensland Government Accelerate Fellow

Dr Esteban Marcellin is investigating new technologies to produce sustainable chemicals through biotechnology. He takes a systematic approach to understanding biological microorganisms at the molecular level. Such an understanding allows him to rewire the organisms' genetic machinery to enable biological manufacturing of chemicals and fuels.

Throughout this year he has focused his effort in understanding acetogens metabolism, a group of organisms capable of utilising C1 gases as feedstock. Through an ARC Linkage Project with Lanzatech, he is working on converting greenhouse gases, which would be otherwise released to the atmosphere, or at best burnt for electricity, into biofuels, biopolymers and chemicals.

In 2016, Dr Marcellin was successful in engineering a Propionibacterium strain for the commercial production of propionate in collaboration with Dow Australia, Dow Brazil and Dow AgroSciences through an ARC Linkage Project. As a result of this project, he has significantly improved the economic viability of propionic acid fermentation process. This provides a clear path to numerous development opportunities.

Finally, in collaboration with Zoetis through another ARC Linkage Grant, Dr Marcellin worked on improving toxin production in pathogenic clostridia. For example, he discovered the tight interconnection between amino acids metabolism and toxin regulation. This research aims at lowering the cost of producing clostridia toxoid vaccines, commonly used in livestock, by decreasing the high level of batch failures and improving toxin production yields.

Further success saw a UQ Development Strategic fellowship awarded to Dr Marcellin for the establishment of a C1 fermentation centre at AIBN.

Dr Yuling Wang
ARC Future Fellow

Dr Yuling Wang's research focuses on the design and synthesis of multifunctional nanostructures (fluorescent clusters and plasmonic nanoparticles) for sensitive biomarker detection by employing an innovative analytical/sensor platform with electrochemistry and surface-enhanced Raman scattering (SERS) as read-out technology.

Since obtaining her PhD in 2009, she has been the recipient of three competitive national and international fellowships including prestigious Alexander von Humboldt (AvH) fellowship in 2010 and German Research Foundation (Deutsche Forschungsgemeinschaft, DFG) individual grant in 2012.

Dr Wang's aim is to improve the speed of point of care diagnosis for cancer by developing an portable handheld SERS machine which can be used at a clinic level removing the need to send patient samples to a pathology lab for testing.

By using SERS to detect breast cancer biomarkers Dr Wang can get a positive or negative result within only 40 minutes.

However these tests are currently only perfomed within a lab setting, and by developing a portable SERS device Dr Wang could enable point of care clinicians to diagnose cancer much faster than current methods.

Associate Professor Kristofer Thurecht
Principal Research Fellow

The development of new nanomaterials that provide insight into the efficacy of nanomedicines is the major focus of Associate Professor Kristofer Thurecht's research.

Holding a joint appointment between AIBN and UQ's Centre for Advanced Imaging, Associate Professor Thurecht is a polymer chemist with a goal of developing new theranostics, which combine the delivery of a therapeutic with the ability to monitor the progression of the disease both before, and after, treatment.

"We want to have an approach where the material we design is able to effectively deliver a therapeutic agent to defined locations in the body, but also assist in monitoring its effectiveness at targeting particular biomarkers and eliciting a controlled response," Associate Professor Thurecht said.

Using animal models of various cancers to test the materials, his work utilises multimodal imaging to monitor the effectiveness of the therapeutic agents in three dimensions; the combination of positron emission tomography (PET), together with magnetic resonance imaging (MRI) and optical imaging are typically employed.

In 2016 Associate Professor Thurecht began working on an ARC Linkage Project with InterK Peptide Therapeutics to develop new delivery approaches for therapeutic peptides.

He has also worked with Professor Stephen Mahler to investigate the potential for improving delivery of novel nanomedicines developed by Samyang. In this research collaboration, Associate Professor Thurecht and coworkers have applied their recently awarded patent using bispecific antibodies for developing targeted therapeutics.

Dr Barbara Rolfe
Senior Research Fellow

Dr Rolfe's research focusses on two main areas: the role of the innate immune system in tumour development and growth, and the application of nanomaterials for diagnostic imaging drug delivery.

With Dr Helga Manthey, Associate Professor Trent Woodruff (School of Biomedical Sciences) and others, she is using small peptide drugs to investigate the role of potent immune mediators, complement proteins C3a and C5a in mouse cancer models. This research has led to the discovery of a previously unidentified role for C3a in promoting tumour growth and has been patented. Ongoing research, funded by an NHMRC Project Grant, is investigating the mechanisms by which C3a promotes tumour growth, and the feasibility of C3a as a therapeutic target for metastatic melanoma.

Collaborations with Professors Andrew Whittaker, Kris Thurecht and others have led to an improved understanding of how the physicochemical properties of nanomaterials determine cellular uptake and biodistribution. This research has investigated the application of novel polymers for MRI imaging of tumours and targeted drug delivery. It has identified mechanisms by which to minimise immune recognition of polymeric nanoparticles, and thus extend the circulation time of these materials for sustained drug delivery. The research highlights the need to ensure the safety and efficacy of nanotherapeutics for clinical applications.

Associate Professor Idriss Blakey
VC's Research and Teaching Fellow

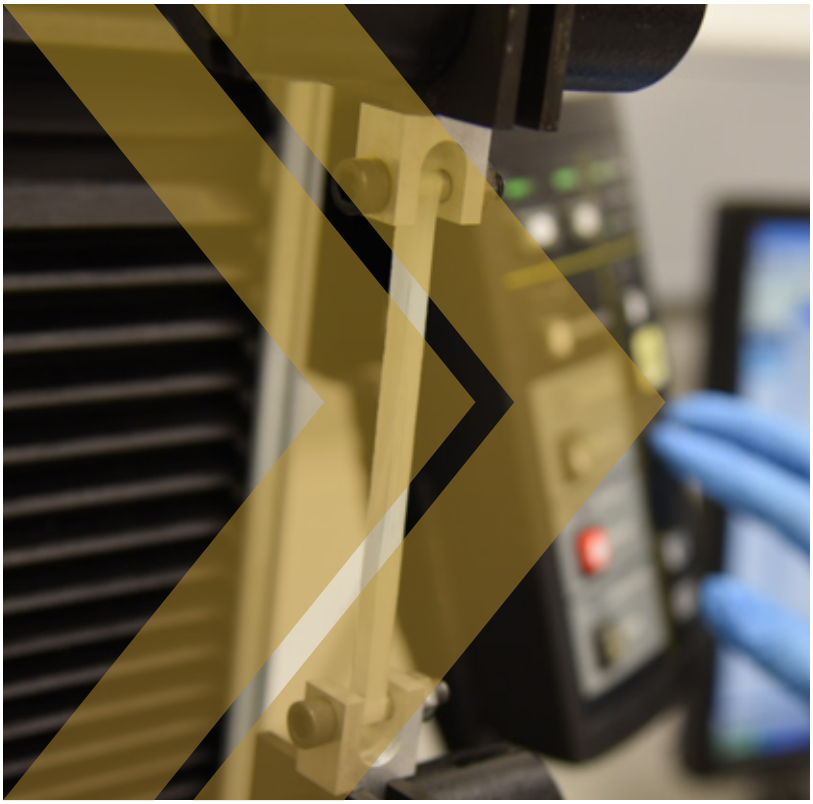
Associate Professor Idriss Blakey's research focuses on understanding how the structure of materials at different length scales relates to their properties. This knowledge allows him to tailor the design of new materials to target properties that result in improved performance for specific applications. He is developing a range novel materials for improving processes used in the fabrication of integrated circuits. This can lead to more powerful and energy efficient computer chips. One patent in this area has recently been granted and three others are in the final stages of examination and are licenced by the Dow Chemical Company. Aspects of this research were also published in Macromolecules this year.

He is also developing materials which are used to detect low levels of chemicals, which is useful for environmental monitoring or detection of disease markers. In collaboration with Associate Professor Caroline Gaus from the National Research Centre for Environmental Toxicology, whose research focusses on detection of ultra-low levels of persistent organic pollutants (POPs). Due to their resistance to environmental degradation, POPs can bioaccumulate which has significant impacts on human health and the environment. This year in a publication in *Environmental Science and Technology Letters* they reported on innovative materials that have a tenfold improvement in performance over the gold standard in the field.

Additional research focusses on optically based chemical sensors. These novel sensors use light to interrogate nanostructured materials to allow selective and sensitive detection of chemicals. These materials have the potential to be used in remote sensing applications such as the waste streams of mining sites or used for the detection of disease metabolites.

Discoveries & Collaborations


3
new provisional patents
2
new centres funded



Spinifex fibres to improve strength and flexibility

Australian native spinifex grass fibres could help make concrete stronger, condoms thinner, and paper more formable for packaging.

Spinifex grass grows in semi-arid regions and covers almost a third of the continent. It has a stretchy nanocellulose composite structure in its cell walls that prevents the cells dessicating and dying in hot weather.

AIBN's Professor Darren Martin has developed a method of breaking spinifex leaves down and extracting these nanoscale fibres using a mild process that retains these unique traits.

"The nanofibres that we extract are long, thin and stretchy - only a few nanometres wide but thousands of nanometres in length," he says.

"As a materials scientist, this is exactly what we look for when we want to reinforce flexible materials."

The spinifex grass used in Professor Martin's research so far has been obtained through a partnership with Aboriginal traditional owners in the Camooweal region in north-west Queensland.

UQ and the Dugalunji Aboriginal Corporation have signed an agreement to recognise the traditional owners' knowledge about spinifex and ensure they have ongoing equity and involvement in commercialisation of the nanocellulose technology.

It is anticipated that this technology will give rise to a new manufacturing industry for the benefit of Camooweal and other regional communities.

Professor Martin and his colleagues are adding the nanofibres to a range of products to improve their strength, toughness and flexibility.

For example, adding just a fraction of a percentage of the nanofibres to water mixed with cement powder yields cement with improved compressive strength. Specimens are being cured in advance of testing to determine whether that also translates into enhanced tensile properties and fracture resistance - the "Achilles heel" of current cement-based products, including concrete.

According to Professor Martin, "when properly incorporated, the nanofibres can act like muscle fibres to allow cement to be bent or stretched".

It could mean less concrete is needed to achieve the equivalent strength, and that concrete infrastructure would last longer. Professor Martin said there was also potential for adding nanofibres to plasterboard to make it lighter and more flexible, meaning less wastage on building sites.
Spinifex nanofibres have also been added to latex to aid in the manufacture of thinner condoms. Commercial trials have been successful in the United States and Asia.

Professor Martin said the nanofibre products had to "tick a lot of boxes before we can scale up and go into commercial production".

Condoms must demonstrate the ability to sustain pressure of at least one kilopascal and have 18 litres of air blown into them before they burst.

"The holy grail is a latex condom of less than 35 microns. When all the ultrathin samples pass the burst test, and the additive is easy to incorporate at tonnage scale, we will be in a very happy place."

Professor Martin said the additive was non-toxic and made latex softer so films were more supple and flexible. This advancement in latex formation is anticipated to significantly improve prophylactic use, which could contribute to a reduction in the transmission of sexually transmitted infections (STIs) like HIV. According to the World Health Organisation, currently more than 1 million STIs are acquired every day.

Another potential application of spinifex derived nanocellulose is the development of a new form of paper that can be stretched like thermoplastic, providing the potential for sustainable, biodegradable paper packaging.

"Our toughest spinifex 'nanopaper' has even better toughness and equivalent formability compared to ABS polymer used to make yoghurt containers and the like. We're pretty excited about that."

Professor Martin is collaborating with scientists at Melbourne's Deakin University to add the nanofibres to polyacrylonitrile used to make carbon fibre, with the potential for countless applications in fields ranging from textiles to aerospace engineering.

"That aspect of our work is at the fundamental basic science level at the moment," he said, noting that there is potential for saving energy by producing carbon fibre at lower temperatures.

UQ's commercialisation company UniQuest has also provided funding through its Pathfinder initiative.

In 2016, the AIBN researchers also continued a collaboration with UQ botanist Professor Susanne Schmidt and commenced a collaboration with Director of UQ's Centre for Nutrition and Food Sciences Professor Mike Gidley to grow spinifex grass at the Gatton campus. They want to determine whether the nanofibres retain their unique qualities when the spinifex is grown away from its natural environment, as this would expand capacity for largescale production.

Centre combines training and research

In 2016, AIBN secured funding and established widespread industry collaborations for a $13 million ARC Training Centre for Biopharmaceutical Innovation.

According to centre director Professor Stephen Mahler, this represents a critical step toward contributing to the ongoing success of the Australian biopharmaceutical industry.

"The Australian biopharmaceutical industry exports products worth $4 billion annually, employs more than 15,000 people, and contributes significantly to Australia's advanced manufacturing capabilities," he said.

The new centre, which will be based within AIBN, will combine cutting-edge biopharmaceutical research with industry-focussed training to ensure graduates are "industry ready".

The centre will be led by AIBN and will benefit from close collaboration with UQ's Institute of Molecular Bioscience, School of Chemistry and Molecular Biosciences and School of Chemical Engineering.

In 2016, the centre was awarded $4.34 million in funding over 5 years from the Australian Research Council's (ARC) Industrial Transformation Training Centres program, which fosters close partnerships between university-based researchers and research end-users. In addition, four major industry partners have collectively committed $5.52 million in cash and in-kind contributions: CSL Ltd, GE Healthcare, the Australian Red Cross Blood Service and Patheon Biologics Australia Pty Ltd.

Andrew Cuthbertson, R&D Director and Chief Scientist at industry partner CSL, said the centre was an ideal way to "progress collaborative projects which are of direct interest to CSL, but early stage and quite innovative and challenging; and to support the next generation of medical researchers and industry-ready scientists in Australia".

Professor Mahler said the centre intends to cultivate a pool of scientific talent that will attract global interest, and will invest significant effort into reaching out to national and international companies and organisations. In this way, the ARC Training Centre for Biopharmaceutical Innovation will develop new networks and foster industry collaborations around the world.

Centre Manager Nancy Eluigwe emphasised that the dual objectives of training and research were of equal significance for the new centre.

Research students will have the opportunity to work closely with centre researchers to develop new biopharmaceuticals and antibody-based reagents, enhanced production methods, and improved manufacturing capabilities.

Specifically, the centre's industry-linked research will focus on three themes:

- Discovering new biopharmaceuticals and diagnostic agents
- Developing mammalian cells as factories for recombinant protein production
- Manufacturing biopharmaceuticals

The first theme focuses on using innovative methodologies to discover therapeutic and diagnostic monoclonal antibodies (mAbs). Researchers will also develop platform technologies for mAb delivery to intracellular targets.

Research within the second theme seeks to understand current limitations in the production of therapeutic proteins and aims to overcome those hurdles by identifying and modifying cellular pathways, engineering therapeutic proteins for improved expression, and improving the manufacturing process.

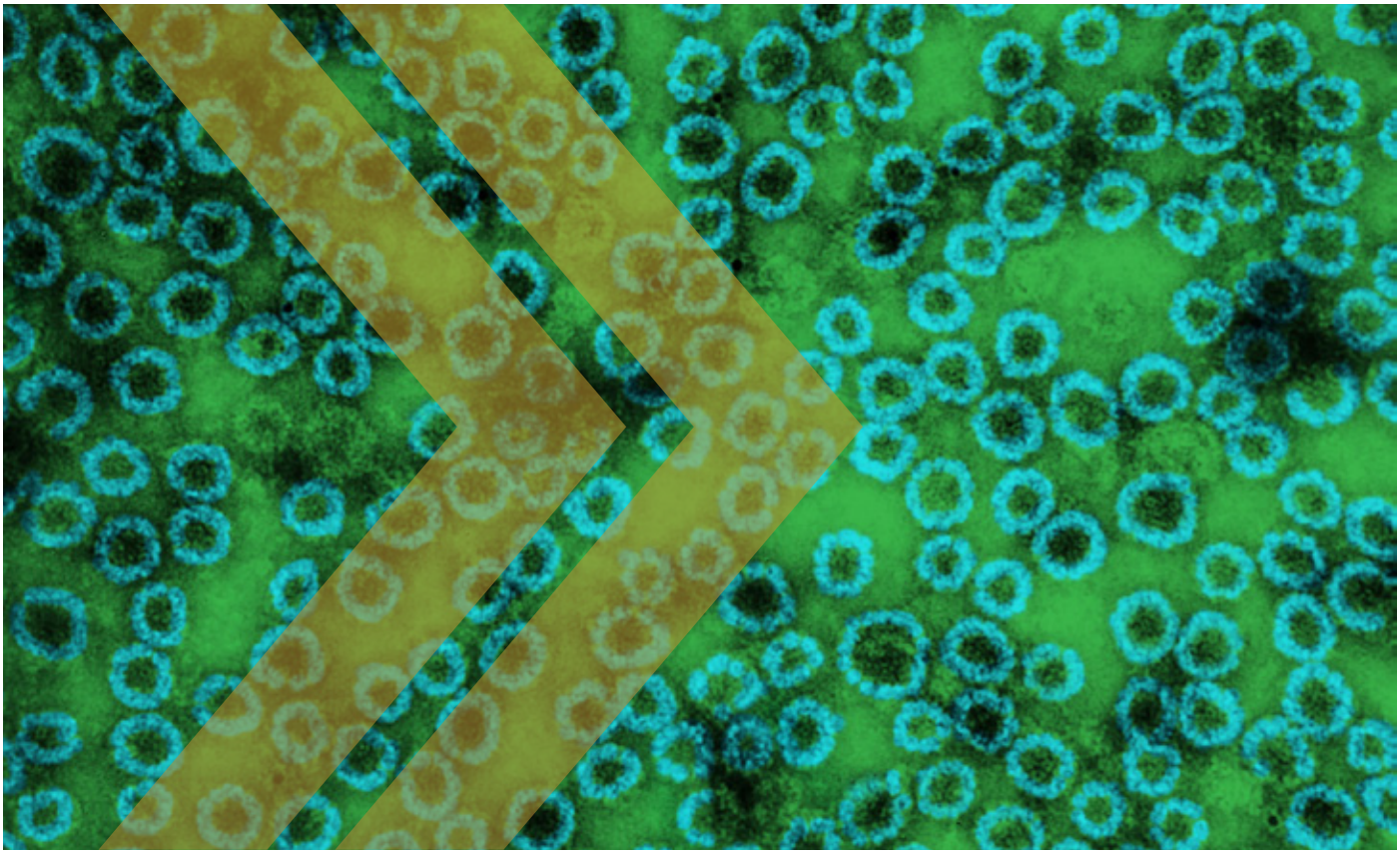
The third theme relates to improving industrial processes in order to provide gains in product yield and quality for new biologic medicines. Research projects within this theme will also identify ways to overcome the costs of large-scale cell culture and downstream processing.

The funding will support 13 PhD students and five early career researchers (postdoctoral scientists) working across 13 research projects within these themes. During the course of their degree, the research students will spend at least 12 months working directly with an industry partner. They will also receive entrepreneurship training so that graduates will have the business skills required to succeed in the global biopharmaceutical industry.

By training scientists to excel at R&D within a commercial context, the centre will provide opportunities to significantly expand the Australian biopharmaceutical industry.

Moreover, by aligning research excellence with industry growth, the new centre will provide options for better health outcomes by translating research into cutting-edge, affordable biopharmaceuticals and diagnostics.

In these ways, the centre will expected to provide significant economic and healthcare benefits for Australia.



Manufacturer to trial rotavirus vaccine candidate

Researchers at AIBN have developed a new, highly stable vaccine candidate for rotavirus. They are now collaborating with an Indian pharmaceutical manufacturer that will soon launch animal trials of the new vaccine.

The World Health Organisation has estimated rotavirus causes more than 200,000 deaths annually in children aged under five. About 85 per cent of these deaths occur in resource-poor countries.
While a vaccine for rotavirus exists, and is commonly used to vaccinate Australian children, it is too expensive for resource-poor nations, where the virus is more prevalent.

Moreover, the current vaccine's side effects include vomiting and diarrhea, which can be more debilitating for children living in nations with less-developed health and sanitation systems.

Vaccine stability presents another critical issue. The current 'live-attenuated' vaccine must be refrigerated, making transport to remote regions extremely difficult.

To address these problems, AIBN's Associate Professor Linda Lua and Professor Anton Middelberg designed a virus-like particle (VLP) that mimics the real rotavirus pathogen.

VLPs mimic the external structures of a virus, but are more stable and non-infectious. They are able to generate an immune response by tricking the body into seeing a pathogen where none is present – training it to fight a real rotavirus infection.

In order to make an effective VLP, it's important to get the proteins to assemble with the right architectural structure. To do this, the AIBN research team developed a unique bioengineering approach that enables VLPs to assemble in just the right way to be effective. Moreover, their method uses bacteria to make the protein components of the VLPs, enabling high volumes to be made.

"We use an E coli bacteria cell factory to produce the proteins, extract the proteins and assemble them into VLPs outside the bacteria," said Associate Professor Lua. "This way we can make them quickly and cheaply."

It's an efficient and powerful approach for low-cost production. Associate Professor Lua also explained that because the VLPs are essentially proteins and non-infectious, they have a much lower risk of potential side effects.

The VLP platform may also eliminate the need for an adjuvant, which is normally needed to enhance the body's immune response to a vaccine, but can add to the complexity and cost of vaccine production.

"Our vaccine candidate has been estimated to cost less than 10 cents a dose to produce, which greatly reduces the accessibility barrier," Associate Professor Lua said.

She hopes to see results from the Indian pharmaceutical company's trials in 2017.

In addition to its use in rotavirus prevention, the VLP platform can be modified to present antigens from a range of other pathogens, including influenza viruses.

Currently influenza vaccines take six to nine months to be manufactured in large enough volumes to yield a public health benefit. Such lag times make it precariously difficult to respond to major changes in seasonal flu strains or to the sudden appearance of a new, pandemic form of influenza.

The speed with which the UQ VLP platform can be developed means large volumes of a new vaccine can be produced within weeks, and could therefore provide the answer to swift vaccination responses.

The rotavirus study was published online in August 2016 in the journal *Biotechnology and Bioengineering.*

UQ-StemCARE

The time span from birth to death is increasing. But, perhaps surprisingly, scientists don't know a lot about how the ageing process works.

In a bid to change that, UQ and AIBN launched a $7.5 million regenerative medicine research centre in 2016 to keep older Australians healthier and more active and thus increase their participation and productivity.

AIBN Director, Professor Alan Rowan, said the UQ Centre in Stem Cell Ageing and Regenerative Engineering (UQ-StemCARE) aimed to understand the ageing process.

"How do cells grow and change as we age? We don't know exactly what processes are going on. Your cells change depending on your basic genetics, whether you exercise or not, what you eat, if you smoke or drink," he said.

"Theory suggests cells have the capacity to live 120 years but, gradually, they stop repairing themselves. The repair process slows down; we have a shelf life. What determines the shelf life and how can we study that? We want to see what changes as a function of the environment."

UQ-StemCARE is combining researchers from across Australia to develop innovative, multidisciplinary research programs and train a new generation of early career researchers to tackle the challenges of demographic change and an ageing society.

It focuses on unravelling key cellular and molecular mechanisms of stem cell ageing and investigates engineering clinical solutions in regenerative medicine for prolonging the human health span.

Professor Rowan's goal is to see UQ-StemCARE develop into an internationally renowned centre.

Eventual clinical translation could allow tissue function to be maintained and possibly restored with declining cell functions reversed. "It's about healthy ageing," he said.

"The population is getting older and the decrease in productivity, coupled with increasing health costs, will be a significant societal problem if solutions are not found."

Professor Rowan says cells contain "incredibly complex interacting, cascading relationships.

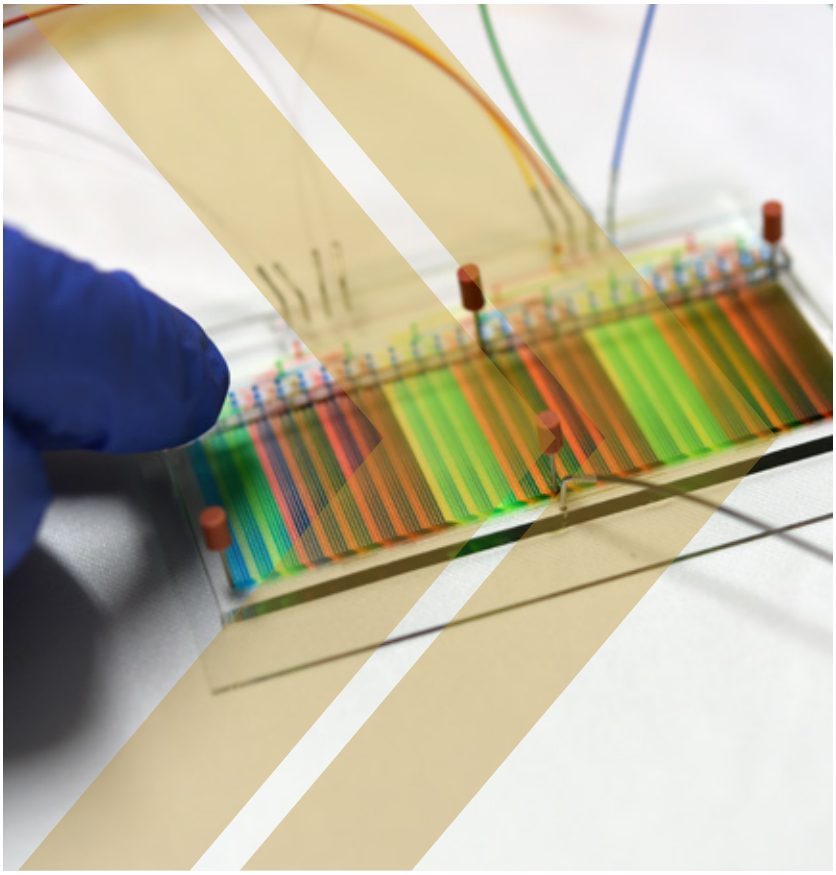
"They're almost like roads that interconnect in a big dynamic environment. Now we can look more closely at what changes in cells so we can identify where there are traffic lights. Why is there more of this car or that bus than another one?"

CRISPR gives researchers the ability to "cut and paste pieces of the genome. It's like a jigsaw puzzle. Get the bigger picture then take things in and out and see how it all fits. Once we find the processes that are going wrong, and what causes them, then we can look for solutions."

Professor Rowan says the social impact of populations living longer is the biggest problem. "What happens if everyone lives 15 years longer? Governments will play a greater role in our health" because of the economic cost of caring for elderly people who are ill.

The centre will study how stem cells impact on age-related musculoskeletal conditions, such as muscle wasting, osteoporosis and osteoarthritis; vascular diseases, such as arteriosclerosis and atherosclerosis; and neural diseases, such as Alzheimer's, Parkinson's and dementia.

The centre, co-directed by AIBN Professors Rowan, Ernst Wolvetang and Justin Cooper-White, was officially launched in October 2016 by Queensland Premier Annastasia Palaszczuk.



Start-up makes quick work of cellular experiments

US-based start-up Scaled Biolabs Inc is commercialising an AIBN-developed credit card-sized device that enables cells to be cultured under thousands of different conditions simultaneously.

The high-density microbioreactor array enables rapid screening and determination of the best conditions for growth and differentiation of induced human pluripotent stem cells (iPSCs) into diverse cell types.

Scaled Biolabs Inc co-founder and Chief Scientific Officer Professor Justin Cooper-White said the technology significantly reduced product development cycles for cellular therapies and biotherapeutics.

"Our devices can scan a set of test conditions at least 10 times faster than a manual process, using fewer reagents, and provide greater insight into the interactions occurring in complex biological systems," he said.

"This technology platform will help unlock the full potential of next-generation therapeutics, particularly cell, biologic, and gene therapies."

Like an electronic chip using resistors to control the flow of electronic signals, the microfluidic chip controls the flow of reagents.

The high-density microbioreactor array has 8,100 culture chambers, ranging in volume from 20 to 200 nanolitres. "It enables us to run 8,100 experiments simultaneously, which would take three to six months using standard experimental protocols," Professor Cooper-White said.

"It has enabled us to optimise media formulations for a range of iPSC differentiation outcomes, including cardiac, bone, kidney and muscle, and we're applying it to a multitude of other differentiation end points."

The disposable device has been validated at laboratories in University College London and Singapore's Agency for Science, Technology and Research.

The microbioreactor array has substantial economic benefits. "In bioprocess development for cell therapies, one of the biggest costs is cell culture media. This device can cut that cost, which enhances the biological outcome substantially," Professor Cooper-White said.

"Rather than doing one test at a time, we can survey thousands of different environments and rapidly understand how cells respond to drug agents. We have shown that the high-density microbioreactor array can rapidly zero in on optimum conditions for cell expansion or differentiation, with savings of 10 to 500 fold."

Each experimental condition is run many times in parallel, providing confidence in the results.

Professor Cooper-White said Scaled Biolabs was established in San Francisco, California, because US investors were "more energetic about biotech start-ups". The market is also much larger than in Australia.

Scaled Biolabs has received $US250,000 from biotech accelerator IndieBio and is seeking an additional $US2 million to grow staff numbers and invest in infrastructure to "build the platform to allow us to get our devices into customers' laboratories".

There are two potential feed investors and many keen to be involved as follow-on investors.

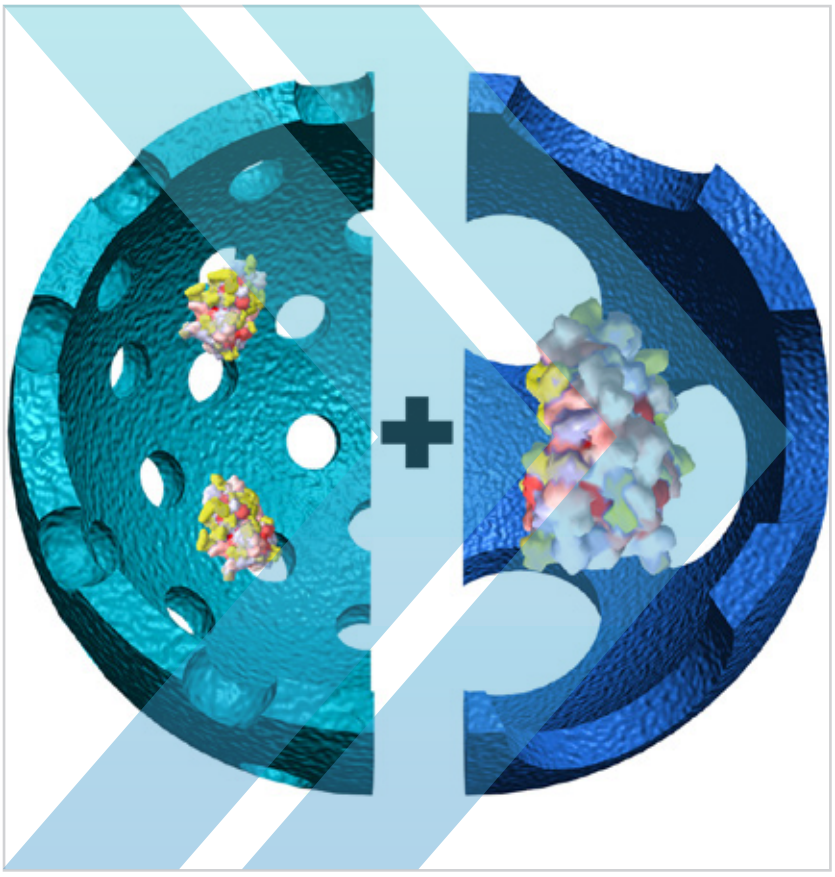
Scaled Biolabs already has service contracts in the US and Europe generating $US150,000 over several months.

Professor Cooper-White said the device's development grew out of the need for "parallelised experimentation" to "turbocharge R&D for cell therapies".

Once the unique device was developed, the team realised there was a substantial market across academic and industrial R&D labs.

Professor Cooper-White said the technology was being adapted for immunology, cancer therapeutics, and antibody and protein production for biopharmaceuticals. "It has lots of potential."

Scaled Biolabs' other two co-founders are both UQ graduates. CEO Dr Drew Titmarsh is an AIBN PhD graduate and Chief Technology Officer Dr Brendan Griffen is a Physics PhD graduate.



Nanocarriers may be alternative to animal antibiotics

A nature-inspired concept adapted to designing nanocarriers for drug delivery could provide an alternative to antibiotics in animal feed.

The overuse of antibiotics is leading to a rise in antibiotic-resistant pathogens, and presents a major threat to public health.

The high level of antibiotic use in the agricultural sector is a known contributor to this problem, due to the addition of antibiotics to livestock feed. Finding safer alternatives to reducing infection rates in lifestock therefore presents an opportunity to reduce agricultural dependence on antibiotics, which could minimise the threat of multi-drug resistant 'superbugs'.

"We should avoid synthetic antibiotics in animal feed, but still need a way to fight infection, so we need an alternative approach," said AIBN researcher Professor Chengzhong (Michael) Yu.

According to Professor Yu, a protein called lysozyme has extremely good antimicrobial properties because of its ability to break down the sugars in the cell walls of bacteria. Unfortunately, lysozyme doesn't work well on most "Gram-negative" bacterial strains, like Escherichia coli (E coli), because it doesn't stick to those bacteria long enough to do its job. Moreover, lysozyme is not very stable, which also limits its use as an antimicrobial drug.

But now, Professor Yu is developing a way to make lysozyme both sticky and stable. Their innovation was inspired by observing how pollen grains stick to the legs of insects. If you look closer, at the microscopic level, you can see that pollen grains have a very spiky surface topology.

"This gives them intriguing surface adhesive properties," he said.

Inspired by this natural design, Professor Yu and his colleagues have developed silica nanopollens that demonstrate enhanced adhesion to bacterial surfaces. Moreover, these nanopollens can be loaded with lysozyme. The lysozyme-loaded nanoparticles are able to maintain strong adhesion to bacterial cell walls, which enables efficient delivery of lysozyme to digest the bacterial cell wall.

Tests directly on bacteria as well as tests on infected animal tissue show that the lysozyme-loaded nanopollen are effective antibacterial agents.

According to Professor Yu, "they exhibit a sustained release profile and potent antimicrobial activity towards E coli, achieving total bacterial inhibition in three days".

In other words, once lysozyme is given the chance to adhere to cell walls, its antibacterial performance significantly increases. This research was published in the *Journal of the American Chemical Society* in May 2016.

He is now working with a corporate partner to introduce the nanopollen-encapsulated enzyme to livestock feed. The collaborative research is examining strategies to load the lysozyme nanoparticles into the raw mixture used to create animal feed, or possibly spray them onto pre-formed feed pellets.

Meanwhile, the research team is looking for ways to increase lysozyme's thermo-stability. A more stable version of the enzyme will facilitate the process of loading the lysozyme onto the nanopollens, and will also improve its long term activity.

With some countries considering bans on synthetic antibiotics in animal feed, yet still wanting to ensure the health and welfare of livestock, Professor Yu's nanopollen technology could facilitate an international shift away from antibiotic overuse in agriculture.

Blocked protein inhibits cancer growth

Queensland researchers have discovered that blocking a protein that is part of the body's immune system can inhibit cancer growth.

In 2016 AIBN's Dr Barbara Rolfe, with fellow researcher Dr Helga Manthey and PhD student Jamileh Nabizadeh, published their discovery that C3a receptor-deficient mice produced more immune cells to fight cancer.

Dr Rolfe said cancer cells could sabotage natural mechanisms designed to protect the body, then use them against us. The immune system is designed to protect against infection, she explained, "But tumours subvert part of the immune system for their own benefit."

Tumours commandeer certain immune cells to help drive cancer growth, form new blood vessels to access nutrients, invade healthy tissue and to assist in the spread of the cancer throughout the body. Meanwhile, tumour cells are also able to hide from parts of the immune system that would otherwise wipe them out.

C3a is a protein produced during the innate immune response, and is part of the first line of defence against pathogens, such as bacteria and viruses. C3a has been detected in tumours from a wide range of cancers, but it was unclear whether it was fighting tumours or helping them.

To find out, Dr Rolfe and her colleagues used a drug to block the interaction between C3a and its receptor in a mouse model of melanoma. With C3a now effectively inactive, they saw an increase in the generation of anti-cancer immune cells (neutrophils and T-cells). At the same time, the number of pro-tumour macrophages (TAMs) diminished. The combined effect of these changes was a four-fold reduction in tumour growth.

Dr Rolfe said this is the first time inhibiting the C3a-receptor interaction has been shown to have an anti-tumour effect.

She also explained that blocking the C3a receptor may have similar effects in cancers other than melanoma. They have already replicated the results in colon and breast cancers.

The research, conducted with Associate Professor Trent Woodruff and now-retired Professor Steve Taylor from UQ School of Biomedical Sciences, as well as Dr Glen Boyle from QIMR Berghofer Medical Research Institute, was published in the June 2016 issue of the *Journal of Immunology*.

The human immune system is similar to that of mice and the researchers hope the results will translate to humans.

The next stage involves developing monoclonal antibodies that can directly block the C3a receptor, as current inhibitors are useful for research but aren't suitable for clinical use.

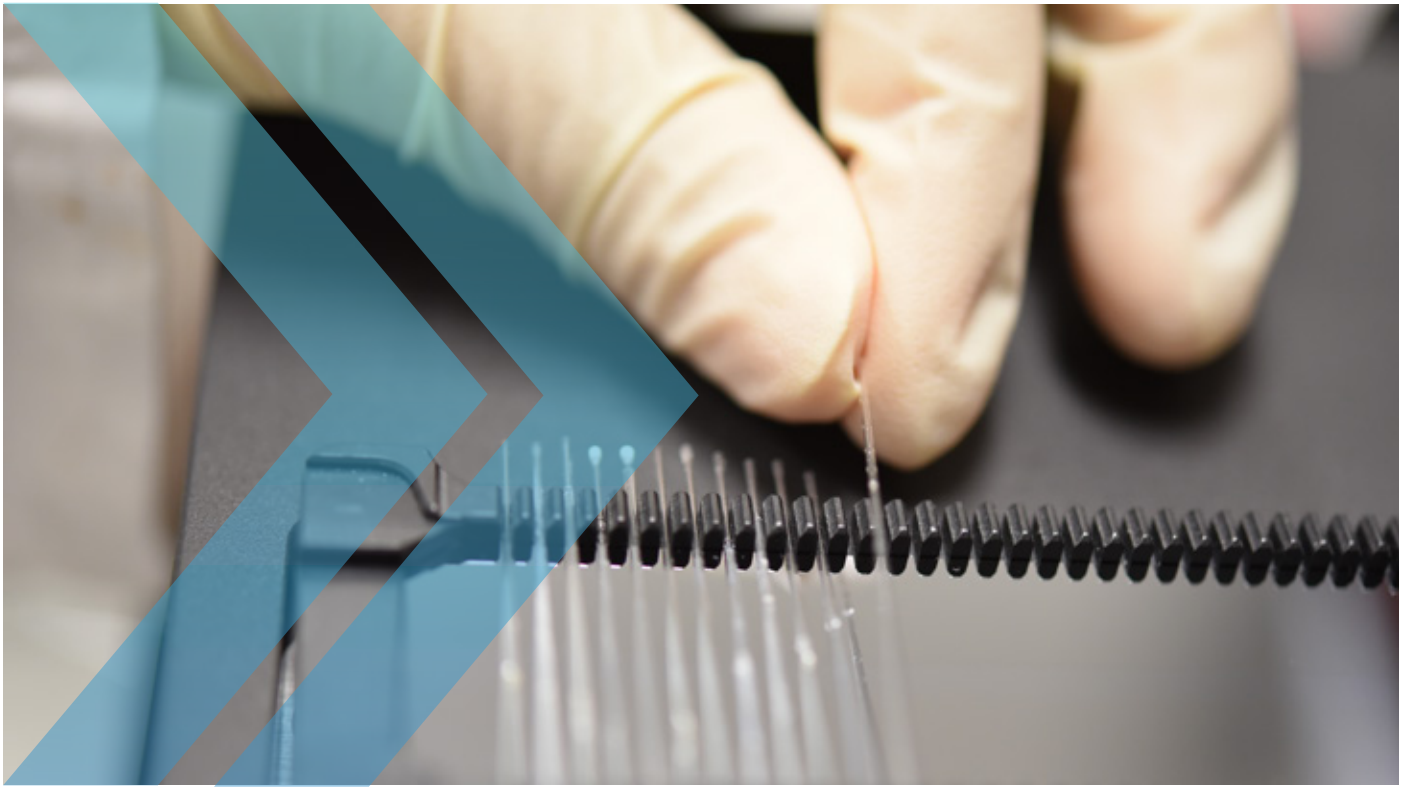
Dr Rolfe points out that just blocking the C3a receptor alone may not be enough to eliminate cancer because research has shown cancers have the ability to mask their presence from the immune system. Moreover they can rapidly develop drug resistance.

Nevertheless, a new antibody that targets the C3a receptor could prove a valuable addition to a multi-pronged therapeutic approach that also includes surgery, radiotherapy, chemotherapy, and immunotherapy drugs.

Dr Rolfe said that it may even improve the power of existing anti-cancer treatments.

"We may be able to stimulate the immune response so tumour cells can better respond to other anti-cancer drugs."

The research is funded by grants from the Queensland Cancer Council, the National Health and Medical Research Council, and the UQ Collaboration and Industry Engagement Fund.



Zika protein enables easier diagnosis

AIBN is developing a synthetic Zika virus protein to help Queensland Health more easily detect the disease.

UQ's Protein Expression Facility (PEF) is working with Queensland Health's Forensic and Scientific Services (FSS) to develop the Zika protein to enable a faster, safer and cheaper blood test for the virus.

Zika is closely related to dengue and is transmitted to humans primarily through the bite of infected *Aedes* species mosquitoes. *Aedes aegypti* mosquitoes are commonly found in tropical and sub-tropical regions, including Queensland.

Significant outbreaks of the virus have been recorded in the Americas, Africa, Asia and the Pacific. Queensland's high tourist numbers mean travellers could inadvertently bring the virus into the country after being infected overseas.

While many people infected with Zika will only experience mild symptoms for several days, infection during pregnancy is linked with a range of serious birth-defects, including congenital abnormalities like microcephaly.

There is currently no vaccine for Zika. Consequently, reducing the prevalence of the disease relies on close surveillance of infection rates in order to monitor outbreaks, guide clinical management, and inform insect control and quarantine responses.

PEF Director Associate Professor Linda Lua said Queensland Health's FSS is at the front line in managing emerging diseases. Underpinning this is the ability to run rapid diagnostics in response to outbreaks. Their capacity to do so, in turn, relies on quick access to the right reagents.

Current laboratory diagnosis of Zika is done by collecting blood samples from patients and then testing those samples for antibodies specific to the virus. FSS requires large quantities of viral proteins from the Zika virus, which bind to those antibodies and enables their detection.

In order to prepare enough of the protein for diagnosis, large volumes of the virus itself must be grown, then broken down so the viral protein can be extracted. This is not only time consuming, it's potentially hazardous.

Associate Professor Lua said there is always risk in working with infectious agents and not all laboratories were equipped to do that because it required high-level biocontainment.

Fortunately, she and her colleagues are providing a safer alternative.

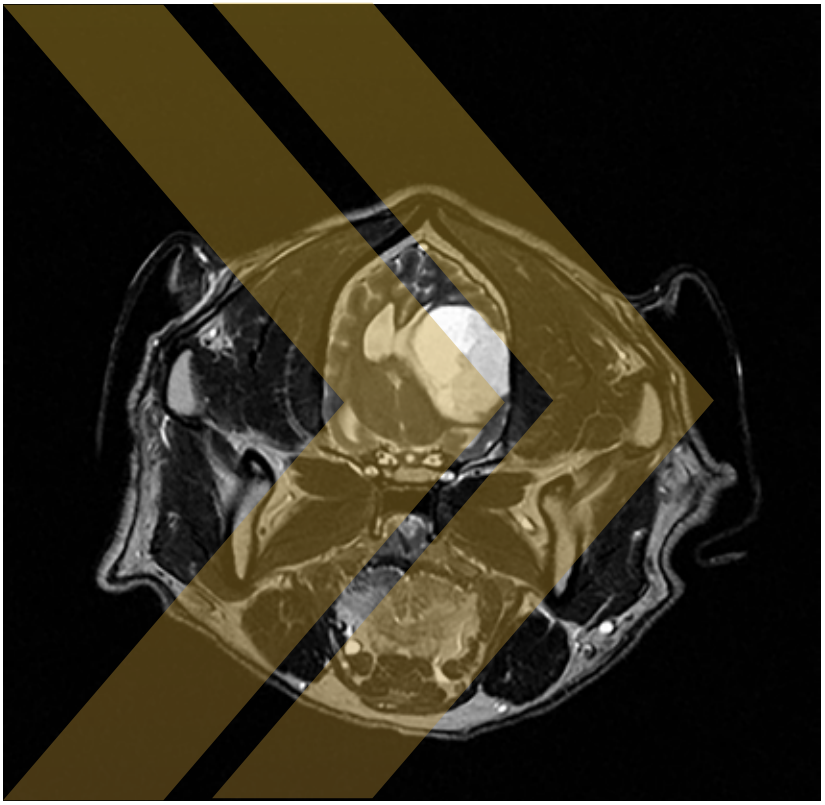
"Our role is to rapidly produce a synthetic version of the protein, in large quantities and with high quality, for FSS to further develop the diagnostic test," she said.

The synthetic protein also enables faster testing. Because symptoms of Zika are so mild, testing may not be conducted very early in the infection. Consequently, it's critical that the testing process does not contribute to further delays in diagnosis.

Associate Professor Lua said there is also the potential to use the synthetic protein to help develop treatments for Zika.

"If they produce monoclonal antibodies against the synthetic protein, they can then use those monoclonal antibodies as a therapeutic," she said.

PEF, established in 2004, supports a range of organisations by providing quality proteins and has gained a reputation for flexibility and rapid response. "PEF is the only facility with all expression systems to allow us to produce diverse proteins," Associate Professor Lua said. In 2016 PEF won the UQ Award for Excellence in Service in recoginition for the outstanding and significant contribution to delivering excellence in service to UQ.



Pet dogs aid in potential cancer cure

Pet dogs with brain cancer could help AIBN scientists cure the same disease in humans.

AIBN's Dr Simon Puttick has been working for many years on developing new diagnostic methods and treatments for glioma, one of the most aggressive forms of brain cancer.

Primary brain tumours account for 1-2 % of all diagnosed cancer in Australian adults and 9 % of all cancers in Australians under the age of 24. Glioma is the most prevalent and aggressive primary brain tumour and has a very poor prognosis.

The current clinically accepted treatment involves surgical removal followed by a combination of radiotherapy and chemotherapy. Despite many advances in surgical techniques and follow-up therapies, the median survival rate has only increased from 7 months to just 14 months in the past four decades.

A major contributing factor is that many preclinical models of glioma do not adequately mirror the disease in humans, so promising results at the preclinical level are failing when translated to clinical trials.

In a joint project between AIBN, CSIRO and the QIMR Berghofer Medical Research Institute, Dr Puttick has started to work in the field of comparative oncology, the study of cancer in companion animals.

"We've begun collaborating with vets because dogs also get brain tumours." he said.

Brachycephalic dog breeds – which have short noses and flat faces – are predisposed to brain cancer. The incidence rate is similar to humans and the cancer is pathologically and genetically similar.

This presents an opportunity to treat dogs with brain cancer with the novel therapies developed at AIBN.

"In 2016 we initiated the collaboration with veterinary centres around Australia. We now have four referring specialist centres who will refer dogs with brain tumours to our trial," said Dr Puttick.

When vets identify signs of neurological disease in dogs, the project funds an MRI to confirm the diagnosis and then offers the dog's owner the opportunity to enrol in a clinical trial.

Dr Puttick and his collaborators will be investigating the efficacy of theranostic antibodies. These antibodies can be labelled with positron emitting atoms that facilitate diagnostic brain imaging, or can be labelled with beta emitting atoms, which have a therapeutic effect. Enrolled dogs will receive a PET scan, and the data from this scan will then be used to calculate a personalised dose regime for each dog using the therapeutic form of the antibody.

If the owner elects surgery or euthanasia instead, AIBN requests tissue samples to develop a "brain cancer bank" so researchers can grow the cells and refine the drugs.

"We've reengineered the theranostics to help treat dogs and humans," said Dr Puttick. He attributes this success to a close collaboration with fellow AIBN researcher, Professor Steve Mahler and his group.

In a parallel project, Dr Puttick also wants to improve the likelihood that the theranostics reach their intended target by manipulating the blood-brain-tumour barrier.

To achieve this, Dr Puttick is collaborating with CSIRO to see if it's possible to temporarily disrupt the blood brain barrier to allow therapeutics to reach the tumours.

The research uses focused ultrasound (FUS), combined with MRI technology, to direct an ultrasound field to target the specific region of the brain where the tumour resides.

"FUS can open the blood-brain-tumour barrier so targeted theranostics can cross it, but only in the area of the tumour, having no effect on the healthy brain," Dr Puttick said.

Furthermore, when patients undergo surgery, drugs could be implanted into the resection cavity in an ultrasound-sensitive, drug-loaded gel to deliver a burst of drugs when provoked by a FUS pulse. The gel is benign unless triggered by FUS.

Over the next 12 months, the research team aims to incorporate FUS into canine clinical trials to test combinations of the theranostics and FUS-activated drug delivery systems.

Dr Puttick is hopeful comparative oncology with dogs will lead to better drugs and cost-effective techniques to improve the prognosis of people with glioma.

Nanopatch delivers polio vaccine

Needle-free Nanopatch technology developed at the AIBN has been used to successfully deliver an inactivated poliovirus vaccine.

The AIBN research team, led by Professor Mark Kendall, collaborated with the World Health Organisation (WHO), the US Centres for Disease Control and Prevention, and the vaccine technology company Vaxxas. They published their new findings in the journal *Scientific Reports* in February 2016.

Although there is no cure for polio, there is potential for the disease to be fully eradicated.

According to WHO, polio cases have decreased by over 99% in the last few decades thanks to the oral polio vaccine. Fewer than 40 cases were reported in 2016. Today only a handful of countries have never stopped transmission of polio: primarily Afghanistan, Pakistan and Nigeria. Most recently the disease has re-emerged in Syria. The high level of conflict in these areas contributes the local persistence of polio because transport and administration of the existing vaccine are very difficult.

As long as a single case of polio infection remains, all countries risk an outbreak in their unimmunized populations. WHO predicts that an international resurgence could lead to as many as 200,000 cases a year within a decade. The Nanopatch, invented by AIBN's Professor Mark Kendall, has the potential to assist in the eradication of polio from such difficult to access areas.

The device is a one square centremetre silicone patch with thousands of small projections. The vaccine is coated onto these miniature spikes, which can then painlessly deliver the vaccine to the immune cells in the skin's outer layers. Moreover, the nanopatch does not require constant refrigeration, making it easier to transport over long distances.

In their 2016 publication, the researchers describe using the Nanopatch to administer an inactivated Type 2 poliovirus vaccine in a rat model.

"We compared the Nanopatch to the traditional needle and syringe, and found that there is about a 40-fold improvement in delivered dose-sparing," Professor Kendall said.

"This means about 40 times less polio vaccine was needed in Nanopatch delivery to generate a functional immune response as the needle and syringe.

"To our knowledge, this is the highest level of dose-sparing observed for an inactivated polio vaccine in rats achieved by any type of delivery technology, so this is a key breakthrough."

Dr David Muller, first author of the research paper said the work demonstrated a key advantage of the Nanopatch.

"The Nanopatch targets the abundant immune cell populations in the skin's outer layers; rather than muscle, resulting in a more efficient vaccine delivery system," he said.

Clinical success and widespread use of the Nanopatch against polio could help in the current eradication campaign. It could be produced and distributed at a cheaper cost, and its ease of use would make it suitable for house-to-house vaccination efforts in endemic areas with only minimal training required.

According to WHO Global Polio Eradication Initiative Director Mr Michel Zaffran, "Needle-free microneedle patches such as the Nanopatch offer great promise for reaching more children with polio vaccine as well as other antigens such as measles vaccine, particularly in hard-to-reach areas or areas with inadequate healthcare infrastructure."

Nanopatch technology is being commercialised by Vaxxas Pty Ltd, which has scaled the Nanopatch from use in small models to prototypes for human use.

Vaxxas CEO Mr David Hoey said the first human vaccination studies are scheduled to commence soon.

Members of the AIBN research team include Professor Kendall, Dr Muller, Dr Germain Fernando, Mr Nick Owens and Ms Christiana Agyei-Yeboah.

The work was funded by the World Health Organisation, Vaxxas, Rotary District 9630 and the Rotary Foundation.

The development of the Nanopatch is an example of research at AIBN leading to translatable outcomes for the improvement of society.

AIBN's key role in biorefineries

AIBN is likely to play a key role in the Queensland Government's Biofutures Acceleration Program, which aims to establish a $1 billion sustainable, export-oriented industrial biotechnology and bioproducts sector.

The government called for expressions of interest, which closed in January 2017, to enable suitable companies to outline potential government support required to develop one or more commercial-scale biorefineries in Queensland.

No announcements have been made about potential partners but, in December, the Queensland Government and US-based biotechnology company Amyris Inc announced a partnership to create a hub for producing sustainable ingredients for Asia's rapidly growing personal care sector.

AIBN is on the front foot because, in June 2016, it signed a memorandum of understanding (MoU) with Amyris to support development of a Queensland biotechnology industry using feedstock from sugarcane.

AIBN's Professor Lars Nielsen said the MoU enabled AIBN researchers to use Amyris's automated strain engineering (ASE) platform. This robotic system significantly speeds the process of developing organic compounds that can be used as sustainable alternatives to petrochemicals in products ranging from cosmetics to biofuels.

The platform uses yeast as a catalyst to convert plant sugars into hydrocarbon molecules to develop products like squalene, a component of moisturisers and other cosmetics. It was originally obtained from shark oil and plants, but yeast cells can now be genetically engineered to produce commercial quantities of synthetic squalene.

Professor Nielsen said there was potential for a wide range of compounds currently extracted from plants. "It can be cheaper with biological synthesis in yeast and the products are valued as being natural," he said.

AIBN will work with Amyris to characterise and optimise the strains to increase their yield and "debottleneck" the production system.

The AIBN-Amyris collaboration will identify target products of regional interest, develop the production technology and scale up production, working with Queensland's sugar industry.

"Cane juice is an ideal feedstock for biorefineries, combining good value, high purity and excellent greenhouse gas abatement potential," Professor Nielsen said.

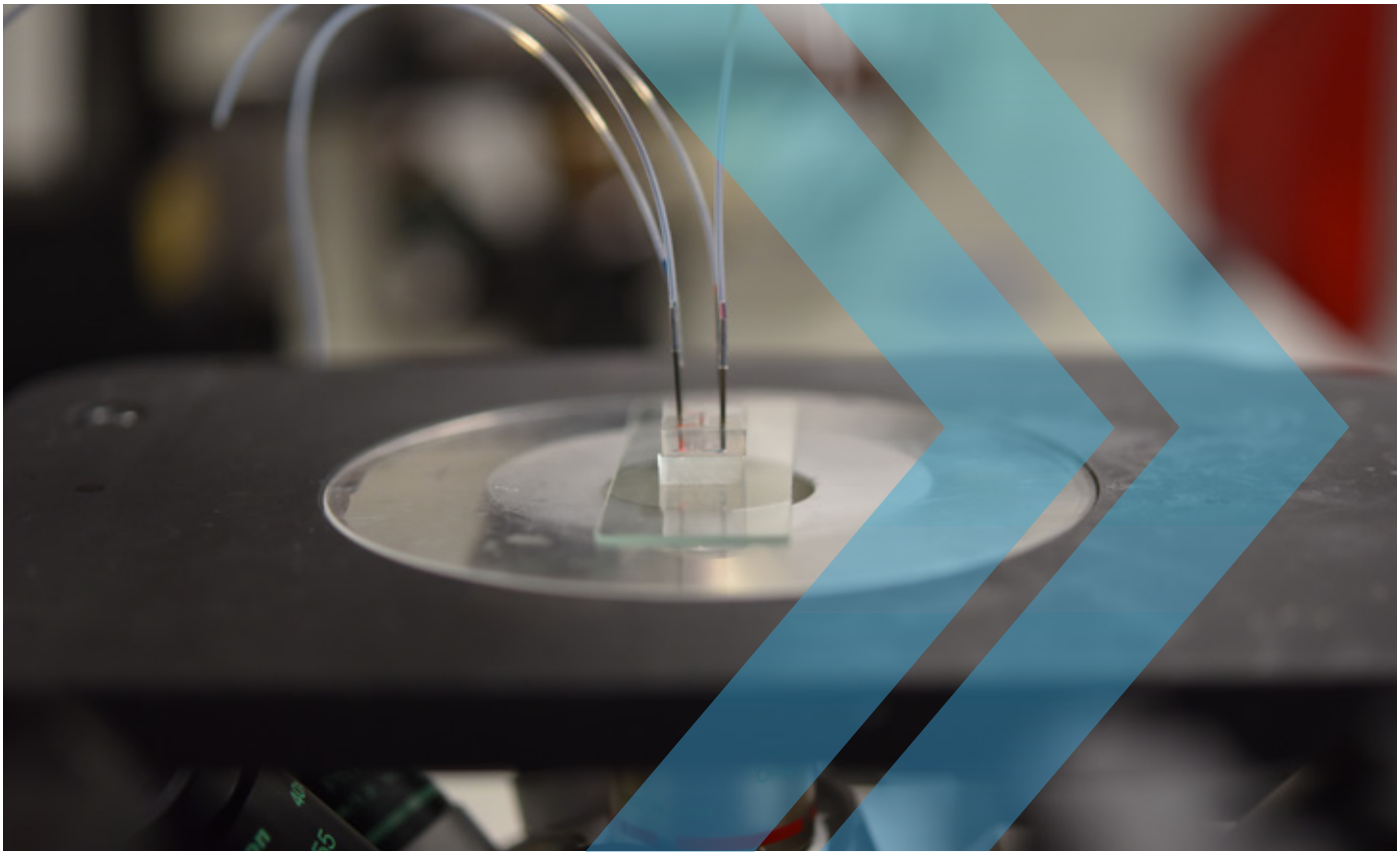
Queensland was attractive to Amyris because it offered a diversified source of raw material and was close to Asian markets.

Professor Nielsen said the company was impressed with the quality of AIBN research and the MoU revived a former collaboration with Amyris on the Queensland Government's 2010 Sustainable Aviation Fuel Initiative, which studied the feasibility of using sugar to produce aviation biofuels.

While biofuels from sugarcane are not currently economically viable, many other products are. For example, Amyris is renowned for developing artemisinic acid-generating yeast strains that can replace a plant-derived compound to produce an anti-malarial drug.

Professor Nielsen says "the space is very big" for potential nutraceuticals, fragrances, vitamins and cosmetics that would previously have been developed from plant extracts, which is expensive.

AIBN is working with CSIRO on synthetic biology initiatives that use Amyris's California-based ASE. Professor Nielsen is confident the facility could be replicated in Brisbane "once we get the demand".



Tumour on a chip advances personalised medicine

Testing potential new anti-cancer drugs is expensive and time-consuming but an AIBN researcher is developing a test that's quicker, simpler and more accurate.

Current drug development requires in vitro cell experiments before graduating to tests in mice and larger animals and eventually human clinical trials. As such, the particular methods used in those early stage experiments have a major influence on which drugs progress to clinical trials.

AIBN researcher Dr Chun-Xia Zhao explains that the current approach of testing drugs on a two-dimensional layer of tumour cells in a petrie dish is not a good way to see how a tumour will really react to a potential therapeutic.

"A petri dish is a static mono-layer environment, which gives potential therapeutic agents more time and greater opportunity to combat tumour cells. This is quite different from the three-dimensional tumour structures in the human body. So, this can lead to false-positive results, where a drug initially identified as a potential candidate subsequently fails when evaluated in live systems," said Dr Zhao.

"Some drugs work well in pre-clinical testing but then fail in human clinical trials because of the differences."

Statistically, if 250 compounds are identified as potential drug candidates for early laboratory testing, only about five per cent of them will progress to clinical trials. Fewer than 10 per cent of those will be successful and gain regulatory approval.

"Currently years and considerable amounts of money are spent investigating whether potential drugs are viable," she added.

In order to streamline this process, her team has developed a testing method that better represents the way a living tumour would respond to drugs.

"A biomimetic tumor chip can be built using 3D cancer structures generated from human cancer cells in combination with microchannels that represent the blood flow," she said. "This mimics in vivo conditions in humans."

The novel tumour-on-a-chip device involves putting a 3D tumour structure onto a microchip, then flowing potential cancer drugs through the tumour structure to evaluate their efficacy.

"The simulated blood flow carries nanoparticle-based therapeutics around and into the tumour, just as it would in a biological system," she said. "It's a simple method that replicates human biological processes."

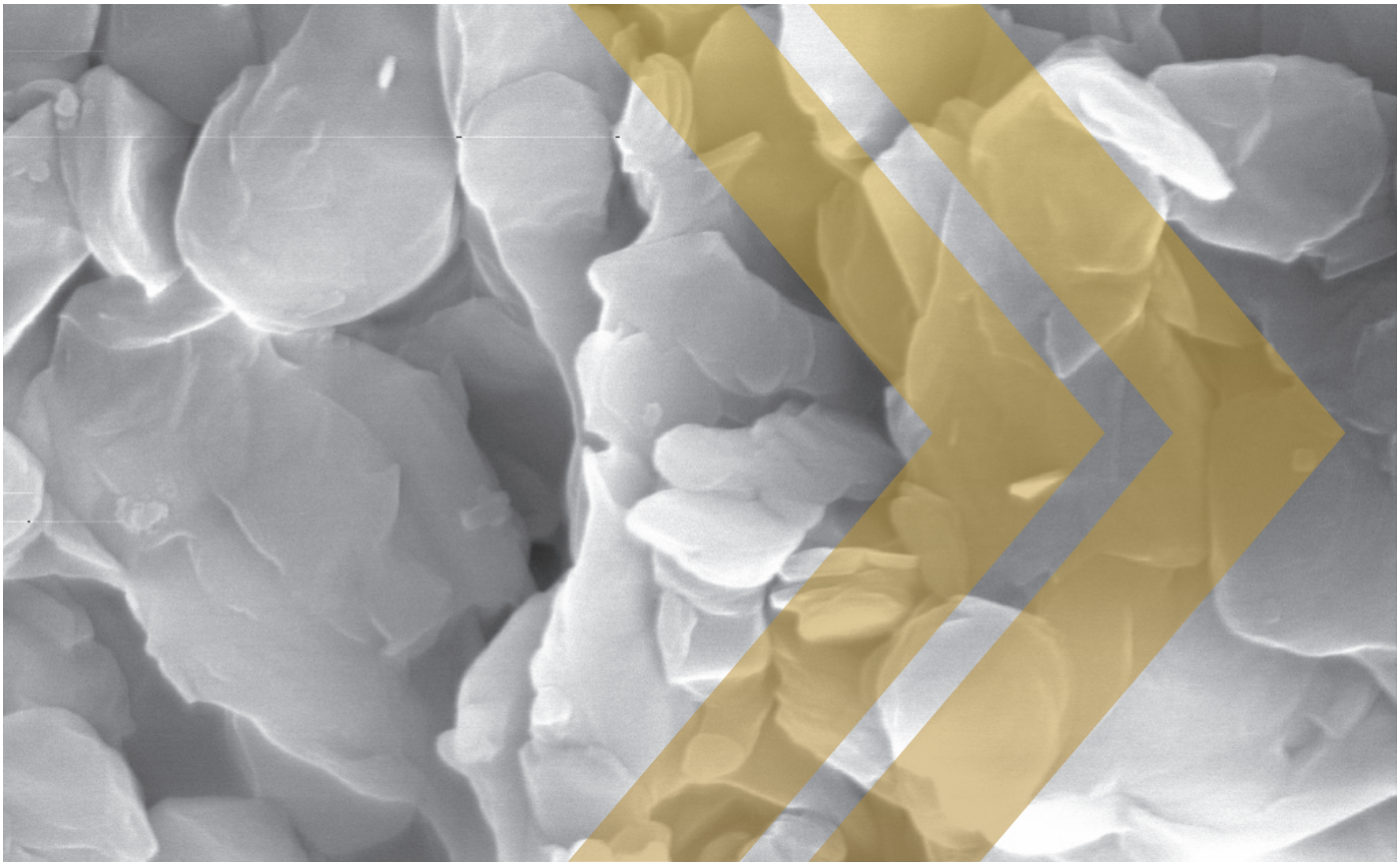
The chip enables real-time observations, monitoring and analysis of what happens when the therapeutic drugs are used to treat the tumour cells.

"By using image analysis, we can get immediate results about the efficacy of the drugs," she said. "This can save significant amounts of time and money for early phases of drug screening, especially when using a high-throughput design with tens or even hundreds of tumour structures on a single chip."

In 2016, this ground breaking research received funding from a UQ Foundation Research Excellence Award.

Dr Zhao is currently validating the chip using in vivo models. The validated device will then be used to screen a range of nanoparticle-based drug delivery systems developed in her lab.

"We're moving towards personalised medicine. The ultimate goal is to build a chip with tumour cells from a patient and use it to find the right drug and dose to treat the patient."



Commercialisation edges closer

Positive results from clinical trials of a new method of drug delivery have prompted an AIBN industry partner to move closer to commercialisation.

Non-steroidal anti-inflammatory drugs (NSAIDs) are the most widely used class of drugs and globally more than 30 million people use them daily for the relief of pain and inflammation associated with arthritis and other musculoskeletal disorders. Ibuprofen and naproxen are the dominant NSAID molecules, with combined worldwide sales of more than US$5 billion per year.

"Unfortunately, chronic use of NSAIDs can cause well-documented gastrointestinal side effects, such as ulcers and bleeding," said AIBN's Professor Zhi Ping (Gordon) Xu.

He and his colleagues have developed clay nanomaterials that can diminish these unwanted side effects.

Initially, the nanomaterials were developed to overcome the bitter taste of the drugs. However further research identified that the anionic clay layered double hydroxide (LDH) nanoparticles, combined with some of the most popular NSAIDs, could reduce NSAID-related gastrointestinal tract damage.

Professor Xu explained that this is because LDH is a powerful antacid that rapidly neutralises gastric acid, binds pepsin and bile acids that could harm the stomach, and strengthens protection of the stomach's mucous membrane.

"Our technology can be used to make NSAID-LDH hybrid particles that are able to mask the drug's bitter taste and reduce the side-effects such as gastrointestinal irritation," he said.

The technology has been licensed to Oxford Pharmascience Group plc (OXP), in the UK.
OXP is a specialty pharmaceutical company that redevelops medicines to make them better, safer and easier to take.

Scientists there are developing two drug programmes – Ibuprofen-LDH and Naproxen-LDH. Both programmes have completed early phase pharmacokinetic and endoscopic clinical evaluation and the Ibuprofen-LDH is currently undergoing a further clinical pharmacokinetic trial with the over-the-counter and prescription strength ibuprofen doses.

The company is talking to potential manufacturers and marketers of commercial quantities of the drugs and getting input from regulatory and medical advisers on development strategies for over-the-counter and prescription-strength products.

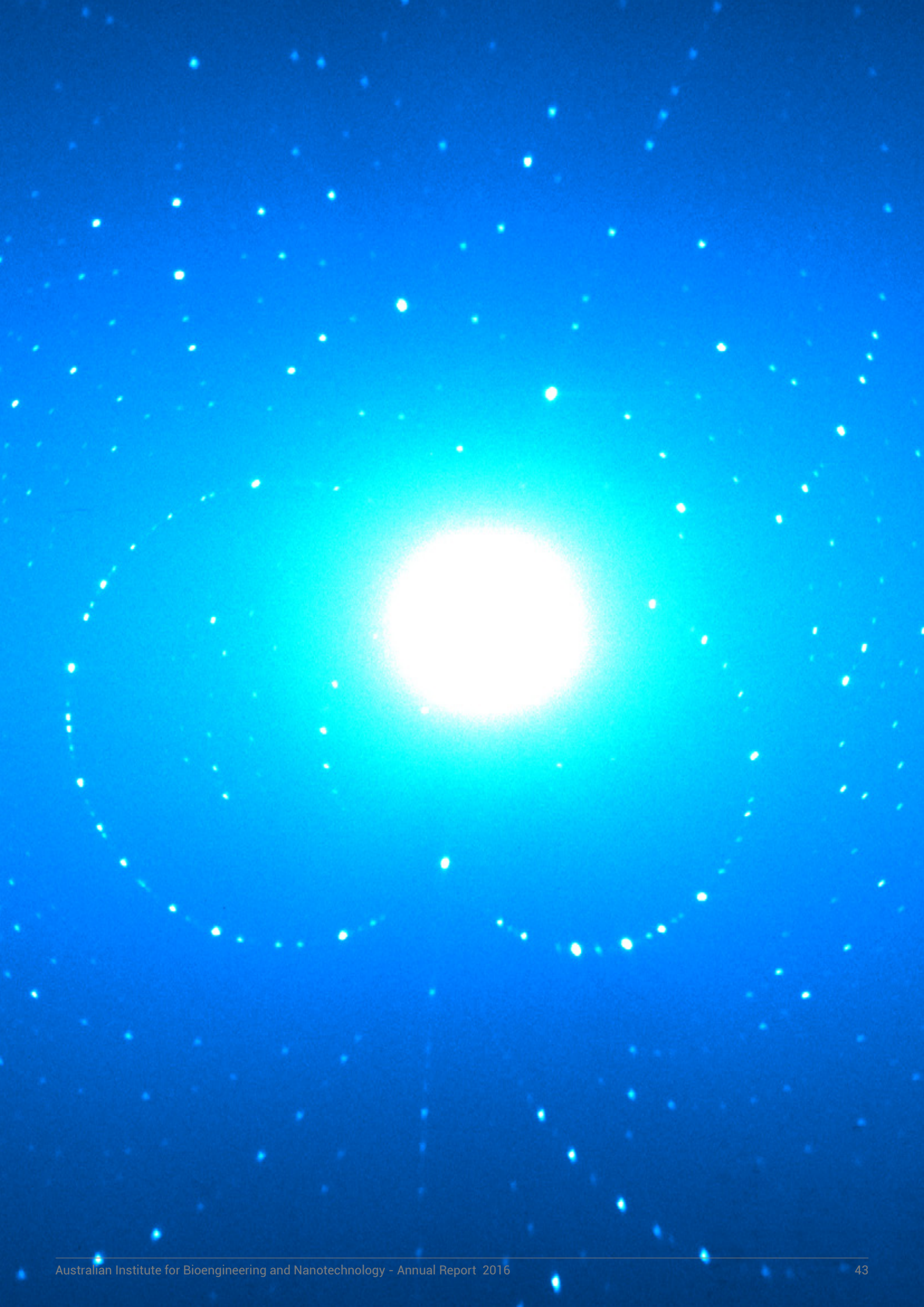
OXP's 2016 end-of-year review said the products, which it has trademarked as OXPzero, would be "potentially disruptive in over-the-counter markets".

OXP said its OXPzero products, compared to generic oral tablets, were milder on the gastrointestinal tract; completely masked NSAIDs' bitter taste and burn; and delivered an "attractive pharmacokinetic profile with adaptable drug-release properties".

OXP is also seeking advice from the US Food and Drug Administration on licensing the product for use in the USA.

OXP says there is also potential for cough and cold medicines using OXPzero Ibuprofen. While paracetamol dominates non-tablet forms of cough and cold remedies because of its gastrointestinal mildness and taste advantages, Professor Xu's technology could enable development of superior non-tablet, taste masked ibuprofen products.

This collaborative research has the potential to generate substantial economic benefits for OXP and UQ in the future, enabling more medical breakthroughs.



Funding and Recognition


$2.3
Million
ARC
Funding
9
Fellowships
awarded in
2016
$3.9
Million
NHMRC
Funding

Australian Research Council Funding

Over the course of 2016, AIBN researchers were involved in major Australian Research Council grants that totalled more than $2.3 million.

The Wang Group received over $795,000 of ARC funding for two projects.

Professor Lianzhou Wang is leading a project which aims to explore functionalities of metal halide perovskite materials for sustainable solar energy conversion and storage, beyond the heavily studied perovskite solar cell application. The project intends to design toxic lead free/less perovskite materials for an integrated photoelectrochemical hydrogen production and solar rechargeable battery system.

The group's second project led by ARC DECRA fellow, Dr Hu Han, aims to design and synthesise compressible hybrid supercapacitors using graphene aerogels as substrates through structural design and surface modification. The success of the project could benefit Australia's booming graphite industry and promote Australian competitiveness in wearable electronics markets.

The Xu Group received over $697,000 of ARC funding for two projects.

One project led by Professor Zhi Ping (Gordon) Xu aims to understand how the liver handles and is affected by nanomaterials in the body.

Nanomaterials are widely used in industrial, environmental, consumer and drug products, but how they affect human health is poorly understood. This project will characterise the spatiotemporal distribution of a set of nanomaterials with defined attributes in naïve and modified livers using chemistry, imaging and biological methods.

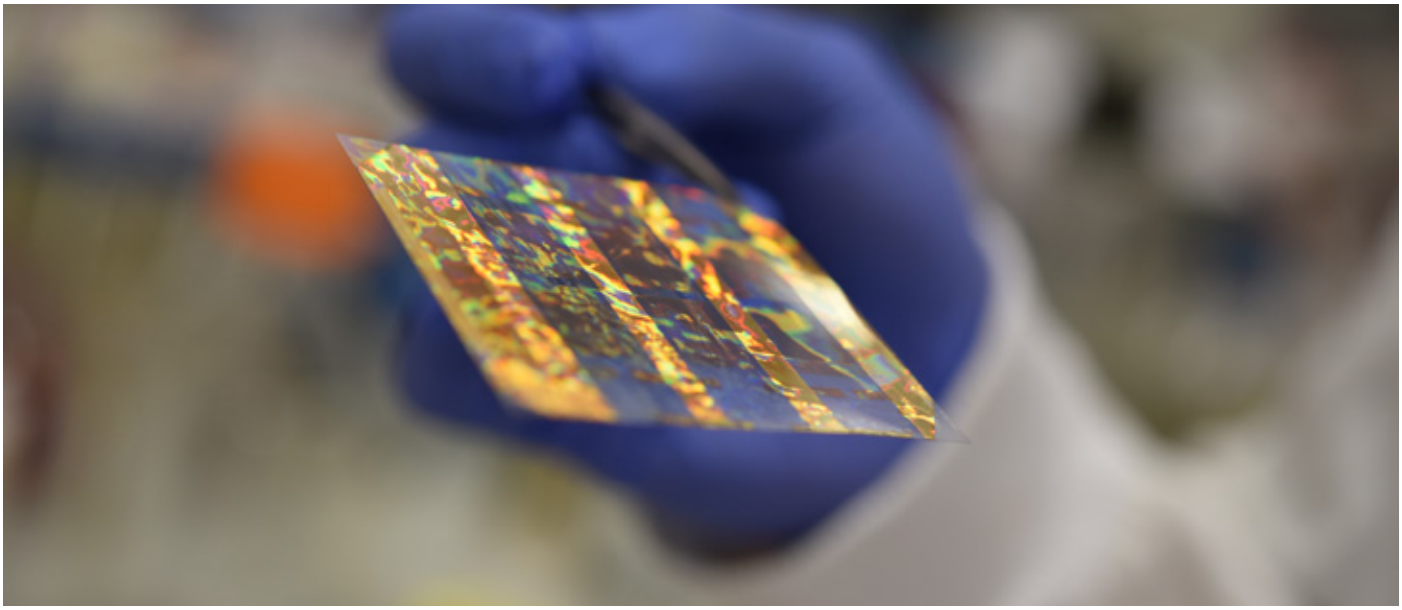
The second project led for the Xu Group by ARC DECRA Fellow, Dr Run Zhang, will look at developing a nanoprobe using an X-ray excited luminescence "nanolaser" as the local light source to activate coupled responsive photoacoustic sensors.

Current imaging techniques using fluorescent probes cannot detect biomarkers in deep tissues due to shallow light penetration. By capitalising on the tissue penetrating properties of X-rays and acoustic waves and collecting acoustic waves as the read-out signal, real-time monitoring of biomarkers in deep tissues could be achieved, advancing detection technology for deep-tissue biomarkers.

Professor Chengzhong (Michael) Yu received $470,000 of ARC funding to develop an advanced small angle X-ray scattering facility for the examination of versatile porous and nano-size sample types.

The proposed facility will support the development of new functional materials for industry reform, mapping oil and gas reserves, developing innovative technologies for new energy resources, and gas deliverability.

The Bernhardt Group received $360,000 of ARC funding for a project which aims to use computational methods to determine the optimal catalyst for growth of high quality, continuous films, a crucial scientific problem in the synthesis of two dimensional materials. It will use first-principles calculations to explore the growth of graphene and hexagonal boron nitride on several designed alloy catalysts and develop a physical model to understand the mechanism of the chemical vapour deposition growth of the materials.



National Health and Medical Research Council Funding

Over the course of 2016, AIBN researchers were involved in National Health and Medical Research Council grants that totalled more than $3.9 million.

The Wolvetang Group received funding of over $900,000 in NHMRC project grants for two separate projects.

Both projects, involving Professor Ernst Wolvetang, will involve the use of induced pluripotent stem cells.

The first project is titled "(Re)wiring a stem cell: Deciphering the molecular mechanism underpinning lineage propensity" and the second project will consider "Leveraging genomics strategies to generate adult neurons from iPSCs and somatic cells."
The Xu Group is involved in NHMRC grants totalling $1.18 million covering two projects

Professor Zhi Ping (Gordon) Xu is involved in a project on physiologically-based pharmacokinetics and pharmacodynamics of therapeutic stem cells for liver disease.

Xu Group member Dr Run Zhang is also involved a project on visualisation and early prediction of ROS-mediated treatment response in liver cancer by a novel nanoplatform.

The Cooper-White Group also received funding for a project called "Unravelling the mechanism coupling synaptic activity with neurotrophin signaling in the nervous system".

Fellowships

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

During 2016 the strength of innovation and output demonstrated by AIBN researchers resulted in another successful year of fellowship funding.

AIBN Director Professor Alan Rowan was awarded a highly prestigious Australian Laureate Fellowship.

Professor Rowan's work, which focuses on the fundamental understanding of how materials found in the body actually work and can be synthetically constructed, has attracted nearly $3 million in funding from the ARC Laureate Fellowships scheme.

In 2016 AIBN received three ARC DECRA Fellowships totalling more that $1.1 million in funding.

Dr Run Zhang, from the Xu Group received a DECRA Fellowship for his project on X-ray induced photoacoustic nanoprobe: Break depth dependency of bioimaging.

Dr Han Hu, from the Wang Group received a DECRA fellowship for his work on designing compressible hybrid supercapacitors from graphene aerogels.

Dr Qinghong Yuan, a DECRA fellowship awardee from the Bernhardt Group is working on catalyst design for synthesis of graphene and boron nitride sheets.

Five researchers received ARC Advance Queensland Research Fellowships totalling $1.14 million of plus additional support from partnering organisations, which will enable their research to continue for three years.

Dr Muxina Konarova is an early-career fellowship awardee in the Wang Group and will develop modular and small-scale syngas to ethanol reactors that make a single transport fuel, ethanol, in close collaboration with the Australian Petroleum International Exploration and Development and Austeng.

Dr Nasim Amiralian of the Martin Group received an early-career fellowship for work with industry partners Derby Rubber and Dugalunji Aboriginal Corporation.

Dr Pratheep Kumar Annamalai, also of the Martin Group, received a mid-career fellowship to develop low cost, environmentally friendly concrete and bitumen for buildings and road infrastructure using spinifex additives, in a partnership with the Queensland Department of Transport and Main Roads.

Dr Li Li of the Xu Group received a mid-career fellowship to partner with JL Dingle Pty Ltd and Huon Aquaculture Company Pty Ltd to develop nano-sized oral delivery systems for the vaccination of animals through their feed.

Dr Meihua Yu of the Yu Group will work together with Ridley Corporation on an early career fellowship to develop a safe alternative to antibiotics for livestock feed by using nanotechnology and natural biomolecules.

Prizes and Awards

In 2016 **Dr Nasim Amiralian**, an early career Advance Queensland Research Fellow, received the Women in Technology (WiT) ICT & Life Sciences Rising Star Award.

She said achieving the WiT award would not have been possible without the "excellent support" she received from AIBN and her supervisor Professor Darren Martin.

Iranian-born Dr Amiralian came to Australia in 2010 to complete her PhD at AIBN. She said she was fortunate to grow up in a family that valued the importance of education.

Her research focuses on processing and structure-property performance of novel materials, renewable polymers and nanocomposites. During her PhD, she discovered and patented a cellulose nanofibre from Australian native spinifex grass.

Professor Darren Martin and **Dugalunji Aboriginal Corporation CEO Colin Saltmere** also won a UQ Partner in Research Excellence Award for their cooperative agreement that recognises the traditional owners' knowledge about the spinifex grass and ensures they have ongoing equity and involvement in commercialising the nanocellulose technology derived from the grass.

At the National Health and Medical Research Council Research Excellence Awards in Canberra in July 2016, AIBN's Professor **Justin Cooper-White** was awarded the Marshall and Warren Award for the most innovative and potentially transformative grant from the 2015 project grants funding round. His project aims to restore damaged heart tissue to a functional state following injury.

At the same awards, **Professor Kirill Alexandrov**, from AIBN and the UQ Institute for Molecular Bioscience, was acknowledged as holding the top-ranked development grant application for his project with Molecular Warehouse Ltd, developing a point-of-care test for immunosuppressant drugs.

Professor Alexandrov's work aims to assist organ transplant patients whose survival depends on immunosuppressant drugs. A point-of-care test can enable patients and clinicians to easily and accurately monitor drug levels at the bedside or at patients' homes to maintain drugs at an optimal level.

Also in 2016, **Professor Mark Kendall** was awarded the prestigious CSL Young Florey Medal by the Australian Institute of Policy and Science.

Professor Kendall was also awarded the Dr John Dixon Hughes Medal for Medical Research Innovation. The National Foundation for Medical Research and Innovation offers the Dr John Dixon Hughes Medal every two years to a researcher aged under 45 for an outstanding contribution towards developing and advancing a biomedical innovation.

Both awards recognised Professor Kendall's world-leading work in developing the Nanopatch, which can replace vaccine delivery via needle and syringe. The Nanopatch targets immune-rich cells of the skin's outer layers with thousands of micro projections on a single patch.

Vaccines are dry-coated onto the patch, helping to eliminate the need for the vaccine cold chain which is expensive to maintain and risks being broken in underdeveloped regions that have poor access to electricity. This technology is being commercialised by spin-out company, Vaxxas.

In June 2016, the **Protein Expression Facility (PEF)**, directed by AIBN's Associate Professor Linda Lua, won the UQ Award for Excellence in Service. PEF is an internationally recognised facility that serves UQ and wider research communities, producing high quality synthetic proteins with superb efficiency to accelerate research.

AIBN researcher **Dr Chunxia Zhao** won a UQ Foundation Research Excellence Award for her work on tumour on a chip, a next generation in vitro model for accelerating translation of nanomedicines.

This award provides funds to advance and facilitate individual early career researchers' work, particularly where there is evidence of the research's strategic significance.

In September, AIBN researchers **Professor Ernst Wolvetang** and **Professor Christine Wells**, along with their collaborators on the FANTOM5 project, were awarded the 2016 Scopus Eureka Prize for Excellence in International Scientific Collaboration, presented by the Australian Museum.

The FANTOM5 project involves 260 specialists from 20 countries. Together they are mapping sets of genes expressed in cell types to interpret genetic diseases and engineer new cells for therapeutic use.

Newly Awarded Research funding commencing in 2016

Granting Body	Granting Scheme	Investigators	Project Title	Funding Years	Total funding Awarded
Australian Research Council	Discovery Projects	A/Prof Linda Lua, Dr Joanne Meers, Prof Anton Middelberg, Mr J Bingham	Engineering a nanovaccine for cost-effective influenza poultry vaccination	2016 - 2018	$430,000
		Prof Kirill Alexandrov, Prof Victor Stein, Prof Zhong Guo	Engineering electrochemical protein biosensors	2016 - 2018	$650,300
		Prof Lianzhou Wang	A New Photocatalytic System for Solar-to-Chemical Energy Conversion	2016 - 2018	$310,000
		Prof Matt Trau, Dr Yuling Wang	Trapping and Watching Biomolecular Complexes near Nanopores	2016 - 2018	$315,000
	Laureate Fellowship	Prof Alan Rowan	Outside-In. Strain stiffening as a key to cell control	2016 - 2021	$2,965,538
	Industrial Transformation Training Centres	Prof Stephen Maher, Prof Kirill Alexandrov, Prof Ross Barnard, Dr Mathias Francois, Prof Peter Gray, Dr Mark Hodson, Dr Jeff Hou, Dr Chris Howard; Dr Martina Jones; Dr Linda Lua and 20 others	ARC Training Centre for Biopharmaceutical Innovation	2016 - 2021	$4,881,754
	Linkage Infrastructure, Equipment and Facilities	A/Prof Kris Thurecht, Prof Andrew Whittaker, Prof Per Setterlund, Prof Pall Thordarson, Prof Mark Walker, Prof Martina Stenzel, Prof Cyrille Boyer, Prof Justin Gooding, Prof David Reutens	Facility for characterisation of bionanomaterials	2016	$930,060
		Prof Alan Mark, Prof Lindsay Botte, Prof Andrew Pitman, Prof Dietmar Muller, Prof Michelle Coote, Prof Derek Leinweber; Prof Andrew Greentree, Dr Andrew Hogg, Dr James Zanotti, Prof Sean Smith, Prof Debra Bernhardt and others	Maintaining and enhancing merit-based access to the NCI National Facility (project administered by The Australian National University)	2016-2018	$450,000
		Prof David Williams, Dr Alexander Scheuermann, Dr Dilum Fernando, Prof Darren Martin, Dr Michael Heitzmann and others	National rock, concrete and advanced composite testing capability	2016	$1,698,000
	Linkage Projects	Prof Lianzhou Wang, Dr Bin Luo	Design of New Two-dimensional Materials for Lithium Sulfur Batteries	2016-2019	$671,000

Granting Body	Granting Scheme	Investigators	Project Title	Funding Years	Total funding Awarded
National Health and Medical Research Council	Project Grant	Prof Justin Cooper-White, Dr Enzo Porello	Targeted direct reprogramming of adult cardiac fibroblasts to functional cardiomyocytes	2016 - 2018	$681,493
		Dr Barbara Rolfe, Dr Trent Woodruff, Dr G Boyle, Dr R Pio	Targeting the Complement Cascade: A Novel Therapeutic Strategy for Metastatic Melanoma	2016 - 2018	$546,496
		A/Prof Kris Thurecht, Prof Pamela Russell, Prof Stephen Mahler, Dr Chris Howard	Immuno-polymeric drugs for prostate cancer therapy	2016 - 2018	$626,995
		Prof Maree Smith, Prof Andrew Whittaker	Novel prolonged-release polymeric microparticles for relief of intractable cancer-related pain	2016 - 2018	$796,950
	Development Grant	Prof Kirill Alexandrov	Point-of-Care test for immunosuppressant drugs	2016 - 2018	$737,360
Australian Government Department of Industry and Science	Research Connections	Prof Andrew Whittaker	Novel in vivo nanoparticles for imaging	2016	$22,000
		Prof Stephen Mahler	The biophysical characterisation of novel, recombinant bi-specific antibodies utilised in drug-delivery technology using Bio-layer Interferometry (Octet).	2016 - 2017	$71,988
		Prof Darren Martin, Dr Grant Edwards	Optimisation of nano-additives for plastics customers	2016 - 2017	$156,369
Australian Government Department of Education and Training	NCRIS 2016-17	Prof Lars Nielsen, Dr Ben Schulz, Dr Mark Hodson	Bioplatforms Australia Project - Metabolomics Australia-Qld node (administered by Macquarie University via Bioplatforms Australia Ltd)	2016 - 2017	$1,005,000
		Prof Justin Cooper-White	Australian National Fabrication Facility -Qld Node (administered by the Australian National Fabrication Facility Limited)	2016 - 2017	$395,000
		Prof Peter Gray, Dr Jeff Hou, Dr Martina Jones, Dr Tim Adams, Dr George Lovrecz	The National Biologics Facility (administered by Therapeutic Innovation Australia)	2016 - 2017	$390,600
Queensland Government	Advance Queensland Research Fellowship	Dr Nasim Amiralian	Advancement and Commercialisation of Spinifex Nanocellulose Enhanced Rubber Products	2016 - 2018	$180,000
		Dr Meihua Yu	Nano-pollen encapsulated lysozyme: a safe alternative to antibiotics for livestock	2016 - 2018	$180,000
		Dr Muxina Konorova	Sustainable production of ethanol from bio-syngas	2016 - 2018	$180,000
		Dr Pratheep Kumar Annamalai	Easily deconstructed spinifex nanofibres for the enhancement of high performance construction materials	2016 - 2018	$300,000
		Dr Li Li	Engineering nanohybrid platforms for oral vaccination combined with animal feed	2016 - 2018	$300,000
	Advance Queensland Women's Academic Fund	Dr Alexandra Depelsenaire	Microneedle patch for skin-based vaccination	2016	$12,100
	Advance Queensland Women's Academic Fund	Dr Laura Garcia Carrascosa	Molecular Diagnostic Platforms	2016	$13,585
Prostate Cancer Foundation of Australia	New Concept Grant	Prof Kirill Alexandrov, Dr Victor Stein, Dr Robert Gardiner	Development of highly sensitive diagnostic test for active form of prostate specific antigen	2016 - 2017	$110,000
Royal Brisbane and Women's Hospital Foundation		Prof Robert Gardiner, Prof Matt Trau, Dr John Yaxley, Dr Geoff Coughlin, Dr Troy Gianduzzo, Dr Rachel Esler, Dr Nigel Dunglison, Prof Martin Lavin	Does prostatic manipulation result in increased numbers and clusters of circulating tumour cells?	2016	$44,000
Bill & Melinda Gates Foundation	Grand Challenges Exploration Grant	Prof Kirill Alexandrov	Repurposing glucose monitoring technology for DNA detection	2016	$133,511
Defence Materials Technology Centre		Dr Bronwyn Laycock, Prof Darren Martin	Polyurethanes	2017	$158,664

Granting Body	Granting Scheme	Investigators	Project Title	Funding Years	Total funding Awarded
Queen Mary University of London	Research Grant	Prof Matt Trau, Dr Darren Korbie	QMUL Research Project 1	2016-2017	$99,780
RANZCR	Research Grant	Dr Gishan Ratnayake, Dr Kris Thurecht	Radiosensitization of prostate cancer by nanoparticle mediated siRNA delivery	2016	$20,137
Contract Research			Contract Research Total Funding		$3,398,680
		Prof Darren Martin	Process Development - downstream processing of spinifex fibre into Nanofibrillated Cellulose (NFC)	2016	
		Prof Jimmy Botella, Prof Matt Trau, Dr Jing (Eugene) Wee	Rapid detection and quantitation of Campylobacter jejuni/ coli in processing.	2016-2019	
		Prof Peter Gray, Dr Martina Jones, Kym Hoger	m102.4 Antibody	2016-2020	
		Prof Stephen Mahler, Dr Kris Thurecht, Dr Chris Howard	EGFR targeted nanoparticle feasibility study	2016	
		Dr Claudia Vickers	Strain Improvement and optimization studies for enhanced production of GGPP (Geranylgeranyl Pyrophosphate)	2016-2017	
		Prof Matt Trau	AC electrohydrodynamics in microfluidic devices	2016-2017	
		Dr Claudia Vickers, Dr Heather Smyth, Dr Benjamin Schulz	Beverage Mouthfeel Ingredient Exploration via Leveraging Brewing Science and Systems Biology	2016-2017	
		Prof Chengzhong (Michael) Yu	DNA vaccine application	2016	
		Prof Chengzhong (Michael) Yu	Oregano essential oil nanocarrier formulation	2016	
		Dr Kris Thurecht	Biodistribution analysis	2016	

Early and Mid Career Researcher Committee

The AIBN Early Mid Career Researcher (EMCR) Committee delivers a dynamic suite of professional development and networking events to support the Institute's postdoctoral researchers.

Typically identified as researchers within the first 5 to 10 years of their careers following the completion of their PhDs, EMCRs form a significant part of AIBN's research capabilities.

EMCR Committee Chair Dr Ilaria Stefani said the researchers all have cutting-edge laboratory skillsets, however, they face new challenges as they start their careers.

"EMCRs soon learn that a PhD is really only the start of their journey, and they begin to face pressures such as securing funding, developing networks and managing projects to establish their own research projects," Dr Stefani said.

"The EMCR Committee was established to provide support in this vital phase of a young researcher's career, and provide training and development opportunities to help them establish themselves."

Throughout 2016, the EMCR Committee worked together with the AIBN research grants unit to present the GrantReady program, and provide researchers with valuable skills to successfully complete grant applications.

The program included seminars with speakers who shared their experiences and insights for successful grant writing, and provided workshops where EMCRs could discuss and develop grant proposal ideas.

Other sessions organised during the year included information sessions on resources available at UQ, as well as industry and commercialisation seminars.

"We hosted a translational research seminar in conjunction with UniQuest, which helped to explain the progression of research towards a commercial outcome," Dr Stefani said.

"To commercialise their work, researchers need skills that extend beyond the lab bench, and they will need the help of people outside of the laboratory to develop a product. Knowing where to go will not only save them trouble, but it will also facilitate quicker translation of their important work."

With AIBN's international EMCR community, the EMCR Committee is also dedicated to providing opportunities for researchers to extend their professional networks.

"EMCRs regularly come from across the world, and many only stay for a year or two to work on specific projects. Enabling them to meet other researchers ultimately helps them meet people with whom they will form important collaborations in the future."

2016 EMCR Committee Members:

- Dr Ilaria Stefani (Chair)
- Dr Michael Crichton (Vice-Chair)
- Dr Alexandra Depelsenaire (Treasurer and Secretary)
- Dr Veronica Martinez-Salazar (Webmaster)
- Dr Nasim Amiralian
- Dr Simon Puttick
- Dr Yuling Wang
- Dr Leila Matindoost
- Dr Claudia Vickers

Facilities and Infrastructure


$75
million
building
8
in house
facilities

Facilities and Centres

Australian National Fabrication Facility (ANFF)
The Queensland node of the ANFF at AIBN is one of eight ANFF nodes in Australia across 21 institutions. Funded by the National Collaborative Research Infrastructure Strategy ANFF is an open access network of facilities for both academic researchers and industry and aims to process hard and soft materials so that these can be transformed into products.

Metabolomics
The Queensland Node of Metabolomics Australia hosted at AIBN provides scientists with access to specialised expertise in the analysis of metabolites (metabolomics), and a particular focus on bioengineering and fluxomics. Metablomics Australia is Funded by the the National Collaborative Research Infrastructure Strategy.

Protein Expression Facility (PEF)
Providing specialised recombinant protein production services across Australia, and increasingly drawing international clients, the PEF experienced growth in its output during the year.

National Biologics Facility (NBF)
NBF assists Australian researchers with the production of biologics - a relatively new class of therapeutic which are produced using a biological process. This Facility produces high-quality recombinant proteins in clinical or pre-clinical quantities and is funded by the National Collaborative Research Infrastructure Strategy.

Nanomaterials Centre (Nanomac)
The Nanomaterials Centre, currently focuses on the synthesis and characterisation of nanomaterials in the three key areas of energy, environment and health. It has a very well-equipped laboratory, housing over $5,000,000 worth of characterisation and synthesis equipment and is located between the School of Chemical Engineering and AIBN.

StemCore
StemCore is a state-of-the-art Pluripotent Stem Cell Core Facility at AIBN that enables and accelerates stem cell research for academics and industries working in the area of regenerative medicine.

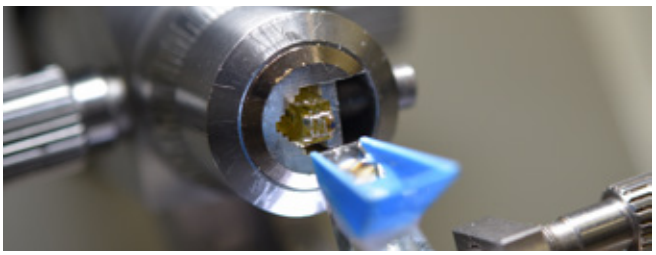
Centre for Microscopy and Microanalysis (CMM)
AIBN is home to one of the four laboratories at UQ that form the Centre for Microscopy and Microanalysis. CMM facilitates research outcomes through the provision of training, expertise and state-of-the-art infrastructure in microscopy and microanalysis.

Centre for Theoretical and Computational Molecular Science (CTCMS)
The 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.

ARC Industrial Transformation Training Centre for Biopharmaceutical Innovation (CBI)
CBI aims to transform Australia's growing biopharmaceutical industry, an advanced manufacturing capability contributing to Australia's economic growth. The centre combines R&D with the manufacturing expertise and capabilites of industry.

UQ Centre in Stem Cell Ageing and Regenerative Engineering (UQ-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 Personalised Nanomedicine (CPN)
CPN was established in 2014 and brings together researchers in the areas of nanotechnology, molecular biology, clinical research and health economics. The vision for CPN is to become a world leader in this field as well as a catalyst for change in the local and international medical system.



Occupational Health and Safety

AIBN's health and safety systems complement UQ's health and safety structure. These systems are designed so as 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 UQ'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 2016, a sponsored prize was awarded monthly to research groups for meritorious efforts on safety and compliance.

An integral part of AIBN's SMS is the OH&S committee, with membership representative 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.

Additionally, AIBN's OH&S Manager, collaborates with the Central UQ OHS Division on the revision of polices and guidelines that will be implemented across UQ. AIBN's OH&S Manager has been part of several working groups and, in 2016, focused on assisting with the selection and implementation of new OH&S databases to manage workplace incidents and OH&S risk at UQ. These databases are used by Central UQ OHS Division to update the Vice-Chancellor's Risk and Compliance Committee, which has oversight of all corporate risk.

AIBN obtained an average audit score of 72% during the 2016 internal UQ OHS audit for 11 different criteria (Table 1). The auditors concluded that the overall health and safety systems of AIBN are well developed, supported, implemented and undergo regular review to ensure ongoing effectiveness.

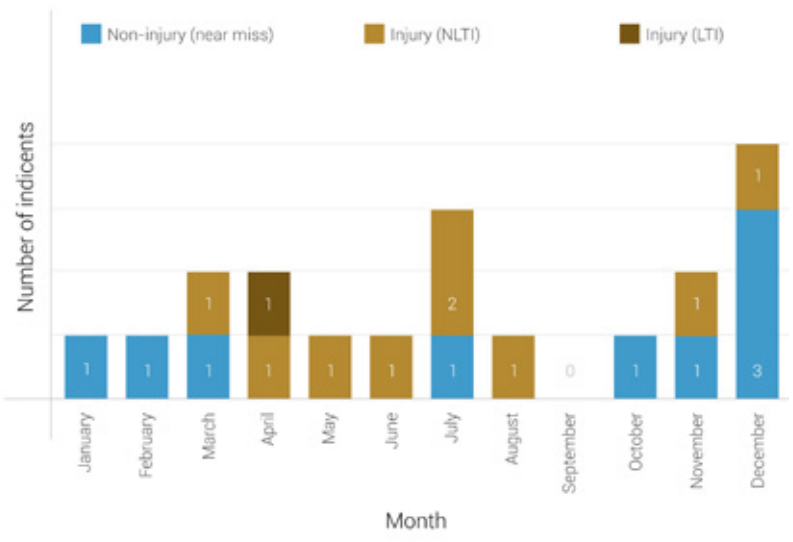
AIBN's workplace incidents, injury and illness data is reflected in Table 2, with eight "Near Misses" and nine "No Lost Time Injuries" representing the most significant types of event. AIBN only had one "Lost Time Injury" report that was an unforeseen event that could not have been controlled. Near misses are a very important tool for hazard identification and trigger the review and monitoring of existing processes at AIBN.

The report also specifically highlighted the following positive findings:

- Demonstrated commitment to implementing UQ's OH&S management systems throughout AIBN.
- Evidence that the implementation of UQ's OH&S management systems is monitored throughout AIBN and regularly reviewed.
- Sufficient staff resources dedicated to the OH&S function.
- Many of the workers interviewed demonstrated good general understanding of OH&S systems and requirements.

Figure 1: Audit Score

Figure 2: Incident, Injury and Illness Data for 2016



Students and Graduates


131
students enrolled in 2016
26
graduates
2
3MT award winners
AIBN
BD

Research Higher Degree Report

The Institute's research higher degree (RHD) student cohort has maintained a high level of enrolment. An additional 20 Doctor of Philosophy (PhD) and two Master of Philosophy (MPhil) students commenced projects in 2016. The RHD cohort of 115 candidates included 41 domestic and 74 international students.

In 2016 another 25 PhDs and one MPhil were awarded bringing the total number of AIBN's RHD graduates to 156.

The AIBN research experience is enriched by the great diversity of our people, the quality of their research and its potential translation to products and technologies that will improve human life and our environment.

AIBN's research students are men and women from 26 nations who are pursuing new knowledge in fields across the science and engineering disciplines. The quality of our students is evident in their success in obtaining competitively awarded scholarships. In 2016 more than 32 merit-based scholarships were awarded to commencing RHD students at AIBN. A further eight travel scholarships were awarded to AIBN students by the UQ Graduate School, enabling students to travel to conferences and visit external institutions to further their education.

In 2016 AIBN reached out to science and engineering students within and beyond UQ to provide insights and exposure to our research. Tour groups included first year engineering and advanced science undergraduates from UQ as well as visitors from the University of Minnesota (USA) and Inje University (South Korea).

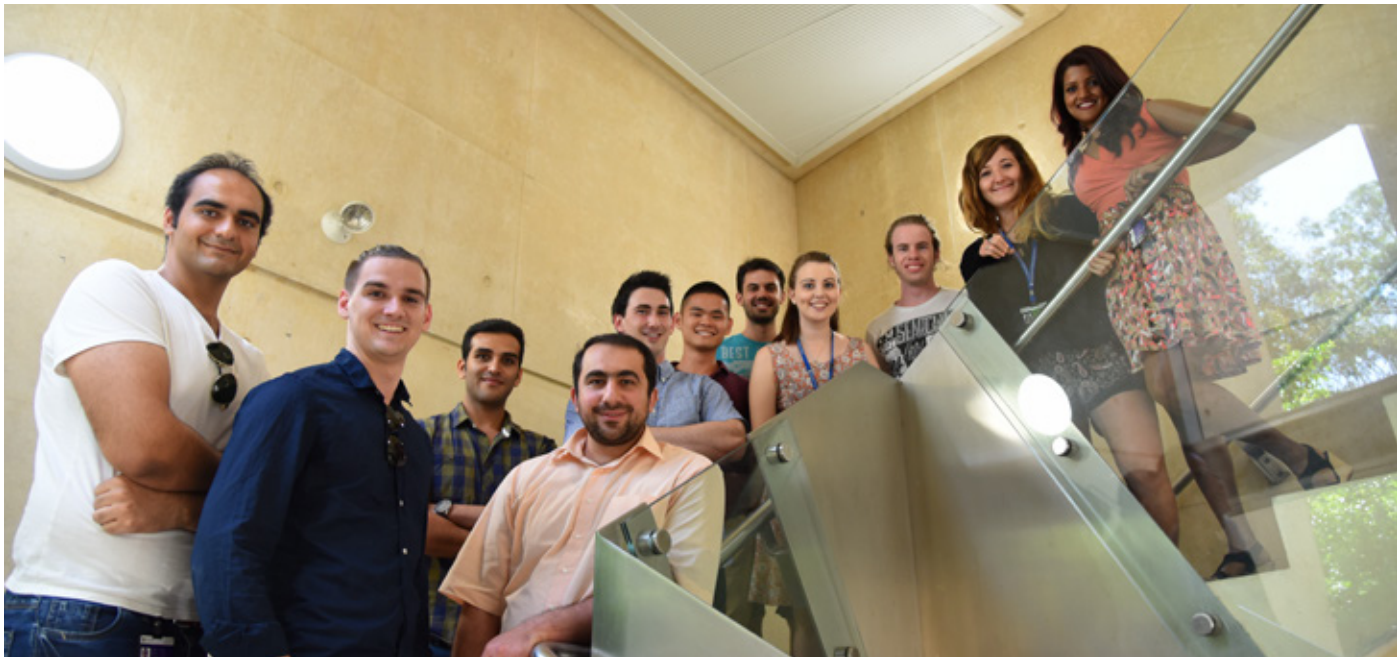
AIBN's outreach program to provide opportunities to high-achieving undergraduate students continued through research internship programs, which collectively hosted 40 high-calibre students from UQ, as well as other Australian and international universities.

These four to 12 week opportunities embed students within research groups, engaging them in authentic research projects of the host laboratories. More than 250 students have now successfully participated in AIBN's research internships since 2007.

AIBN also hosts Industry placements from UQ's growing Bachelor of Engineering/Master of Engineering (BE/ME) program. These placements provide hands-on experience to emerging, talented students who aspire to a career in research.

The Institute is proud of its track record of attracting research talent from geographically and academically diverse sources. AIBN has the highest rate of international RHD enrolment within the university, and this ability to draw overseas students highlights its international reputation.

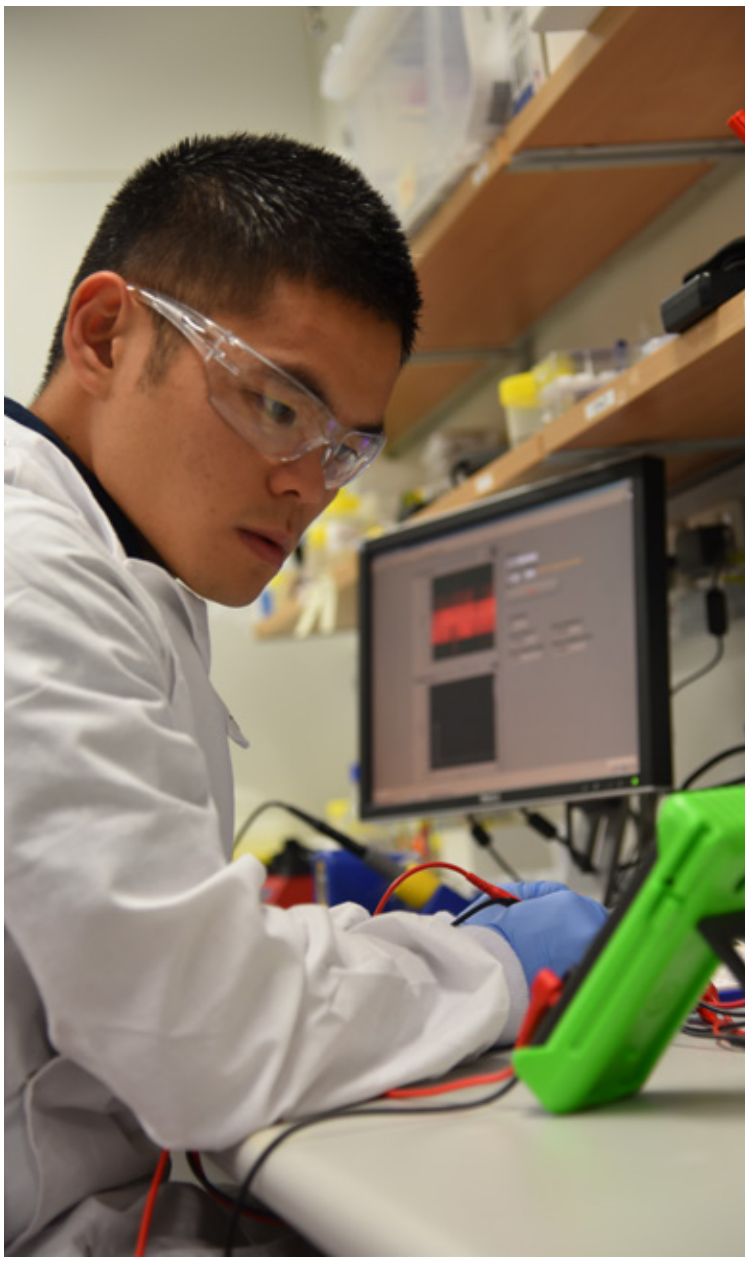
However, a further focus is to attract emerging talent from other universities in south-east Queensland and Australia more broadly. The RHD team attends key student career fairs and expos throughout the year to promote the Institute and recruit local students who exhibit academic excellence. In 2016 the proportion of domestic students at AIBN increased from 25% to 36%.



New Research Higher Degree Students

Students form a significant proportion of AIBN's research personnel, and we recognise the following students who were enrolled at the Institute during 2016 and contributed to AIBN's successes during the year

Gishan Ratnayake
Irene Reto
Samuel Richardson
Tim Ruder
Pedro Andres Eduardo Saa Higuera
Jennifer Schoning
Joshua Simpson
Abu Ali Ibn Sina
Mohammad Soheilmoghaddam
Faheem Amir Solangi
Hao Song
Marcos Saul Soto Perez
Baode Sun
Qi David Sun
Xiaoran Sun
Jie Tang
Hossam Tayeb
Kanupriya Tiwari
Nicole van der Burg
Jarurin Waneesorn
Jing Wang
Andri Wardiana
Jonathan Wei
Nicholas Westra van Holthe
Rebecca Wood
Yanheng Wu
Yilun Wu
Mu Xiao
Guang Ze Yang
Yannan Yang
Shiyu Yan
Nicolas Eugenio Zaragoza
Kai Zhang
Min Zhang
Liang Zhao
Yongmei Zhao
Xiaobo Zhu
Yingdong Zhu
Huali Zuo



2016 Graduates

Rufika Shari Abidin

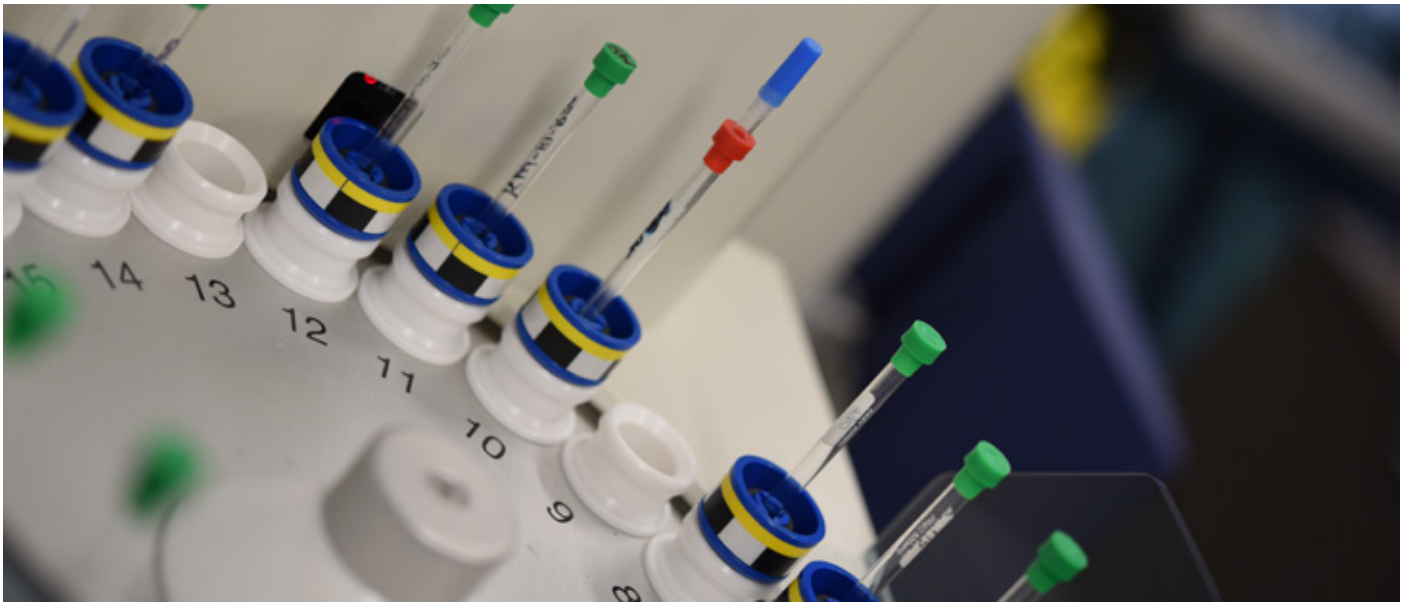
Qualifications: Masters in Health Sciences, Hasanuddin University; Masters in Biotechnology with First Class Honours, Australian National University; Sarjana Sains in Biology, Gadjah Mada University
PhD Awarded: December
Principal supervisor: Dr Frank Sainsbury
Thesis Title: Murine Polyomavirus VLPs as a Platform for Cytotoxic T Cell Epitope-Based Influenza Vaccine Candidates
Project Abstract: Influenza vaccines based on cytotoxic T cell (Tc) epitopes are a promising approach in the design of broadly protective vaccines and virus-like particles (VLPs) hold promise as potent and affordable antigen carriers. This project aimed to combine these concepts. Successful external VLP display of single epitopes necessitated molecular design and bioprocess condition screening. Encapsidation of multi-epitope domains was achieved via bioengineering native coat protein binding domains for non-covalent association with the internal cavity of VLPs, first validated with a fluorescent reporter protein. The successful biomolecular engineering of these disparate approaches to antigen delivery could lead to better influenza vaccine design.

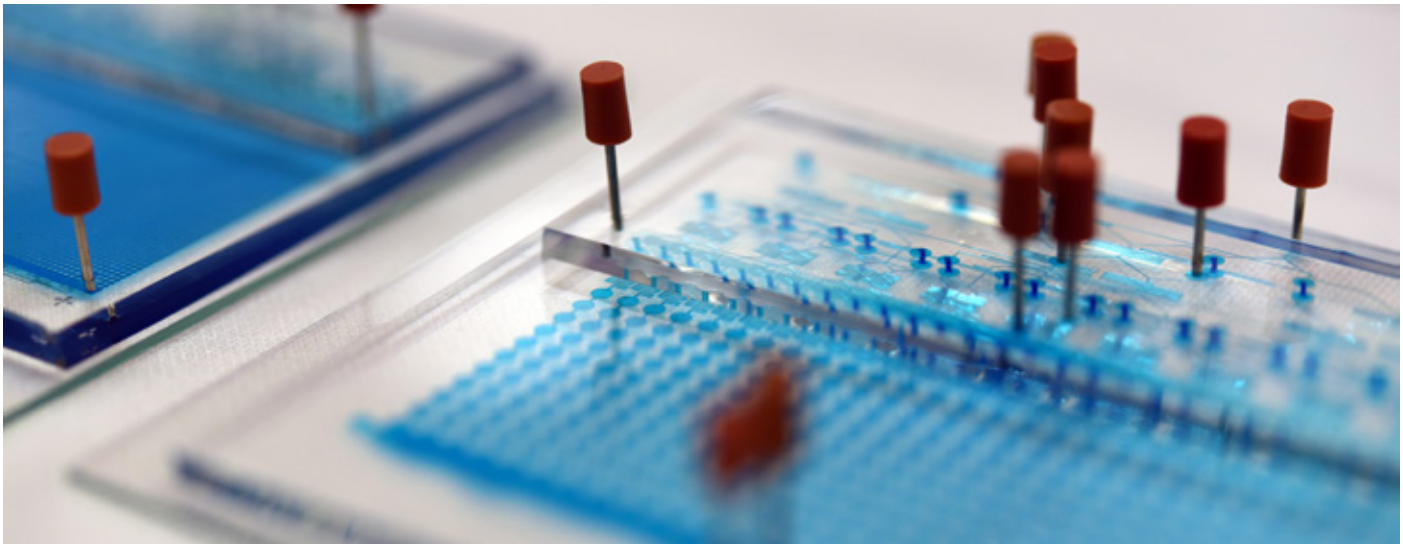
Yusilawati Ahmad Nor

Qualifications: Master of Science by Research, International Islamic University Malaysia; Bachelor of Engineering, International Islamic University Malaysia
PhD Awarded: December
Principal supervisor: Professor Chengzhong Yu
Thesis Title: Hollow Mesostructured Nanoparticles with Unique Properties as Antibiotic Carriers
Project Abstract: This research aims to develop a new family of biocompatible hollow mesostructured nanocarriers with unique properties to explore their potential applications for the delivery of antibiotics. Mesoporous hollow nanoparticles with silica, carbon and iron oxide compositions and well defined structures have been developed. Owing to their low density, large surface area and high pore volume, mesostructured hollow nanoparticles demonstrate high loading and sustained release of vancomycin, which enables enhanced drug delivery efficiency and long term bactericidal activity compared to free drugs. The iron oxide nanoparticles show great antibacterial efficacy and safety profiles with potential applications as carriers for delivering antibiotics

Suad Alateeq

Qualifications: Master of Science, King Faisal University; Bachelor of Science, College of Science
PhD Awarded: December
Principal supervisor: Professor Ernst Wolvetang
Thesis Title: CRISPR/Cas9-mediated traceless gene correction and activation of the HBB locus in iPSCs with the beta thalassaemia mutation
Project Abstract: This study combined cutting-edge cellular reprogramming methods to generate beta thalassaemia iPSCs, a double nickase-mediated gene editing approach and piggyBac transposase-aided excision to achieve seamless gene repair, and a CRISPRa approach to model the impact of the disease-causing mutation and demonstrate restoration of normal transcription following genetic repair. Having established a platform for precise gene correction and for validation of the restoration of the functional allele in this monogenic disease, this strategy may provide a viable avenue for iPSC-based cell therapy of beta thalassaemic patients provided mature engraftable blood cells can be generated from hiPSCs in the future.





Eid Alosime

Qualifications: Master of Science, University of Putra Malaysia; Bachelor Science, King Saud University
PhD Awarded: August
Principal supervisor: Professor Darren Martin
Thesis Title: Processing-Structure-Property Relationships in Copolyester Elastomer Nanocomposites
Project Abstract: Thermoplastic copolyesters (TPE-Es) are high-performance thermoplastic alternatives to natural or synthetic cross-linked rubbers. TPE-Es are segmented block copolymers typically incorporating hard (polyester) and soft (polyether) blocks. This thesis investigates the "processing-structure-property" of nanocomposites of TPE-E reinforced with organically-modified nanoclays. Two methods of materials processing are investigated for the preparation of the nanocomposites: melt compounding and reactive extrusion. The main objectives of this research are the investigation of the utility of organically-modified nanoclays to enhance the properties of segmented TPE-E, and to understand in parallel how these nanofillers influence the underlying TPE-E microphase morphology, from which segmented TPE-E elastomers derive their properties.

Aditya Ardana

Qualifications: Master in Science, Bandung Institute of Technology; Bachelor of Science (Cum Laude), Bandung Institute of Technology
PhD Awarded: October
Principal supervisor: Dr Kristofer Thurecht
Thesis Title: Design of functional hyperbranched polymers for gene delivery
Project Abstract: The discovery of RNA interference pathway which leads to efficient silencing of specific genes by siRNA has opened up a revolutionary way of treating gene-related diseases. Nonetheless, in order for it to be a viable and universal therapeutic option, a number of important issues must be first addressed. Of particular importance is the poor RNA stability within blood plasma. This makes systemic administration of RNA virtually impractical. Thus, this thesis is aimed to address the problem by constructing a rational design of a synthetic delivery platform based on a comprehensive understanding of the challenges for *in vivo* siRNA delivery.

Thomas Bennett

Qualifications: Bachelor of Science (Honours), University of Queensland
PhD Awarded: June
Principal supervisor: Associate Professor Idriss Blakey
Thesis Title: Polymer-Ionic Liquid Composites for Advanced Material and Solid Polymer Electrolyte Applications
Project Abstract: Predicting and controlling the phase behaviour and thus physical properties of block copolymer/ionic liquid mixtures is a critical step towards their implementation into commercial devices. In this thesis, the lyotropic phase behaviour of a series of polystyrene-block-poly(methyl methacrylate) block copolymers has been studied via small-angle X-ray scattering in several ionic liquids, and the data compiled in the form of several quantitative experimental phase diagrams. Relationships between the morphology and several physical properties were also investigated. The findings will serve as an important model for future investigations that aim to target specific self-assembled morphologies to suit a desired application.

Will Anderson

Qualifications: Bachelor of Biotechnology First Class Honours, University of Queensland
PhD Awarded: October
Principal supervisor: Professor Matt Trau
Thesis Title: Resistive pulse sensing through tunable nano-scale devices: Fundamental investigations, developments and applications
Project Abstract: The recent uptake of nano-scale particle suspensions for research, industrial and medical applications has resulted in greater demand for new, in-situ, nanoparticle characterisation techniques. This thesis investigated the capabilities and fundamental physical chemistry of a novel, nano-scale particle characterisation platform, termed Tunable Resistive Pulse Sensing (TRPS), which has the capacity for in-situ, high throughput, particle-by-particle analysis. Key insights in this thesis included investigations into the capacity of TRPS to characterise complex, biological, nano-scale particle samples, theoretical and experimental investigations into the underlying physical chemistry of the TRPS system and the development of an integrated TRPS/optical microscopy particle tracking analysis platform.

Luqman Atanda

Qualifications: Master of Science, King Fahd University of Petroleum & Minerals; Bachelor of Science, University of Lagos
PhD Awarded: July
Principal supervisor: Dr Jorge Beltramini
Thesis Title: Catalytic conversion of biorenewable-carbohydrate sources to 5-Hydroxymethylfurfural: a platform molecule for future chemical and energy
Project Abstract: Cellulosic biomass provides renewable alternatives to fossil-fuel resources for the sustainable production of liquid fuels and valuable chemicals. One of the attractive strategies of biomass valorization is the catalytic transformation of cellulosic biomass into 5-Hydroxymethylfurfural (HMF), a molecule that is pivotal to the generation of an array of bio-based fine chemicals, polymers and transportation fuels. Hence, this research study has contributed to the advancement of catalytic technologies through novel catalyst design and innovative reaction engineering towards realizing a cost-effective, eco-friendly and sustainable bio-refinery process for the conversion of biopolymer cellulose content of agricultural residues (as biomass source) into HMF.

Mareike Bongers

Qualifications: Master of Science in Biology, ETH Zurich; Bachelor of Science, Ruprecht Karls University
PhD Awarded: March
Principal supervisor: Professor Lars Nielsen
Thesis Title: Unraveling metabolic flux control of the methylerythritol phosphate (MEP) pathway: a systems biology study
Project Abstract: Isoprenoids are a superfamily of natural compounds that hold potential as therapeutics, fine chemicals and biofuels. In this work, one of the two metabolic pathways leading to the production of isoprenoids, the MEP pathway, was investigated with the aim of unravelling how pathway flux is regulated. Systems and synthetic biology tools were developed to examine flux control: by comparing *in vivo* function of bacterial and plant enzymes, investigating global regulators in different E. coli strains, and by developing an in silico kinetic pathway model. The insights gained in this thesis allow prediction of more efficient strategies for microbial isoprenoid production.

Liyu Chen

Qualifications: Master of Science, Sichuan University; Bachelor of Science, Sichuan University
PhD Awarded: October
Principal supervisor: Dr Kristofer Thurecht
Thesis Title: Physiological Response to Polymeric Materials in Nanomedicine
Project Abstract: Hyperbranched polymers (HBPs) are a class of architectural polymer currently under development as multi-component/multi-functional therapeutic agents. This thesis focused on investigating the influence of surface charge on the behavior of HBPs synthesized in a controlled manner such that variation in other physical parameters were kept to a minimum. This allowed us to gain insight into the relationship between surface charge and cellular interactions both *in vitro*, ex vivo and *in vivo*, ultimately providing guidance for improving the biocompatibility of hyperbranched polymers, and tailoring their properties to suit different clinical applications.

Chang Lei

Qualifications: Master of Stomatolgy, Wuhan University; Bachelor of Medicine, Wuhan University
PhD Awarded: September
Principal supervisor: Professor Chengzhong Yu
Thesis Title: Nanomaterial-based Sensitive Detection of Biomolecules
Project Abstract: This thesis focuses on the development of new and effective nanomaterial-based approaches for sensitive detection of biomolecules (e.g. insulin) in complicated biological samples. Nanomaterials have been specially designed and deliberately implemented for enhancing biomolecules detection. Detection of biomolecules (e.g. insulin) in urine/serum has been achieved with extremely low limits of detection, which are better than previous reports and commercial products. Our innovative approaches have shown great potential in enhancing the efficiency of current detection strategies by rationally designed nanomaterials, which is important for the diagnosis of disease in early stage and the detection of biomarkers with trace amount.

Khairatun Najwa Mohd Amin

Qualifications: Master of Science, Universiti Teknologi Malaysia; Bachelor of Engineering, Universiti Teknologi Malaysia
PhD Awarded: August
Principal supervisor: Professor Darren Martin
Thesis Title: Cellulose nanocrystals reinforced thermoplastic polyurethane nanocomposites
Project Abstract: Enhancement of thermoplastic polyurethane (TPU) properties can be achieved by reinforcement with fillers. Cellulose nanocrystals (CNC) have gained high interest due to good mechanical properties and reinforcing capability. Current research on CNC reinforced TPU nanocomposites has typically employed solvent-based fabrication methods. For widespread application, processing via scalable approaches has to be demonstrated. However, CNC usage has been limited by the poor thermal stability and low dispersibility when more scalable methodologies are used. Thus, this study aims to explore and develop CNC with enhanced thermal stability, and to incorporate these thermostable CNC into TPU via scalable melt-compounding and reactive extrusion methods.

Geoffrey Lawrence

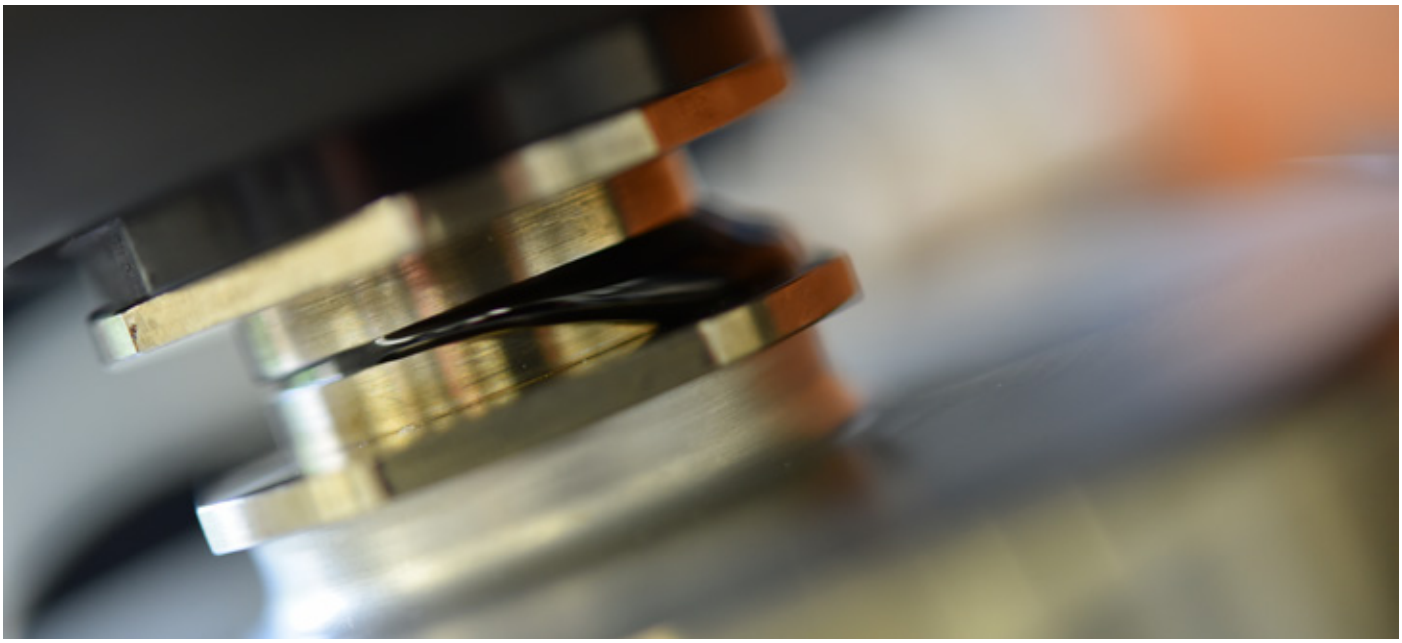
Qualifications: Master of Technology, Anna University; Bachelor of Technology, Anna University
PhD Awarded: July
Principal supervisor: Professor Ajayan Vinu
Thesis Title: Design of Proteins with Highly Ordered Porous Structure for Sensing Applications
Project Abstract: The properties of biomolecules have proven to be highly attractive in many complex organic transformations, biosensing, drug delivery and nano-bio-medical devices. By immobilizing the biomolecules in a solid support or creating nanoporosity in biomolecules in itself, we can not only help to preserve the activity and stability under extreme conditions but also provide excellent textural parameters such as high surface area. Based on the results obtained so far, we envisage that nanoporous protein materials with highly ordered porous structure and well-interconnected pores will be a significant breakthrough in porous materials science and in the field in catalytic and biomedical applications.

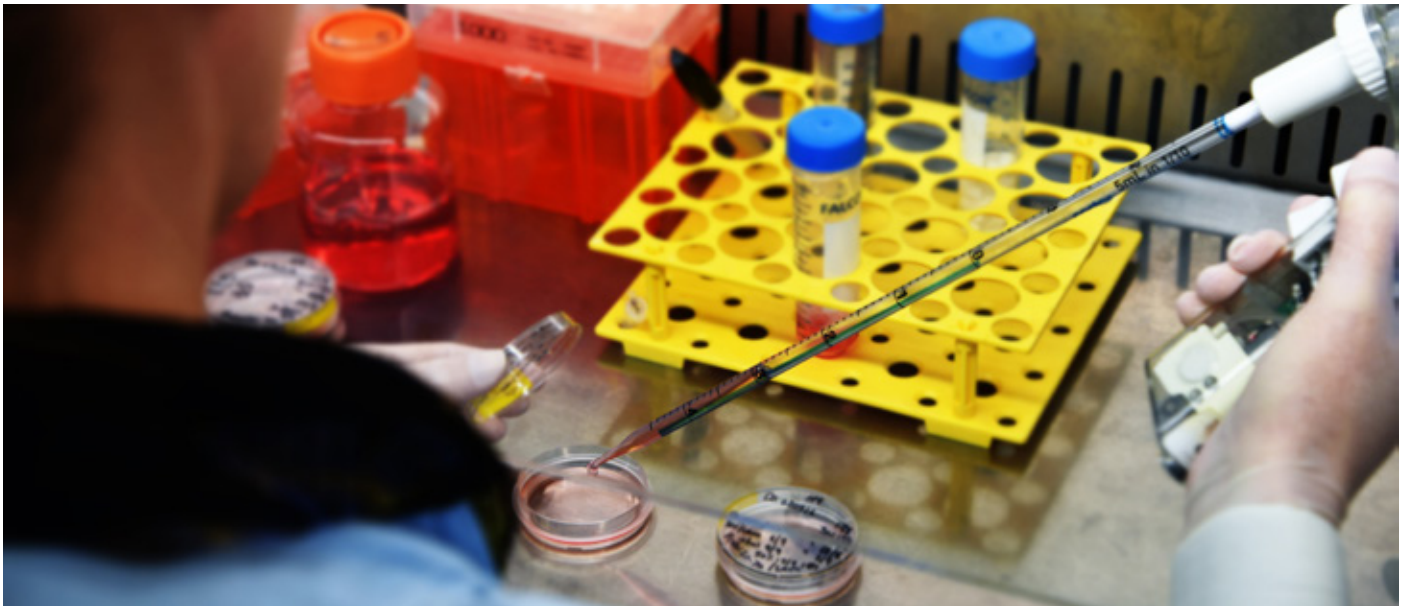
Derong Lu

Qualifications: Master of Science, Huaqiao University; Bachelor of Engineering, Huaqiao University
PhD Awarded: February
Principal supervisor: Professor Michael Monteiro
Thesis Title: Synthetic Strategies to Build Macromolecular Architectures
Project Abstract: The ability to build complex macromolecular architectures from linear polymer building blocks through a combination of 'living' radical polymerization (LRP) and 'click' chemistries has opened the way for tailor-made polymers. The great advantage of LRPs (e.g., RAFT polymerization, ATRP, and SET-LRP) is the production of polymers with high chain-end fidelity, which in combination with orthogonal 'click' reactions (i.e., thiol-ene, CuAAC, and NRC) allows precise coupling of building blocks into a desired architecture. In this thesis, functional cyclic polymers, dendrimers and miktoarm star copolymers were prepared through the strategy combining LRP and 'click' techniques.

Jamileh Nabizadeh

Qualifications: Bachelor of Biotechnology (Honours), University of Queensland
PhD Awarded: January
Principal supervisor: Dr Barbara Rolfe
Thesis Title: Contribution of complement anaphylatoxin receptors to melanoma growth: potential therapeutic targets
Project Abstract: This thesis demonstrated the key role of complement components C3a and C5a in regulating the anti-tumour immune response to melanoma. The results presented in this thesis provide convincing evidence that therapeutic inhibition of C3aR and/or C5aR1 is an effective means to tip the balance towards an anti-tumour response.





Camila Orellana Montecino

Qualifications: Master of Science, Universidad de Chile; Bachelor of Science, Universidad de Chile
PhD Awarded: June
Principal supervisor: Professor Lars Nielsen
Thesis Title: Understanding CHO cells biology for enhanced biopharmaceutical production: a comparative transcriptomic and proteomic approach
Project Abstract: CHO cells are the preferred production host for biopharmaceuticals. RNA-Seq and SWATH were used to compare gene and protein expression between CHO cell lines displaying different mAb specific productivity (qp). The average biological variation was remarkably less than 10%. Surprisingly, more than half the genes and proteins were differentially expressed between the two clones. Overexpression of Gclm, involved in glutathione synthesis, improved mAb qp, final titre, and the frequency of high producer clones by 70%. However, the substantial genetic fluidity in CHO lines challenges the notion of identifying and manipulating a few key genes to generate high production clones.

Andrea Schaller

Qualifications: Diploma Life Science Engineering, Karlsruhe Institute of Technology
PhD Awarded: October
Principal supervisor: Professor Anton Middelberg
Thesis Title: Computational Molecular and Chemical Engineering of a Stimuli-responsive Biosurfactant
Project Abstract: Biosurfactants produced by microorganisms are a green alternative to chemical surfactants. In particular, protein biosurfactants offer vast design opportunities and variability in their properties due to the flexibility in amino acid side chain characteristics. DAMP4, a designed four-helix bundle biosurfactant protein, addresses problems frequently associated with biosurfactants including low yield, purification cost, and a lack of fundamental understanding. By applying MD simulations in combination with experiments on DAMP4 and purposefully designed variants, this thesis gives new insights into the sequence-structure-function relationships of protein biosurfactants. It contributes to the knowledge of molecule design in order to overcome cost-barriers and have desired functionalities.

Alemu Tekewe Mogus

Qualifications: Master of Technology, National Institute of Pharmaceutical Education and Research; Bachelor of Pharmacy, Addis Ababa University
PhD Awarded: December
Principal supervisor: Professor Anton Middelberg
Thesis Title: Virus-like particle and capsomere vaccines against rotavirus
Project Abstract: A high burden of rotavirus disease and the unresolved challenges with the marketed rotavirus vaccines, particularly in developing countries, have ignited efforts to develop next-generation vaccine candidates using a virus-like particle (VLP) technology. This thesis demonstrates multipronged approaches for a low-cost production of bacterially-produced capsomeres and *in vitro* assembled VLPs displaying a rotavirus RV10 peptide modules or 18 kDa VP8⋆ large antigens. The modular capsomeres and VLPs induced high levels of antigen-specific antibodies in mice, likely indicates protective efficacy and makes them a more viable vaccine candidates for further development to prevent rotavirus in the developing world at affordable cost.

Amanda Pearce

Qualifications: Bachelor of Science First Class Honours, University of Queensland
PhD Awarded: June
Principal supervisor: Dr Kristofer Thurecht
Thesis Title: Development of a Hyperbranched Polymer Theranostic for Prostate Cancer
Project Abstract: Prostate cancer causes 3000 deaths each year in Australia, emphasising a need for new technologies specifically targeted towards cancer cells that also allow for controlled drug delivery and enhanced imaging. The work in this thesis describes the synthesis of a biocompatible hyperbranched polymer drug delivery carrier that can be imaged optically, can target and be internalised within prostate cancer cells and can ultimately deliver a chemotherapeutic drug to the tumour site in a controlled manner. The findings demonstrate that this synthetic approach has promise as a theranostic platform, thus offering an improved treatment strategy for treating prostate cancer.

Jessica Schwaber

Qualifications: Bachelor of Science Engineering, Smith College
PhD Awarded: October
Principal supervisor: Professor Lars Nielsen
Thesis Title: Order from Noise: Modelling the Stochasticity of Lineage Commitment
Project Abstract: Immune system cells circulating in the blood begin as bone marrow stem cells, but the paths by which they differentiate into subtypes of immune cells with specific roles in health and disease remain unknown. In the post-genomic era, data has emerged suggesting differentiation rests on combinations of gene regulatory factors. This thesis now finds the dynamic network interactions of these regulatory factors that causally drive each pathway of differentiation. Our approach combines experimental data acquisition with stochastic modelling of dynamics that separate progenitor populations. The resulting improved understanding of the paths to specific cell types may enable their therapeutic uses.

Yue Wang

Qualifications: Bachelor of Bioengineering, Tianjin University
MPhil Awarded: October
Principal supervisor: Professor Chengzhong Yu
Thesis Title: Designed synthesis of large pore mesoporous silica nanoparticles as nano-carriers for bio-applications
Project Abstract: This thesis focuses on the synthesis and application of small-sized dendritic mesoporous silica nanoparticles (DMSNs). By comparing small-sized and large-pore DMSNs with large-sized DMSNs, the size effect on bacterial adhesion and antimicrobial protein delivery performance have been investigated. Moreover, DMSNs with small particle sizes (<50 nm) have been prepared at room temperature for the first time. Such DMSNs are expected to have effective cellular uptake and high loading of large biomolecules in bio-applications. Our study provides a new understanding in the facile synthesis of MSNs with controllable structures for the rational design of nano-carriers for improved delivery efficiency.

Yangyang Wen

Qualifications: Master of Engineering, Tianjin University; Bachelor of Engineering, Tianjin University
PhD Awarded: October
Principal supervisor: Professor Lianzhou Wang
Thesis Title: Two-Dimensional Nanomaterials for Supercapacitors
Project Abstract: In recent years, two-dimensional nanomaterials have been the subject of numerous studies for their potential application as electrode materials for supercapacitors. The aim of this thesis is to study how heteroatom doping in two-dimensional nanomaterials affects the electrochemical performance of supercapacitors. Four types of heteroatom-doped nanosheets were systematically studied in this thesis, including nitrogen-rich graphene, phosphorus-doped graphene, nitrogen/phosphorus co-doped graphene and nitrogen-doped titanium carbide. The results demonstrate that heteroatom doping plays a significant role in modifying the structure, composition and electrochemical performance of nanosheets and paves an effective way to achieve electrodes with high specific capacitances and excellent retention performance.

Chun Xu

Qualifications: Master of Stomatolgy, Wuhan University; Bachelor of Medicine, Wuhan University
PhD Awarded: October
Principal supervisor: Professor Chengzhong Yu
Thesis Title: Design of Mesoporous Silica Nanoparticles as Drug Carriers
Project Abstract: This study focuses on the development of novel mesoporous silica nanoparticles (MSNs) with desirable structures and functionalization as drug carriers. MSNs with unique pore structures or morphology have been synthesized to efficiently deliver functional proteins or drugs into cells. In addition, novel MSNs based responsive release systems have been developed for glucose triggered insulin release. Our innovative approaches have provided conceptual advancement in the designed synthesis of novel MSNs for intracellular delivery and controlled release of proteins or drugs.

Hongwei Zhang

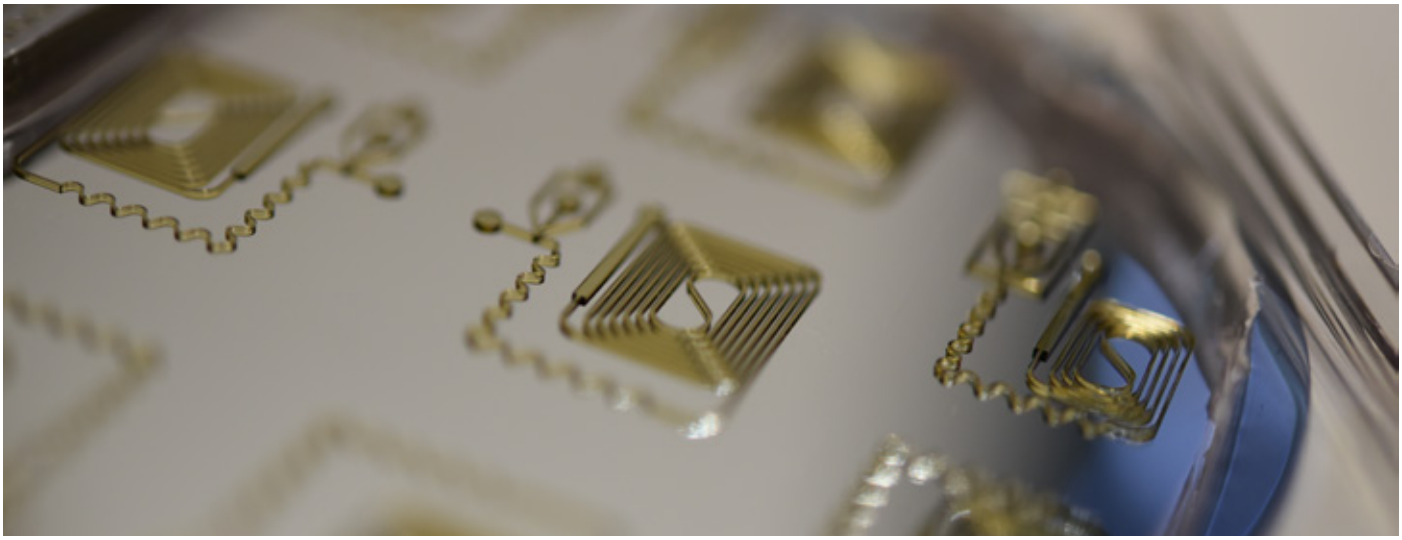
Qualifications: Bachelor of Science, Fudan University
PhD Awarded: February
Principal supervisor: Professor Chengzhong Yu
Thesis Title: Novel Carbon-based Nanomaterials for Diverse Applications
Project Abstract: Nanostructured carbon materials and their derived nanocomposites have recently attracted extensive research interest in adsorption, catalysis, biomedicine, and energy storage/conversion. In this thesis, we have developed iron oxide-carbon nanocomposites with novel architectures and compositions (including iron oxide@graphene, iron oxide@graphitic carbon, and iron oxide@carbon yolk-shell structures) as high-performance anode materials for advanced lithium ion batteries. In addition, we have proposed a new sequential heterogeneous nucleation pathway to synthesise monodispersed porous hollow carbon spheres with controllable mesostructures (bi- and triple-layered) and rich morphologies (invaginated, intact, and endo-invaginated spheres) which show potential in biomedicine and energy storage/conversion applications.

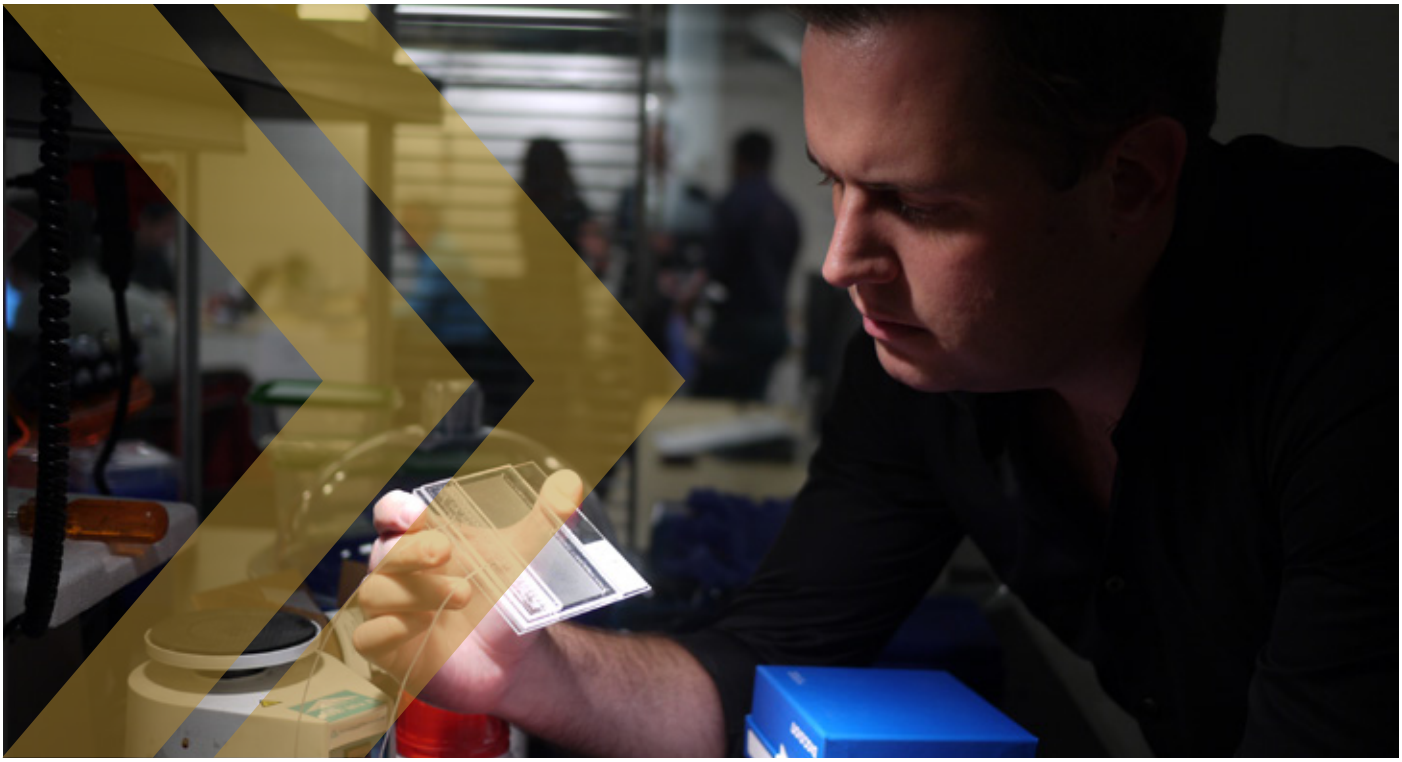
Li-Yen Wong

Qualifications: Bachelor of Engineering (Honours), University of Melbourne
PhD Awarded: October
Principal supervisor: Professor Justin Cooper-White
Thesis Title: A Self-Assembling, Targeted Biomaterial Delivery System for Cardiac Regeneration
Project Abstract: Myocardial infarction (MI) is a serious and life-threatening condition, accounting for 13% of all deaths in 2013. Regenerating damaged heart tissue remains a significant challenge. Direct cardiac reprogramming is an exciting therapeutic strategy for heart regeneration, which relies on the principle of delivering transcriptional regulators to reprogram cardiac fibroblasts (CFs) into cardiomyocyte-like cells. This thesis was focused on developing a stimuli-responsive nanoparticle system to provide targeted gene delivery in CFs to invoke cardiac reprogramming. This work therefore highlights the strong potential of this non-viral system in cardiac regeneration, offering a promising strategy for future therapeutic treatments for MI in humans.

Cheng Zhang

Qualifications: Postgraduate of Engineering Materials, Harbin Institute of Technology; Bachelor of Engineering Materials, Yantai University
PhD Awarded: September
Principal supervisor: Professor Andrew Whittaker
Thesis Title: Biologically-responsive Polymers for MRI: Measuring Temperature and Ionic Strength
Project Abstract: The development of MRI imaging agents has been central to the rise of MRI as a leading medical diagnostic tool. While many advances have been made in the field of molecular imaging agents, the development of partially-fluorinated 19F MRI agents is hindered by a lack of clear understanding of their properties. Therefore, it is very important to develop effective molecular imaging agents from both the fundamental and the applied perspectives, and to build a molecular-level understanding of the responsive behaviour of 19F MRI agents to external stimuli.





Graduate commercialises PhD project in the USA

Inspiring and training the next generation of innovators is a primary aim of AIBN. So, it's always a source of great pride when one of our former students makes a significant achievement in the development and translation of their research.

In 2016, AIBN alumnus Dr Drew Titmarsh did just this, co-founding a new biotechnology start-up company in San Francisco to advance a novel technology first developed during his PhD project at AIBN.

Dr Titmarsh's journey began in 2007, with a research project in the laboratory of Professor Justin Cooper-White, which involved building new devices to advance the way stem cells are cultured and analysed.

At the time, Dr Titmarsh was part of one of the Institute's earliest student cohorts, and his research training took place during the emergence of the field of stem cell research.

"The overwhelming sense of value I feel from my time at AIBN came from my exposure to so many cutting-edge disciplines, at a time when these were all breaking new ground," Dr Titmarsh said.

"For instance, induced pluripotent stem cells (iPSCs) were only just discovered when I started my PhD. So we were really riding a wave, and the collaborative work we did at AIBN really die-cast me as a multidisciplinarian."

Together, Professor Cooper-White and Dr Titmarsh worked on devoping microbioreactor arrays that could be used for screening and controlling pluripotent stem cell expansion.

"When culturing cells, we don't know the direct effects of the stimuli we expose them to. Cells condition their own environment by pumping out a lot of their own signals in response to the stimuli, and this is very important when studying stem cell differentiation," said Dr Titmarsh.

To help researchers better understand which stimuli produced which signals , they developed a microfluidic device called a high density microbioreactor array (HDMA). The HDMA features many cell culture chambers of minute capacities, allowing for different combinations of reagents to flow inside and interact with the cell cultures. This enables researchers to rapidly determine the best conditions for growth and differentiation of stem cells into diverse cell types.

The HDMA can run experiments in parallel, and has evolved over time to feature over 8,000 culture wells on a device the size of a credit card. As a result, stem cells can be cultured under thousands of different conditions simultaneously, speeding up analysis, and making the system extremely useful for rapid screening of drugs that can affect stem cell behaviour.

Dr Titmarsh graduated in 2011, and spent two further years at AIBN to continue the research, before moving to UQ's School of Biomedical Sciences to study cardiac culture systems and validate the HDMA platform.

In 2013, he moved to the Agency for Science Technology and Research (A*STAR) in Singapore as a Research Fellow to start a new project making blood vessels from human stem cells. During this time he also continued to refine the HDMA.

In mid-2016 Dr Titmarsh stepped away from academia. With funding from the IndieBio accelerator he founded and became CEO of Scaled Biolabs Inc in California, together with co-founders Professor Cooper-White and fellow UQ PhD graduate Dr Brendan Griffen.

"The time felt right to progress the HDMA towards a marketplace outcome. Our technology was ready, and there is a market and demand to improve the way we screen and grow cells, unlocking their potential," he said.

"I wanted to make an impact that was felt outside of the journal pages, and I felt that the more entrepreneurial mindset currently being promoted in academia would mean it would not be a career killer if I decided to give this a go and return later."

Although the start-up is still in its earliest incubation phases, Dr Titmarsh is thankful for the opportunity that grew out of his time at AIBN.

"I'm tremendously proud to have been through AIBN. I think it was founded at a crucial time in the growth of these fields, and I think it is widely recognised for that."

Engagement


18
AIBN seminars
7
Institute tours

Scientific Engagement

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

In February, the Honourable Leeanne Enoch (Minister for Innovation, Science and the Digital Economy) toured the Martin Group lab. Ms Enoch was shown the process of taking spinifex grass and pulping it into nanofibers as well as demonstrations which showed the increased durability of rubber latex after addition of spinifex nanofibers.

The Martin Group's work with spinifex nanofibres is part of a landmark agreement between UQ and the Dugalunji Aboriginal Corporation to recognise local Aboriginal traditional owners' knowledge about spinifex which has the potential to create new industries in rural Queensland.

This was followed by a visit from the Honourable Tarnya Smith (Shadow Minister for Science, Innovation and the Digital Economy) who visited AIBN in June to discuss research with Professors Ernst Wolvetang and Justin Cooper-White.

In July, Professor Andrew Whittaker and Professor Chengzhong (Michael) Yu co-chaired the Inaugural China-CSIRO-Queensland Workshop on Advanced Materials.

The workshop, which was held in AIBN, recognised existing deep levels of collaboration between leading Chinese, CSIRO, UQ and QUT researchers.

During the two day program this workshop examined potential for broadening the collaboration between the different institutes and engaging emerging scientific talent.

In September, AIBN hosted a visit from Australian Chief Scientist Dr Alan Finkel. AIBN Director Professor Alan Rowan toured Dr Finkel through some of the research and facilities at AIBN.

In October, AIBN launched the UQ Centre in Stem Cell Ageing and Regenerative Engineering (UQ-StemCARE). The launch was attended by Premier the Honourable Annastacia Palaszczuk and Hon Leeanne Enoch, as well as UQ Vice Chancellor and President Professor Peter Høj who said the Centre would further develop UQ's already significant interdisciplinary ageing research capabilities.

"The establishment of UQ-StemCARE builds on this in a concerted push to deliver more in an area where society has a real need – here and abroad – and will provide technological contributions for a better world," he said.

UQ-StemCARE will focus on unravelling the key cellular and molecular mechanisms of stem cell ageing, and seek to engineer clinical solutions in regenerative medicine to prolong the human health span.

In November, the AIBN Centre for Theoretical and Computational Molecular Science, led by Professor Debra Bernhardt, held a symposium on Computational Methods and Applications.

The symposium offered a platform for researchers in the areas of development and applications of theory and computational methods (encompassing biomolecular systems, materials and fluids) to share their work.

Each year AIBN researchers are involved in a number of engagement activities which further the promotion of AIBN's work to scientific peers. These efforts increase the scientific profile of the AIBN, and regularly lead to research collaborations.

The researchers presented their work across three themes: Computational Methods and Theory, Biomolecules and Computational Biology, Materials and Fluids.

Some of AIBN's Early Career Researchers (ECRs) Dr Ilaria Stefani, Dr Nasim Amiralian, and Dr Alexandra Depelsenaire, were involved in the steering committee for the Brisbane Life Science ECR Symposium (BLiSS).

BLiSS was a one-day symposium created for ECRs, by ECRs which provided a unique opportunity for life science ECRs from all the major universities and research institutes in and around Brisbane to, meet their peers, share their research and network.

Three of AIBN's top researchers participated in a Teaching and Learning Week seminar on translational science - innovation with commercial applications.

Professor Michael Monteiro spoke on nanotechnological applications for future devices. Professor Ernst Wolvetang covered the use of stem cells in regenerative medicine and Professor Darren Martin discussed his work with nanofibres from spinifex grass.

In December, Group Leader Professor Stephen Mahler co-chaired the second Workshop for Biomedical Applications of Engineered Antibodies and Proteins.

The all-day workshop focused on the latest developments in antibody engineering across a variety of applications that include diagnostic/ bioanalytical reagents and associated medical devices, imaging/theranostics, biologic medicines and targeted nanomedicines.

The workshop was run jointly by the ARC Centre of Excellence in Convergent Bio-Nano Science and Technology and the new ARC Training Centre for Biopharmaceutical Innovation and included presentations from invited speakers across the field.

Community Engagement

AIBN staff and students took science out of the lab and into the public sphere to raise awareness of the need for scientific advances.

Researchers provided insights into their work, the current scientific landscape, and offered views of how their fields may positively impact society in the future.

AIBN is committed to communicating science to the next generation, and ran a range of school tours in 2016, ranging from kindergarteners to high school seniors.

More than 50 kindergarten children and caregivers got an up-close glimpse of science during a two day visit to the Centre for Microscopy and Microanalysis (CMM).

Using the equipment available to them through their everyday work, CMM's Associate Professor Kevin Jack said the facility endeavoured to provide the children with an insight into science that they understood, enjoyed and were inspired by.

"It was really good to see them so excited by the science and technology we have here, and it's really important to get young people engaging with science and seeing how it plays a part in the world," Dr Jack said.

In April the Martin Group, who have signed a landmark agreement with the Dugalunji Aboriginal Corporation to recognise local Aboriginal traditional owners' knowledge about spinifex, hosted a tour of Indigenous students.

Two other student groups came through the AIBN with the Youth ANZAAS group of 55 students touring the Whittaker Group in July and the ConocoPhillips Science Experience science Camp of 90 top science students touring the Martin and Middelberg Groups in January.

In October AIBN hosted the UQ Class of 1966 Electrical Engineering 50 Year Reunion Tour. The visitors took a look at next generation solar technology from the Yu and Wang Groups, as well as a the Golden Orb Supercomputing cluster from the Bernhardt Group. The stand out from the tour was a virtual experience inside a cancer cell via an Oculus Rift.

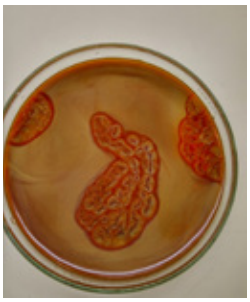
Two AIBN researchers also participated in TedxUQ: Professor Ernst Wolvetang spoke about using artificial human mini-brains to cure diseases and Professor Matt Trau gave a seminar on engineering an end to cancer mortality with nano-diagnostics.

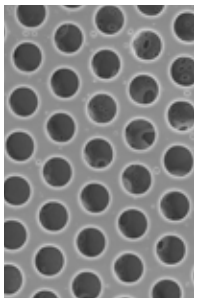
In 2016 AIBN revitalised its annual science image contest which called on researchers to submit images from their research, with over 50 entries. The winner was an image of a sodium cathode microcluster under development for use in next generation rechargeable batteries submitted by AIBN PhD student Xiaobo Zhu from the Wang Group, this beautiful image was captured using a scanning electron microscope.

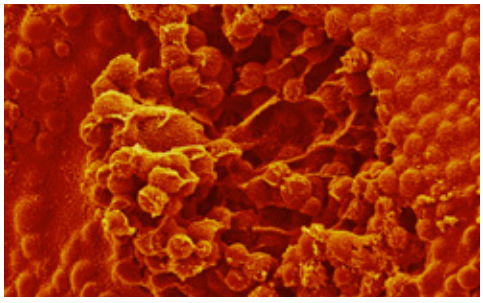
"Some people say it looks like a bouquet of flowers, others say it looks like a plume of feathers; I just know it's a striking image," Mr Zhu said.

"It's extremely difficult to isolate a single unbroken microcluster like this, so to capture this in an image was fortunate."

Throughout the year AIBN researchers also made media appearances in leading outlets across television, radio, newspapers and online platforms.






AIBN Seminar Series

February

Dr Pierre Savatier,
Stem cell and Brain Research Institutue, France
Naïve-like Pluripotency And Chimeric Competency In Primates And Rabbits

Professor Yoshide Hayashizaki
Director of RIKEN Preventative Medicine and Diagnosis Innovation Program (PMI)
The recent progress of FANTOM omics and its application to health care

March

Professor Rong-Jun Xie
Sialon Group, Sialon Unit, Environment and Energy Materials Division, National Institute for Materials Science (NIMS), JAPAN
Development Of Novel (Oxy) Nitride Phosphors As Spectral Converters In Solid State Lighting

April

Dr Joel Cherry
President, R&D Amyris
Crossing The Valley Of Death: Making Renewables Mainstream

May

Professor Jenny Martin
Director, Eskitis Drug Discovery Institute
The Athena Swan Pilot and What it Means for Australian Universities

Professor E.W. (Bert) Meijer
Institute for Complex Molecular Systems, Eindhoven University of Technology
Non-covalent Synthesis Of Functional Supramolecular Systems

June

Professor Trevor Douglas
Department of Chemistry Indiana University
Virus-like particles: Targeted diagnostic imaging and directed immune responses

Professor Heather Clarke
Vice Chair Department of Pharmaceutical Sciences at Bouvé College, Northeastern University
Building An Imaging Toolbox: Nanosensors For Biological Discovery

July

Professor George Whitesides
Woodford L. and Ann A. Flowers University Professor, Department of Chemistry and Chemical Biology, Harvard University
Soft Robotics

Professor Vince Rotello
Professor of Chemistry and a University Distinguished Professor at the University of Massachusetts at Amherst
Interfacing Nanomaterials With Biology: Applications In Therapeutics And Diagnostics

Professor Jan Van Esch
Department of Chemical Engineering, Delft University of Technology
Fuel-driven Active Materials

Professor Jerry Atwood
Curators' Professor and Chair of the Department of Chemistry, University of Missouri-Columbia
Crystal Form Control Via Gas Pressure

Professor Wilhelm Huck
Professor of Physical Organic Chemistry, Radboud University Nijmegen
Cells And Gels: Matrix Elasticity And Spreading Dynamics Regulate Cell Behaviour

August

Professor Hans Heus
Institute for Molecules and Materials, Biophysical Chemistry, Radboud University Nijmegen
What Four Building Blocks Can Do: The Challenge Of Understanding And Exploiting Nucleic Acids

Professor Claudia Kemper
Professor of Innate Immunology, Wellcome Trust Investigator, King's College London, Division of Transplant Immunology and Mucosal Biology
A Force From Within: Unexpected Roles For Intracellular Complement In Th1 Responses

September

Mr Michael Molinari (MCRF) & Dr Anthony Musumeci (Uniseed)
Through The Valley Of Death To Commercial Success – Taking Your Research To The Next Level

October

Professor Eric Bakker
University of Geneva
Nanoscale Phase Ion Transfer Reactions For Sensing Applications

November

Professor Bernd H.A. Rehm
Massey University, Institute of Fundamental Sciences
Synthetic Biology Towards The Self-assembly Of Functional Materials

Publications


310
Journal articles
1
Book
12
Book chapters

Book

Evans, D. J., Searles, D. J., and Williams, S. R. (2016) *Fundamentals of Classical Statistical Thermodynamics: Dissipation, Relaxation, and Fluctuation Theorems*, Wiley-VCH, Weinheim, Germany.

Book Chapters

Chan, L. C. L., and Reid, S. (2016) Development of serum-free media for lepidopteran insect cell lines, in *Baculovirus and insect cell expression protocols* (Murhammer, D. W., Ed.) Third edition ed., pp 161-196, Humana Press, New York, NY, United States.

Crichton, M. L., and Kendall, M. A. F. (2016) Nanopatches for vaccine delivery, in *Micro and nanotechnology in vaccine development* (Skwarczynski M., Ed.), pp 343-356, Elsevier, Oxford, United Kingdom.

Dal'Molin, C. G. O., and Nielsen, L. K. (2016) Algae genome-scale reconstruction, modelling and applications, in *The Physiology of Microalgae* (Borowitzka M. A., Beardall J., and Raven J. A., Eds.), pp 591-598, Springer International Publishing, Switzerland.

Hill, D. J. T., and Whittaker, A. K. (2016) Radiation chemistry of polymers, in *Encyclopaedia of polymer science and technology* (Herman, F. M., Ed.) 4th ed., pp *-*, John Wiley & Sons, (online).

Pile, K. D., Graham, G. G., and Mahler, S. M. (2016) Interleukin-12/23 Inhibitors: Ustekinumab, in *Encyclopedia of Inflammatory Diseases*, (Parnham, M., Ed.) pp 1-3, Springer, Basel Switzerland.

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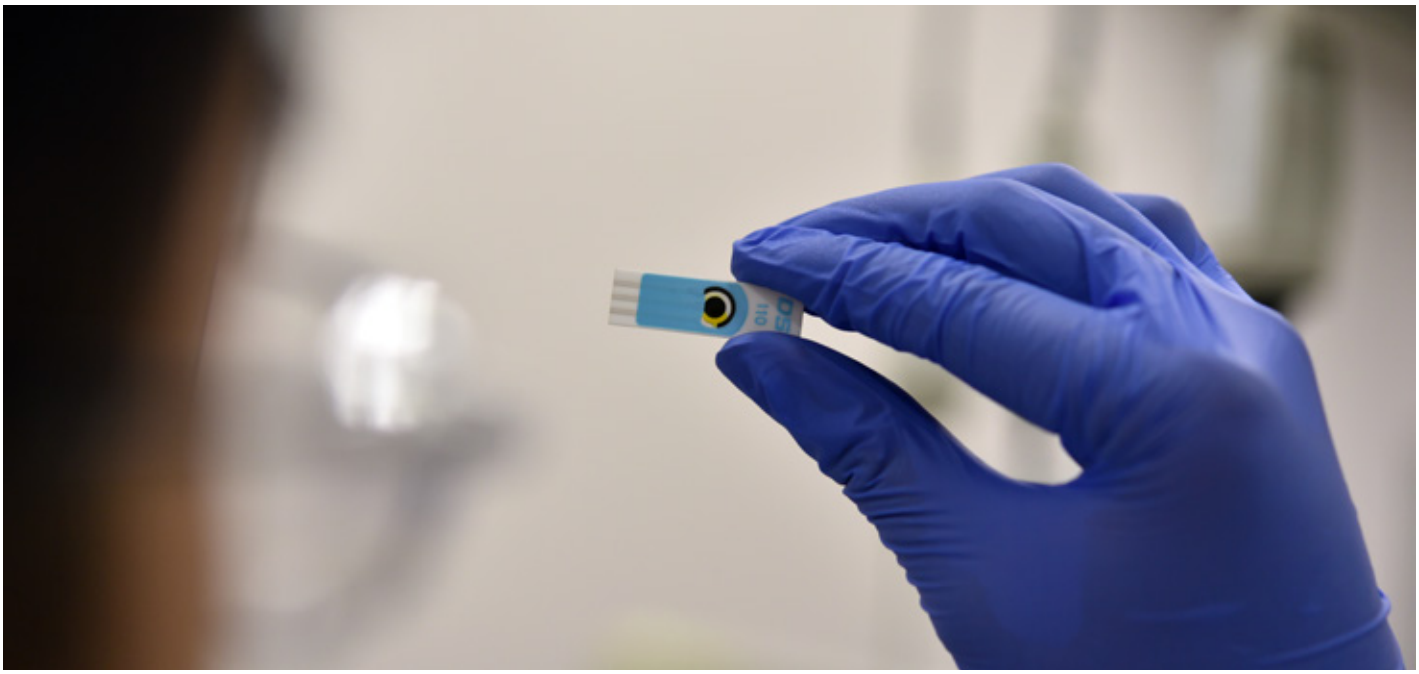

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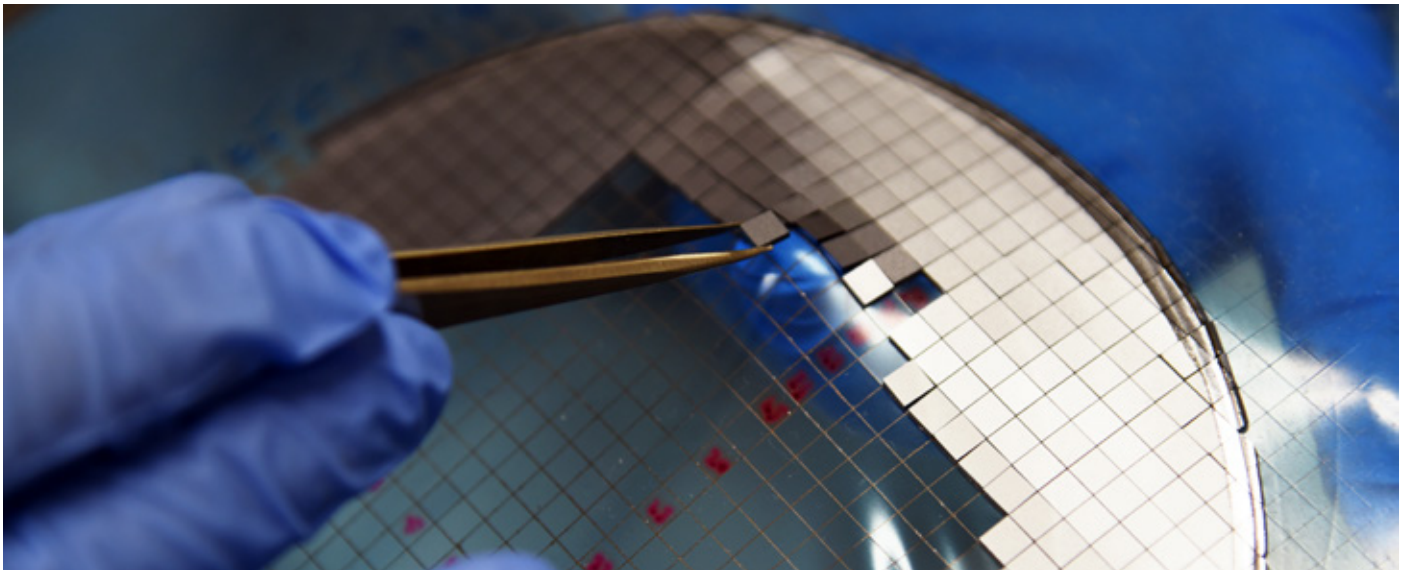

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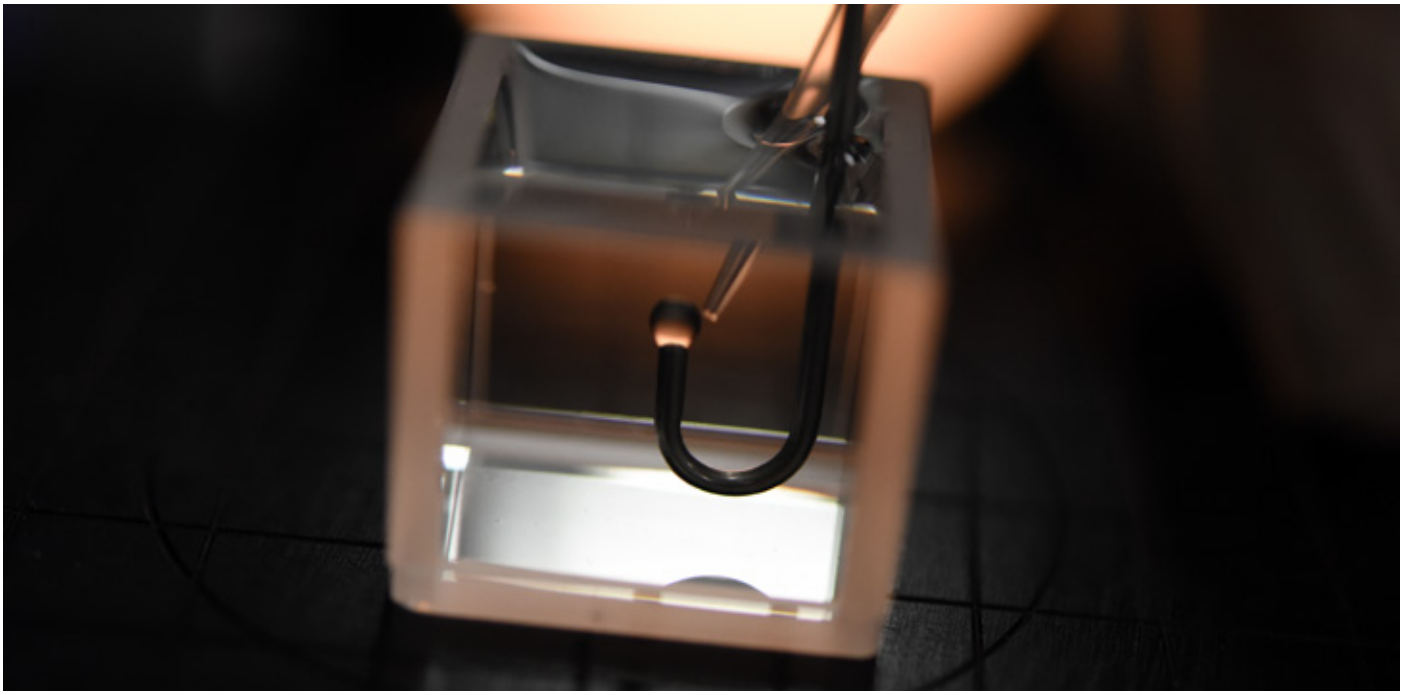

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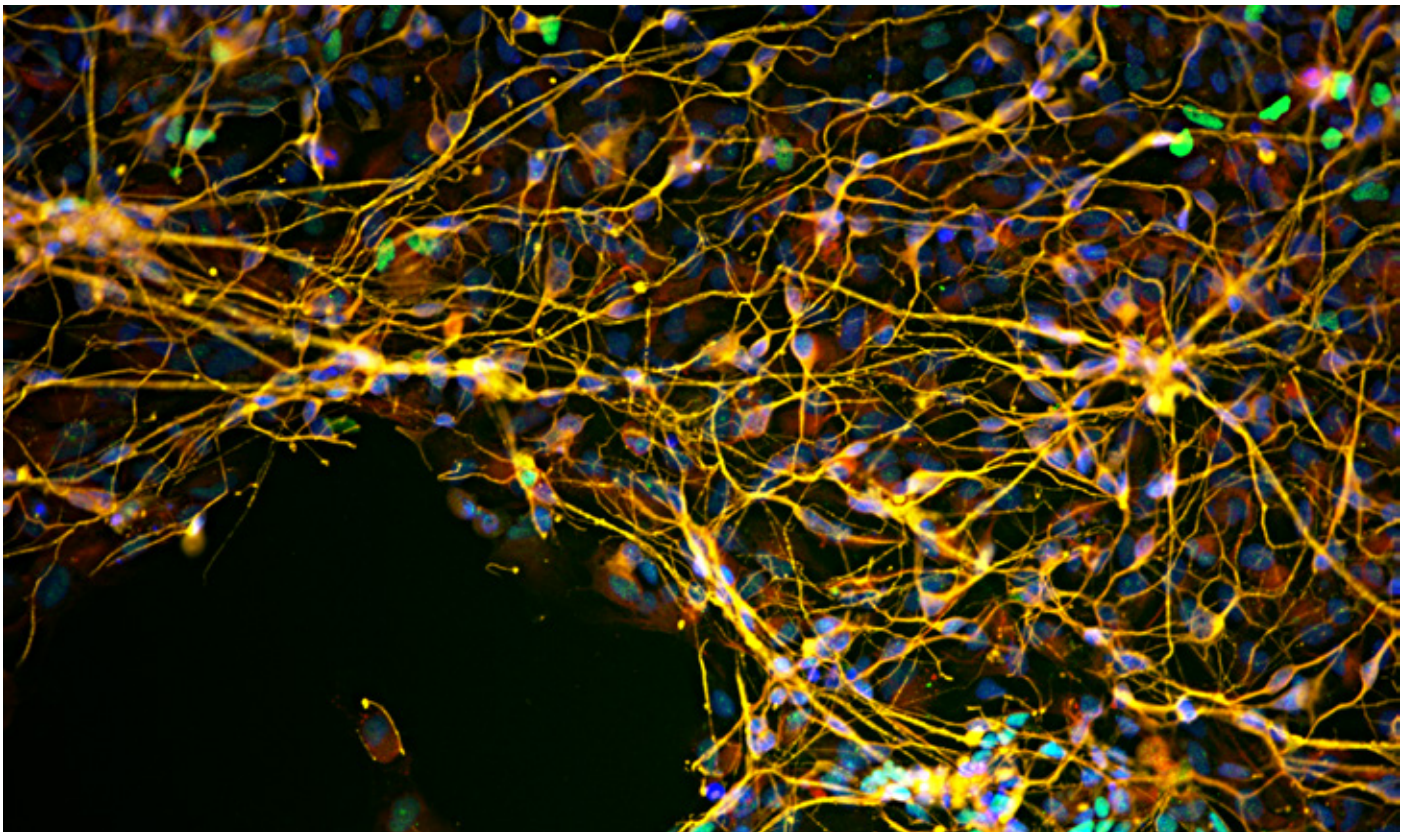
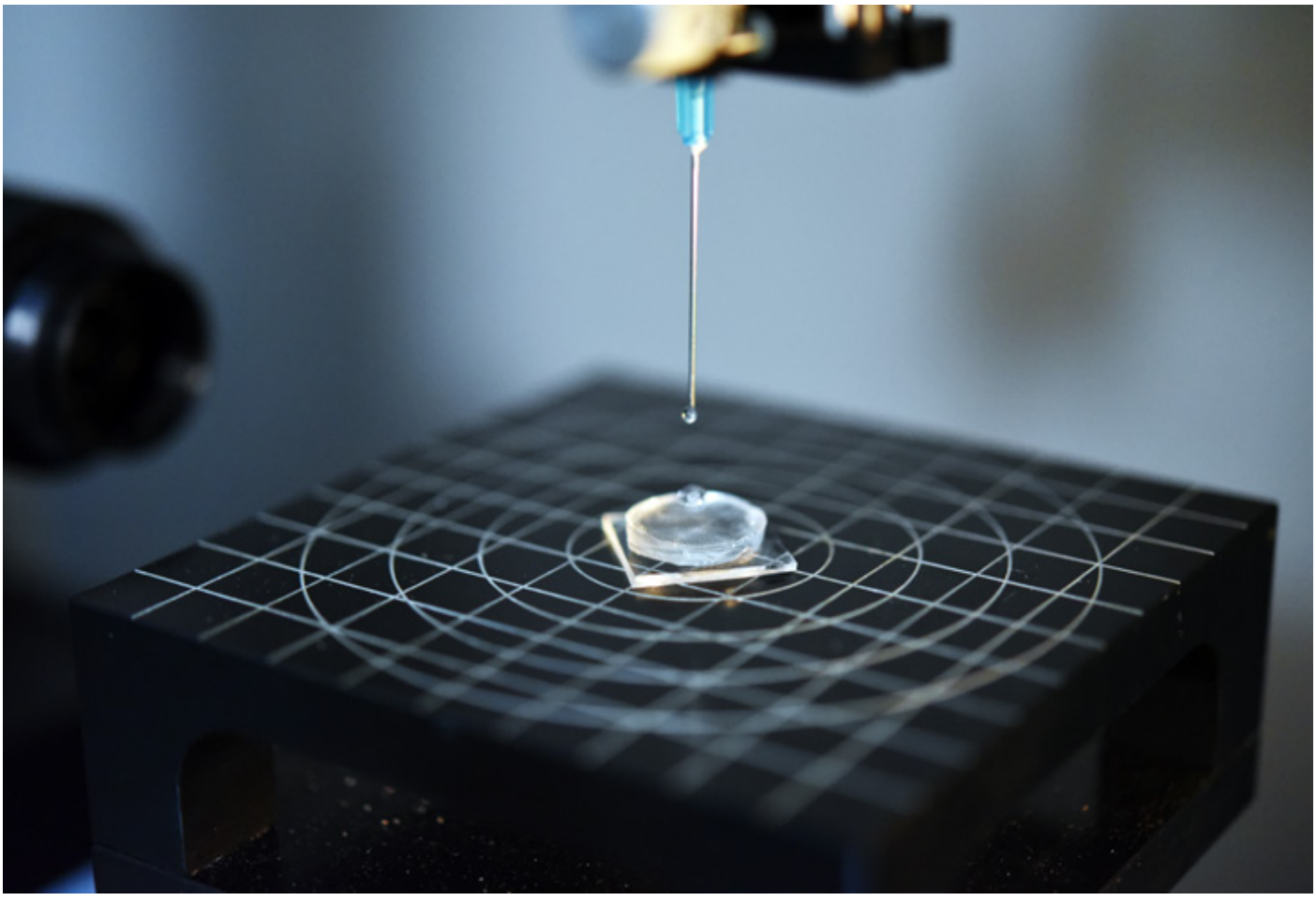


New Provisional Patents

Nanoparticle composition
Researcher: Michael Yu
Description: Scaffold particles for assembling clusters of quantum dots for display and lighting applications
UniQuest ref: PAT-02256

Detecting an analyte
Researcher: Michael Yu
Description: Scaffold particles used to construct labels for use in high sensitivity in vitro diagnostics
UniQuest ref: PAT-02252

Biosynthetic production of propionic acid
Researcher: Lars Nielsen
Description: Biosynthetic production of propionic acid
UniQuest ref: PAT-02251



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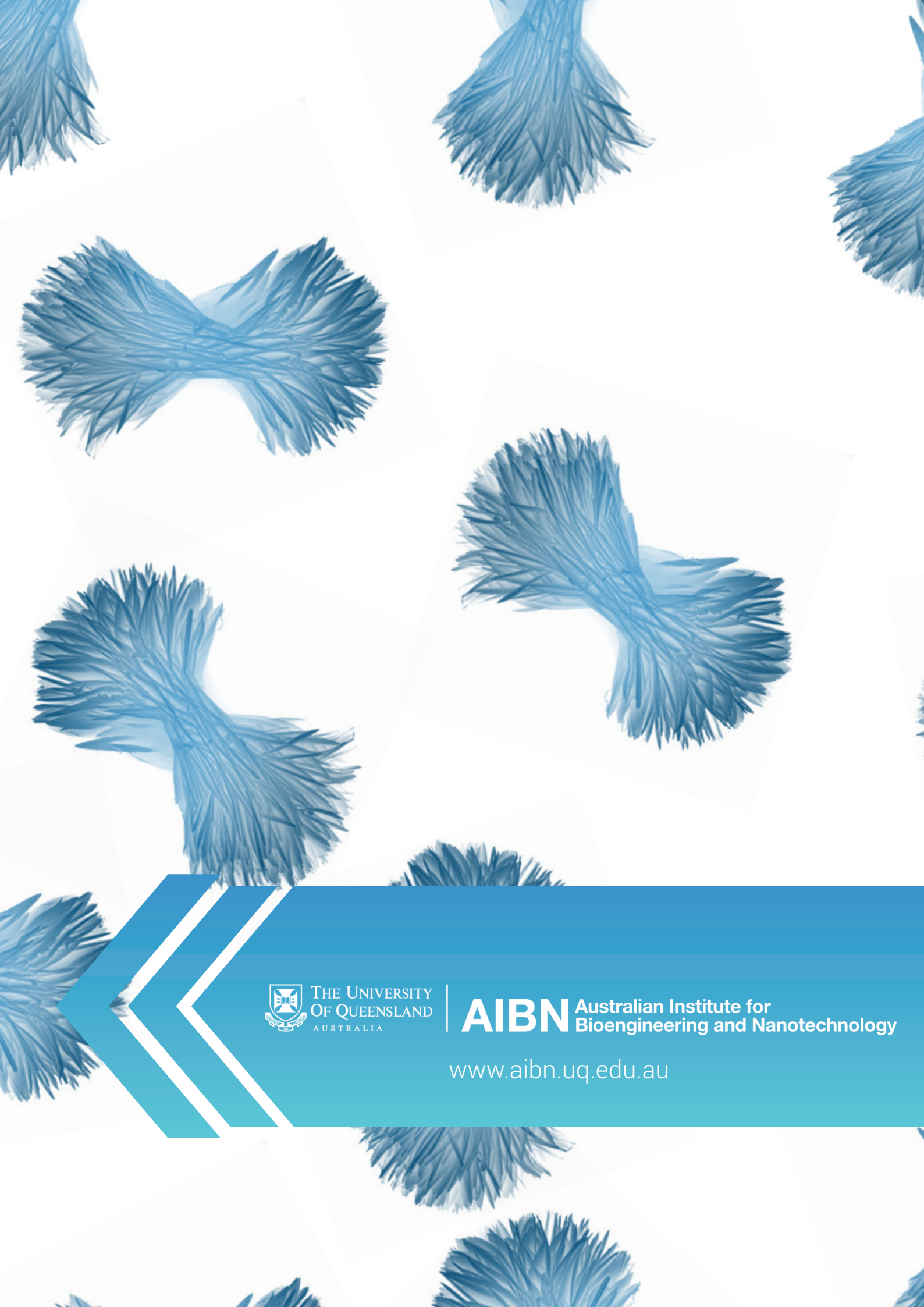

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