# AIBN

Australian Institute for Bioengineering and Nanotechnology

# Annual Report 2015

The University Of Queensland
AUSTRALIA

*Scanning electron microscopy samples undergoing preparation at the Centre for Microscopy and Microanalysis facility at AIBN.*

# AIBN Annual Report 2015


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*Cover image: A high density microfluidic array for rapid screening of cells under development in the Cooper-White laboratory.*

# VICE-CHANCELLOR AND PRESIDENT'S MESSAGE

With its proven record for propelling the outcomes of excellent research from the laboratory to end-users, AIBN is primed to be a heavy-lifter for national innovation and global problem-solving.

After more than a decade of increasingly robust associations with industry, 2015 saw the Institute and its partners continue to demonstrate the benefits and exciting potential of partnerships between strong researchers and innovative companies.

The AIBN again showed that it has both raw research power, and the capacity to translate this into great outcomes for society. The raw power is reflected in some of The University of Queensland's strongest scores in the Excellence in Research for Australia evaluation (published in December). AIBN contributed to six fields where UQ gained the highest possible rating of 'well above world standard' – including one field, industrial biotechnology, where UQ is the outright national leader.

Industry's appreciation of the downstream potential of this research is evident in AIBN's success in the vigorous contest for Australian Research Council Linkage Project grants. AIBN is involved in six new Linkage-funded projects, leading four of them. The industry-supported grants are worth more than $1.7 million in total.

An exciting example of downstream potential is exemplified by the Nanopatch, an original technology developed in the AIBN laboratory of Professor Mark Kendall. It is one of UQ's hot innovation prospects. In 2015 Vaxxas, the start-up that has grown around the invention, attracted $25 million in series B financing to bring its total capital raising to $40 million. The new funding will further the novel vaccine delivery device's progress towards clinical trials. Vaxxas has previously forged a partnership with pharmaceutical giant Merck & Co.

This annual report highlights many other notable 2015 developments. Among them are Professor Lars Nielsen's success in securing an $8.6 million Laureate Research Grant from the Novo Nordisk Foundation, and Associate Professor Zhi Ping "Gordon" Xu's receipt of $100,000 of philanthropic funding from China. In both cases, the funding supports work that strives to benefit cancer patients.

Crucially, AIBN staff do not only pursue their own research goals; they also impart their wisdom and experience to students. The resulting talent cycle is essential for national and global productivity and prosperity. It was therefore very satisfying to see AIBN pass the milestone of 100 PhD conferrals in 2015. The one hundredth graduate, Dr Nick Fletcher, is highlighted in these pages.

Just as young, exciting researchers begin riding the innovation escalator, so the seasoned veterans make way for others at the top. At the year's end, Professor Peter Gray retired as Inaugural Director of AIBN, having built it into an institute of international standing, respected by collaborators from leading global institutions, as well as leaders in business, government and philanthropy.

I look forward to working with Peter's successor, Professor Alan Rowan, an outstanding scientist and energetic leader who has joined UQ from the Institute of Molecules and Materials at Radboud University Nijmegen, a highly-regarded European centre for nanoscience research and training. With an impressive background in molecular systems, Alan is ideally placed to lead AIBN to its next stage of excellence and impact, where outstanding research and partnerships will continue to create advantageous change.

Effective leaders need focussed and energetic teams, and I am confident that is what Alan will find at AIBN.

In closing, I would like to thank and congratulate Peter and all AIBN staff, students, partners and supporters for another strong year, which will be the springboard to a great future.

**Professor Peter Høj**
Vice-Chancellor and President

# DIRECTOR'S MESSAGE


We live in exciting times as our ability to look down to and manipulate at the atomic scale allows for tantalising prospects. New scientific discoveries are made every day, and AIBN has proven to be one of the world leaders in turning these discoveries into applications for better health and sustainable solutions for energy, manufacturing and more. Many technologies developed under AIBN's roof play a significant role in shaping our society and environment for the better.

In 2015 with the stepping down of Inaugural Director Professor Peter Gray, AIBN saw the end of an era that started with its foundation in 2002.

I now have the honour to further develop this Institute with its proven reputation for research excellence, its world class facilities, and its talented cohort of more than 450 staff and students.

The Institute owes tremendous gratitude to Professor Peter Gray for his courage and dedication to join UQ and establish this incredible lasting legacy. I am excited to step into this role with the foundations well and truly established; the people in place, the research programs developed and infrastructure built. There are a great – and ever increasing – number of people who owe their careers and livelihoods to AIBN, and I hope Professor Gray takes great satisfaction in what he has achieved.

In 2015 the Institute saw further change, with two foundation Group Leaders departing. After an exceptional career Professor John Drennan retires, leaving the Centre for Microscopy and Microanalysis as his AIBN legacy. Professor Peter Halley's dedication saw him promoted to Head of School of Chemical Engineering at UQ. Furthermore, Professor Ajayan Vinu took up a Professorship at the University of South Australia. We wish them all well.

These departures bring renewed opportunity; for individuals to rise to the challenge of scientific endeavour, and for new ideas to flourish. Coming to AIBN with my external perspective from the Radboud University Nijmegen, Netherlands, in my opinion the Institute's greatest strengths are its dedication to applied research outcomes and the breadth and scope of the work undertaken. They are a truly unique and remarkable combination. I look forward to cultivating those strengths and building upon them.

Within the pages of this report you will find summaries of the work, achievements and success stories accomplished at AIBN during 2015. Reading it myself, I am enthused by the high quality of the work being accomplished. The year saw the Institute enjoy success in science, as well as in funding, awards and recognition. The achievements highlighted here are a credit to the researchers, students and support staff that make up this Institute.

I would like to particularly recognise the work of the AIBN Board, which has been ably chaired by Euan Murdoch, and fellow Board members Kathy Hirschfeld, Chris Lowe, Bob McCarthy, Susan Pond and Robyn Ward. Additionally, I would like to acknowledge the efforts and direction provided by the Scientific Advisory Board.

The support of the greater University of Queensland also deserves our thanks. Since my arrival to this university I have been pleased to see the collaborative nature UQ shares across its institutes, schools, centres and faculties, which I intend to further explore. The leadership of Professor Peter Høj (Vice-Chancellor and President), together with Professor Max Lu (Provost), Professor Robyn Ward (Vice-Chancellor (Research)) and Professor Anton Middelburg (Pro-Vice-Chancellor (Research and International)) has been pivotal in the success of the university in recent years, and fostering an environment in which AIBN has been able to thrive.

I look forward to a future in which AIBN will continue to turn ground breaking science into innovative applications, from advanced materials and diagnostic tools, to cures for important diseases and many more.

Close cooperation with medical professionals and industries will be key to achieving such goals, as is providing promising young academics with the entrepreneurial skills required to turn cutting edge science into successful products. The foundations for a dynamic AIBN, recognised around the world, have been laid. Now it is my challenge to enable it.

**Professor Alan Rowan**
AIBN Director

# AIBN BOARD

Following its establishment in 2011, AIBN has drawn on the interdisciplinary expertise of the Board whose collective experience spans industrial, corporate, research, government and academic sectors.

Together with the Scientific Advisory Committee, the AIBN Board plays a key role in the development and strategic planning of the Institute.

## 2015 Board membership

### Euan Murdoch (Chair)
Founder of Australian-owned Herron Pharmaceuticals, Mr Euan Murdoch has held positions including on the Australian Food and Grocery Council, the Complementary Healthcare Council of Australia, the Queensland Biotechnology Advisory Council, the Reserve Bank of Australia Small Business Advisory Board, Harvest Fresh Cuts Pty Ltd and Sigma Pharmaceuticals. In 2000, he received the Bicentenary Medal for services to the pharmaceutical and complementary healthcare industry.

### Professor Peter Gray
Inaugural Director of AIBN, 2003-2015. Professor Peter Gray has held positions at University of New South Wales as Director of the Bioengineering Centre and Professor of Biotechnology, and at the Garvan Institute of Medical Research as a Senior Principal Research Fellow. Professor Gray has had commercial experience in the US, working for Eli Lilly and Co and Cetus Corporation. He has held academic positions at the University College of London and the University of California, Berkeley.

### 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
Affiliated with 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 Chair of the AIBN 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.

### Dr Susan Pond AM
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 Robyn Ward AM
Deputy Vice Chancellor (Research) at UQ, Professor Robyn Ward has held roles including 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, and 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
- Assisting to maintain the high visibility and reputation of AIBN in research, industry, government and public domains.


AIBN Board Members (from left to right): Bob McCarthy AM, Professor Peter Gray, Kathy Hirshfeld, Emeritus Professor Chris Lowe OBE, Dr Susan Pond, Euan Murdoch, Professor Robyn Ward AM, Dr Zoe Cahill.

# SCIENTIFIC ADVISORY COMMITTEE

The Scientific Advisory Committee is comprised of renowned researchers from across the globe. The group are tasked with advising the AIBN Board and Director on scientific direction and research strategies.

This highly skilled group are leaders in their fields, and are at the forefront of scientific research. Their combined expertise and knowledge is a valuable source for AIBN to use for maintaining its leadership position.

## 2015 Committee membership

**Professor Chris Lowe (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 activities
- Assist in providing global visibility for AIBN activities
- Propose strategies for training and developing researchers and research students to build scientific capacity and capability in a multi-disciplinary, global environment.

# AIBN RESEARCH

# SYNTHETIC BIOLOGY DRIVES DIAGNOSTIC CARE

## Focus

The Alexandrov Group uses protein engineering to build entire biological expression systems using standardised biological blocks that can be integrated with electronics for application in diagnostics and analytics.

"Most of our work is centred on signal detection and signal propagation. A key challenge is to detect and recognise biomarkers of disease, which appear as very weak biological signals in a very noisy, chemically similar background," Professor Alexandrov said.

Spin-out company Molecular Warehouse Ltd has been established to further develop and commercialise this research, focussing on point-of-care diagnostics that could, much like glucose monitors for diabetics, enable individuals to extract and analyse their own biological data.

One stream of research is developing point-of-care sensors for monitoring immunosuppressant drugs given to organ transplant recipients. The therapeutic window for delivering these drugs requires extreme precision; over-dosage will shut down the immune system and the patient dies from infection, and under-dosage can lead to the body rejecting the organ. The group has shown the sensors can detect clinically relevant levels of immunosuppressant drug Sirolimus, and is currently investigating detection of other commonly used drugs Tacrolimus and Cyclosporin.

In further work, the group are developing electrochemical sensors that could rapidly extract biomarkers from blood, saliva, urine or sweat to allow quantitative measurement of markers of various psychological and physiological conditions.

"One application area is detecting stress levels, which would be particularly important for monitoring people in professions subjected to high levels of stress that can drastically impact their work and the people they interact with as a part of their duties," he said.

## Highlights

Of the many scientific publications produced by the group in 2015, two were seminal papers. An article in the *Journal of the American Chemical Society* used *in vitro* protein synthesis using semi-synthetic tRNAs to formulate all 20 common amino acids. A separate paper in *Chemical Communications* was the first to demonstrate a functional electrochemical biosensor for human saliva using a repurposed glucometer, which used Ca2+ to electrochemically activate the sensor.

An international collaboration was established with the laboratory of Professor Andreas Plückthun at the University of Zurich, Switzerland. As international leaders in DARPin (designed ankyrin repeat proteins) research, the Plückthun Laboratory collaboration will assist the Alexandrov Group to develop a pipeline for creating DARPins that can be used for cell signalling and receptor binding.

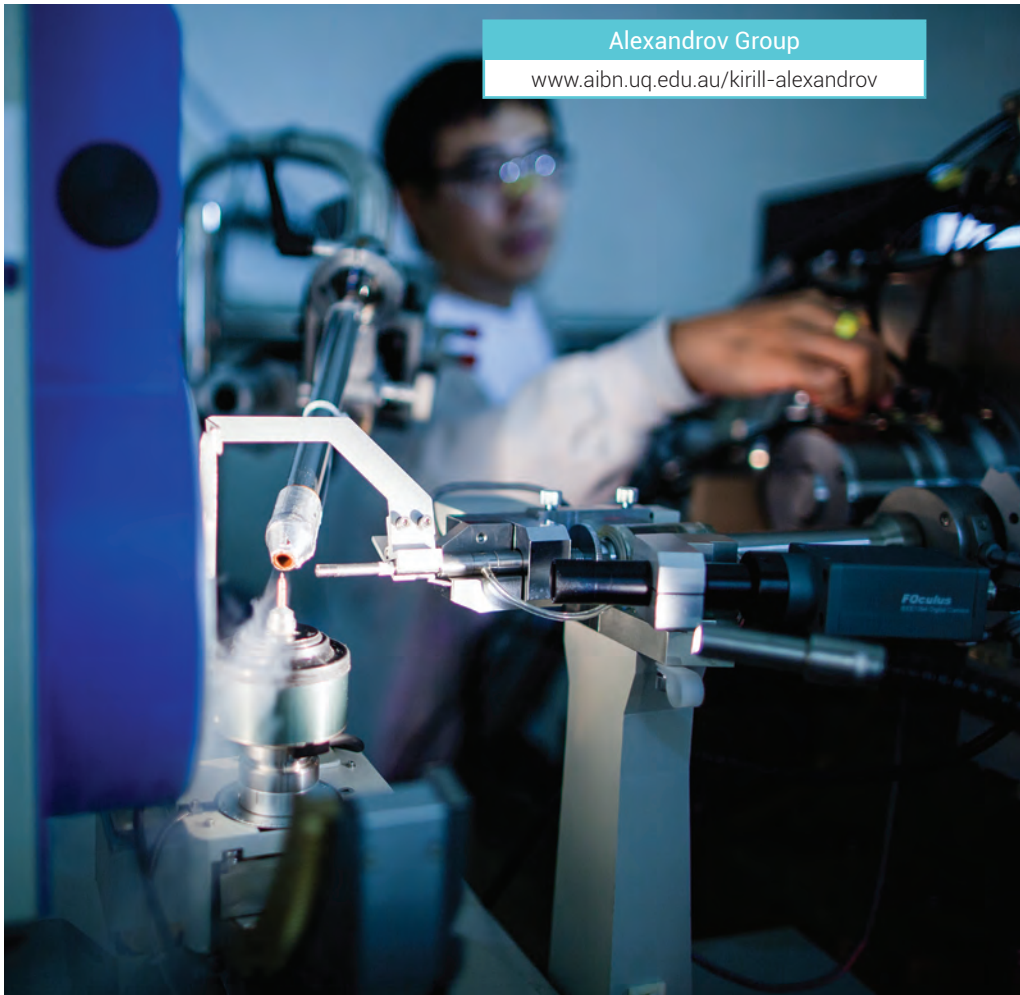
Major funding success in 2015 included an ARC Linkage Project with industry partner Phylogica Limited for research studying the generation and screening of highly diversified macrocyclic peptide libraries for use in pharmaceuticals. Additionally, an ARC Discovery Project will aim to develop a new class of electrochemical biosensors using artificial protein receptors.

A three year NHMRC Development Grant was also awarded to further develop the Group's work in point-of-care diagnostics for monitoring the concentration and uptake of immunosuppressant drugs.

"Over the last eight years we have had a 100 per cent success rate with securing ARC Discovery Project grants we have applied for, so we know our work is being recognised for its need and output," he said.

Professor Alexandrov's work was further acknowledged during the year with an Innovator and Vision in Research Award from the National Breast Cancer Foundation (NBCF). This follows on from the award of an NBCF Innovator Grant in 2014 for research on point-of-care biosensors for detection of relapse in breast cancer patients.

"We are still in the early days of our work with the NBCF, but I feel there is a compelling narrative there for the patient having more control over their condition," he said.



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

# USING THEORETICAL AND COMPUTATIONAL SCIENCE FOR NANOMATERIALS AND FLUIDS

## Focus

The Bernhardt Group develops theory and algorithms, and uses computational modelling to develop new materials and enhance the properties and capabilities of existing materials.

Utilising high performance computing, including a cluster housed at AIBN, the group models how materials, chemicals and biologics interact with each other.

Professor Debra Bernhardt said a prime example of the group's work is its study of rechargeable batteries. Through computational modelling, the team is calculating how much lithium can be loaded onto an anode, how strongly it will bind, and how quickly it will diffuse.

Different cathode and electrolyte materials are also being studied as part of this process, and a paper published in *The Journal of Physical Chemistry C* highlighted the importance of the membrane structure and composition in determining its capacity.

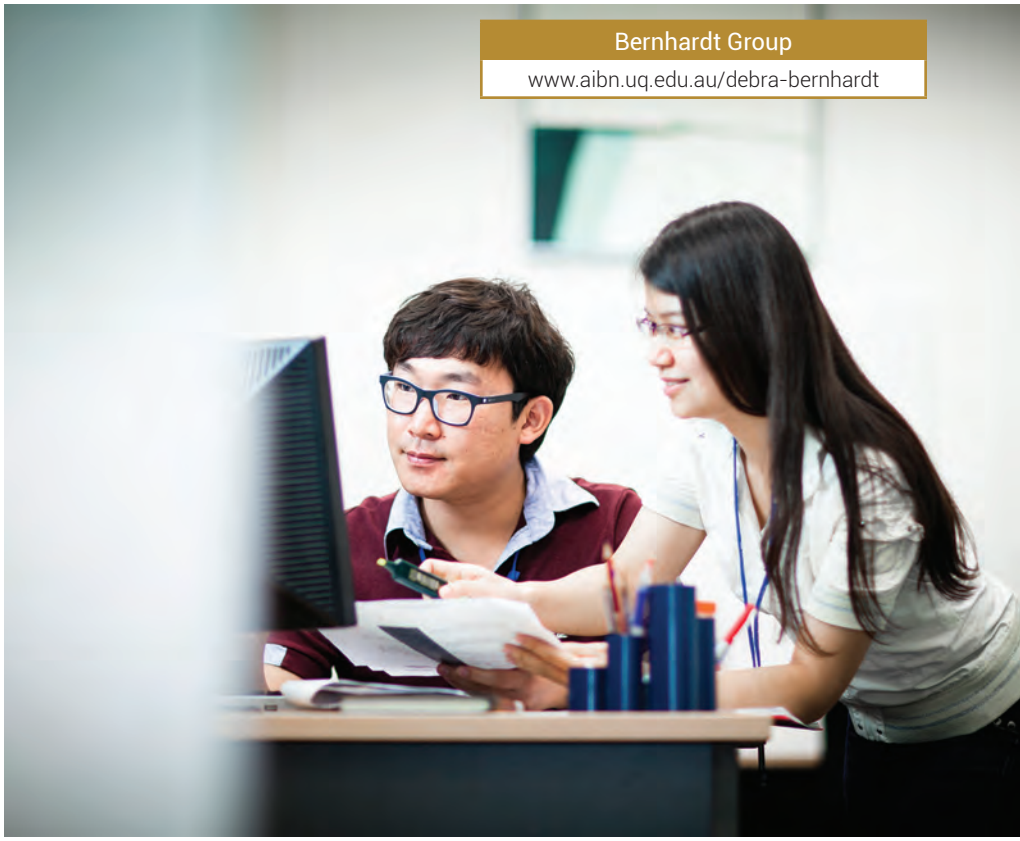
"These relationships between materials help determine how long the battery will last in one cycle, as well as how many cycles of discharge and charge can occur through the battery's life," Professor Bernhardt said.

Further research was focussed towards optimising the effectiveness of materials used in water desalination by studying the diffusion of water through zeolites, which act as reverse osmosis membranes. Work published in the *Journal of Membrane Science* found one dimensional cylindrical pores can result in higher rates of diffusion.

"Atomic level modelling of the diffusion of water and exclusion of ions for different zeolites can predict which zeolites would be the most effective at desalinating water," she said.

At a fundamental level, the Bernhardt Group made a major breakthrough with the development of a new understanding of how systems relax to steady states, and these new theoretical relationships have been verified for the study of flow far from equilibrium.

Standard theories do not apply to nonequilibrium systems and interesting phenomena can be the direct result of the nonequilibrium nature of the system – for instance, the alignment of polymers in solutions that are being sheared – leading the Bernhardt Group to develop theories and algorithms to model nonequilibrium systems and investigate their behaviour at the molecular level.



Bernhardt Group

www.aibn.uq.edu.au/debra-bernhardt

Professor Bernhardt also leads the AIBN Centre for Theoretical and Computational Molecular Science (CTCMS). The Centre has high throughput computational facilities, and leads collaborative activities with a number of UQ schools and centres in the areas of algorithm development, materials, fluids, and biomolecular systems.

## Highlights

During the year Professor Bernhardt received a Window of Science Award from the United States Air Force, supporting her to visit NASA and the Langley Air Force Base laboratories.

The award was enabled through a continuing study funded by the Asian Office of Aerospace Research and Development (AOARD) – an arm of the Air Force Office of Scientific Research – for research into the reinforcement of metals such as aluminium and titanium with boron nitride nanotubes to reduce the overall weight and increase strength.

"The problem with any type of reinforcement, however, is that if it slips or corrodes, it will degrade the strength to a level that was lower than it was originally, so we are investigating how to alleviate this," Professor Bernhardt said.

The year also saw the Bernhardt Group commence new interdisciplinary projects with AIBN colleagues Professors Andrew Whittaker and Chengzhong (Michael) Yu.

Work established with the Whittaker Group is investigating how temperature fluctuations can influence the structure of polymers and molecules, and determine how the molecular structure can influence the ability of a molecule to sit at interfaces between liquids such as oil and water. The collaboration with the Yu Group will research the mechanism by which surfactant molecules form micelles, and the passage of molecules into the micelle for the synthesis of porous nanoparticles.

In 2015 the group also oversaw the launch of a new high performance computational facility, established with $275,000 of funding received through the UQ Major Equipment and Infrastructure scheme.

The dedicated machine has greatly enhanced throughput capability - allowing calculations that provide immediate access to high performance modelling and computations (full story page 33).

# BIOMATERIALS DEVELOPMENT AND DISCOVERY FOR REGENERATIVE MEDICINE

## Focus

The Cooper-White Group is focussed on improving health outcomes by utilising biomaterials in regenerative medicine to assist the body's ability to heal beyond its natural limits.

Led by Professor Justin Cooper-White, the group studies novel methods to promote tissue regeneration in the bone, heart, intervertebral discs and the meniscus.

"The body is quite remarkable in its ability to heal itself. However, those capabilities only extend so far, and we are looking at ways to promote further regenerative healing," Professor Cooper-White said.

One strategy the laboratory is investigating is the development of novel biomaterials that can direct stem cells to turn into the desired tissue end points.

During the year the group focussed on *in vivo* validation and assessment of its methods using animal models.

"We have large animal trials in sheep currently in progress, assessing the efficacy of our hydrogels to elicit chondrogenesis locally to repair cartilage within the intervertebral disc," he said.

Future large animal model trials will utilise porous scaffolds which have been developed and modified by the laboratory to promote meniscal repair.

Their engineered hydrogels are also being applied to promote repair in cardiac tissue. Trials in mice are investigating whether hydrogels developed by the Cooper-White laboratory have the ability to stimulate cardiac repair by delivering small therapeutic molecules. Further potential applications for these gels will be to study their suitability for meniscal repair.

Separately, microfluidic and micro-bioreactor technology is being developed that screens soluble environments to identify the optimal setting required for cellular growth in tissues. Thousands of factors can be tested simultaneously using a nested fluidic circuit that trials different chemical configurations of growth factors.

"Our microfluidic technology could accelerate the development of new media to discover new molecules that can enhance the differentiation process of cells," he said.

The research team looks to apply that knowledge to the earliest stages of cellular development from pluripotent stem cell starting points, and guide their specification into kidney, cardiac and other tissues such as cartilage and skeletal muscle.

Similarly, the group is continuing research into kidney genesis using directed differentiation of human embryonic stem cells as kidney progenitors.

Cooper-White Group
www.aibn.uq.edu.au/justin-cooper-white

## Highlights

In 2015 the Cooper-White Group was successful in achieving both philanthropic and competitive grant funding.

"We were very excited to receive philanthropic support to test our biomaterials system in large animal trials. We really want to acknowledge this valuable support, as it will enable us to generate essential data to support our case of advancing this technology to pre-clinical trials in humans," Professor Cooper-White said.

An NHMRC Project Grant will support research to deliver targeted nanoparticles containing genetic material to repair cardiac cells that have been damaged through ischemic heart disease, which accounts for 15 per cent of Australian deaths every year. The project aims to transform a patient's damaged cardiac fibroblast cells into functional cardiomyocytes *in situ*.

Publication highlights from the year included a paper in *Biomacromolecules*, which highlighted a significant improvement in the lifespan of self-assembled pseudopolyrotaxane hydrogels from a few hours up to one week. The team achieved this result by introducing an enzymatically mediated chemical bond with a branched eight-arm poly(ethylene glycol) linked to the hydrogel structure to improve its environmental resistance. A review article was also published in *Stem Cells Translational Medicine* on the topic of tailoring bioengineered scaffolds for stem cell applications.

Professor Cooper-White received recognition from Queensland Life Sciences – accepting the 2015 Aon Risk Solutions Regenerative Medicine Award. Separately, he was elected to the Queensland Academy of Arts and Sciences, where he joined fellow AIBN Group Leader Professor Matt Trau and retired Group Leader Professor John Drennan.

Professor Cooper-White holds a joint appointment with the CSIRO as an Office of the Chief Executive Science Leader, and is Director of the Australian National Fabrication Facility - Queensland Node.

# MAMMALIAN CELL EXPRESSION AND BULK STEM CELL CULTIVATION

## Focus

The Gray Group is developing novel methods to reduce the cost of producing monoclonal antibodies for therapeutics, and significantly boost the production yields of stem cells for use in regenerative medicines.

Professor Peter Gray said many modern pharmaceutical products rely on complex recombinant proteins, most of which are manufactured in mammalian cell culture.

"The cost of supplying these is very high, however, given their efficacy such products now make up seven out of the top 10 selling pharmaceuticals globally," Professor Gray said.

"Australia alone is spending billions of dollars on therapeutics such as these under the pharmaceutical benefits scheme, and a lot our work is in developing ways to lower the manufacturing cost of these drugs."

In collaboration with the Nielsen and Mahler Groups at AIBN, continued research in improving production yields of therapeutic monoclonal antibodies (mAb) using Chinese hamster ovary (CHO) cells as a host was published in *Metabolic Engineering Communications* and the *Journal of Proteome Research* in 2015.

This research program using CHO cells produced a four-fold improvement in mAb yields and six-fold improvement in culture volumes. These results demonstrate economically significant advances to reducing the production costs of high-expression cell lines.

In further work, the Gray Group combined their expertise in stem cells with the Monteiro Group's knowledge of materials to address the significant challenge of achieving desirable properties when growing these extremely fastidious cells.

The Monteiro Group has developed a thermo-responsive polymer that allows an aggregate of cells to stick together and promotes cell growth and replication at 37°C. When followed by a reduction in temperature, the aggregates divide when subjected to mild shear forces.

"By raising the temperature again, the smaller aggregates of stem cells once again grow into larger aggregates. By repeating the process you get an exponential increase in cell yield using very benign conditions which the cells tolerate well."

The team hopes to initially use stem cells for treating injured heart muscle with a differentiated progeny as cardiomyocytes. Another application area being investigated is their use as neural progenitor cells, which have been difficult to produce, but there are hopes that the thermo-responsive polymer method developed by the Gray and Monteiro Groups could resolve this challenge.

## Highlights

During the year the team was involved with the Phase I clinical safety trials of the m102.4 Hendra virus antibody which it assisted in producing for Queensland Health, with the trial progressing well.

Outbreaks of Middle East respiratory syndrome (MERS) also led to collaborative talks between Queensland Health, AIBN, and US collaborators. The US researchers from the National Institutes of Health, who were involved in the initial development of the anti-Hendra virus antibody, have now developed a monoclonal antibody against MERS (full story on page 30).

The year also saw philanthropic research funding from the Merchant Charitable Foundation and the JEM Research Foundation enable the laboratory to expand its efforts in understanding how it will be possible to take the work with the thermo-responsive polymers and develop scalable processes which will allow sufficient stem cells to be produced for future clinical applications.

The group's expertise led to a new collaboration being established with Translational Cell Imaging Queensland at the Translational Research Institute, which will investigate methods for high density 3D imaging of cell aggregates and examine their organisation.

In December Professor Gray took the esteemed position of Interim President of the Australian Academy of Technological Sciences and Engineering (ATSE), one of four learned Academies in Australia. Professor Gray, who served on the ATSE board for six years, replaced Dr Alan Finkel who was appointed as Australia's Chief Scientist.

**Gray Group**

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

# BIOPOLYMERS AND STARCH FOR A CHEAPER, CLEANER FUTURE

## Focus

The Halley Group are leaders in the field of biopolymer processing, with strengths in developing materials with lower carbon footprints.

This year saw the group led by Professor Peter Halley embark on a number of new research programs.

"Traditionally our work has been in starch polymers for use in films and packaging, but a number of new opportunities have arisen from what we had learned from that research," Professor Halley said.

In the first of those new areas is research into bio-based composite materials led by Dr Bronwyn Laycock.

"This has created a whole different area of composite materials that combines a polymer with a fibre to create a stronger material," Professor Halley said.

Dr Laycock led new projects in 2015 at the UQ School of Chemical Engineering, the UQ Dow Centre for Sustainable Engineering Innovation and the QLD Advanced Materials Processing and Manufacturing (AMPAM) Centre. One stream of research, with findings published in *Water Practice and Technology*, is evaluating the economic feasibility of using polyhydroxyalkanoate (PHA) biopolymers derived from wastewater treatment for value-added use in the production of biodegradable plastics.

Another new area of research is investigating whether the hydrophilic nature of abundant starch is suitable for use in extractive metallurgy to separate minerals from their ore. Led by Dr Paul Luckman, the work is being undertaken with industry partner Manildra Group in Nowra, NSW.

Current extraction techniques use synthetic chemicals to separate minerals from their ore. While existing methods are effective, they are costly due to the expense of the chemicals – a cost that is more pronounced while commodity prices are low.

"Our work has been very promising, but we are still looking to understand exactly why this process works, and whether we could apply it to other areas," Professor Halley said.

The group is further investigating the use of starches for improving the adhesive properties of glues on cardboard to develop stronger and more robust packaging.

## Highlights

During the year Professor Halley's spin-out company Plantic Technologies, which produces biodegradable plastic packaging from corn starch, was purchased by Japanese company Kuraray Co. Ltd following 20 years of research and more than $75 million in venture financing.

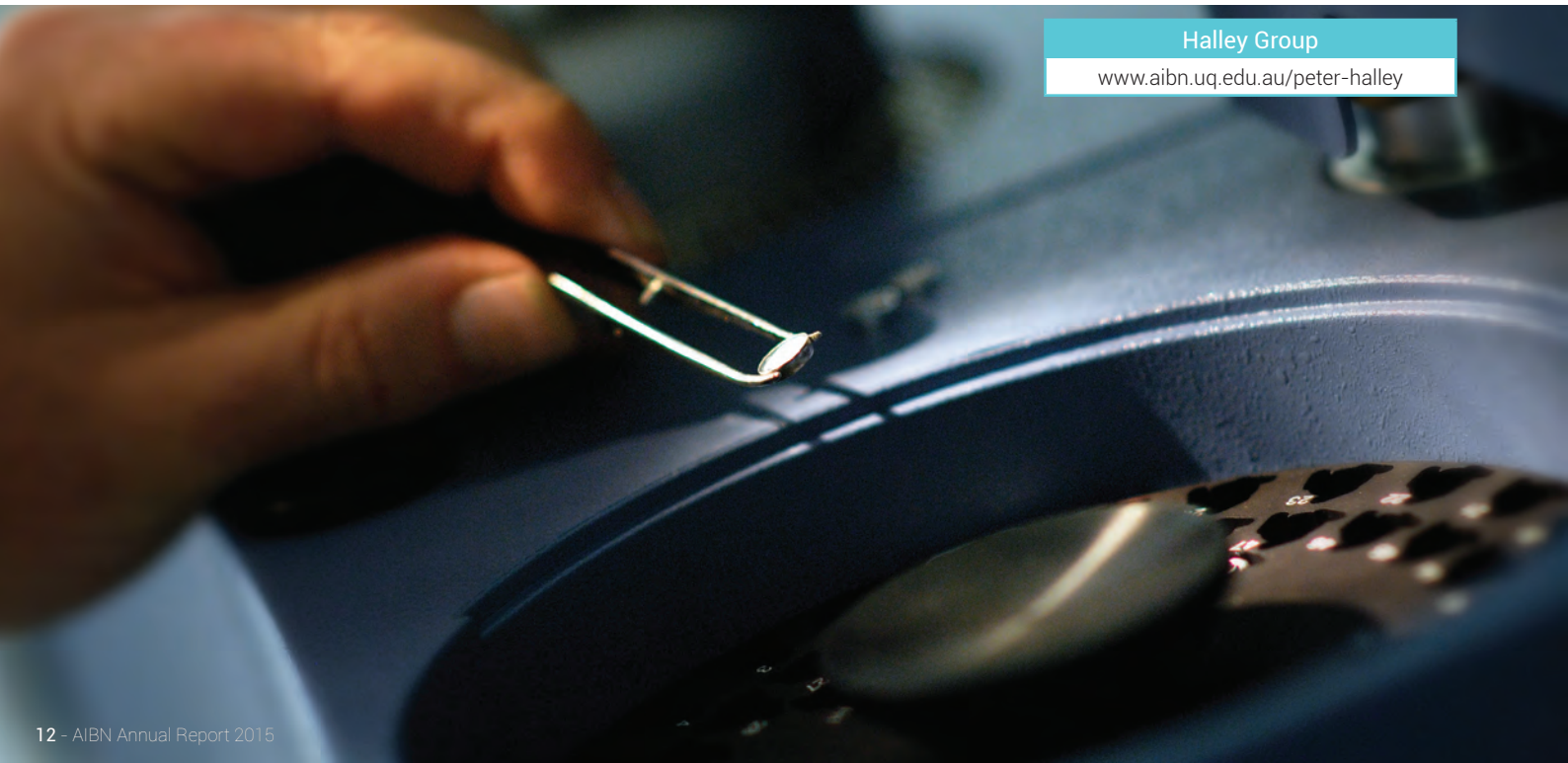
"The company was spun-out in 2001, and started funding the group with PhDs and projects to continue the research and development, alongside the company's strong domestic and international growth," Professor Halley said.

"The acquisition of Plantic Technologies is truly an example of commercial success being led by university research."

Dr David Fengwei Xie from the Halley Group has also played a leading role in strengthening the laboratory's international linkages, with collaborations formed with the South China University of Technology (SCUT) and the University of Strasbourg, France.

The productive collaboration has involved joint students, laboratory exchanges and joint publications, including a paper published with SCUT in *Innovative Food Science and Emerging Technologies* on the pasting properties of mechanically modified high-amylose corn starches. Dr Xie's work is centred on new biopolymer systems such as chitin and the use of ionic liquids as novel biopolymer plasticisers.

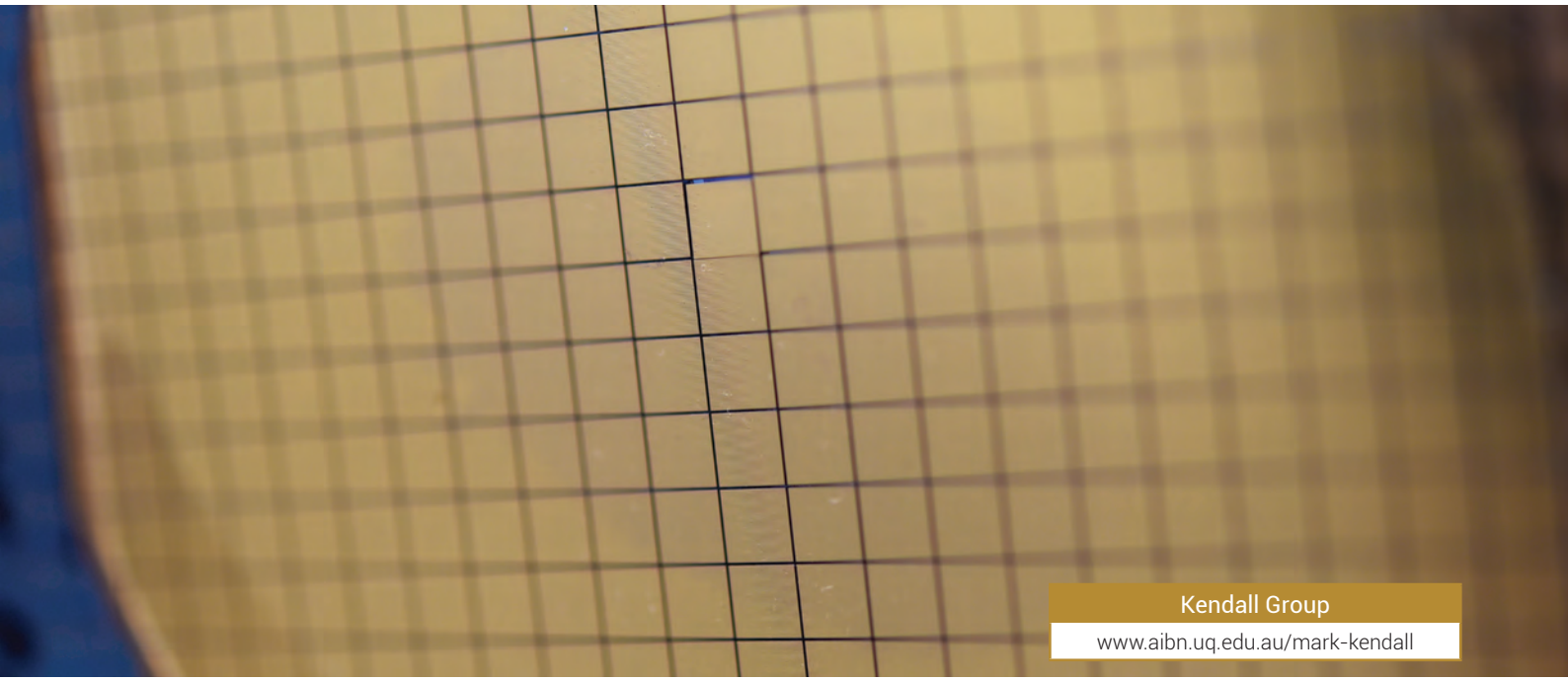
Following his appointment as Head of the UQ School of Chemical Engineering, Professor Halley has transitioned his work to the School-based AMPAM Centre.



**Halley Group**

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

# GENE AND DRUG DELIVERY AND DIAGNOSTICS THROUGH THE SKIN



Kendall Group

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

## Focus

The Delivery of Drugs and Genes Group is prompting the world to rethink the role of the needle and syringe as a method of both introducing vaccines to the body and extracting biological material.

Group Leader Professor Mark Kendall is inventor of the patented Nanopatch technology, which has many important benefits over the more than the needle and syringe, which – more than 160 years after it was first invented – is still the main way vaccines are administered.

"The Nanopatch has the potential to significantly improve the reach of effective vaccines, by overcoming key limitations of the needle and syringe," Professor Kendall said.

Because the Nanopatch is designed to target the immune-rich cells of the skin's outer layers (the epidermis and upper dermis), it offers improved immune responses, compared to the needle which puts vaccine into muscle (which has comparatively fewer immune cells). It does this with an array of thousands of micro projections – invisible to the naked eye – on a single patch.

Vaccines are dry-coated onto the patch, helping to eliminate the need for the vaccine cold chain which is both expensive to maintain, and risks being broken in underdeveloped regions that have poor access to electricity networks.

"In animal studies, we have shown the Nanopatch generates equivalent and protective immune responses as the needle and syringe (into muscle), but with only small fraction of the delivered dose (e.g. 1/100th). Steps are underway to translate this to humans," Professor Kendall said.

Professor Kendall founded Vaxxas in 2011, with the aim of taking the Nanopatch through clinical testing and along the commercial pathway to a product in market.

Vaxxas are scheduled to conduct vaccination clinical trials with Nanopatches in 2016. The technology has also been licenced to Merck & Co for the development of further vaccines to work in conjunction with the Nanopatch.

## Highlights

Working with the World Health Organisation, US Centres for Disease Control and Prevention and Vaxxas, Professor Kendall's team has been testing the utility of polio vaccines with Nanopatches. They have shown that in rats, using just a fraction of the dose that is required with a needle and syringe, the Nanopatch generates functional immune responses (publication in *Scientific Reports*).

Furthermore, the group published work in *Vaccine* highlighting the first use of a pneumococcal-conjugate vaccine delivered using micro projections, achieving through targeted delivery to the skin improved functional immune responses compared to the needle and syringe. Pneumonia is a leading cause of death in children globally under the age of five, and was estimated to cause more than 900,000 childhood deaths in 2015.

Moving from vaccination to disease diagnosis, the group advanced a micro projection technology which selectively extracts biomarkers from the skin – with minimal invasion – for the detection of disease. Work published in *Biointerphases* demonstrated *in vivo* application of the system with successful detection of the dengue NS1 disease biomarker (full story page 32), followed by new insights into how to gain access to blood through the use of physical stress in the skin (published in *Biomaterials*).

The group's line of research inquiry extends at the interface of biomaterials and immunology, including 3d printing of microstructures, their utility in epithelial tissues and the interrogation of key interactions (e.g. with systems biology and proteomics).

In 2015 Vaxxas secured a further $25 million in Series B venture financing to extend the development of the Nanopatch for further clinical platforms and vaccines for diseases.

# BIOLOGICS FOR MEDICAL APPLICATIONS

## Focus

The Mahler Group is working in drug discovery and development, principally researching biologic medicines and nanomedicines for the treatment of human disease.

The research led by Associate Professor Stephen Mahler has a focus on the discovery of new therapeutic proteins, as well as developing drug delivery platforms to precisely target cancer cells.

"In particular we are focussing on therapeutic and diagnostic applications of antibodies and antibody derivatives, which are engineered proteins built from monoclonal antibodies," Associate Professor Mahler said.

"The approach of using nanoparticles laden with drugs targeted at tumours, with our antibodies on the surface, provides an added targeting capability to drug-loaded nanomedicines."

The work is being primarily applied to the development of antibody-targeted nanomedicines and theranostics, with a number of influential collaborations advancing the Mahler Group's research.

**Mahler Group**
www.aibn.uq.edu.au/stephen-mahler

## Highlights

A provisional patent "Targeting Constructs for the Delivery of Payloads" with co-inventor Dr Chris Howard was filed in April 2015 and has advanced to the PCT stage to provide international legal protection. The invention is associated with the discovery of systems for the targeted delivery of nanoparticles to cells using bispecific antibodies (BsAbs). The technology will be used to target promising prostate cancer antigen MIL38 in a new partnership with Minomic International Ltd. The work also offers hopes as a pancreatic cancer therapy.

"We had an existing relationship with Minomic International Ltd through prior work, and we were very happy to secure an ARC Linkage Project grant with them led by Associate Professor Kristopher Thurecht to continue our research," Associate Professor Mahler said.

Related work utilising BsAbs saw the group's involvement in a successful NHMRC Project Grant with Associate Professor Kristopher Thurecht on immuno-polymeric drugs for prostate cancer therapy. Associate Professor Mahler also led a paper published in *mAbs*, which investigated nanocell targeting using engineered BsAbs, which enabled enhanced tumour regression by 40 per cent.

In other work associated with antibody research and development, an international (PCT) patent application "CD83 antibodies and use thereof" entered the national phase in Australia, New Zealand, Europe, Japan, South Korea, Mexico and the United States. The parent antibody 3C12 was first isolated at the National Biologics Facility at AIBN, with AIBN co-inventors Dr Martina Jones and Dr Trent Munro (now at Amgen).

Further success was achieved with the first royalties arriving for the licensing of 3C12 as a therapy against graft-versus-host disease. The group's work on CD83 saw research published in the high impact factor journal *Leukemia*, led by Professor Derek Hart of the University of Sydney, demonstrating that 3C12 can be used as an immunosuppressive therapy in organ transplantation.

In the area of bioengineering and biologics production, a paper in *Process Biochemistry* studied the production and characterisation of an anti-inflammatory biologic, recombinant human chaperonin 10 (Cpn 10). Ala-Cpn10 is undergoing phase two efficacy trials as a potential treatment of autoimmune disease systemic lupus erythematosis.

"Cpn10 is a new potential drug for the treatment of inflammatory and autoimmune disorders, so this is providing further avenues for our research to progress in new areas," he said.

A Research Connections Grant was also secured during the year through AusIndustry to continue work into targeted delivery of nanoparticles for therapy with Sydney-based company EnGeneIC. This follows a previously successful ARC Linkage Project.

The success of the group's work in antibody discovery and drug delivery also led to a new collaboration with Australian pharmaceutical leader CSL Limited, which will begin in early 2016.

"It is very gratifying to see momentum building behind this research, and we are hopeful of rapidly advancing these technologies," he said.

In December, Associate Professor Mahler and AIBN colleague Dr Simon Corrie organised a successful workshop hosted at UQ entitled "Biomedical Applications of Engineered Antibodies and Proteins", attracting many research leaders and industry representatives from around Australia, leading to plans to hold the event annually.

# ADVANCES MAKE PLASTIC TRULY FANTASTIC

## Focus

A significant amount of plastics, rubbers and carbon fibres are unsustainably sourced from petrochemical-derived materials, which consume limited resources and adversely impact the environment.

The Martin Group, led by Professor Darren Martin, is investigating ways to not only replace these materials with sustainable alternatives, but in many cases enhance the performance compared to existing products.

"We established a company called Tenasitech Pty Ltd in 2009, which has developed polymer nanocomposites targeting products such as scuff resistant golf balls and scratch and mar resistant headlight lenses and kitchen cupboard doors, but without the need for solvent-based 'hard coats'," Professor Martin said.

"However, recent developments have seen us significantly extend the sustainable, scalable, and high performance nanomaterial theme of our research into new and truly exciting areas."

A discovery in the Martin laboratory found an economically viable and environmentally friendly method of extracting nanocellulose fibres derived from the Triodia *pungens* species of Australian spinifex grasses. This nanocellulose can be used as an additive to enhance the strength and toughness of a range of materials, offering numerous commercial opportunities.

A study in *RSC Advances* compared spinifex nanocellulose to other sources of cellulose, and found its unusually high remnant hemicellulose content is responsible for the significant "effortless fibrillation" characteristics it displays. A further study in *Cellulose* highlighted the ease of extraction, requiring minimal energy input to deconstruct the spinifex leaves into cellulose nanofibrils with an average diameter below 10nm.

## Highlights

In 2015 an umbrella agreement with Dugalunji Aboriginal Corporation (DAC) was signed to ensure ongoing equity between UQ and DAC in the development and commercialisation of the nanocellulose technology. Development of a commercial spinifex feedstock industry could provide new and sustainable economic opportunities for remote communities.

The research team was awarded a three year ARC Linkage Project with CarbonNexus at Deakin University to investigate the additive's utility in remodelling the way carbon fibres are made at the world's first university-based carbon fibre research facility. The team is studying the suitability of nanocellulose as an additive to create more renewable, cost-effective nanocomposite precursor materials – and convert these to high performance carbon fibre (full story page 31).

Martin Group

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

"There is growing use of carbon fibre due to its strength and light weight, but cost is the restriction between it becoming more mainstream, and the spinifex nanocellulose looks like it could play a significant role in reducing those costs," he said.

Another industrial collaboration sees the group working with Sydney-based Derby Rubber Products Pty Ltd to investigate manufacturing stronger compounded rubber using nanocellulose in applications such tyres and traffic counter tubes. Compounded rubber products wear down via abrasion, and also tear and deform through the application of various forces – particularly under elevated service temperatures. The improvement of these products could lead to commercial avenues in the $200 billion global compounded rubber market.

The work could also be extended to civil infrastructure applications as an additive for bitumen road surfaces to improve durability, after research found nanocellulose increases the dimensional stability of bitumen.

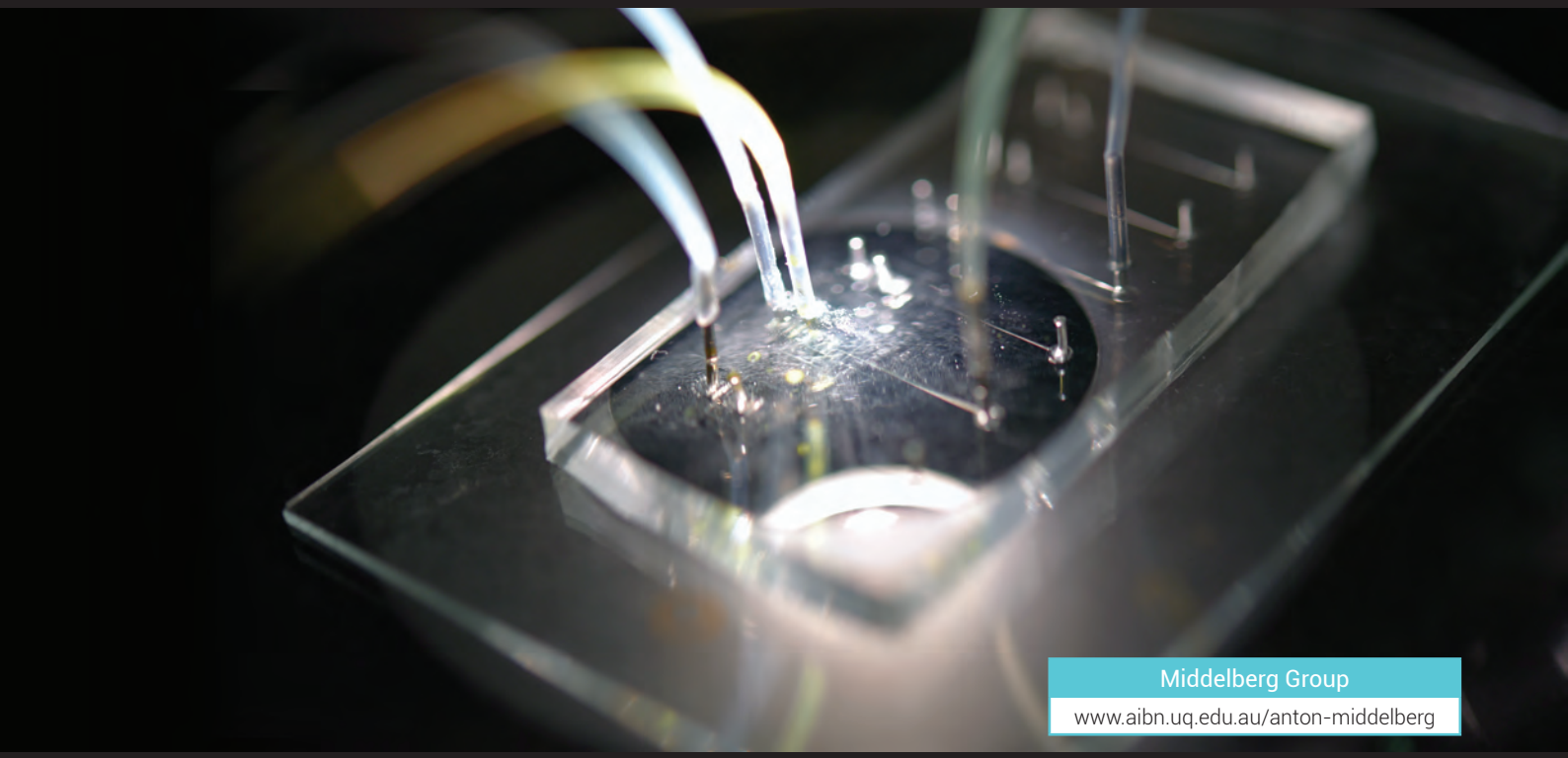
"In Northern Queensland, for instance, bitumen roads quickly develop ruts with extreme temperatures and use by heavy vehicles. If a road lasted twice as long, you would save a lot of money."

The technology is also being investigated to improve water filtration, which ideally provides for high flux – allowing a lot of water through, but also separating fine particles or nasty bugs. Together with Stony Brook University, USA, the group is studying whether the nanocellulose could be used to develop a cheaper and possibly even higher performing membrane.

During the year group also gained support from Cook Medical Australia Pty Ltd for research and development of polymeric materials for medical applications.

The efforts of Tenasitech Pty Ltd were recognised as a finalist in the 2015 Telstra Australian Business Awards.

# SELF-ASSEMBLING SOFT CONDENSED MATERIALS SCIENCE



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

## Focus

The primary research theme of the Middelberg Group is the engineering of self-assembling bio-molecular systems.

Group Leader Professor Anton Middelberg said that the laboratory's work uses bio-inspiration to drive new functional outcomes in materials sciences and health.

"When people think of nanomaterials, they tend to be perceived as inorganic, hard materials; whereas our group primarily intersects nanomaterials with a field called soft condensed matter," Professor Middelberg said.

"It is the meeting of polymer chemistry and protein chemistry for the design of self-assembling systems such as virus like particles (VLPs), with multiple layers of self-assembly to create entirely new functional structures."

The group has developed a platform technology that modularises VLPs with entirely new antigenic modules to drive favourable antibody and cellular responses in both human and animal diseases.

The development of soft templated nanocapsules has also led to new discoveries in smart reaction systems.

In a world first approach, work led by ARC Future Fellow Dr Chunxia Zhao of the Middelberg Group has developed a recombinant catalytic modular protein that can take a base oil droplet at room temperature and encase it with silica formed out of 116-residue protein D4S2.

This design creates a barrier that protects the cargo, and provides control over the rate at which the cargo is released into the surrounding environment. If used in agricultural applications such as crop protection, for example, the system allows for a prolonged treatment period with a lower environmental impact than traditional pesticides (full story page 34).

Dr Frank Salisbury is furthering this targeted nano-emulsion delivery technology with self-assembling oil droplet technology for health-related applications.

Nanoparticles are traditionally solid and unable to pass through narrow *in vivo* obstacles such as blood capillaries, whereas the deformable oil droplets can carry a therapeutic cargo that could distort to pass through. Use of such carriers would allow for quicker and wider circulation through the body, and consequently require lower doses of therapeutics.

"The human body is a collection of soft matter, so this focus on exploring deformable, condensed soft matter systems is for the creation of more robust drug delivery platforms," Professor Middelberg said.

## Highlights

During the year the Middelberg Group was awarded an ARC Discovery Project grant to study vaccine delivery for pathogenic viruses. In a high value collaboration for AIBN and UQ, the grant will establish a major strategic partnership with UQ Gatton and CSIRO's animal sciences facility in Geelong, which is one of only a handful of high level biocontainment facilities worldwide.

"There are some fundamental science questions underpinning the system that can really radically change how we do vaccine delivery, and the vaccine field has been very conservative without a lot of innovation from the manufacturing side," Professor Middelberg said.

In 2015 the group published a study in *Vaccine*, with Associate Professor Linda Lua as first author, which used the laboratory's self-created vaccine platform to develop a VLP against rotavirus. The illness is responsible for around 400,000 deaths annually.

The study showed strong immunogenicity results for the VLP when paired with an antigen as large as 18kDa in size. The VLP removes the need for a vaccine adjuvant, has the potential to be cheaper to produce than existing vaccines, and is not dependent on the vaccine cold chain.

The research team chose to publish this work in an open access journal due to its potential to significantly impact human health globally, and to facilitate the work to progress towards translational pathways.

# SYNTHESIS AND APPLICATION OF COMPLEX POLYMER ARCHITECTURES

## Focus

The Monteiro Group takes a holistic approach towards polymer chemistry, understanding the fundamentals of kinetics and thermodynamics of polymers to create complex polymer architectures that can be custom designed to suit specific applications.

Group Leader Professor Michael Monteiro said the approach has allowed the group to design complex dendritic structures using polymeric building blocks.

"We use living radical polymerisation techniques, including SET-LRP, which allows us to create polymers with very high chain-end functionality to connect polymers together," Professor Monteiro said.

Papers published during 2015 in *Current Drug Delivery* and the *Journal of Medicinal Chemistry* with Professor Istvan Toth and Dr Mariusz Skwarczynski of the UQ School of Chemistry and Molecular Biosciences successfully demonstrated the use the Group's polymers as carriers for vaccine and drug delivery. The respective findings showed decreases in tumour size and eradication of E7-positive TC-1 tumours in a murine human papilloma virus tumour model.

Taking their work of complex structures further, the group studies emulsion polymerisation to make nanoparticles beyond the traditional spherical shape. Recent advances have enabled the creation of a range of shapes from loops, rods, worms, vesicles, and now a bi-compartmentalised tadpole nanostructure.

"We can now put chemical functionality onto these custom designed nanoparticle structures by binding molecules such as fibronectin and vitronectin on the surface," he said.

The group is collaborating with the Gray Group at AIBN to use these types of polymeric nanostructures to study cell expansion for stem cell research.

Work previously published in *Biomacromolecules* (2014) demonstrated the novel growth of human embryonic stem cells (hESCs) in suspension cultures using the Monteiro Group's thermo-responsive polymer worm nanostructures.

"Together with the Gray Group we have clearly demonstrated that hESCs can be built, cooled down and then broken up using our polymer nanoworms as a suspension culture for scaled-up production," Professor Monteiro said.

The research team reported a more than 30-fold expansion in cell numbers over 18 days with the enzyme-free propagation approach, while critically maintaining cell pluripotency.


Monteiro Group

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

## Highlights

In 2015 the group built on previous work published during 2014, which developed nanoparticles in the shapes of worms and rods. They were the first to demonstrate the creation of polymeric tadpole structures, with a paper appearing in the *Journal of the American Chemical Society*.

"With the tadpole structure, the tail can have a different functionality to the head, which can be important in vaccine and drug delivery where the optimal application requires more than one agent to be administered," Professor Monteiro said.

Further work published in the *European Polymer Journal* developed methods to accurately measure the molecular weight of polymers using size exclusion chromatography (SEC). The paper received more than 3,000 views in the first six months following its publication, indicating wide scientific appeal.

Findings published during the year in *Polymer Chemistry* (RSC) in collaboration with Professor Virgil Percec (University of Pennsylvania) provided the strongest evidence for Copper(II) oxide (Cu(0)) activation in water, resulting in the preparation of water-soluble polymers directly in water. Both propagation and reversible deactivation steps occur while the polymer radical is adsorbed on the surface of the Cu(0) catalyst.

During the year work continued on existing grants, including an ARC Discovery Project on precision-engineered polymer nanomaterials, which is linking synthetic materials and biological systems. Work was also undertaken on developing highly productive and selective bio-organic hybrid membrane water filters, through a grant awarded by the National Centre of Excellence in Desalination Australia.

Professor Monteiro is an editor of the *European Polymer Journal*, and also accepted a position as an editor of the *Heliyon journal* in 2015. He is also on the advisory boards of *Biomacromolecules* (ACS) and the Journal of *Polymer Science Part A: Polymer Chemistry*.

He was an organiser of two symposia at the Pacific Chem Conference held in Hawaii, USA, in December and over the year also delivered three plenary lectures at international conferences in the USA, Mexico and Greece.

# SYSTEMS BIOLOGY TO UNLOCK BIOLOGICAL COMPLEXITY

## Focus

The Human Genome Project inspired the development of high throughput, low cost 'omics technologies. We can now sequence a microbe in a morning and prepare a comprehensive molecular inventory (expressed genes, proteins, metabolites) in a week. However enumerating the components in a biological system does not in itself yield understanding.

The Nielsen Group uses systems biology, that is systems science, modelling and simulation, to integrate data streams and generate knowledge. As applied systems biologists or biotechnologists, they do more than develop tools for better understanding (analysis); they use these tools to design products and processes for human benefit (synthesis). The science is moving from crude retrofitting of living systems with a single or few genes using genetic engineering to purposeful re-engineering of living systems using systems and synthetic biology.

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

"Studying such a diverse range of organisms is challenging and is only practical through close collaboration with field experts," Professor Nielsen said.

"However, the advantage is that knowledge gleaned from one system can lead to unanticipated findings in unrelated organisms."


Nielsen Group

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

## Highlights

The group produced more than 20 peer-reviewed publications during the year. Of particular significance was a paper published in high impact factor journal *PLoS Computational Biology*, which employed a General Reaction Assembly and Sampling Platform (GRASP) developed within the laboratory to consistently parameterise and sample accurate kinetic models of enzymatic reactions. The framework allows for complex kinetic modelling without requiring large data points to parameterise enzyme kinetics under non-equilibrium conditions.

2015 was a successful year for securing funding for the group. Professor Nielsen was awarded a $AUD8.6 million Novo Nordisk Foundation Laureate Research Grant, which will see him develop computational models of mammalian cell metabolism. The aim is to build a detailed kinetic model explaining why cancer cells and other fast-growing cells produce lactic acid.

"The grant enables me to return to the problem that first attracted me to a career as a research scientist, namely how do we develop a tractable model of the complex set of biochemical reactions within a human cell," Professor Nielsen said.

During the year the group was also awarded an ARC Linkage Project grant to work with Zoetis Australia on improving production techniques for animal toxoid vaccines. The project continuous a successful pilot project and aims to reduce the number of batch failures and increase the concentration and quality of the vaccines.

Work also commenced on a new ARC Linkage Project with Lanzatech on gas fermentation, in particular the use of systems biology to guide strain engineering. The project has already produced the first comprehensive systems biology platform for gas fermenting bacteria and the first patent application.

Work continued on an existing ARC Linkage Project with The Dow Chemical Company on propionic acid production leading to very high yielding strains and a patent application.

# POINT-OF-CARE DIAGNOSTICS TO SAVE LIVES

## Focus

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

By understanding disease epigenetics and combining chemistry with nanotechnology, Professor Matt Trau said the Group's research aims to provide improved accuracy over existing diagnostic devices, at a cheaper price.

"We have a strong history of developing diagnostics that use novel biomarkers to detect the presence of diseases such as cancer," Professor Trau said.

The group engineers platforms that allow biological data to be collected and analysed outside of clinics – with the goal of providing patients with an enhanced quality of life, while monitoring disease progression, regression, or reoccurrence.

The group has been strongly supported by the National Breast Cancer Foundation, with successive grants of $5 million funding the development of next generation breast cancer diagnostics. An Australian Research Council Discovery Project grant is also providing the opportunity to develop accurate methods of capturing specific cells and molecules, such as low concentration pathogenic molecules and circulating tumour cells (CTCs).

CTCs shed from cancerous tissue and travel away from a primary tumour site through the bloodstream, eventually establishing secondary sites that speed the progression of cancer in the body.

"As hazardous as CTCs are, they provide us with a biomarker that we can detect in the blood stream, which can help tailor more effective and personalised treatment of cancer," Professor Trau said.

"We are very passionate about inventing highly innovative technologies that can be translated into the clinic. We thank all of our supporters, funding agencies, charitable organisations, industry partners and philanthropic donors."

## Highlights

2015 was a successful year for the Trau Group, seeing broad research outcomes and grant success provide a foundation for further work to continue.

The group secured a new ARC Discovery Project grant to develop a platform technology to characterise nano-scaled objects on a particle-by-particle basis *in situ*. Driven by a need across broad industries to understand the distribution, charge and composition of nano-particles, the project aims to design a system to accurately ascertain these features.

More than 20 peer-reviewed journal articles were published by the lab in 2015, including two papers in the *Nature* family of journals and a front cover article in the journal *Chemistry Communications*. In collaboration with the Garvan Institute of Medical Research, work published in *Nature Communications* described the study of the responsive enhancer methylation of oestrogen receptor 1 (ESR1). The presence of ESR1 determines whether a breast cancer patient receives endocrine therapy, but does not predict the success of treatment. The findings showed that ESR1-responsive enhancer methylation status could potentially be used to classify patients as responders to endocrine therapy.

In further work published on the cover of *Chemical Communications*, a collaboration with Professor Jimmy Botella from UQ's School of Agriculture and Food Sciences developed a single-drop DNA test that can detect disease in crops and livestock, as well as human diseases.

"The test uses fully automated molecular/nanoparticle systems within a single drop of fluid to analyse a sample, detect the presence of a pathogen, and in 55 minutes provide a positive or negative result," Professor Trau said.

The single-drop test has been proven to work in human diseases such as prostate cancer, HIV and malaria, as well as bovine herpes virus in cattle, and fusarium fungus in crops. Another avenue of development includes a cost-effective tuberculosis screening test for use in developing countries, which resulted in the publication of three papers during the year in *ACS Sensors*, *Scientific Reports*, and *Analytical Chemistry* (full story page 35).

**Trau Group**

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

# DEVELOPMENT OF SOLAR CONVERSION AND STORAGE MATERIALS FOR A GREENER FUTURE

## Focus

The Wang Group is focussed on the clean energy sector, developing new functional materials for solar energy conversion and storage systems.

Led by Professor Lianzhou Wang, who also directs the Nanomaterials Centre that was established at UQ in 2000 by former AIBN Group Leader Professor Max Lu, the group is building on the Centre's strong legacy.

"One of my main research areas has been in solar hydrogen generation, and around half of the team is working on photocatalytic hydrogen production," he said.

Dubbed artificial photosynthesis, the splitting of water to produce hydrogen is a very promising solution to address renewable energy utilisation and climate change abatement.

The group is also actively developing new advanced rechargeable battery technologies to improve existing lithium-ion batteries as well as discover competitive alternatives.

"Lithium-ion batteries are the state-of-the-art technology in rechargeable batteries and are quite effective, but lithium is a very limited resource so the world cannot rely on it for our energy storage needs," Professor Wang said.

To address this, the team is developing new materials for a next generation sodium-ion battery. Although originating from a far more plentiful source, there are substantial technological hurdles to overcome before it can genuinely challenge lithium-ion in the marketplace.

"The sodium-ion is bigger, so the charge has been slower and the capacity is smaller. However, during the year our group made significant inroads by developing a prototype sodium-ion battery with comparable capacity and charge times to lithium-ion ones."

## Highlights

2015 was a successful year for the group, with a number of publications in high impact journals and successful funding outcomes.

Dr Delai Ye published a new design for a high capacity lithium-ion battery using a new cathode material in *Advanced Functional Materials*. The design allows for around a 30 per cent capacity increase, with more than 800 cycles without significant degradation in performance.

In work published in *Advanced Materials* with Dr Eun Ji Yoo, Mr Miaoqiang Lyu and colleagues reported the first example of using organic-inorganic hybrid perovskite materials in resistive random access memory devices.

Another paper in *Advanced Energy Materials* by Dr Qiong Wang highlighted a new design for a solar battery, combining the concept of a solar cell and rechargeable battery in one integrated system by using lead and iodine on one electrolyte.

"We are very excited by the potential of this work, but further progress is needed in the capacity and energy conversion rate. If this can be addressed it would be a very elegant system," Professor Wang said.

An ARC Discovery Project was awarded for work on a new bifunctional photocatalytic reaction system, which will provide new opportunities to convert industrial waste water into solar hydrogen and valuable chemicals such as bromine using solar energy.

Additionally, Dr Yu Chen from the Wang Group secured a highly competitive ARC Discovery Early Career Research Award for the development of a multi-functional nanoparticle system, which is expected to lead to exciting new progress on a diagnostic and therapeutic system to combat cancer.

An ARC Linkage Project grant was also awarded mid-year for a partnership with UQ's School of Mechanical and Mining Engineering and Baosteel Company to develop nano-lubricants that can be used for steel processing.

"We are investigating the development of nanoparticle suspension to replace oil-based lubricants that would be more environmentally friendly," he said.

Professor Wang was also honoured during the year with his inclusion in the ARC College of Experts for 2016-2018 within the Engineering, Information and Computing Sciences discipline grouping.

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

# BIG DATA SHOWS BIG STEM CELL POSSIBILITIES

**Wells Group**
www.aibn.uq.edu.au/christine-wells

## Focus

The Wells Group is seeking to unlock the long term potential stem cells have promised for the last four decades. The team primarily uses a computational approach to analyse enormous datasets.

Professor Christine Wells said the group is addressing key questions that still need to be answered about stem cells, which, functionally, can become any other type of cell in the body.

"In every cell of your body there are stem cells that are critically important for how you age and how your body repairs itself, and there are also implications for disease. So understanding this process is critically important," Professor Wells said

"It remains to be properly understood as to what mechanisms dictate whether a stem cell converts into kidney or a beating heart."

In a research field known as computational genomics, the team grapple with incredibly vast amounts of data, dealing with millions of data points at any given time.

The group is a member of Project Grandiose, led by Dr Andras Nagy of the Lunenfeld-Tanenbaum Research Institute, Canada, which identified new F-class stem cells in a 2014 *Nature* paper. These artificial cells only exist in culture and are formed from the reprogramming of somatic cells in elevated reprogramming factor expression. Studies are continuing into F-class stem cells to gain insights into the formation of stem cells.

## Highlights

As part of a large international research consortium named FANTOM (Functional Annotation of the Mammalian Genome), in 2015 the group published a paper in *Science*.

Using a large-scale comparative analysis, the paper describes how stem cells are activated by a DNA "switch" and genetic information. The cascade of changes that occur to a mammalian cell during transcription are triggered by enhancer transcription, followed by the production of enhancer RNA.

"I think this will continue to be a very major resource for the entire research community for some time because the depth of information there is very rich," Professor Wells said.

The FANTOM consortium has previously published work in *Nature* and *Science*.

In 2015 the group's international online platform Stemformatics.org grew to around 7,000 users a month. The platform – a collaboration with Stem Cells Australia – processes and presents data to stem cell researchers and clinicians in a way that is easily understood. It hosts hundreds of data sets, and thousands of different stem cells have been identified within the platform.

Successful application of the Stemformatics platform answered one of the biggest challenges the field has faced: identifying what is a stem cell and not an already differentiated cell assigned to a particular role.

By taking hundreds of data sets from around the world the group's work with Stemformatics found a genetic signature – 16 genes that are like a fingerprint that highlight whether a cell is actually a stem cell.

The group also partnered with Bioplatforms Australia to work with eight different laboratories around Australia to establish a large new data set. $1 million in funding across the labs for 18 months will enable research into stem cell biology, with the Wells Group taking on the role of coordinating the data gathering, and processing the data through the Stemformatics platform.

Professor Wells' achievements were recognised during the year with the award of the prestigious Metcalf prize for stem cell research, and a prestigious ARC Future Fellowship to undertake a systems biology approach to understand the complex cell-to-cell interactions of cellular populations. This work to identify new classifiers will further assist in identifying the differentiation potential of stem cells.

NHMRC funding also supported work to investigate stroke and stroke outcomes, a research theme led by Dr Silvia Manzanero. Additionally, in work supported by the ARC, Dr Florian Rohart is looking to build new statistical tools to continue improving data mining techniques.

Professor Wells has held a joint appointment as a reader at the University of Glasgow's Institute of Infection, Immunity and Inflammation.

# INNOVATIVE POLYMER CHEMISTRY FOR HEALTH AND IT

## Focus

The Whittaker Group applies synthetic methods to develop technologies for health and our modern technological society. These include advanced next generation molecular imaging agents for disease detection, and polymers to be used in advanced lithography for the fabrication of integrated circuits.

Professor Andrew Whittaker said future imaging agents injected into the body and imaged using MRI, CT or fluorescence imaging will go beyond just identifying the location of disease.

"We are developing new technologies that will report on the local biology of a patient by sensing the presence of specific proteins, or measuring changes in ionic make-up or local temperature. These are all potential indicators of tissue health," Professor Whittaker said.

Such non-invasive methodologies would provide clinicians more comprehensive diagnoses without the need for biopsies, which are particularly problematic for internal medicine.

In medical imaging, the group is directing efforts towards detection and treatment of glioblastoma, the most aggressive form of brain cancer with an average life expectancy of only 14 months after diagnosis. New imaging technologies are being developed for delineation of diseased tissue in projects supported by the NHMRC and the Cure Brain Cancer Foundation.

Addressing such complex challenges requires expertise from a wide range of disciplines. Dr Simon Puttick from the Whittaker Group is performing pre-clinical imaging, and the group is working with molecular biologists to identify molecular targets. Partners with expertise in clinical scanning have also been formed, and the work is being done in collaboration with neurosurgeons who implement the findings.

Another important area of nanomedicine being addressed by the group is the development of anti-microbial surfaces to remove or kill microbes on surfaces to reduce hospital-born infections.

"Around 30 per cent of patients admitted into hospital acquire infections, which is a frightening statistic. Dr Hui Peng from our laboratory has assembled a team to tackle this problem," Professor Whittaker said.

The Whittaker Group has a separate research program focussed on the development of next generation lithography for use in integrated circuitry. As integrated circuitry in devices such as mobile phones become ever smaller, yet more powerful, technological pressures have been placed on the microfabrication process of lithography, requiring novel solutions to be found.

The group are developing light-sensitive polymers to transfer intricate structures on silicon wafers spaced tens of nanometres apart. This is the fundamental process involved in fabrication of integrated circuits. The group's experience in polymer science and photochemistry has attracted collaborations with leading global companies such as Sematech, Intel and The Dow Chemical Company.

## Highlights

In lithography, the group continues to be innovators in the field, with an ARC Linkage Project with The Dow Chemical Company leading to a number of patents being filed in 2015, together with licensed technologies. Funding secured from the Asian Office of Aerospace Research and Development to work on fundamentals of thin polymeric films will help to further build this program.

Amongst the numerous papers published from the group during the year, PhD student Cheng Zhang's work on thermoresponsive poly(OEGMA-co-TFEA) in the leading research journal *Macromolecules* was a standout. The copolymers, synthesised using reversible addition-fragmentation chain transfer (RAFT) polymerisation, are temperature sensitive, leading the polymer chains to respectively collapse and become solubilised at higher and lower temperatures in water.

"Responsive polymers are attracting significant interest in the field for their use in drug and gene delivery, tissue engineering and in the creation of sensing devices," Professor Whittaker said.

Professor Whittaker continued his engagement with China, being the only Australian researcher for 2015 to be awarded the Chinese Academy of Sciences President's International Fellowship, enabling him to work in Beijing with the National Centre for Nanoscience and Technology. New collaborations were also forged with Shanghai University, Fudan University, and within the framework of the Wuhan-Brisbane Research Alliance in Functional Polymeric Materials, of which Professor Whittaker will direct the Brisbane node.

Professor Andrew Whittaker is the Theme Leader of Imaging Technologies within the ARC Centre of Excellence in Convergent Bio-Nano Science and Technology.

**Whittaker Group**

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

# FUNCTIONAL GENOMICS DRIVE REGENERATIVE MEDICINE

**Wolvetang Group**

www.aibn.uq.edu.au/ernst-wolvetang

## Focus

The Wolvetang Group is working towards solving neurological diseases by understanding the relationships between genes and neurological abnormalities.

Primarily focussed on utilising stem cells to this end, Professor Ernst Wolvetang said the scope of the laboratory's work ranges from common disorders such as Alzheimer's disease, to rarer conditions such as forms of childhood leukodystrophy.

"We harvest cells from patients and reprogram these into induced pluripotent stem cells, essentially bringing them back to a fetal state, which then allows them to make all the different cell types in the body," Professor Wolvetang said.

The group is particularly interested in the complex interconnectivity of cells in the brain and how a breakdown in these connections contributes to disease. They use high content real time imaging, gene expression analysis tools, and a range of cell biology techniques in order to identify disease phenotypes.

The group is currently screening for genes that cause demyelinating diseases, where damage to the insulation of nerve fibres in the brain leads to impaired nerve impulses and neurological defects. Using clustered regularly interspaced short palindromic repeats (CRISPR) technology, the group can mutate or correct genes suspected to be involved in a disease.

"Generation of isogenic controls through CRISPR gene correction is essential for seeing disease phenotypes emerge at a gene expression level," he said.

The research is also increasingly engineering mini organoids from human stem cells with the aim of employing these as 3D models for studying diseases in vitro. The construction of these organoides will help develop platforms for screening drugs in a high throughput manner, with the postulation that the results of testing in the cellular environment of an organoide will be more relevant than disease cell types grown in a petri dish.

## Highlights

The group built on its strong program in ataxia telangiectasia (A-T), which is a rare disease where sufferers lose motor control as a result of brain cell degeneration. Affecting around 50 people in Australia, primarily children, most patients lose their lives before the age of 20.

"We are working very closely with a patient and parent support group, BrAshA-T, and we are very grateful for the generous philanthropic funding they have provided for our research," Professor Wolvetang said.

As a potential prelude to cellular therapy for this disease, the group is researching how to deliver gene-corrected, patient-specific cells to the brain of a mouse and determine if they integrate and function correctly. Once this capability becomes clinically viable they hope to be able to apply this cell-based therapy to children with A-T and other degenerative brain diseases.

The group had a successful year in publications, co-authoring a number of papers in high impact journals, including *Nature*, *Science*, *Nature Communications*, *Neuron*, *Human Molecular Genetics*, and *PLoS Genetics*.

The group also hosted Cell Reprogramming Australia's 3rd Annual Collaborative Conference in May, and Professor Wolvetang was invited to present a plenary lecture at the Joint Australian- Chinese Academy of Sciences symposium.

The Wolvetang laboratory was also part of a new $1 million initiative with Bioplatforms Australia, led by the Wells Group, to establish a new stem cells data set.

Professor Wolvetang's vision for stem cell based regenerative medicine of the 21st century is exemplified by his engagement with patient advocate groups such as the Mission Massimo Foundation, which aims to eradicate childhood leukoencephalopathies.

"It is at this interface between cutting edge research, patient advocacy, philanthropy, and industry engagement that our stem cell research can make a real difference for children suffering from rare and currently incurable diseases," Professor Wolvetang said.

# NANOPARTICLES TO BOOST HEALTHCARE

## Focus

The Xu Group is developing nanoparticles to act as carrier devices for novel applications in healthcare and agriculture.

Associate Professor Zhi Ping (Gordon) Xu said a significant reduction in the debilitating side-effects of anti-cancer drugs is one of the group's primary goals in the fight against cancers. In parallel, the group is also looking to develop improved cancer treatments that boost the body's immune system against cancer cells.

"Many anti-cancer drugs in the market are quite efficient in killing cancer cells, however they are very efficient in killing healthy cells as well, which is why chemotherapy is such an awful process," Associate Professor Zhi Ping Xu said.

The team is investigating the delivery of two or more therapeutics in one nanoparticle to produce a synergic effect and minimise the amount of therapeutics delivered. Smaller dosages reduce the cost of the drugs required, but moreover there is a reduced impact of the therapeutic escaping from the cancer target and causing cellular damage to other parts of the body.

The group is also looking to build on these advances in tandem by developing nanoparticles that maximise the body's immune response to fight the illness. Studies are underway using nanoparticles to interfere with the PD1-PDL1 interaction which acts as a shield to mask the presence of cancer from the body, and provide the immune system's T cells a target to engage.

The other focus of the research group is studying how to use nanoparticles to reduce the disease susceptibility of plants and animals. This work is investigating methods to deliver therapeutics such as an anti-oxidant, anti-bacterial agent, vaccine, or gene.

"The agricultural sector suffers from huge loses each year due to various diseases. Our aim is to deliver therapeutics and protect animals and plants from infections, insects, microbes and viruses."

## Highlights

The group was highly productive throughout the year with the publication of more than 15 journal articles.

A study appearing in the *Journal of Materials Chemistry B* provided *in vitro* demonstration of lipid coated calcium phosphate (LCP) nanoparticles delivering the functional cell death siRNA to human breast cancer cell line MDA-MB-468. The LCP nanoparticles were also more effective in inhibiting the tumour growth in comparison with a commercial transfection agent.

Further work published in this same journal showed inorganic layered double hydroxide (LDH) nanoparticles pre-coated with albumin are able to achieve colloidal stability. The capacity of particles to resist aggregation is an important attribute for the successful *in vivo* delivery of a drug or gene.

A collaboration established with UQ's Queensland Alliance for Agriculture and Food Innovation is investigating oral delivery methods for animals such as chicken or fish that are farmed in vast numbers.

"There can be tens or hundreds of thousands of animals, so practically you cannot vaccinate them individually. However, you could quite easily deliver a vaccine through food that is then absorbed through the intestines."

The team is also using environmentally friendly dsRNA biological pesticides instead of traditional chemical alternatives to protect plants and crops from diseases.

A limitation of dsRNA pesticides is that they quickly break down under natural conditions, so are only effective for a short period of time. However, when they are loaded into nanoparticles, their release is controlled, resulting in a longer protection period.

In 2015 the group's work also received a $100,000 private donation from China for its cancer research, following a separate donation from China in 2014. The group also received an Australian Government Department of Industry and Science Research Connections grant with Cobbett Pty Ltd, and contract research with NuFarm Ltd for plant protection.

**Xu Group**

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

# APPLIED FUNCTIONAL MATERIALS

## Focus

The Yu Group is internationally recognised for its development of functional materials that are tailored to needs-based research outcomes in sustainable agriculture, water treatment, energy storage and biomedical applications.

Professor Chengzhong (Michael) Yu said the group's work combines its knowledge of fundamental material principles to rapidly deliver tailored platforms and systems in extensive collaboration with researchers and industrial partners.

"Nanoscale platforms have a remarkable ability to alter the environments they are in, creating changes that are seen on a much larger scale," Professor Yu said.

Functional materials can react to their surroundings through catalytic reactions, separate molecules based on size and composition, and have desirable attributes such as solubility or strength.

"By knowing the needs of Queensland, Australia, and the world more broadly, the group is dedicated to needs-driven applications, using innovative functional nanomaterials," Professor Yu said.

Yu Group

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

## Highlights

2015 was a successful year for the Yu Group, securing an ARC Linkage Project grant with industry partner Elanco Animal Health, together with Associate Professor Neena Mitter from UQ's Queensland Alliance for Agriculture and Food Innovation. The project, "Novel Nano-Pesticides for Animal Healthcare", will use a nanotechnology patented during the year to develop a new generation nano-pesticide with improved safety and performance.

"Spinosad, a naturally derived pesticide with low environmental impact and low toxicity, will be loaded into designer nano-carriers which will improve adhesion to skin and hair and protect against UV degradation," Professor Yu said.

The nano-spinosad pesticide is expected to enhance the efficacy and effective duration in field conditions, significantly reducing the cost of pest control and the risks associated with the highly toxic synthetic pesticides that currently have widespread use in the Australian livestock industry.

The group published a number of influential papers during the year, including a journal paper in *ACS Central Science* as a cover story, which investigated mesoporous hollow silica nanoparticles with hydrophilic compositions and hydrophobic properties as nano-carriers for diverse bio-applications. Findings in the paper showed that nanoparticles with a rough surface displayed an enhanced antibacterial effect when loaded with antibiotic vancomycin, compared to nanoparticles with a smooth surface.

Additional work published in *Chemistry of Materials* showed mesostructured hollow carbon nanoparticles can be synthesised with bi- and triple-layered walls for diverse biomedical applications. Furthermore, a paper published in *Nanoscale* showed mesoporous hollow silica–fullerene nanoparticles can be prepared using a selective etching method, and have a significantly higher drug loading capacity as well as enhanced photodynamic properties.

Related work was published in *Small,* which showed mesoporous silica nanoparticles can be synthesised with a large core-cone cavity structure, that is suitable for protein delivery. The findings displayed the highest ever reported pore size and volume for mesoporous silica nanoparticles with a radial pore structure.

A *Chemical Communications* paper highlighted synthesised mesoporous nanomaterials with co-modified aptamers and methyl groups, which provide more sensitive and measureable detection of insulin in serum compared to commercially available products.

Professor Yu co-chaired the 9th International Mesostructured Materials Symposium (IMMS-9), which was held at the Brisbane Convention and Exhibition Centre during August. He also received the 2015 Le Févre Memorial Prize for Chemistry from the Australian Academy of Science.

More broadly in the group, three research higher degree students completed their studies during the year, and Dr Jun Zhang was awarded the 2015 Distinguished International Students Scholarship by the China Scholarship Council.

# ASSOCIATE GROUP LEADERS

## Dr Claudia Vickers

*Queensland Government Accelerate Fellow*

Sustainability through the development of novel bio-products is a core focus area of Dr Claudia Vickers' research, which aims to redesign microbial cells for producing industrially useful bio-chemicals.

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

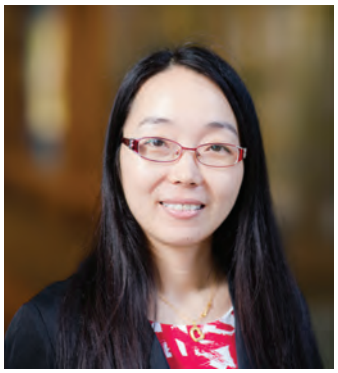
She focusses on a group of natural organic compounds called terpenoids. This group includes compounds that can be used as biofuels and rubbers, as well as specialty chemicals that can be used to improve crop yield and make industrial fragrances.

"Making cells do something that they haven't spent millions of years evolving to do is not trivial," she said.

Dr Vickers uses synthetic biology to create new biological components, or substantially modify existing components that can be applied to re-engineer cells. She then uses systems biology tools to examine the effect of her engineering approaches.

She also investigates sustainable feed stocks, particularly sucrose, which is a large economic driver locally in Queensland.

Further research 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 its quality.



## Dr Chun-Xia Zhao

*ARC Future Fellow*

Dr Chun-Xia Zhao's research program is focussed on improving production of nanomedicines, and faster screening and evaluation of promising nanomedicine candidates using biomimetic chips.

Medical research takes many years to progress. Successful drug candidates first need to be packaged in a drug delivery system that effectively transports them to the target cell or organ. This is followed by another five to 10 years to proceed through animal and then human clinical trials.

"A lot of drug delivery systems have been developed, however, many fail in human trials despite working in animal models," Dr Zhao said.

"We are interested in developing *in vivo* mimicking biochips, with critical cell types that resemble different human organs onto small chips, allowing tests to occur very quickly, and at lower cost."

2015 was a productive year for Dr Zhao; building collaborations with Harvard University and Cornell University, receiving a UQ Advancing Women Researchers Grant, and beginning an ARC Future Fellowship.

Additionally, she received an ARC Discovery Project for further developing the patented nanocapsule technology and an ARC Linkage Project grant for improving the manufacture of nanoparticle-based adjuvants in partnership with Vaxine Pty Ltd.

## Associate Professor Kristofer Thurecht

*ARC Future Fellow*

Associate Professor Kristofer Thurecht is developing new materials in nanomedicine that combine the ability to deliver therapeutics with monitoring disease progression.

Holding a joint appointment between AIBN and UQ's Centre for Advanced Imaging, he is a polymer chemist with a goal of developing new materials classed as 'theranostics'.

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

Using tumours in animal models to test the materials, his work utilises positron emission tomography (PET) to see therapeutic agents effectiveness in three dimensions, together with magnetic resonance imaging (MRI) and optical imaging.

In 2015 Associate Professor Thurecht was awarded an ARC Linkage Project with AIBN Group Leader Associate Professor Stephen Mahler to partner with Minomic International Ltd on developing an antibody delivery platform for a prostate cancer antigen. He will also lead a facility for characterising bionanomaterials through the ARC Linkage, Infrastructure, Equipment and Facilities scheme.

An NHMRC Project Grant was awarded to him as lead investigator to study immuno-polymeric drugs for prostate cancer therapy. In further success during the year, he and Associate Professor Mahler were awarded a patent for developing new antibody conjugates using antibody engineering combined with imaging.

## 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 stem cells and batteries.

During 2015 he won a UQ Foundation Research Excellence Award to provide one year of funding to develop a battery made entirely of plastic.

"It is an exciting new area that shows a lot of promise, however, it is only in the earliest stages of development," Dr Jia said.

The vision sees a fully completed product where the waste battery could be disposed of into a recycle bin, without the environmental concerns of heavy metals used in current batteries.

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.

"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.

Work undertaken in his Future Fellowship project is using polymer nanostructures that are decorated with growth factors to facilitate the generation of stem cells in a three dimensional environment, allowing for a new source of stems cells that could be applied in regenerative medicine.

*High achieving early and mid-career researchers at AIBN are recognised with appointment as Associate Group Leaders. These researchers are the next generation of leaders, selected for their excellence in research output, collaborations, and professional leadership qualities.*

## Dr Esteban Marcellin

*Queensland Government Accelerate Fellowship*

Dr Esteban Marcellin's research is focussed on reducing industrial waste and producing chemicals and fuels sustainably.

The highlight of the year was the establishment of a gas fermentation group and facility hosted at AIBN, which is the first of its kind in Australia. The facility was enabled through a UQ Major Equipment and Infrastructure grant, and an ARC Linkage Project with Lanzatech. Concurrently, he worked with The Dow Centre for Sustainable Engineering and Innovation to evaluate the economic feasibility of fermenting methane.

"There is a lot of gas that is flared and lost, which is a major contributor to climate change," Dr Marcellin said.

"Finding a method for recapturing carbon monoxide, carbon dioxide and methane, and converting them into fuels and chemicals would provide a new way for reducing climate change through biotechnology."

He is also working with The Dow Chemical Company to sustainably produce propionic acid from sugar – a collaboration that won him the 2015 Science Prize of the UQ Partners in Research Excellence Award.

"A bacterial strain we found achieved our target yield, and it is in the process of being patented," he said.

Further success saw another ARC Linkage Project awarded with industry partner Zoetis Australia. This will support research aimed 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.

## Associate Professor Idriss Blakey

*Principal Research Fellow*

Associate Professor Idriss Blakey is developing new materials for the generation of semiconductors and sensors in future technologies.

"We are working with The Dow Chemical Company on an ARC Linkage Project to develop polymers that improve the manufacturing processes for semiconductors to be used in computer chips such as random access memory," Associate Professor Blakey said.

The project has been highly successful, with the filing of three patent applications during 2015 based on technology developed during the project. A further patent was also granted for a previous project with Intel.

In the same area of photolithography, he is working on an ARC Discovery Project with Dr Kevin Jack from UQ's Centre for Microscopy and Microanalysis.

"We are looking to develop self-assembling polymers, using light to direct the nanoscale structure of the polymer."

A research paper based on the Discovery Project was published during the year in *Macromolecules*.

Research partnered with the Queensland University of Technology is studying the design of a new type of sensor. Unlike today's devices that rely on electronic sensing, is has a wider sensing range and detects chemical signals using light.

## Dr Muhammad Shiddiky

*NHMRC Career Development Fellow*

Dr Muhammad Shiddiky is working on the development of a new generation of cancer detecting devices.

Circulating tumour cells are the invasive bodies that enable the spread of cancer by travelling from one tissue site to another through the bloodstream. As a result, the detection of these cells and diagnosis of the particular cancer type is vital to inform therapeutic strategies.

"We are trying to develop devices for circulating tumour cell detection using microfluidic devices and electrochemical nanobiosensors," Dr Shiddiky said.

It is hoped that microstructured electrodes may enable this diagnosis by selectively capturing biological data, achieving not just increased sensitivity but the ability to achieve a diagnosis in a quicker fashion than current methods.

"Our work with biomarkers to develop diagnostic devices could also be applied to other diseases outside of cancer," he said.

This research, initially funded through an ARC Discovery Project, has resulted in the most productive couple of years in Dr Shiddiky's career with more than 20 research papers published.

In this time he has also obtained a NHMRC Career Development Fellowship, and developed closer ties with the University of Washington.

## Dr Simon Corrie

*ARC DECRA Fellow*

Dr Simon Corrie has led research in the development of a needle-free blood test device, dubbed the Micropatch.

This new device, which initially looks similar to a Nanopatch, features longer projections for deeper entry into the skin and access into the top layer of blood vessels known as capillaries.

"We're really excited that we have now progressed to testing this new diagnostic microneedle array in a dengue fever disease model; previously we have been restricted to testing artificial biomarkers," Dr Corrie said.

The new patch selectively collects biomarkers from the blood in the skin, which can then be analysed offline.

Dr Corrie has worked together with the Australian National Fabrication Facility – Queensland at AIBN to develop a microfluidic device that will make the Micropatch a standalone diagnostic tool without the need for a laboratory.

"This would make it a very practical field device, especially for areas where hospital and laboratory access is limited, allowing for a quick diagnosis," he said.

The work is supported by an NHMRC Development Grant, ARC Discovery Early Career Researcher Award, and the ARC Centre of Excellence in Convergent Bio-Nano Science and Technology.

# DISCOVERIES AND COLLABORATIONS

# MERS ANTIBODY BUILDING ON HENDRA VIRUS WORK

One of the Institute's most outstanding achievements has been the successful partnership between AIBN and Queensland Health to produce an antibody treatment for the deadly Hendra virus.

2015 was a landmark year for this collaborative endeavour, with the m102.4 antibody entering phase 1 clinical safety trials run by Q-Pharm in Brisbane.

Professor Peter Gray said there was good cause to be optimistic about the trial.

"The Hendra virus has claimed the lives of four people since 1994, and the availability and use of the antibody on compassionate grounds means that there is now a treatment to offer people who are at risk from the disease." Professor Gray said.

The clinical safety trial is aimed at better understanding the impact of m102.4 on the body, and whether it has adverse side effects that would impact its suitability as a drug candidate to treat infected patients.

The antibody was initially discovered by a team of US researchers led by Professor Christopher Broder at the Uniformed Services University of the Health Sciences, and Dr Dimiter Dimitrov of the National Cancer Institute, National Institutes of Health.

AIBN advanced this discovery to successfully develop the capability to produce the antibody at the highest quality and in sufficient quantities for the clinical trial to occur, as well as provide emergency supplies of the antibody for further compassionate use if required.

Professor Gray said the threat of another virus, Middle East respiratory syndrome (MERS), led the parties to discuss the continuation of the collaboration in a new area.

"Since its discovery in 2012, MERS has claimed the lives of more than 400 people in more than 20 countries," he said.

"Just one infected patient entering South Korea resulted in thousands of people entering quarantine and the deaths of 36 people, which shows that MERS is a highly virulent disease, and has made Queensland Health take notice."

MERS has been linked to dromedary camels as the reservoir for the coronavirus, and there are estimated to be approximately 300,000 of the animals in Australia, which were first introduced in the 1840s.

Given previous experience that the Hendra virus jumps from bats to horses, and from horses to humans, the Queensland Government has prioritised the need to identify a means to help combat the MERS virus.

The same team of US researchers has now developed an antibody for use in MERS, leading to high level discussions in Washington with the Queensland Chief Health Officer to bring the antibody to Australia.

"AIBN has been at the centre of these discussions, given our mutual track record in the production of the Hendra virus antibody," Professor Gray said.

"We are hopeful that a similar agreement can be reached to help secure our biosecurity."

# CHEAPER, CLEANER PRODUCTION OF CARBON FIBRE

AIBN research from the Martin Group has developed an innovative technology that promises to radically disrupt the global carbon industry by producing a more cost-effective and sustainable product.

Current production methods for the lightweight and strong material use unsustainable petrochemical precursors, and are costly to manufacture. This makes the material economically unfeasible for many industries that would otherwise benefit from its advantages.

Existing production techniques use a precursor polymer resin called polyacrylonitrile, or PAN, which is spun into threads finer than a human hair, and then fired in a furnace at increasing temperatures to convert it into strong, stiff carbon fibre.

"You don't need the world's strongest or stiffest carbon fibre to make a wind turbine blade, for instance. It just needs to be lightweight and lower cost than, for example, heavier but currently cheaper fibreglass – and that is where our technology is targeted," Professor Darren Martin said.

To improve the process, the group is using spinifex grass – a native grass which is endemic in outback Australia – to develop nanocellulose, which they have demonstrated to have remarkable properties.

"We discovered that if we blend the polyacrylonitrile with only a small amount of our spinifex-additive, then we can reduce the furnace temperature – which is a large energy saving," Professor Martin said.

Even more incredibly, the team has discovered that the new nanocellulose material can be cleverly used to enable further significant reductions in PAN precursor cost.

"We've experimented with blending our nanocellulose with the PAN precursor in all sorts of ways, and some of them happen to be dramatically more cost-effective, we now have to work with our collaborators at Deakin University to take this proof-of-concept and scale it up over the next two years," he said.

Such breakthroughs would revolutionise the carbon fibre industry if successfully scaled up, however, Professor Martin said the team have an even more ambitious goal in mind.

"The Holy Gail of carbon fibre research is to remove the solvents used to make it, which aren't particularly green."

The nanofibres the team have created can suspend in water and are long and thin, lending themselves towards the spinning and aligning required for thread production. This could result in a totally water-based textile that removes the solvents from the process.

The team has signed a landmark agreement with the Myuma Dugalunji Aboriginal Corporation in Camooweal, north-west Queensland. It provides a mechanism to commercialise the technology with indigenous-royalty sharing in any commercialised products that evolve out of the technology.

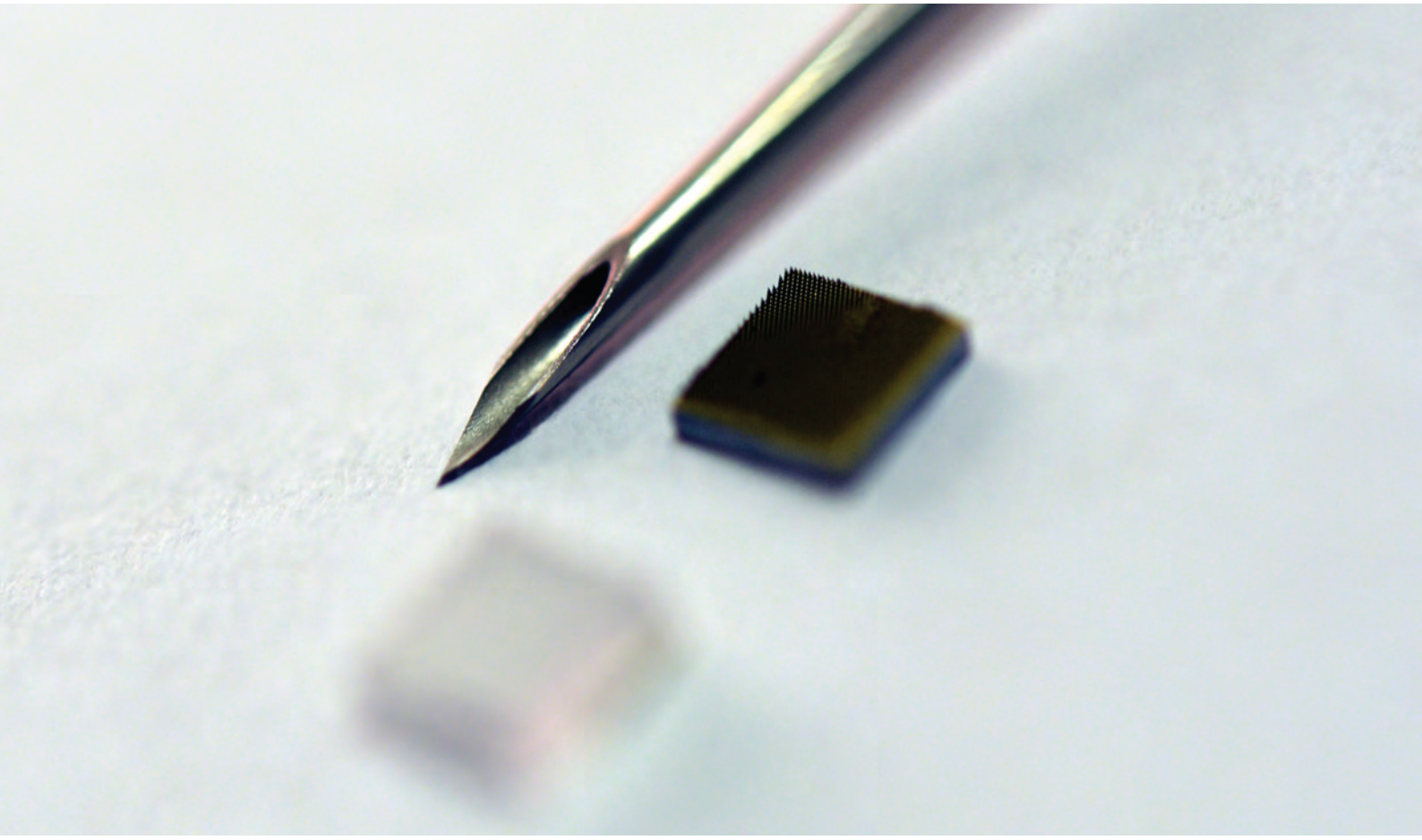
"The grass grows where indigenous communities are, and if we can develop this process then this opens up strong economic possibilities across regional Australia," Professor Martin said.

The research is also supported by an ARC Discovery Project in collaboration with Carbon Nexus at Deakin University, providing access to state-of-the art carbon fibre production and testing facilities.

"Commercially there is a black art to making carbon fibre, and the big players do not share information, so we're looking at opening up that knowledge with Carbon Nexus at Deakin University," he said.

Research on spinifex-derived nanocellulose was published in *Cellulose* and *RSC Advances* during the year.

# GETTING BIOMARKERS OUT OF THE SKIN WITH MICROPATCHES



The Kendall Group is researching a device, which rather than delivering vaccine to the skin, instead takes biological samples away as a needle-free blood test.

Professor Mark Kendall said the Micropatch features projections designed for selectively-extracting biomarkers from the outer layers of the skin, rather than needing a needle or lancet for a blood sample.

"By applying the Micropatch to the skin, and leaving it on for under an hour, the micro projections are exposed to the fluid in the skin – which includes blood in the capillaries – capturing protein biomarkers which can be analysed when the patch is removed," Professor Kendall said.

"The device is being advanced to have 'plug-and-play' functionality with a diagnostic reader. Achieving this will allow for quick and easy diagnosis of diseases such as dengue fever or malaria."

Professor Kendall said that while blood samples taken with a needle and syringe are effective, the Micropatch offers a number of competitive advantages.

"The obvious advantage is that the Micropatch is far less invasive than a needle. But potentially of even greater relevance, we envisage that as a diagnostic tool the Micropatch would only require minimal training and would offer an immediate diagnosis," he said.

"Currently patients have to wait for a diagnosis, especially in developing countries; whereas an immediate diagnosis allows treatment to begin straight away."

Kendall Group PhD student Kye Robinson was the first author on a paper published in *Biointerphases*, and said the Micropatch has key differences from the Nanopatch.

Proof of concept was successfully established during the study, with in vivo capture of antibodies specific to the dengue NS1 protein from the skin of a live mouse model.

This was followed by work published in *Biomaterials* showing how Micropatches can access biomarkers in blood vessels, instantaneously and over several hours as a wearable device.

First author Dr Jacob Coffey said, "The Micropatch is designed with different projection shapes to sample material, with surface chemistry to allow for the selective extraction of biomarkers."

The projections featured on the Micropatch are also longer than those on the Nanopatch, due to the need to access deeper into the skin. Despite this, the Micropatch only delves as far as the capillary loops in the dermal papillae – or fingerprints – for target probes to capture target biomarkers.

In 2011, Professor Kendall founded the UQ start-up Vaxxas, which achieved initial capital raising of $15 million to advance the Nanopatch through clinical testing and along the pathway to a commercial product. A further $25 million was secured during 2015 through Series B venture financing, funding Nanopatch clinical programs and the application of further vaccines.

# HIGH PERFORMANCE CLUSTER BOOSTS RESEARCH CAPABILITIES

Computational capabilities at UQ were significantly boosted in 2015 with the arrival of a new high performance computing cluster at AIBN.

A UQ Major Equipment and Infrastructure grant awarded to Professor Debra Bernhardt enabled the purchase of the $275,000 cluster dubbed 'Golden Orb'.

Replacing the previous 'Funnel Web' cluster, which operated for six years, the new cluster became operational in April to the immediate benefit of computational researchers.

Dr Marlies Hankel of the Bernhardt Group manages the new equipment, which has significantly accelerated the time it takes to run modelling simulations.

"Runtimes are much quicker; in a day we can now run a calculation that would have taken a week with the old cluster," Dr Hankel said.

This increase in processing speed is attributable to an increase in the number of cores from 280 to 500, and a significant increase in memory per core. Critically, however, half of the new cores come from the new Phi co-processor family, which can operate numerous data threads similar to a GPU (graphics processing unit).

"The Phi cores are used to give the calculation a boost, by providing extra cores that are located on the same node and do not need to be reached over the network," she said.

"We are seeing a better speed up for a calculation using the Phi cores compared to a calculation using a second node.

"The other big advantage of the Phi cards is that existing programming languages can be used and programs do not need to be rewritten, like for a GPU."

In addition to the Bernhardt Group, the advanced capability of the new cluster is being utilised by the Wells, Middelberg, Yu and Wang Groups at AIBN, as well as a number of others across the University, including the Centre for Hypersonics.

"As an example of what we work on, the cluster enables us to rapidly model different materials and the impact of manipulating various components of these materials," Dr Hankel said.

"That allows us to model materials that have different chemical elements added to them, and we are able to model how that changes the material's behaviour," she said.

The new Golden Orb cluster has a modular design which will allow future expansion to meet the growing demand for state-of-the-art computational capability.

# SELF-ASSEMBLED NANOCAPSULES DELIVER RESULTS

Nanocapsule technology invented by Professor Anton Middelberg and Drs Chun-Xia Zhao and David Wibowo could be applied to a variety of industrial applications, with a lower environmental impact during production and usage.

Group Leader Professor Anton Middelberg said UQ has developed a patented process of using a peptide or a protein to self-assemble a shell around a pharmaceutical-grade oil that can carry a chemical or therapeutic cargo.

"What's unique about the nanocapsule technology is that you make the droplet at room temperature with the proteins on the surface, which self-assemble, and when a reagent is added a protective silica layer builds around the surface," he said.

"At no point do you use any toxic solvents or high temperature in the process, whereas the traditional way is very resource and energy intensive."

Associate Group Leader and ARC Future Fellow Dr Chun-Xia Zhao said that the traditional approach of producing nanoparticle carriers uses what is called a template particle, which a layer of silica is grown around.

High temperatures or extreme pH levels with solvents are then used to remove the core, leaving the shell.

"These are difficult steps, and a lot can go wrong – the shell can rupture, or the agents that are meant to be added might be too big for the gap that is created," Dr Zhao said.

Nanoparticles have been studied worldwide as delivery vehicles for many years, however these manufacturing processes have proven limiting for bringing the technologies to some markets.

"However, our system is very simple. The proteins and peptide sequence at the interface harden into a silica shell that surrounds the oil droplet, which is pre-loaded with the agent you want to deliver," she said.

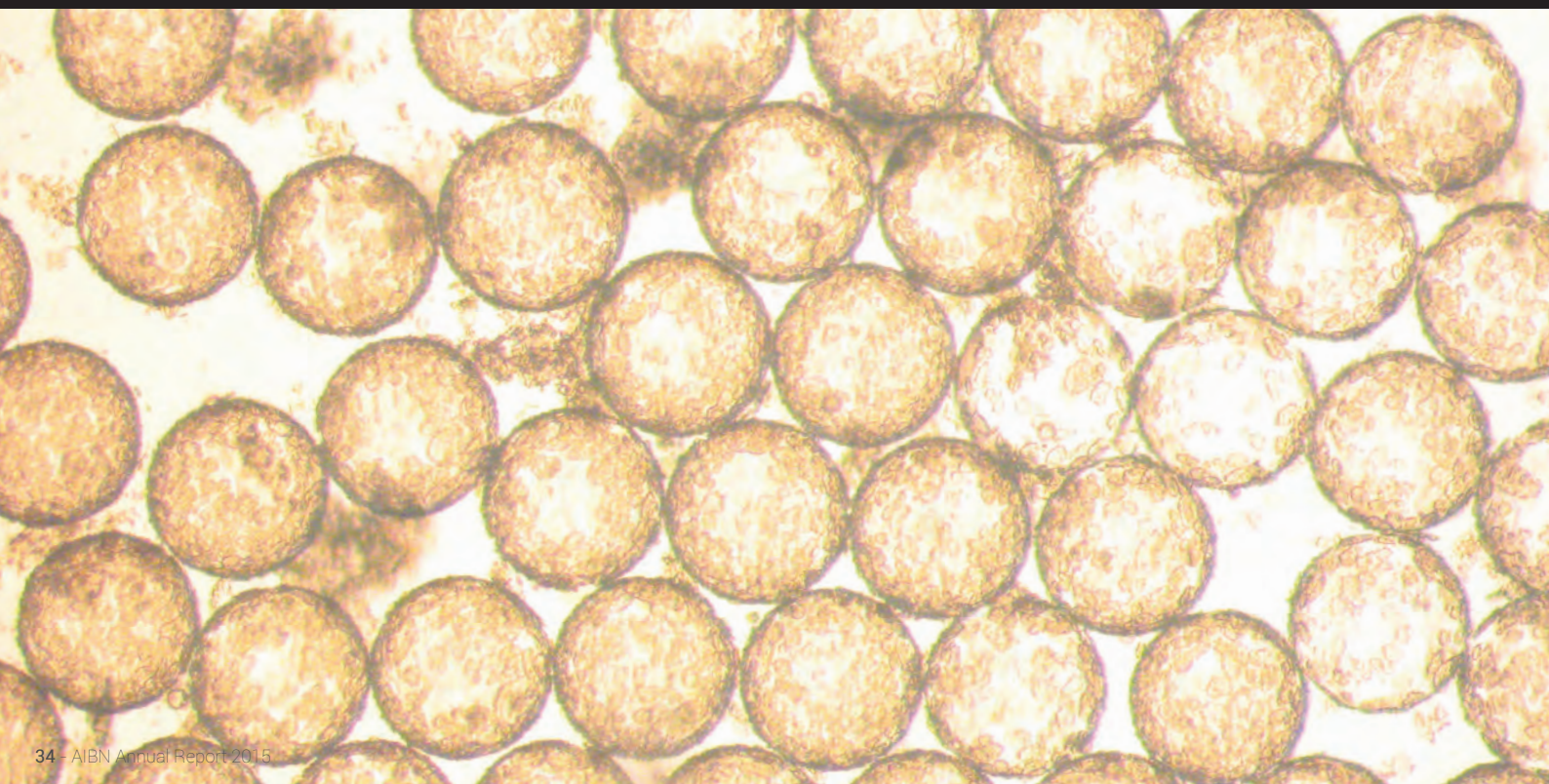
This method has the additional advantage of having a high loading capacity, and the precursor can control the shell's thickness, which in turn controls the speed of release. Together with agricultural applications, the nanocapsules could also be used in areas as diverse as health and cosmetic products.

As a proof of concept, the team collaborated with Mr Brenton Peters, formerly Principal Entomologist at the Queensland Department of Employment, Economic Development and Innovation, in a field trial to use the nanocapsules as a cost-effective termite pesticide with a lower ecological impact than when used with current delivery methods.

Although highly effective as a pesticide, fipronil has been identified as one of the leading causes behind the declining number of bee colonies worldwide, and also affects many other animals including insects and fish. Consequently, discovering a method of minimising its consequences is of high importance.

"The termite pesticide fipronil is highly toxic to the environment, and current methods rely on burst release of a large amount of it at once. However, using fipronil in conjunction with the nanocapsules resulted in a significant materials saving and lower environmental impact," Dr Zhao said.

Research on the termite field trial was published during the year in *Langmuir*, and a new trial began in December 2015 looking to eliminate termite nests within a period of several weeks. The research program is funded through an ARC Discovery Project grant.



# FAST, CHEAP AND EASY TO USE TUBERCULOSIS SCREENING

The dire need for improved diagnosis of tuberculosis (TB) has led UQ researchers to develop a testing platform to suit the specific needs of developing countries where the illness is most prevalent.

Work led by AIBN's Professor Matt Trau and Dr Nick West of the School of Chemistry and Molecular Biosciences is looking to build a system that is substantially cheaper and easier to use than those currently available.

The work is based on the "Single Drop Genomics" technology first invented through a collaboration between Professor Jimmy Botella's laboratory at UQ's School of Agriculture and Food Science and the Trau laboratory.

"Though the numbers are slowly dropping, around 10 million people still fall ill from TB each year, and devastatingly this is fatal for around one and half million of these people," Professor Matt Trau said.

"Left unchecked, tuberculosis is an extremely powerful illness that together with HIV is one of the leading causes of death worldwide, making the need for an easily accessible diagnosis even more pronounced.

"In developing countries there is an urgent need for a way to diagnose people cheaply, and in a way that requires minimal training as medical practitioners are thinly spread on the ground."

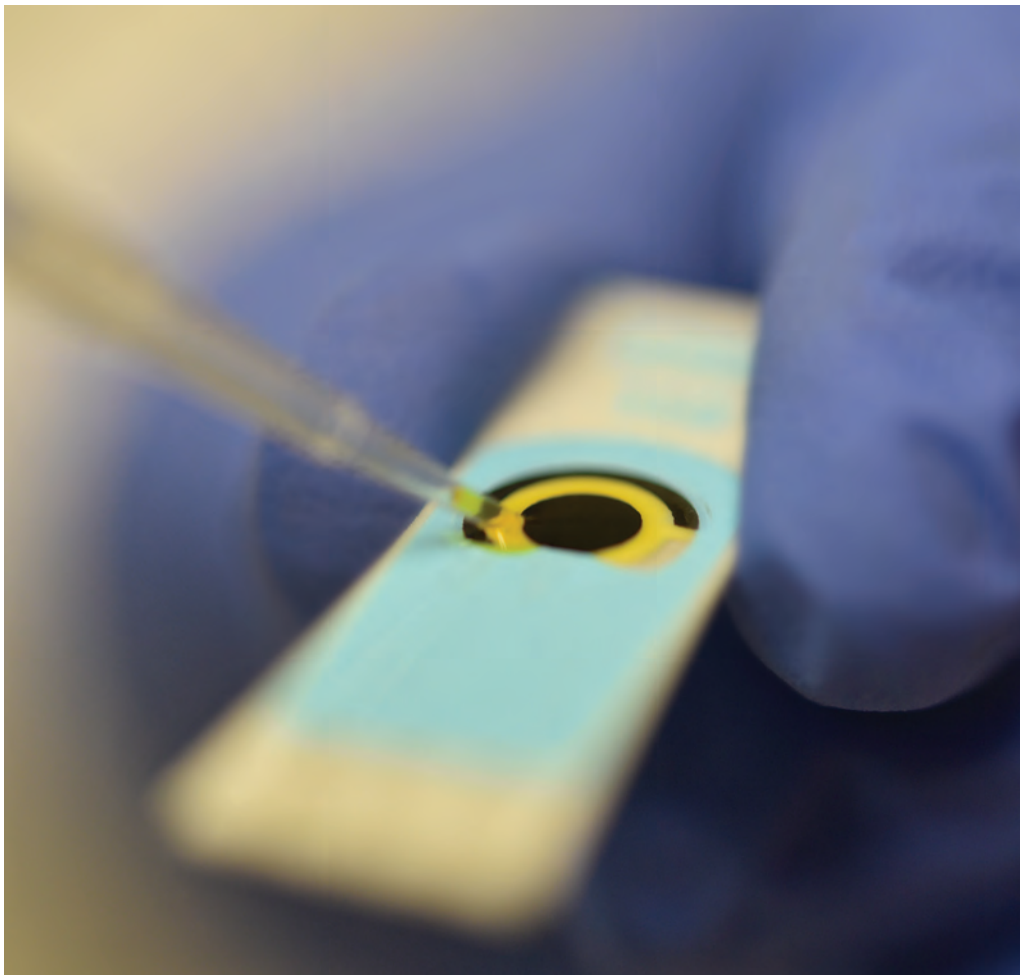
Collaborator Dr Nick West said many existing detection methods have limitations including cost or lengthy wait times for accurate results. This presents problems for wider adoption in developing countries at the point of care.

"PCR (polymerase chain reaction) tests exist, which are accurate and quite quick, but they are expensive and require training and expertise to run and interpret," he said.

"There are also other methods to detect TB, such as a skin test, but if you have previously been inoculated with the BCG vaccine, which is the only vaccine against TB currently used, then there is a high chance you will return a positive result."

PhD student Mr Benjamin Ng said their test analyses DNA biomarkers from tuberculosis for a reliable result.

"Sputum is the easiest way to obtain a sample from a patient with TB, but often they also cough up blood which tempers the sample, which means that our system requires a robust DNA purification technique," Mr Ng said.



"We are also incorporating isothermal DNA amplification, which allows us to work at a constant temperature to copy the DNA and increase the signal without the need for sophisticated laboratory equipment."

In 2016 the team will test the system with patient samples, and hopes to have a workable prototype for field trials in 2017.

"On the patient side we would ultimately like the test to be available in the local pharmacy for a cheap price," Mr Ng said.

"A person feeling unwell at home could purchase the test, give a sample, run the test, and within the hour know if they are infected with TB.

"Once you identify a person with active TB, you can administer antibiotics immediately and take measures to ensure they do not spread the illness further, and you can also quickly and cheaply screen people they've already been in contact with. This will bolster national healthcare efforts to control the spread of TB through systematic screening and early diagnosis."

If successful, this research is of immense significance. The potential cost savings per test will be amplified many fold when extrapolated across the millions of diagnostic tests that are performed annually on suspected TB cases worldwide.

This research has been published in three seminal papers in 2015, with findings appearing in *ACS Sensors*, *Scientific Reports*, and *Analytical Chemistry*.

The work is in part funded by a donation of more than $3 million to UQ in 2012 by the TB Sailors', Soldiers' & Airmen's Association of Queensland, and continues the University's historical connection with the illness. UQ's Fryer Library is named after a former UQ student and First World War veteran, John Denis Fryer, who died of tuberculosis in 1923.

# INDUSTRIAL AFFILIATES PROGRAM REMOVES BARRIERS BETWEEN ACADEMIA AND INDUSTRY

The Industrial Affiliates Program (IAP) is a conduit between AIBN's ground-breaking research and the establishment of industry partnerships.

Founded in 2009, the IAP directly links domestic and international industry with the Institute via a membership program, together with networking events held throughout the year.

The program enables the formation of partnerships to accelerate research and form consultative agreements.

## Networking events

There were three very well attended IAP events during the year, beginning with the annual Showcase and Networking Event held at AIBN on 19 March.

More than 60 guests from industry, philanthropy, academia and government were given a taste of the research undertaken at the Institute.

Professor Andrew Whittaker spoke about advances in battling brain cancer, while Professor Peter Gray described new technology for growing stem cells for regenerative medicine.

Professor Matt Trau closed the evening with a stimulating discussion about his research aimed at developing a novel diagnostic platform that will enable personalised nanomedicine with the capacity to tailor treatments to patients based on their individual physiology and disease pathology.

On 16 April the eighth event in the AIBN Thought Leaders' dinner series was held at Customs House, with guest speaker Professor Jim Patrick AO describing his journey in developing the globally successful cochlear implant technology.

His presentation included personal insights into biomedical research and engineering innovation, as well as education and professional associations. The cochlear success story was particularly relevant to those in attendance, with the development and commercialisation of novel technologies at the forefront of AIBN's mission.


The year's final event was the ninth AIBN Thought Leaders' dinner held on 1 October at Customs House.

Dr Alan Finkel AO, then Chancellor of Monash University and President of the Australian Academy of Technological Sciences and Engineering, spoke about his experience in founding the US-based, ASX-listed company Axon Instruments, from original idea through to acquisition by NASDAQ-listed Molecular Devices. He shared what he considered to be the key drivers behind this successful venture, gave thought-provoking insight on the innovation culture in Australia, and challenged us to change the way we see ourselves by acknowledging and celebrating our global success stories.

## Membership

The IAP provides three levels of membership, with scaled levels of access to AIBN researchers and facilities.

More than 20 companies have joined the program which, at its highest level, provides significant discounts on consulting fees and privileged access to AIBN researchers to engage with the member company's own personnel.

AIBN Industry Fellow Dr Ian Nisbet said IAP memberships provide affordable access to companies of differing sizes and needs. "Companies are fortunate to be able to work with our researchers for their own separate programs, together with developing relationships that could lead to joint-developments," Dr Nisbet said.

"The Premier, Member, and Associate Member levels of the program provide tailored access depending on the company's needs and budget."

More information: www.aibn.uq.edu.au/iap.

# AIBN EARLY-/MID-CAREER SUPPORT PROGRAM

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

AIBN EMCR Chair Dr Michael Crichton said EMCRs, which comprise researchers in the first five to 10 years of their career after completing a PhD, face the challenge of establishing their career after an extended period of education.

"It's not a situation too dissimilar to what any other university graduate faces as they enter the workforce and try to establish a career," Dr Crichton said.

"We look to support the 100 or so EMCRs at AIBN through a number of initiatives that assist them on a professional and personal level."

Faced with a competitive funding environment, the EMCR Committee launched the *GrantReady* Program in collaboration with the AIBN grants unit and executive. This encompasses a range of support initiatives targeted at improving the scientific and written quality of grant applications, and also educating EMCRs on the various schemes and how to best position themselves to be competitive. The program culminates in a pitch session to a panel of scientific experts where EMCRs have the opportunity to rigorously test the merit of their application.

Following a survey of the EMCR cohort, the committee initiated a professional development seminar series during the year.

"We ran seminars to inform the cohort about commercial avenues for research; what kinds of work are of interest to industry, and developing career paths for researchers outside of academia," Dr Crichton said.

Over the course of the year the committee ran three networking events at AIBN to foster internal collaborations and discuss the EMCR environment. The committee also worked closely with other UQ institutes to cross-promote events for EMCRs.

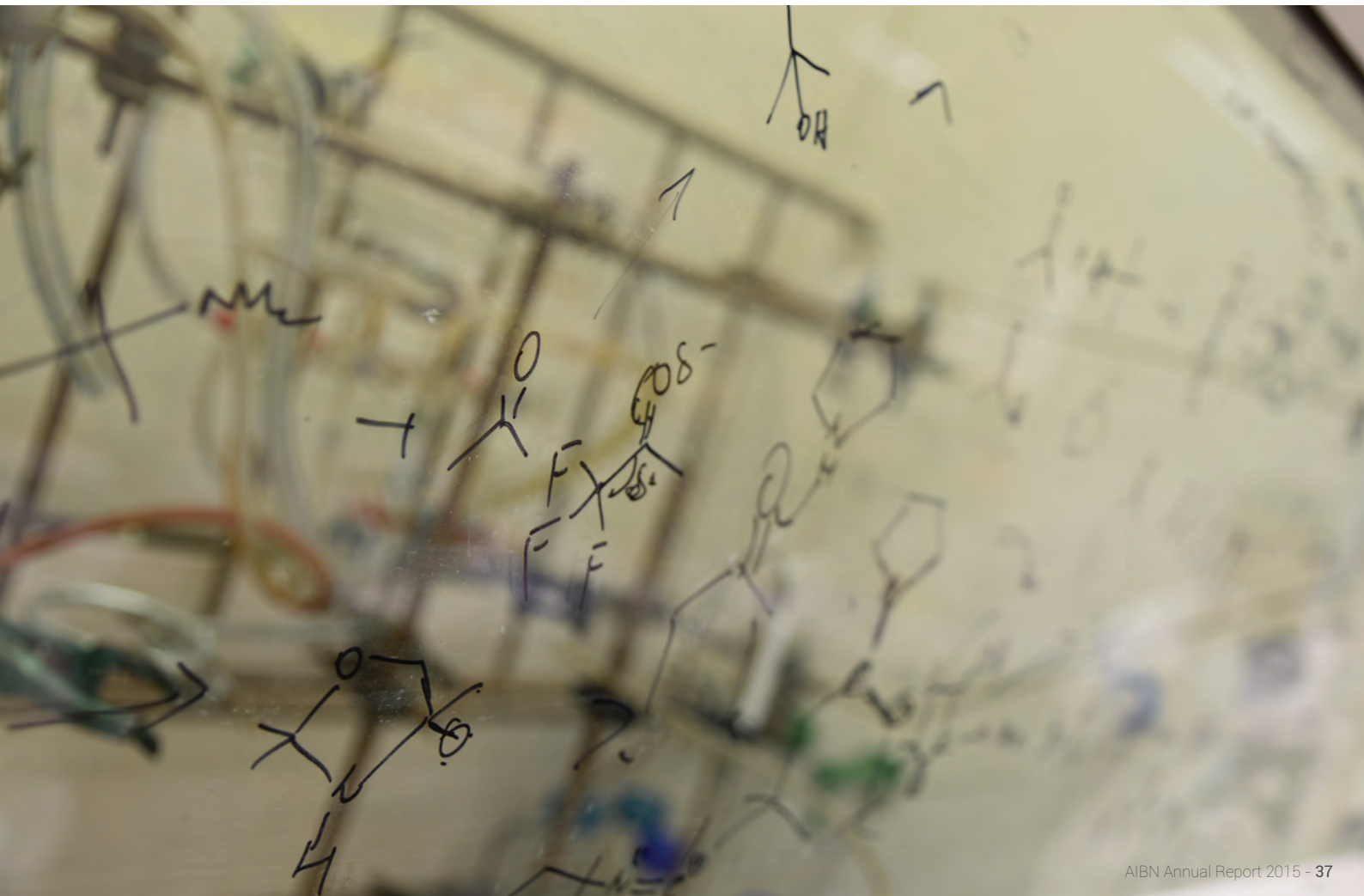
AIBN Group Leaders rotated their attendance at the EMCR Committee meetings, offering valued support and guidance in developing the many activities throughout the year.

The committee is seeking to expand its activities to develop initiatives that support EMCRs in achieving work/life balance, particularly focussing on ways to build a research career while balancing family commitments.

"Most EMCRs are of an age where starting a family is important, and they do not want to miss out on having a career or a family," he said.

Members of the committee also assisted in hosting the 6th Annual Early Career Researcher Symposium, which was held at UQ in December and attended by more than 200 registered guests.

In 2016 the committee will continue building its program, collaborating with other institute committees and engaging with EMCRs. Dr Ilaria Stefani will take over as Chair the committee, with a team of enthusiastic EMCRs.



# FUNDING AND RECOGNITION

L-R: Professor Mark Kendall, The Hon. Christopher Pyne - Minister for Education and Training, The Hon. Jane Prentice - Federal Member for Ryan, Professor Peter Gray, and Professor Peter Høj.

# AUSTRALIAN RESEARCH COUNCIL FUNDING

Over the course of 2015, AIBN researchers were involved in Australian Research Council grants that totalled more than $5.8 million.

The Institute's commercial focus was reflected in particularly strong results in securing ARC Linkage Projects, which provides funding to partner with external companies and end-user organisations to expedite translation of innovative ideas and technologies.

In total, AIBN researchers were named investigators on six new ARC Linkage Project grants, attracting funding in excess of $2.3 million.

$488,000 was awarded to Professor Lars Nielsen and Dr Esteban Marcellin for research to lower the cost of producing toxoid vaccines commonly used in livestock. Partnering with Zoetis Australia, they will look to decrease the high level of batch failures and improve vaccine concentration.

Associate Professors Kris Thurecht and Steve Mahler will partner with Minomic International Ltd on a $360,000 grant to develop a stable nanomaterials and biomolecules delivery platform for antibodies, using promising prostate cancer antigen MIL38 as a translational test bed.

Professor Chengzong (Michael) Yu and Elanco Animal Health will look to combat the annual $400 million loss of Australian livestock to ticks and the buffalo fly. A $330,000 grant will study the use of a naturally derived pesticide called Spinosad in silica hollow nanospheres for improved adhesion to fur and skin, and reduced ultraviolet degradation.

Professor Kirill Alexandrov will lead the study of novel peptides for use in pharmaceuticals in a $670,243 grant partnered with Phylogica Limited.

In further research involving AIBN researchers, Professor Lianzhou Wang will partner with Professor Han Huang of the UQ School of Mechanical and Mining Engineering and Baosteel Company in a $377,000 project to study the development of water based nano additive lubricants for use in steel production. They aim to improve the quality of steel and reduce waste by-products.

Professor Darren Martin was named on a $159,661 Linkage Project with DOW Chemical (Australia) Ltd to develop innovative, high performance carbon fibres that are cost effective using plastic polyethylene to reduce the restrictive price of carbon fibres.

The Institute also secured four ARC Discovery Projects, a prestigious Discovery Early Career Researcher Award, and two Linkage Infrastructure, Equipment and Facilities grants.

Associate Professor Linda Lua and Professor Anton Middelberg will study a single-dose nanovaccine for cost-effective influenza poultry vaccination, which does not require refrigeration but is advantageously stable at room temperature in a $430,000 project.

Professor Matt Trau secured $315,000 to develop a technology that can capture and study nano-sized molecular complexes in their natural state for use in biology, biotechnology and advanced materials.

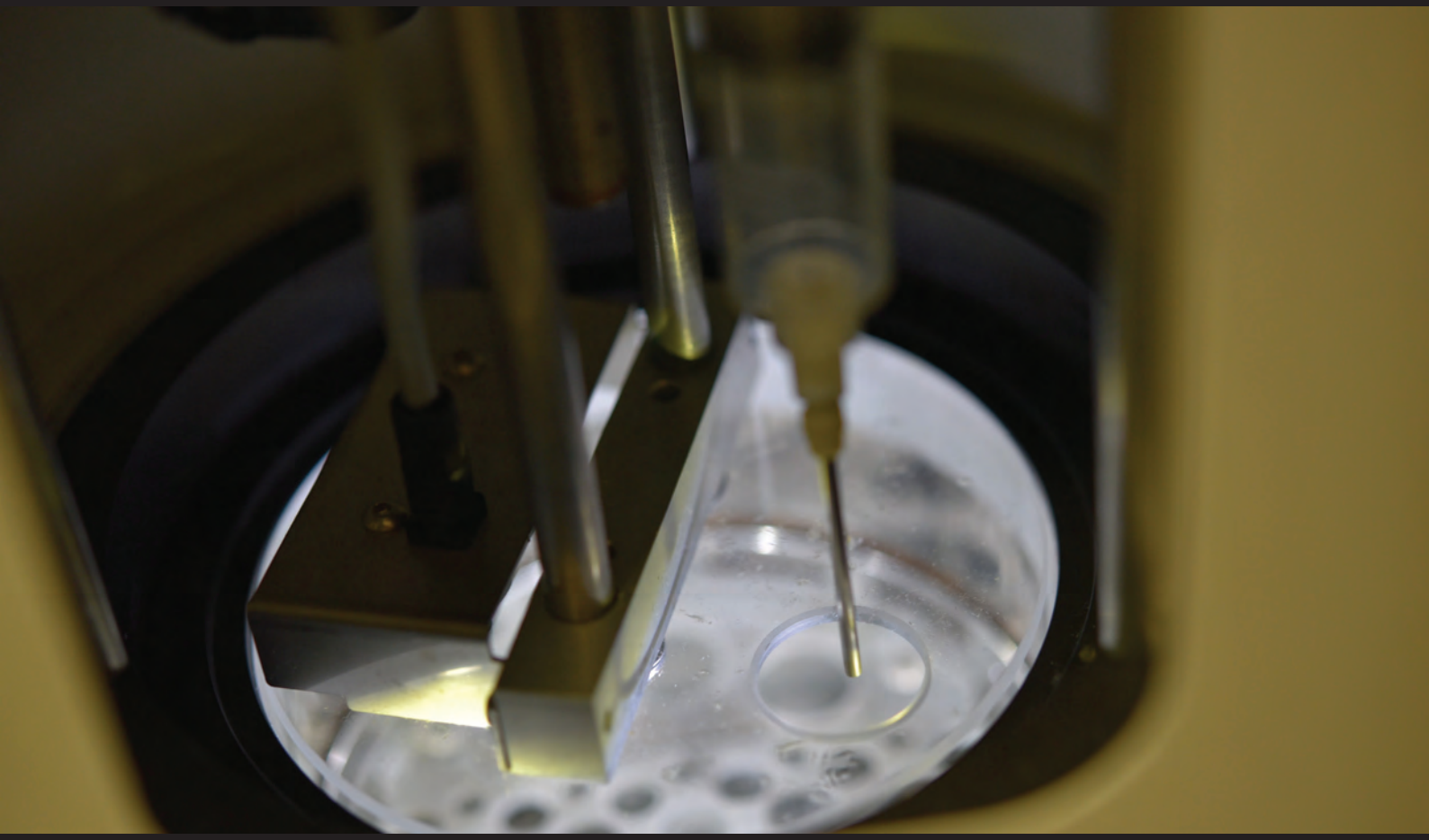
Professor Lianzhou Wang will develop photocatalyst systems that can convert waste products into valuable chemicals using solar energy in a $310,000 project. Professor Kirill Alexandrov will also lead a $650,000 project to develop electric biosensors that utilise a new class of artificial protein receptors.

Dr Yu Chen from the Wang Group received a prestigious Discovery Early Career Researcher Award worth $355,000 for the development of a diagnostic and therapeutic nano-platform for cancer treatment.

Separately, Associate Professor Kristofer Thurecht will lead the establishment of an advanced facility for the characterisation of bio-nanomaterials in biomedical applications, with the award of a $650,300 Linkage Infrastructure, Equipment and Facilities project.

In partnership with Professor David Williams of the UQ School of Civil Engineering, Professor Darren Martin was an investigator on a successful Linkage Infrastructure, Equipment and Facilities bid for $800,000 to create a national rock, concrete and advanced composite testing facility.

# NATIONAL HEALTH AND MEDICAL RESEARCH COUNCIL



AIBN celebrated a very successful year in National Health and Medical Research Council funding, attracting new project funding totalling more than $4.5 million.

The Institute achieved an outstanding 60 per cent success rate in AIBN-led NHMRC Project Grants – significantly higher than the national success rate of 13.7 per cent. A total of six new projects will commence in 2016, in addition to two new NHMRC Development Grants which support research at the pre-seed stage to drive commercial outcomes within a five-year timeframe.

AIBN Associate Group Leader Associate Professor Kristofer Thurecht will lead a project studying immuno-polymeric drugs for prostate cancer therapy. The $626,995 study, which also involves AIBN's Associate Professor Stephen Mahler and Dr Christopher Howard, seeks to eliminate side-effects of chemotherapy agents.

"We're developing a targeted approach that uses nanomedicine to increase the delivery of the therapeutic to the tumour site, and reduce the amount lost to other sites," Associate Professor Thurecht said.

AIBN Group Leader Professor Justin Cooper-White secured $618,493 of Project Grant funding to study the direct reprogramming of adult cardiac fibroblasts following injury.

"Rather than a patient's heart tissue becoming scarred, it could become functional heart tissue," Professor Cooper-White said.

"Current drug-based therapies work towards stopping further damage to the heart, but the impact on heart repair is marginal at best."

A novel therapeutic strategy for metastatic melanoma will be the subject of a $546,495 study by AIBN's Dr Barbara Rolfe. The research will investigate how an immune protein, C3a, regulates melanoma metastasis – an aggressive and advanced form of skin cancer that has spread to other sites.

"We have seen dramatic reductions in the size of primary tumours with this treatment in the laboratory, and will now look into whether it can also reduce the spread of the metastasis," Dr Rolfe said.

In a joint project with UQ's Professor Maree Smith from the School of Pharmacy, Professor Andrew Whittaker was awarded $796,950 to study relief strategies for patients suffering from advanced cancer by using polymer microparticles.

"We are looking to develop polymer microparticles that can be injected into spinal fluid, and deliver a prolonged-release of analgesic drugs with the objective of reduced complications and longer periods of pain relief," Professor Whittaker said.

A $621,979 project in collaboration with Dr Kate Stacey and Professor Paul Young from UQ's School of Chemistry and Molecular Biosciences will see AIBN's Dr David Muller study the dengue virus NS1 protein as a mediator of pathology.

Professor Kirill Alexandrov, who shares a joint appointment between AIBN and the Institute for Molecular Bioscience, was awarded a $587,360 NHMRC Development Grant for work on developing a point-of-care diagnostic test for immunosuppressant drugs.

Professor Peter Gray was named on a $736,300 Development Grant administered by the University of Sydney and led by Professor Derek Hart for the a new immunosuppressive monoclonal antibody to advance transplantation.

# FELLOWSHIPS FUEL RESEARCH OPPORTUNITIES

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

During 2015 the strength of innovation and output demonstrated by AIBN researchers resulted in another successful year of achieving fellowship funding.

Professor Lars Nielsen was awarded a highly prestigious Novo Nordisk Foundation Laureate Research Grant which will fund his research to the value of $8.6 million over seven years.

Professor Nielsen is one of the world's foremost systems biology researchers, and the honour marks the first time the Novo Nordisk Foundation has awarded a grant to a biotechnology researcher.

The research will seek to understand why cancer cells and other rapidly growing mammalian cells produce lactic acid.

Professor Nielsen's work will aim to develop a detailed kinetic and regulatory model of the central carbon metabolism in cultured mammalian cells.

In addition to understanding the differences between healthy and cancerous cells, findings of the research could also be applied to metabolic diseases such as diabetes.

Professor Christine Wells was recognised for her leading work in understanding stem cells with the award of one of only fifty ARC Future Fellowships awarded nationally.

Her work will seek to understand the systems biology of stem cells and how complex populations of stem cells behave.

It is hoped that identifying new classifiers for stem cells will provide molecular predictors for the differentiation potential that stem cells have, which control what type of cell they will become.

The project will use new bioinformatic methods and develop statistical models that address population heterogeneity for new insights into stem cell biology and tissue engineering.

Dr Muhammad Shiddiky of the Trau Group received a NHMCR Career Development Fellowship for his work in developing a microfluidic strategy for analysing circulating tumour cells in cancer patients.

Circulating tumour cells detach themselves from a primary tumour and travel through the blood stream, often resulting in secondary cancer sites.

Though they show excellent promise as a biomarker, the low abundance of circulating tumour cells in the blood stream has up until now made their presence difficult to detect.

The objective of Dr Shiddiky's work is the development of a standard diagnostic tool for cancer patients undergoing systemic therapy.

Dr Yu Chen of the Wang Group will study the development of two-dimensional nanosheets for novel applications under an ARC Discovery Early Career Researcher Award.

The nontoxic and biocompatible manganese-oxide nanosheets have the potential to perform as a new theranostic nanomaterial platform.

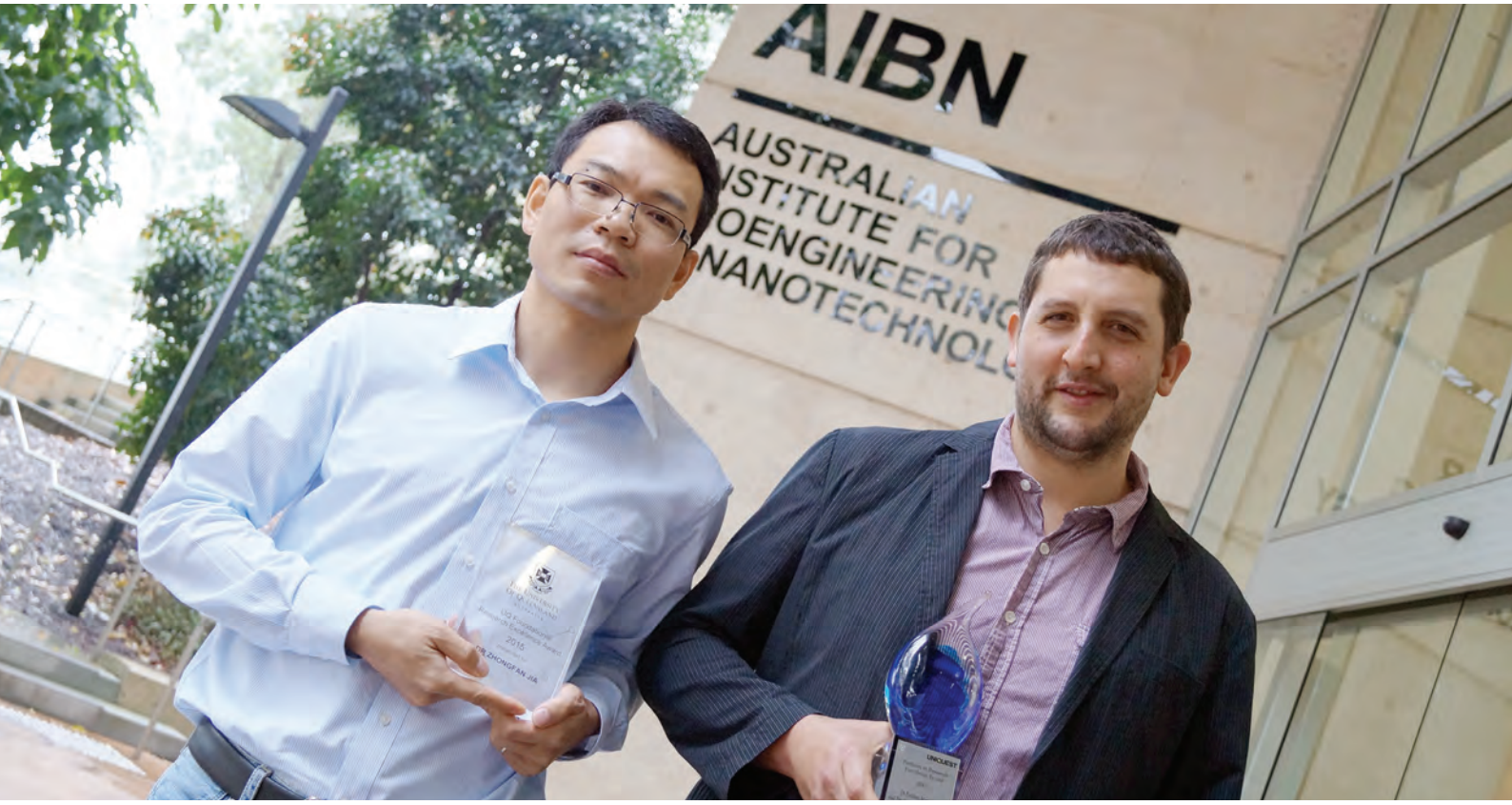
Dr Chen will investigate their use as stimuli-responsive agents that could combine simultaneous targeting, magnetic resonance imaging enhancements, and drug release and delivery.

Internationally, Professor Andrew Whittaker was the only Australian during the year to be awarded a Chinese Academy of Sciences President's International Fellowship Initiative.

Fifty such fellowships are awarded annually to support leading international scientists to conduct research at a CAS institute.

Under the fellowship, Professor Whittaker spent one month working in Beijing and at the National Centre for Nanoscience and Technology.

# AWARDS HIGHLIGHT SCIENTIFIC EXCELLENCE




The top quality science at AIBN was recognised with a number of researchers receiving both local and national awards during 2015, highlighting their outstanding contribution to their respective fields.

**Professor Christine Wells** won a prestigious Metcalf prize for her leadership in stem cell research.

Awarded by the National Stem Cell Foundation of Australia, the $50,000 award is named after the late Professor Donald Metcalf AC, an internationally renowned Australian expert on haematopoiesis.

"It was great recognition for what the lab is doing, and the resources we have made available," Professor Wells said.

AIBN's expertise in stem cell research was further recognised during the year with **Professor Justin Cooper-White** being awarded the 2015 Aon Risk Solutions Regenerative Medicine Award by Life Sciences Queensland for his research at the interface of engineering and biology.

"I'm proud to receive this award from my peers, and will continue to advocate for the development of regenerative medicine to improve clinical outcomes for patients," Professor Cooper-White said.

It was the second successive year an AIBN researcher has won the award, with Professor Ernst Wolvetang being the recipient in 2014.

**Professor Chengzhong (Michael) Yu** was awarded the 2015 Le Fèvre Memorial Prize by the Australian Academy of Science.

Named after the late Professor RJW Le Fèvre FAA FRS, the prize recognises outstanding basic research in chemistry.

**Professor Mark Kendall's** ongoing work on nano projections for vaccine delivery and diagnostics was recognised by professional body Engineers Australia. He was named on the organisation's annual Top 100 Most Influential Engineers list. AIBN Board member Kathy Hirschfeld was also named on the 2015 list.

AIBN has proudly been consistently represented by its researchers on this annual list, with former AIBN Director Professor Peter Gray, former Group Leader Professor Max Lu, and current Group Leader Professor Anton Middelberg all being included in past years.

During the annual UQ Research Week ceremonies AIBN researchers were recognised for their contribution to science, and the strong potential and novelty of their work.

Associate Group Leader **Dr Esteban Marcellin** from the Nielsen Group won the Science Prize of the Partners in Research Excellence Award for his collaboration with The Dow Chemical Company.

Dr Marcellin's research program is studying the production of an industrially organic insecticide, the development of tools to better understand microbes, and finding genetic engineering targets.

"It is a great honour to get recognition for the work I am doing and I am very grateful for it," Dr Marcellin said.

Fellow Associate Group Leader **Dr Zhongfan Jia** from the Monteiro Group won a UQ Foundation Research Excellence Award for work to develop a totally plastic battery to power future flexible and wearable electronic devices.

"I am very proud and excited to get this award because it is very competitive," Dr Jia said.

"This is a big step towards obtaining competitive grant funding to progress my career, and it is a big boost for my research," he said.

Dr Jia is the eleventh AIBN recipient of the UQ Foundation Research Excellence Award, including Group Leaders Professor Michael Monteiro, Professor Lianzhou Wang and Associate Professor Zhi Ping (Gordon) Xu.

# NEWLY AWARDED RESEARCH FUNDING COMMENCING IN 2015

| Granting Body | Granting Scheme | Investigators | Project Title | Funding Years | Total Funding Awarded |
|---|---|---|---|---|---|
| Australian Research Council | Discovery Projects | Dr Zhi Chen, Prof John Drennan, Dr Gerard Snyder | Development of high performance nanostructured (Bi, Sb)2Te3 nanomaterials | 2015 - 2017 | $305,900 |
| | | Prof Ajayan Vinu, Prof Mietek Jaroniec | Design of functionalized mesoporous fullerenes for clean energy | 2015 - 2017 | $324,700 |
| | | Prof Darren Martin, Prof Eric McFarland, Dr Bronwyn Fox, Dr Pratheep Annamalai, Dr Bronwyn Laycock | High performance sustainable carbon fibres from Australian spinifex grass | 2015 - 2017 | $345,500 |
| | | Dr Chunxia Zhao, Prof Anton Middelberg, Prof Zhengzhong Shao | Next generation core-shell materials based on biomolecular dual-templating | 2015 - 2017 | $458,600 |
| | | Prof Kirill Alexandrov | Developing orthogonal synthetic signaling cascades | 2015 - 2018 | $534,700 |
| | Future Fellowships | Prof Christine Wells | The systems biology of stem cells | 2015 - 2018 | $931,552 |
| | Linkage Infrastructure, Equipment and Facilities | Prof Lianzhou Wang, A/Prof Shanqing Zhang, A/Prof Nunzio Motta, Prof Eric McFarland, Dr Jung Ho Yun, Dr Hongxia Wang, Prof Peter Halley, Dr Bin Luo | A new integrated photo-electrochemical device fabrication & testing system | 2015 - 2015 | $371,500 |
| | | Prof Ben Hankamer, Dr Michael Landsberg Prof Joel Mackay, Prof Robert Parton, Prof Paul Young, Prof Michael Monteiro, Dr Daniela Stock | Reaching new heights in high-resolution electron microscopy | 2015 - 2015 | $956,000 |
| | | A/Prof Glenda Gobe, Prof Pam Russell, A/Prof John Hooper, Prof Adrian Herington, Prof Christian Langton, A/Prof Kristofer, Prof Ian Brereton, Prof Ian Frazer, Dr Andrew Fielding, Prof Dietmar Hutmacher, Dr Michelle Hill, Prof Josephine Forbes, Dr Allison Pettit, Dr Kate Johnston | The Vevo 2100 micro-ultrasound plus LAZR photoacoustic imaging platform | 2015 | $55,000 |
| | Linkage Projects | Prof Eric McFarland, Prof Darren Martin, Dr Bronwyn Fox, Dr Jorge Beltramini, Dr Christopher Derstine, Dr Michael Mills | Cost effective carbon fibres from polyethylene for lightweight applications | 2015 - 2017 | $159,661 |
| | | Prof Chengzhong Yu, A/Prof Neena Mitter, Dr Aleta Knowles | Novel nano-pesticides for animal healthcare | 2015 - 2018 | $330,000 |
| | | A/Prof Kristofer Thurecht, A/Prof Stephen Mahler, Dr Bradley Walsh, Prof Pamela Russell, Dr Douglas Campbell | Next generation hybrid nanomaterials: bispecific antobodies using antibody-targeted polymers | 2015 - 2018 | $360,000 |
| | | Prof Han Huang, Prof Lianzhou Wang, Prof Zheng Jiang, Dr Jianqiang Zhang | Understanding the role of nanoparticles in water-based lubrication | 2015 - 2018 | $377,000 |
| | | Prof Lars Nielsen, Dr Esteban Marcellin Saldana, George Moutafis | Improving clostridial toxoid production through molecular fermentation maps | 2015 - 2018 | $488,000 |
| | | Prof Kirill Alexandrov, Dr Paul Watt | In vitro expression of macrocyclic peptides | 2015 - 2018 | $670,243 |
| National Health and Medical Research Council | Project Grant | Prof Ernst Wolvetang, Dr Ryan Lister, Dr Ozren Bogdanovich | Deciphering the role of atypical DNA methylation in neural genome regulation and neurological disorders | 2015 - 2017 | $278,617 |
| | | Prof Ernst Wolvetang, Prof Melissa Little, Prof Justin Cooper-White | Directed differentiation of human embryonic stem cells to kidney progenitors | 2015 | $110,000 |
| | Career Development Fellowship | Dr Muhammad Shiddiky | Microfluidic strategy for circulating tumour cells analysis in cancer patients | 2015 | $52,397 |
| Australian Government Department of Industry and Science | Australia-India Strategic Research Fund | Dr Jorge Beltramini, Dr John Zhu | Value adding to agriculture waste by catalytic gasification to bio-fuel production | 2015 - 2016 | $218,957 |
| | Research Connections | Dr Yasmina Sultanbawa, A/Prof Zhi Ping Xu | Natural additives to improve quality and shelf life of animal feeds | 2015 - 2016 | $143,000 |
| Australian Government Department of Education and Training | NCRIS 2013/2015 | Prof Lars Nielsen | National Collaborative Research Infrastructure Strategy: Bioplatforms Australia Project - Metabolomics Australia-Qld node | 2015 - 2016 | $250,000 |
| | | Prof Justin Cooper-White | National Collaborative Research Infrastructure Strategy: Australian National Fabrication Facility | 2015 - 2016 | $1,562,079 |

| Granting Body | Granting Scheme | Investigators | Project Title | Funding Years | Total Funding Awarded |
|---|---|---|---|---|---|
| Queensland Government | Accelerate Fellowship | Dr David Muller | Novel tetravalent dengue virus subunit vaccines delivered by Nanopatch | 2015 - 2017 | $441,000 |
| | Advance Queensland Women's Academic Fund | Dr Claudia Vickers | Microbial metabolic engineering | 2015 | $13,585 |
| National Breast Cancer Foundation | Innovator Award | Prof Kirill Alexandrov, Dr Viktor Stein | Developing of point-of-care biosensors for detection of breast cancer relapse | 2015 - 2016 | $220,000 |
| Asian Office of Aerospace Research and Development | Air Force Defense Research Sciences Program | Prof Andrew Whittaker, Dr Hui Peng, Dr Kevin Jack | Unlocking the structure and dynamics of thin polymeric films | 2015 - 2015 | $73,457 |
| Australian Cancer Research Foundation | Major Equipment Grant | Prof David Reutens, Prof Matt Cooper, Prof Maree Smith, Prof Andrew Boyd, Prof Linda Richards, Prof Perry Bartlett, Prof Pam Russell, Prof David Walker, A/Prof Rajiv Bhalla, A/Prof Markus Barth, A/Prof Chiara Palmieri, A/Prof Kristofer Thurecht, Dr Venku Venkatachalam and others | ACRF Facility for Molecular Imaging Agents in Cancer (AFMIAC) | 2015 - 2015 | $3,200,000 |
| Australian Nuclear Science and Technology Organisation | Bragg Institute Neutron Beam Instrument Proposal | Dr Jack Clegg, Dr Alison Edwards, Dr Michael Pfrunder, Dr Samuel Richardson, Prof Andrew Whittaker | Investigating the oxidation state of bis(diphenylglyoximato) cobalt dihalide catalysts by single crystal neutron diffraction | 2015 - 2015 | $1,476 |
| Cure Brain Cancer Foundation | Biomarker Discovery Program Grant | Dr Simon Puttick, A/Prof Steven Rose, Prof Andrew Boyd, Prof Andrew Whittaker, Dr Michael Fay, A/Prof Stephen Mahler, Dr Brett Stringer, Dr Bryan W. Day, A/Prof Kristofer Thurecht | Developing targeted EphA2 based imaging technology for glioblastoma | 2015 - 2016 | $219,712 |
| Go8 and the German Academic Exchange Service | Go8 Australia - Germany Joint Research Co-operation Scheme | Prof Lianzhou Wang, Dr Hongjun Chen | Complex mixed oxide photocatalysts with high porosity and surface area | 2015 - 2016 | $20,000 |
| King Saud University | Research Grant | Prof Ajayan Vinu, Prof Salem Al-Deyab, A/Prof Mohamed El-Newehy | Functional nanoporous materials for renewable energy applications | 2015 | $51,329 |
| Contract Research | Cook Medical Australia Pty Ltd | Prof Darren Martin | Research & development of polymeric materials for medical applications | 2015 - 2016 | N/A* |
| | Boeing Defence Australia | Prof Michael Monteiro | Development of polymer coated surface with a significantly greater surface area to capture and kill microbes | 2015 - 2016 | N/A* |
| | ProteoBioactives Pty Ltd | Prof Justin Cooper-White | Evaluation of the suitability of cross-linked hydrogels formed from Polyethyleneglycol (PEG), Hyaluronic Acid (HA) and Hyaluronic Acid-Pentosan Polysulfate (HA-PPS), alone or in combination with ... | 2015 | N/A* |
| | UniQuest Pty Ltd | Prof Darren Martin | Pathfinder Funding:condom prototyping project | 2015 | N/A* |
| | Medicago | Dr Frank Sainsbury | Tailorable nanoemulsions as prophylactic Influenza vaccines | 2015 | N/A* |
| | N4 Pharma Ltd | Prof Chengzhong Yu, A/Prof Neena Mitter | Development of an advanced Hepatitis B nanovaccine for human use - Stage 1 | 2015 | N/A* |
| | FMC Australasia Pty Ltd | Prof Chengzhong Yu | Transfer of Materials | 2015 | N/A* |
| | Bioproton Pty Ltd | Prof Kirill Alexandrov | Identification of thermostable variants of Phytase for use as an animal feed additive | 2015 | N/A* |
| | King Saud University | Prof Ajayan Vinu | One-dimensional nanostructured photoanodes for efficient solar-driven hydrogen production | 2015 - 2017 | N/A* |
| | TenasiTech Pty Ltd | Prof Darren Martin | Research Sub-Contract | 2015 | N/A* |
| | TenasiTech Pty Ltd | Prof Darren Martin | Nanocomposite R&D | 2015 - 2016 | N/A* |
| | Nufarm Ltd | Dr Bhagirath Chauhan, A/Prof Neena Mitter, A/Prof Zhi Ping Xu | Herbicide nanotechnology efficacy trial | 2015 - 2016 | N/A* |
| | Vaxxas Pty Ltd | Prof Mark Kendall, Dr David Muller | Nanopatch and delivery device for Polio vaccine | 2015 | N/A* |
| | Vaxxas Pty Ltd | Prof Mark Kendall | Funding of UQ personnel dedicated to Vaxxas activities | 2015 - 2016 | N/A* |
| Research Donation | Mr Shufeng Yang | Dr Wenyi Gu, A/Prof Zhi Ping Xu | Bio-immunotherapy for cervical cancer | 2015 | $100,000 |

# FACILITIES AND INFRASTRUCTURE

# INFRASTRUCTURE FACILITATES RESEARCH

## Australian National Fabrication Facility – Queensland

The Queensland node of the Australian National Fabrication Facility at AIBN is one of eight ANFF nodes in Australia across 21 institutions. ANFF is an open access network of facilities for both academic researchers and industry.

Facility Manager Mr Derek Hirons said ANFF-Q provides specialised facilities and expertise in fabricating microfluidic devices, organic electronics, biomaterials and semiconductor materials.

"Our position at AIBN allows us to service the needs of many of the researchers at the Institute and The University of Queensland, but also the needs of the Queensland bio and nanotechnology sector," Mr Hirons said.

In 2014, over 100 peer-reviewed publications acknowledged the support provided by ANFF-Q.

"At ANFF-Q, researchers can develop their work from a concept to a prototype, and consultation with our Professional Officers can clarify potential applications of fabrication and characterisation," he said.

"All of this can be supported in-house using our specialised software packages, fabrication facilities ranging from 10nm to 70µm resolution, and our suite of imaging and characterisation tools."

ANFF-Q continued to expand its capabilities in 2015, with the procurement of a JEOL IT-300 variable pressure scanning electron microscope allowing for larger sample sizes and different compounds such as samples that are wet, oily, non-conductive or outgas excessively.

The facility's fabrication capabilities were also extended with the addition of an air objective for the NanoScribe Photonic Professional GT. ANFF-Q's Nanoscribe is the only open-access piece in the world, and is capable of fabricating true three-dimensional nanostructures in numerous photoresists down to 100nm resolution.

Other equipment secured during the year includes an Oxford PlasmaPro NGP80 RIE system for dry etching and plasma deposition, and an Ultimaker II 3D Printer, which is capable of 3D printing at a 20 micron definition, allowing for rapid bespoke fabrication at minute scales.

"Through National Collaborative Research Infrastructure Strategy funding we have been able to continue to develop our resources and expertise, and will continue to do so in the future," Mr Hirons said.

## Centre for Microscopy and Microanalysis

AIBN is home to one of the four laboratories at UQ that form the Centre for Microscopy and Microanalysis.

The centre is the Queensland node of the Australian Microscopy and Microanalysis Facility and it facilitates research outcomes through the provision of training, expertise and state-of-the-art infrastructure in microscopy and microanalysis.

The CMM houses an impressive array of multi-million dollar electron and optical microscopes and X-ray analysis instruments. The Centre's facilities enable much of the imaging and microanalysis that supports AIBN researchers as well as external academic and industry clients.

"The Centre enables researchers to glimpse the world at atomic, nano, molecular, cellular and macromolecular scales," Acting Director Dr Kevin Jack said.

In 2015 four new state-of-the-art instruments and imaging cameras were commissioned, providing improved imaging to existing transmission electron microscopes and a range of new capabilities.

"The Gatan K2 Summit and OneView cameras enable a new level of detail to be captured, further improving CMM's already impressive capabilities in structural biology and material science," he said.

CMM commissioned a new Rigaku X-ray Diffractometer, which offers thin-film diffraction and reflectivity, micro-diffraction and in-situ temperature studies. An FEI focussed-ion-beam scanning electron microscope was also commissioned providing high-resolution and 3D imaging, analysis and fabrication for a range of materials and biological samples.

The Centre has been particularly involved in enabling the imaging of research for AIBN spin-out companies Vaxxas Pty Ltd and Tenasitech Pty Ltd, which were formed out of the Kendall and Martin Groups respectively. The level of detail provided by CMM equipment allowed both companies to improve their products and accelerate their development.

During the year the quality of the provision of service CMM provides through its facilities across UQ was recognised with a Commendation for the Service award at the UQ Awards for Excellence.

## 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.

Facility Manager Dr Mark Hodson said the facility specialises in understanding cellular behaviour at the metabolite and system level. "We measure concentrations of endogenous (and exogenous) metabolites, which are the chemical products of metabolism," Dr Hodson said.

"Studying metabolism extends well beyond the human body – it is the process by which all organisms convert and utilise energy, and thus sustain life."

Understanding this process can result in advances in a diverse range of bioengineering projects, with recent highlights in studies involved in the production of biofuels, biopesticides, and bioplastics.

The facility offers its expertise to any project with a biological question where metabolism plays a role.

"Our extensive expertise in metabolomics and analytical chemistry extends from pure service provision to active collaboration on study design and grant submission as co-investigators that shape the direction of research projects," Dr Hodson said.

In the past two years the Queensland Node has successfully extended the reach of its services, with an increasing number of external contracts and clients.

The Node has worked on a multitude of projects from very different areas of biology, including studying wheat, maize, sugarcane, and avocado crops, as well as microbial and mammalian cell systems, to either improve yields, disease resistance or increase output of bioengineered products.

"We have also been involved in projects centred on the understanding of disease/treatment, both in animals (equine laminitis) and also humans, such as anaesthesia, diabetes (types 1 & 2), chronic kidney disease, bacterial infection, liver transplantation, and so on."

The facility has also been actively involved in areas of national importance, investigating organisms from the Great Barrier Reef, with interest in signalling and communication in Crown of Thorns starfish as well as marine sponge ecology. Further collaborations with researchers are investigating seasonal behaviour in crop pest snails, and provision of expertise to a study on the health and mating behaviour of a Northern Quoll population.

*Cutting edge research is progressing at AIBN in part because of support infrastructure based at the Institute, with expertise in nano-fabrication, metabolomics, biologics, protein expression, stem cells, microscopy and microanalysis*

## National Biologics Facility

The National Biologics Facility (NBF) assists Australian researchers with the production of biologics - a relatively new class of therapeutic which are produced using a biological process. Funded by the National Collaborative Research Infrastructure Strategy, the NBF has two nodes – one at AIBN and the other at CSIRO Molecular Health Technologies in Melbourne.

The Queensland node houses a $15 million suite of laboratories, clean rooms and equipment, and is staffed by a dedicated team of researchers engaged in antibody discovery, protein engineering, mammalian cell line development and biopharmaceutical development. The Queensland node is led by AIBN Group Leaders Professor Peter Gray and Associate Professor Stephen Mahler.

"The National Biologics Facility works together with academia, government, private research bodies and industry to develop new therapeutics and accelerate their path to commercialisation," Antibody Development Manager Dr Martina Jones said.

Following a number of years manufacturing an experimental antibody (m102.4) to combat the deadly Hendra virus, 2015 saw the start of the Hendra Phase I safety trial. Involving 40 participants, the trial organised by Q-Pharm will report its results in early 2016. In collaboration with Queensland Health, NBF manufactured sufficient amounts of m102.4 to complete the safety trial and stock-pile the antibody for compassionate use in individuals deemed to have had high-risk exposure to Hendra virus.

"NBF has showcased its ability to mobilise resources in the interest of national safety, in response to the threat of an emerging infectious virus," Manufacturing Manager Dr Jeff Hou said.

The year also saw the licence of a novel antibody targeting the dendritic cell marker CD83 transfer from TransBio Ltd to DendroCyte BioTech Pty Ltd for the purpose of developing novel therapeutics to prevent and treat graft versus host disease, a common side effect of bone marrow transplantation. This antibody was isolated at the NBF, followed by the creation of a production level cell line and bioprocess optimisation.

The NBF's reputation is growing within the research sphere, resulting in a marked increase of external users accessing the facility's analytical equipment and services during the year.

## Protein Expression Facility

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

PEF's existing relationship with Malaysian biotechnology company Sentinext Therapeutics Sdn Bhd was expanded with the signing of a contract to deliver a fifth project to develop an antivirus vaccine for Enterovirus 71, which is known for causing hand, foot and mouth disease.

The facility has also developed a reputation for producing virus-like particles for diagnostic and vaccine development in other areas such as human papillomavirus, hepatitis B, influenza, chikungunya virus, and porcine circovirus.

PEF Director Associate Professor Linda Lua said the facility's capabilities make it a standout among other service providers.

"Our strength is in the expertise and skill of our staff. Clients come to us with a problem wanting a solution, and we then design the experiment, and conduct the experiment all in-house with our facilities at the AIBN," Associate Professor Lua said.

"Some clients want knowledge-based results and data, others want materials to be produced."

In a trend seen among other facilities based at AIBN, PEF saw growth in the number of external users accessing its services.

"Small biotech companies are increasingly seeing us as a viable alternative to heavily investing in their own internal capabilities," she said.

As the Foundation Director of PEF, Associate Professor Lua has seen rapid growth in PEF's size and research output since 2004; more than 220 projects were completed in 2015 for over 40 groups.

Trends point to requests for larger scale protein production, resulting in an increased capacity in upstream and downstream processing.

During the year the facility worked with international non-profit organisation PATH Malaria Diagnostic Development Group, and also supported research targeting Middle East Respiratory Syndrome during the year's outbreak in Asia.

## 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.

The facility offers a range of products and services, including proprietary human embryonic and induced pluripotent stem cells (iPSCs), cell characterisation, and training. The organisation also produces custom generation of induced pluripotent stem cell lines and differentiation of stem cells into ectodermal, mesodermal and endodermal cells.

During the year, StemCore embarked on an exciting development phase that will open new opportunities to validate stem cell research capabilities in Australia.

In late 2015 StemCore entered into a strategic partnership with international drug discovery company.

General Manager Dr Nilay Thakar said the agreement is a milestone for the organisation.

"This is StemCore's first commercial agreement with a large multinational biotech company, providing an endorsement of our capabilities and paving the way for further partnerships with pharmaceutical and biotechnology companies," Dr Thakar said.

Further developments during the year resulted in a research agreement with the Translational Research Institute and the Wolvetang Group at AIBN to generate induced pluripotent stem cells from patients with intellectual disorders.

"This is an exciting pilot study that brings together the best of Stemcore, AIBN and TRI to systematically investigate the mechanisms underlying the development of certain intellectual disorders and may inform new intervention strategies," he said.

StemCore serves academic and industry clients, and is one of the few Australian labs to have successfully employed non-viral, genome-integration free technology to generate iPSC lines from several diverse and challenging diseases such as schizophrenia, X-linked cerebral palsy, X-linked Chromosomal disorders, Parkinson's, Down syndrome and certain intellectual disorders.

# STUDENTS AND GRADUATES

# STUDENT DIFFERENCE

The AIBN aims to cultivate academically talented individuals with the potential and desire for a successful career in research.

AIBN's commitment to research excellence is embedded in our quality research programs and the selection of high calibre students for these projects, which positions students to be leaders of exciting science that produces high impact peer-reviewed publications. The dynamic research environment at AIBN also provides opportunities for students to be named on patents for discoveries they are a part of.

Students can engage with AIBN through a range of formal opportunities. These include the Doctor of Philosophy (PhD) and Master of Philosophy (MPhil) programs, undergraduate honours projects, and research internships.

This range of programs allows AIBN to foster individuals throughout the tertiary education lifecycle, and promotes students to develop their abilities and interests at multiple entry points during their studies.

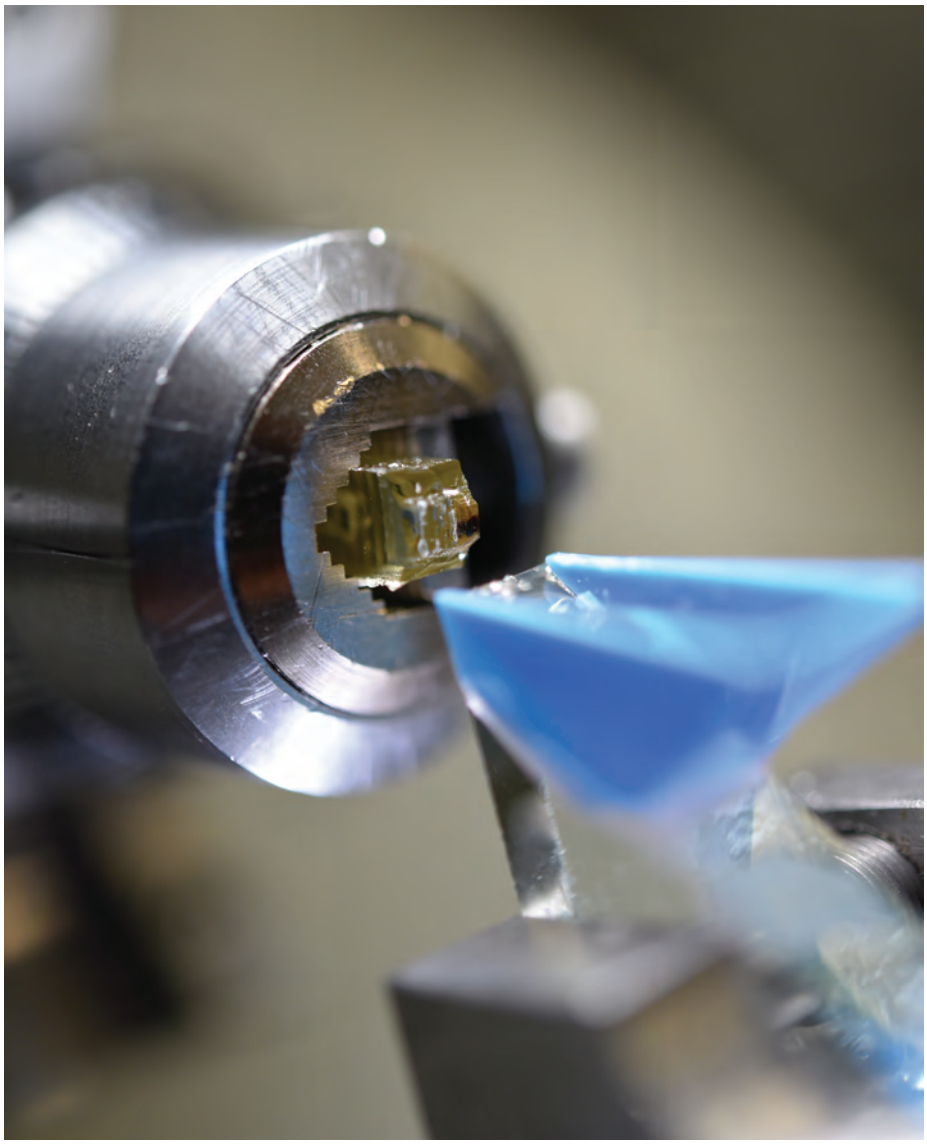
## Support

AIBN provides a suite of research student support that promotes timely progress through candidature and productive outcomes in the form of publications, patents and industry-ready graduates.

All commencing students receive a $2,000 IT package to ensure efficient and contemporary IT infrastructure from the start. All AIBN PhD and MPhil students have a minimum living allowance equal to the current Australian Postgraduate Award (APA) rate.

Progress through candidature is incentivised by top-up payments of $1,800 for each milestone that is attained on time. AIBN provides $4,000 to each research student to present their research and grow their academic network at conferences in Australia and abroad.

AIBN's research higher degree team are always available to provide advice, administrative and pastoral support to our RHD students.



## Undergraduate opportunities – research internships and honours projects

Research internships are available to undergraduate science and engineering students from Australian and International universities. Research internship projects may be from six weeks to six months, depending on program arrangements.

AIBN hosted 37 undergraduate research interns from universities in Australia, Europe, Asia and the Americas.

Some interns have returned to AIBN to complete further research in their Honours or Masters degrees.

## Research degrees – PhD and MPhil projects

The Doctor of Philosophy (PhD) and Master of Philosophy (MPhil) programs are typically 3.5 – 4 years and 1.5-2 years in duration respectively. The PhD is the entry qualification for those who wish to teach and research in an Australian university.

There are 130 individuals whose PhD or MPhil has been awarded through AIBN.

# AIBN STUDENT ASSOCIATION

The research higher degree cohort at AIBN has grown to more than 120 students attracted to the institute from across the globe – spanning 26 countries and six continents. This group has long been represented by a very active and valued AIBN Student Association (ASA).

The year saw student representatives from nearly every floor of the building lend a hand on the committee, including ASA President Lewis Chambers, Vice-President Hamid Ilbeygi, Secretary Anand Meka, Treasurer Anna Gemmell, RHD Representative Jessica Schwaber, Academic Representatives Manasi Mantri and Abu Sina, and Social Representatives Trisha Ghosh, Alireza Hosseinmardi and Prasanna Abbaraju.

"2015 was a very active year for the ASA, hosting 20 sporting, social, cultural and academic events, with a particular focus on integration with the student associations of other research institutes and schools around UQ," ASA President Mr Lewis Chambers said.

In conjunction with the Institute for Molecular Bioscience, the ASA organised and promoted a six part statistics workshop, which covered areas of statistical data analysis of relevance to those working in the fields of molecular biology and biomedical research.

The year saw the return of the AIBN Student Conference, which was held in Customs House. With this historic venue as a backdrop, students were given the opportunity to showcase the diverse and exciting work that they undertake at AIBN. The standard of presentations was notably high, and special congratulations go to Benjamin Ng (Trau Group) and Amanda Septevani (Martin Group) who took out the top prizes for best oral and digital poster presentations respectively.

Delivering the keynote presentation of the conference, AIBN Industry Fellow Dr Ian Nisbet spoke of experiences that have served him best in the field of biotechnology commercialisation, and gave his unique insight from a career which has spanned both the academic and industrial spheres of scientific research.

One of the key goals for the ASA in 2015 was to expand interactions with the student associations of other institutes. This was to promote cooperation and collaboration not just between students in the different research groups at AIBN, but also within UQ as a whole.

"This was reflected most in the social and sporting events hosted during the year where, in addition to social events the ASA has run in the past, we also collaborated with the student associations of both the Institute for Molecular Bioscience and the School of Chemistry and Molecular Biosciences on a number of events," Mr Chambers said.

The year also saw the first inter-Institute soccer competition, which featured eight teams from five different institutes, and the beginning of an Ultimate Frisbee competition with the Centre for Advanced Imaging. Within the Institute, the annual staff versus students' soccer and cricket matches continue to be a source of social interaction and friendly competition.

# RHD REPORT

The Institute's research higher degree (RHD) student cohort has maintained a high level of enrolment. An additional 34 Doctor of Philosophy (PhD) and five Master of Philosophy (MPhil) students commenced projects in 2015. The RHD cohort of 122 candidates included 30 Australian and 92 international students.

In 2015 another 29 PhDs and two MPhils were awarded bringing the total number of RHD graduates to 130. The research student cohort has been sustained above 120 for several years and features a regular intake and graduation of approximately 30 students annually. Impressively, we are seeing a consistent reduction in the time taken to complete a PhD at AIBN to well below 4 years, largely supported by the well-defined milestone structure and financial and pastoral support provided to all students.

A significant milestone for the Institute in 2015 was the graduation of our one hundredth PhD student, signifying the growth the Institute has experienced since its inception. The first annual report published by AIBN for 2004 shows six students enrolled. Fast forwarding to the 2008 annual report, AIBN celebrated the completion of its first PhD student, Dr Akshat Tanksale, in December of that year, and the Institute's student cohort then numbered 64.

It was therefore of particular significance and pride that Dr Nicholas Fletcher graduated in March 2015, as part of a cohort nearly double the size of that in 2008. Students are at the heart of AIBN – a commitment shown by research groups and supervisors to support and provide the opportunity to train budding researchers, and in turn a commitment by students to further the pursuit of scientific research undertaken at the Institute.

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 2015 more than 34 merit-based scholarships were awarded to commencing RHD students at AIBN. A further 11 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.

AIBN's outreach program to provide opportunities to high-achieving undergraduate students continued through Summer and Winter research internship programs, which collectively hosted 37 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 at the host laboratories. More than 200 students have now successfully participated in the Summer and Winter research internships since the program's inception in 2007.

The AIBN internship program has an alumni that includes many students who have acquired a passion for research, transitioning through honours research projects to PhD and into post-doctoral research. Current PhD students Rebecca Lane, Lewis Chambers and

*The Institute's research higher degree (RHD) student cohort has maintained a high level of enrolment. An additional 34 Doctor of Philosophy (PhD) and five Master of Philosophy (MPhil) students commenced projects in 2015. The RHD cohort of 122 candidates included 30 Australian and 92 international students.*

Ellen Otte, as well as AIBN graduates Dr Amanda Pearce, Dr Nathan Boase and Dr Nick Fletcher are all among the students who were introduced to AIBN as undergraduates and participated in the internship program.

2015 also marked the second year of hosting students from Fudan University on a student exchange program over six weeks. The visits are part of a wider UQ initiative to engage with Chinese institutions, and build on AIBN's already strong ties with Fudan University through the work of Professor Chengzhong (Michael) Yu and Professor Andrew Whittaker.

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. In addition to the 92 international students from 25 countries enrolled in 2015, the research intern program attracted a further four overseas students. AIBN has the second highest rate of international RHD enrolment within the university, and this ability to draw overseas students highlights its reputation on an international level.

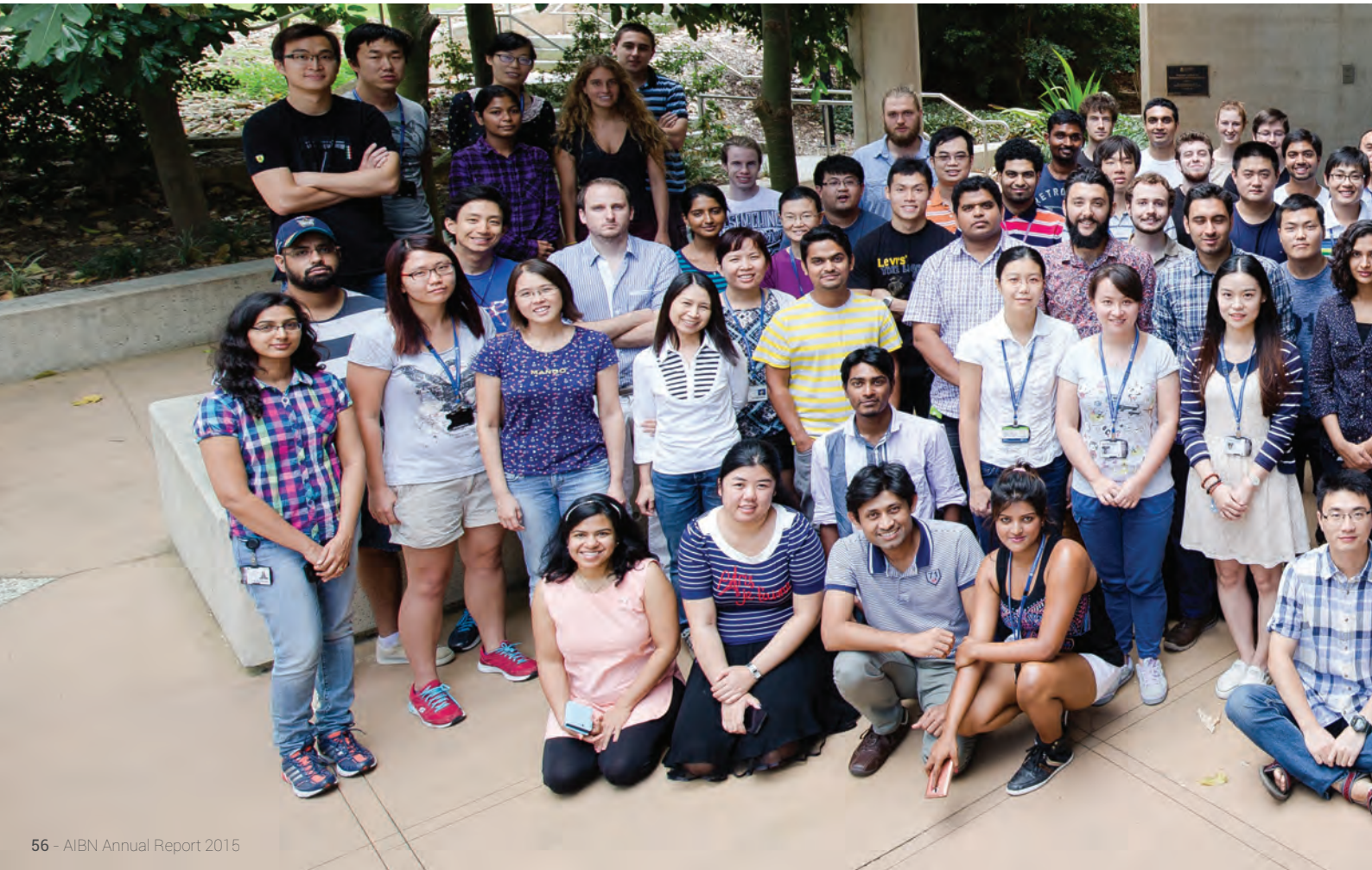
A further focus is to attract emerging talent from other universities in south-east Queensland and Australia more broadly. The RHD team attends key student career fairs and expos throughout the year to promote the Institute and recruit local students who exhibit academic excellence.

After taking on the duty of AIBN Deputy Director (Graduate Studies) in 2012, Professor Darren Martin stepped down at the end of the year, with the appointment passing to Professor Chengzhong (Michael) Yu. The Institute is grateful of Professor Martin's service in the role.

# 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 2015 and contributed to AIBN's successes during the year.*

Prasanna Lakshmi Abbaraju
Rufika Shari Abidin
Yusilawati Ahmad Nor
Mostak Ahmed
Dewan Taslima Akhter
Md. Mahbub Alam
Suad Alateeq
Mohamed Ahmed M Alfaleh
Samah Alharbi
Eid Alosime
Abdul Karim Al Sultan
Will Anderson
Aditya Ardana
Waqas Aslam
Luqman Atanda
Thejus Baby
Anushree Balachandran
Thomas Bennett
Nathan Boase
Valentin Bobrin
Mareike Bongers
Marion Brunck
Teera Butburee
Suzanne Kathryn Butcher
Donna Capararo
Ian Cartmill
Lewis Charles Chambers
Ao Chen
Liyu Chen
Weiyu Chen
Xiaoli Chen
Panagiotis Chrysanthopoulos
Jacob Coffey
Noor Dashti
Renato de Souza Pinto Lemgruber
Shuvashis Dey
Thanh Tam Doan
Amir Hossein Farokh Niaei
Julia Fischer
Nicholas Fletcher
Patrick Fortuna
Jianye Fu
Wanli Johnny Fu
Mikhail Gavrilov
Anna Gemmell
Trisha Ghosh
Marsel Gokovi
Arghavan Golbaz Hagh
Ricardo Axayacatl Gonzalez Garcia
Stephen Goodall
Yadveer Grewal
Zhengying (Allison) Gu
Gency Gunasingh
Michael James Hayter
Matthew Henry
Hadi Hezaveh
Alejandro Hidalgo-Gonzalez
Elizabeth Hines
Alireza Hosseinmardi
Cheng Huang
Yue Hui
Alessandro Iovino
Jiaul Islam
Manasi Jambhrunkar
Edward Jiang
Zhen Jiang
Andrew Johnston
Mohammad Kalantari
Li Pin Kao
Kamil Reza Khondakar
Maisheng Koo
Rebecca Emily Lane



Geoffrey Lawrence
Kebaneilwe Lebani
Hong Seng Lee
Chang Lei
U Wang Lei
Bei Beatrice Li
Juan Li
Lim, Soo
Sharon Chien-Yu Lin
Yang Liu
Yun Liu
Derong Lu
Jennifer Lu
Carlos Luna Flores
Yiming Ma
Vijayan Manoharan
Elizabeth Mason
Aini Syahida Mat Yassim
Sainimili Vaubula Mateyawa
Nicholas Matigian
Alireza Mayahi
Timothy McCubbin
Michael Mehlman
Anand Kumar Meka
Khairatun Najwa Mohd Amin
Shehzahdi Moonshi
Fatemeh Movahedi
Swathi Mukundan
Taryn Naidoo
Amir Nemati Hayati
Benjamin Yong Chou Ng
Hwee Ing Ng
Yuting Niu
Owen Noonan
Camila Orellana
Ellen Otte
Harish Padmanabhan
Amanda Pearce
Bingyin Peng
Nicolas Pichon
Clementine Pradal
Ramanathan Pudhukode Vaidyanathan
Swasmi Purwajanti
Lyndon Raftery
Rui Ran
Masih Rashidi
Gishan Ratnayake
Irene Reto
Samuel Richardson
Kye Jakob Robinson
Tim Ruder
Pedro Andres Eduardo Saa Higuera
Andrea Schaller
Jennifer Schoning
Jessica Schwaber
Athanasia Amanda Septevani
Arjun Seth
Abu Ali Ibn Sina
Mitchell John Smith
Mohammad Soheilmoghaddam
Faheem Amir Solangi
Hao Song
Michael Song
Marcos Saul Soto Perez
Qi David Sun
Xiaoran Sun
Jie Tang
Hossam Tayeb
Karin Taylor
Alemu Tekewe Mogus
Kanupriya Tiwari
Nguyen Tran
Nicole van der Burg
Dhanunjaya Naidu Vangapandu
Jarurin Waneesor
Haofei (Faye) Wang
Jing Wang
Yue Wang
Jonathan Wei
Yangyang Wen
David Wibowo
Thomas Williams
Li-Yen Wong
Yanheng Wu
Yilun Wu
Mu Xiao
Chun Xu
Shiyu Yan
Guang Ze Yang
Tianyu Yang
Yannan Yang
Nicolas Eugenio Zaragoza
Bijun Zeng
Cheng Zhang
Hongwei Zhang
Jun Zhang
Kai Zhang
Min Zhang
Liang Zhao
Yongmei Zhao
Ruifeng Zhou
Xiaobo Zhu
Yingdong Zhu
Huali Zuo

** The list includes graduating students and those in a UQ RHD program undertaken at AIBN during 2015, and excludes withdrawn students.*

# 2015 GRADUATE LIST

## Samah Alharbi

**Qualifications:** Bachelor of Medical Sciences (Pathology Medicine) - Umm Al Qura University, Master of Clinical Sciences (Clinical Physiology) with Honors - Griffith University
**PhD Awarded:** July
**Principal Supervisor:** Professor Ernst Wolvetang
**Thesis Title:** Generation of Intestinal Stem Cells from Human Pluripotent Stem Cells and Partially Reprogrammed Mouse Fibroblast Using a Novel LGR5 Promoter-Based Reporter.
**Publications:**

- Ovchinnikov, et al., (2014) Transgenic human ES and iPS reporter cell lines for identification and selection of pluripotent stem cells *in vitro*. *Stem Cell Research*, 13 2: 251-261. doi:10.1016/j.scr.2014.05.006.

## Abdul Karim Al Sultan

**Qualifications:** Bachelor of Pharmacy (Pharmaceutical and Industrial Pharmacy) - King Saud University, Master of Biotechnology (BioPharmaceutical and Bioprocessing Industry) - University of Queensland
**PhD Awarded:** June
**Principal Supervisor:** Associate Professor Stephen Mahler
**Thesis Title:** Beyond Antibodies: Development of a Novel Molecular Scaffold Based on Human Chaperonin 10.

## Nathan Boase

**Qualifications:** Bachelor of Science (Honours) - University of Queensland
PhD Awarded: July
**Principal Supervisor:** Associate Professor Kristofer Thurecht
**Thesis Title:** Hyperbranched Polymers for *In Vivo* Multimodal Molecular Imaging.
**Publications:**

- Ma, et al., (2015) The *in vivo* fate of nanoparticles and nanoparticle-loaded microcapsules after oral administration in mice: evaluation of their potential for colon-specific delivery. *European Journal of Pharmaceutics and Biopharmaceutics*, 94393-403. doi:10.1016/j.ejpb.2015.06.014.
- Eliezar, et al., (2015) *In vivo* evaluation of folate decorated cross-linked micelles for the delivery of platinum anticancer drugs. *Biomacromolecules*, 16 2: 515-523. doi:10.1021/bm501558d.
- Puttick, et al., (2014) Imaging tumour distribution of a polymeric drug delivery platform *in vivo* by PET-MRI. *Journal of Chemical Technology and Biotechnology*. doi:10.1002/jctb.4489.
- Boase, et al., (2014) Synthesis of a multimodal molecular imaging probe based on a hyperbranched polymer architecture. *Polymer Chemistry*, 5 15: 4450-4458. doi:10.1039/c4py00513a.
- Rolfe, et al., (2014) Multimodal polymer nanoparticles with combined 19F magnetic resonance and optical detection for tunable, targeted, multimodal imaging *in vivo*. *Journal of the American Chemical Society*, 1366:2413-2419. doi:10.1021/ja410351h.
- Coles, et al., (2013) Aptamer-targeted hyperbranched polymers: towards greater specificity for tumours *in vivo*. *Chemical Communications*, 4937:3836-3838. doi:10.1039/c3cc00127j.
- Boase, et al., (2012) Molecular imaging with polymers. *Polymer Chemistry*, 3 6: 1384-1389. doi:10.1039/c2py20132a.

## Marion Brunck

**Qualifications:** BSc with Honours (Class I) Immunology stream - University of Queensland, BSc in Biological Sciences (Immunology) - University of Queensland
**PhD Awarded:** June
**Principal Supervisor:** Professor Lars Nielsen
**Thesis Title:** RNA CaptureSeq: Targeted Sequencing for Comprehensive Transcriptome Studies.
**Publications:**

- Schwaber, et al., (2015) Filling the void: allogeneic myeloid cells for transplantation. *Current Opinion in Hematology*, 1-6. doi:10.1097/MOH.0000000000000205.
- Clark, et al., (2015) Quantitative gene profiling of long noncoding RNAs with targeted RNA sequencing. *Nature Methods*, 12 4: 339-342. doi:10.1038/nmeth.3321.
- Mercer, et al., (2015) Genome-wide discovery of human splicing branchpoints. *Genome Research*, 25 2: 290-303. doi:10.1101/gr.182899.114.
- Brunck, et al., (2014) Absolute counting of neutrophils in whole blood using flow cytometry. *Cytometry Part A*, 85 12: 1057-1064. doi:10.1002/cyto.a.22503.
- Brunck, et al., (2014) Concise review: next-generation cell therapies to prevent infections in neutropenic patients. *Stem Cells Translational Medicine*, 3 4: 541-548. doi:10.5966/sctm.2013-0145.

## Xiaoli Chen

**Qualifications:** Bachelor of Engineering (Bioengineering) - Nanyang Technological University
**PhD Awarded:** December
**Principal Supervisor:** Professor Peter Gray
**Thesis Title:** Development of a Culture Platform for the Expansion of Pluripotent Human Embryonic Stem Cells Cells with the use of Nanopolymers
**Publications:**

- Chen, et al., (2014) Thermoresponsive worms for expansion and release of human embryonic stem cells. *Biomacromolecules*, 15 3: 844-855. doi:10.1021/bm401702h.

## Panagiotis Chrysanthopoulos

**Qualifications:** Bachelor of Science - University of Patras
**PhD Awarded:** May
**Principal Supervisor:** Professor Lars Nielsen
**Thesis Title:** Systems Level Signalling Analysis A Case Study of Growth Hormone Receptor Signalling.
**Publications:**

- Bongers, et al., (2015) Systems analysis of methylerythritol-phosphate pathway flux in *E. coli*: Insights into the role of oxidative stress and the validity of lycopene as an isoprenoid reporter metabolite. *Microbial Cell Factories*, 14 . doi:10.1186/s12934-015-0381-7.
- McQualter, et al., (2014) The use of an acetoacetyl-CoA synthase in place of a ?-ketothiolase enhances poly-3-hydroxybutyrate production in sugarcane mesophyll cells. *Plant Biotechnology Journal*, 13 5: 700-707. doi:10.1111/pbi.12298.
- Conwell, et al., (2014). 1,5-Anhydroglucitol, an indicator of short term glycaemic control, is the most discriminatory metabolomic marker in adolescents with type 1 diabetes compared to control subjects. In: APPES & APEG 2014: Asia Pacific Paediatric Endocrine Society & Australasian Paediatric Endocrine Group Joint Annual Scientific Meeting, Darwin, NT, Australia, 29 October-1 November, 2014.
- Behrendorff, et al., (2013) 2,2-Diphenyl-1-picrylhydrazyl as a screening tool for recombinant monoterpene biosynthesis. *Microbial Cell Factories*, 12 76: 1-11. doi:10.1186/1475-2859-12-76.
- Dietmair, et al., (2012) Metabolite profiling of CHO cells with different growth characteristics. *Biotechnology and Bioengineering*, 109 6: 1404-1414. doi:10.1002/bit.24496.
- Dietmair, et al., (2012). Metabolomic analysis of CHO cultures with different growth characteristics – development of a metabolite extraction protocol for suspension adapted mammalian cells. In Nigel Jenkins, Niall Barron and Paula Alves (Ed.), Proceedings of the 21st Annual Meeting of the European Society for Animal Cell Technology (ESACT), Dublin, Ireland, June 7-10, 2009 (pp. 37-41) Dordrecht, Netherlands: Springer.
- Constantinou, et al., (2011) GC-MS metabolomic analysis reveals significant alterations in cerebellar metabolic physiology in a mouse model of adult onset hypothyroidism. *Journal of Proteome Research*, 10 2: 869-879. doi:10.1021/pr100699m.

## Jacob Coffey

**Qualifications:** Bachelor of Science (Nanotechnology) - University of New South Wales, Diploma of Innovation Management - University of New South Wales
**PhD Awarded:** October
**Principal Supervisor:** Professor Mark Kendall
**Thesis Title:** Microprojection arrays for selective capture of circulating biomarkers *in vivo* from the skin
**Publications:**

- Robinson, et al., (2015) Comparison between polyethylene glycol and zwitterionic polymers as antifouling coatings on wearable devices for selective antigen capture from biological tissue. *Biointerphases*, 10 4: 04A305.1-04A305.11. doi:10.1116/1.4932055.
- Corrie, et al., (2015) Blood, sweat, and tears: developing clinically relevant protein biosensors for integrated body fluid analysis. *Analyst*, 140 13: 4350-4364. doi:10.1039/c5an00464k.
- Lee, et al., (2014) Capture of the circulating Plasmodium falciparum biomarker HRP2 in a multiplexed format, via a wearable skin patch. *Analytical Chemistry*, 86 20: 10474-10483. doi:10.1021/ac5031682.
- Depelsenaire, et al., (2014) Colocalization of cell death with antigen deposition in skin enhances vaccine immunogenicity. *The Journal of Investigative Dermatology*, 134 9: 2361-2370. doi:10.1038/jid.2014.174.

- Meliga,et al., (2014). A validated computational approach to study skin mechanical interaction with dynamically-applied microneedle and microprojection arrays. In: NanoBio Australia 2014, Brisbane, Australia, 6 - 10 July 2014.
- Yeow, et al., (2013) Surface modification and characterization of polycarbonate microdevices for capture of circulating biomarkers, both *in vitro* and *in vivo*. *Analytical Chemistry*, 85 21: 10196-10204. doi:10.1021/ac402942x
- Meliga, et al., (2013). Rational design of microprojection array-mediated vaccine delivery to skin, using mathematical modelling and experimental methods. In: 13AH: Vaccine Delivery and Stabilization: Improving the Reach of Vaccines, Boston, MA, USA, 8-10 September, 2013.
- Meliga, et al., (2013). Improving vaccine targeting to skin using mathematical model-driven design and application of microprojection arrays. In: Skin Vaccination Summit, Seattle, Washington, USA, 4 - 6 September 2013.
- Corrie, et al., (2013). *In Vivo* Biomarker Capture Via the Skin Using Surface-Modified Microprojection Arrays. In: Proceedings of the Asme 2nd Global Congress On Nanoengineering for Medicine and Biology. 2nd ASME Global Congress on NanoEngineering for Medicine and Biology, Boston MA., United States, (9-10). 04-06 February 2013. doi:10.1115/NEMB2013-93215.
- Coffey, et al., (2013) Early circulating biomarker detection using a wearable microprojection array skin patch. *Biomaterials*, 34 37: 9572-9583. doi:10.1016/j.biomaterials.2013.08.078.
- Muller, et al., (2012) Surface modified microprojection arrays for the selective extraction of the dengue virus NS1 protein as a marker for disease. *Analytical Chemistry*, 84 7: 3262-3268. doi:10.1021/ac2034387.


## Nicholas Fletcher

**Qualifications:** Bachelor of Biotechnology First Class Honours (Nanotechnology) University of Queensland
**PhD Awarded:** March
**Principal Supervisor:** Professor Andrew Whittaker
**Thesis Title:** Bioproduction and self-assembly of designer peptides
**Publications:**


- Fuchs,et al., (2015) Evaluation of Polymeric Nanomedicines Targeted to PSMA: effect of Ligand on Targeting Efficiency. *Biomacromolecules*. doi:10.1021/acs.biomac.5b00913.


## Stephen Goodall

**Qualifications:** Bachelor of Applied Science (Applied Chemistry) - Queensland Institute of Technology, Master of Applied Science - Queensland University of Technology, Master of Business Administration - Queensland University of Technology
**PhD Awarded:** October
**Principal Supervisor:** Associate Professor Stephen Mahler
**Thesis Title:** Design, Assembly and Characterisation of a Multifunctional, Self-Assembled Nanoparticle incorporating Antibody Fragments
**Publications:**


- Goodall, et al., (2014) Monoclonal antibody-targeted polymeric nanoparticles for cancer therapy - future prospects. *Journal of Chemical Technology and Biotechnology*, 90 7: 1169-1176. doi:10.1002/jctb.4555.
- Buecheler, et al., (2014) Development of a protein nanoparticle platform for targeting EGFR expressing cancer cells. *Journal of Chemical Technology and Biotechnology*, 90 7: 1230-1236. doi:10.1002/jctb.4545.
- Goodall, et al., (2014) An EGFR targeting nanoparticle self assembled from a thermoresponsive polymer. *Journal of Chemical Technology and Biotechnology*, 90 7: 1222-1229. doi:10.1002/jctb.4509.


## Yadveer Grewal

**Qualifications:** Bachelor of Information Technology (Software Architecture)/Bachelor of Applied Science (Biochemistry) - Queensland University of Technology, Bachelor of Applied Science First Class Honours (Life Science) - Queensland University of Technology
**PhD Awarded:** November
**Principal Supervisor:** Professor Matt Trau
**Thesis Title:** Nanoyeast Antibody Fragments: Engineering the Next Generation of Molecular Diagnostics
**Publications:**


- Vaidyanathan, et al., (2015) Enhancing protein capture using a combination of nanoyeast single-chain fragment affinity reagents and alternating current electrohydrodynamic forces. *Analytical Chemistry*, 87 23: 11673-11681. doi:10.1021/acs.analchem.5b02490
- Grewal, et al., (2015) Structural characterization of nanoyeast single-chain fragment variable affinity reagents. *The Journal of Physical Chemistry Part C: Nanomaterials*, Interfaces and Hard Matter, 119 22: 12674-12680. doi:10.1021/acs.jpcc.5b01234.
- Wang, et al., (2014) Duplex microfluidic SERS detection of pathogen antigens with nanoyeast single-chain variable fragments. *Analytical Chemistry*, 86 19: 9930-9938. doi:10.1021/ac5027012.
- Grewal, et al., (2014) Nano-yeast–scFv probes on screen-printed gold electrodes for detection of Entamoeba histolytica antigens in a biological matrix. *Biosensors and Bioelectronics*, 55 417-422. doi:10.1016/j.bios.2013.12.043.
- Grewal, et al., (2013) Label-free electrochemical detection of an Entamoeba histolytica antigen using cell-free yeast-scFv probes. *Chemical Communications*, 49 15: 1551-1553. doi:10.1039/c2cc38882k.


**Patents:** Affinity Reagents

## Alejandro Hidalgo-Gonzalez

**Qualifications:** Bachelor of Biotechnology Engineering - Costa Rica Institute of Technology
**PhD Awarded:** May
**Principal Supervisor:** Professor Justin Cooper-White
**Thesis Title:** *In Vitro* Ischemia-Reperfusion Injury Model for Pharmacological Post Conditioning of Human Pluripotent Stem Cell-Derived Cardiomyocytes
**Publications:**


- Titmarsh, et al., (2015). Multiplexed Microbioreactor Arrays for Rapid Optimisation of Pluripotent Stem Cell Maintenance and Differentiation. In: Tissue Engineering Part a. 4th TERMIS World Congress, Boston Ma, (S335-S336). Sep 08-11, 2015.
- Ovchinnikov, et al., (2014) Isolation of contractile cardiomyocytes from human pluripotent stem-cell-derived cardiomyogenic cultures using a human NCX1-EGFP reporter. *Stem Cells and Development*, 24 1: 11-20. doi:10.1089/scd.2014.0195.
- Ovchinnikov, et al., (2014) Transgenic human ES and iPS reporter cell lines for identification and selection of pluripotent stem cells *in vitro*. *Stem Cell Research*, 13 2: 251-261. doi:10.1016/j.scr.2014.05.006.


## Li Pin Kao

**Qualifications:** Bachelor of Science (Biochemistry) - University of Otago, Master of Science (Biochemical Engineering) - National Chiao Tung University
**PhD Awarded:** March
**Principal Supervisor:** Professor Ernst Wolvetang
**Thesis Title:** Regulation of Mitochondrial Biogenesis in Human Embryonic Stem Cells
**Publications:**

- Turner, et al., (2014) Metabolic profiling and flux analysis of MEL-2 human embryonic stem cells during exponential growth at physiological and atmospheric oxygen concentrations. *PLoS One*, 9 11: e112757.1-e112757.13. doi:10.1371/journal.pone.0112757.
- Briggs, et al., (2013) Integration-free induced pluripotent stem cells model genetic and neural developmental features of Down Syndrome etiology. Stem Cells, 31 3: 467-478. doi:10.1002/stem.1297.

## Kebaneilwe Lebani

**Qualifications:** Bachelor of Biomedical Science - Monash University, Master of Biotechnology - University of Queensland
**PhD Awarded:** March
**Principal Supervisor:** Associate Professor Stephen Mahler
**Thesis Title:** Antibody Discovery for Development of a Serotyping Dengue Virus NS1 Capture Assay

## Soo Lim

**Qualifications:** Bachelor of Information Technology (Computing) - Monash University, Bachellor of Plant Science - Seoul National University, Master of Applied Science (Bioinformatics) - University of Sydney
**PhD Awarded:** April
**Principal Supervisor:** Professor Lars Nielsen
**Thesis Title:** Quantitative bacterial phosphoproteomics
**Publications:**

- Lim, et al., (2015) Global dynamics of Escherichia coli phosphoproteome in central carbon metabolism under changing culture conditions. *Journal of Proteomics*, 126 24-33. doi:10.1016/j.jprot.2015.05.021.
- Arifin, et al., (2014) Escherichia coli W shows fast, highly oxidative sucrose metabolism and low acetate formation. *Applied Microbiology and Biotechnology*, 98 21: 9033-9044. doi:10.1007/s00253-014-5956-4.
- Licona-Cassani, et al., (2014) Temporal dynamics of the Saccharopolyspora erythraea phosphoproteome. *Molecular and Cellular Proteomics*, 13 5: 1219-1230. doi:10.1074/mcp.M113.033951.

## Sharon Chien-Yu Lin

**Qualifications:** Bachelor of Biotechnology (Honours Class IIA) - University of Queensland
**PhD Awarded:** July
**Principal Supervisor:** Professor Traian Chirila
**Thesis Title:** Production and *in vitro* Evaluation of Macroporous Alginate Hydrogel Fibres for Nerve Tissue Engineering

## Yiming Ma

**Qualifications:**
**PhD Awarded:** May
**Principal Supervisor:** Associate Professor Kristofer Thurecht
**Thesis Title:** Controlled delivery of nanoparticles to the colon for tumour targeting
**Publications:**

- Ma, et al., (2015) The *in vivo* fate of nanoparticles and nanoparticle-loaded microcapsules after oral administration in mice: evaluation of their potential for colon-specific delivery. *European Journal of Pharmaceutics and Biopharmaceutics*, 94 393-403. doi:10.1016/j.ejpb.2015.06.014.

## Sainimili Vaubula Mateyawa

**Qualifications:** Bachelor of Science - University of the South Pacific , Postgraduate Diploma of Chemistry - University of the South Pacific, Master of Science - University of the South Pacific
**PhD Awarded:** June
**Principal Supervisor:** Professor Peter Halley
**Thesis Title:** Understanding the role of water-ionic liquid mixtures on the gelatinization and dissolution of maize starches
**Publications:**

- Mateyawa, et al., (2013) Effect of the ionic liquid 1-ethyl-3-methylimidazolium acetate on the phase transition of starch: dissolution or gelatinization? *Carbohydrate Polymers*, 94 1: 520-530. doi:10.1016/j.carbpol.2013.01.024.
- Xie, et al., (2013). Starch-based bioplastics: using ionic liquid as a novel plasticiser for improving the processibility of starch polymers. In: EP'2013: The Sixth International Symposium on Engineering Plastics, Xiamen, China, (121-122). 25-28 August, 2013.
- Xie, et al., (2013). Ionic liquid plasticised starch-based materials. In: 4th International Conference on Biodegradable and Biobased Polymers (BIOPOL 2013), Rome, Italy, (). 1-3 October 2013.

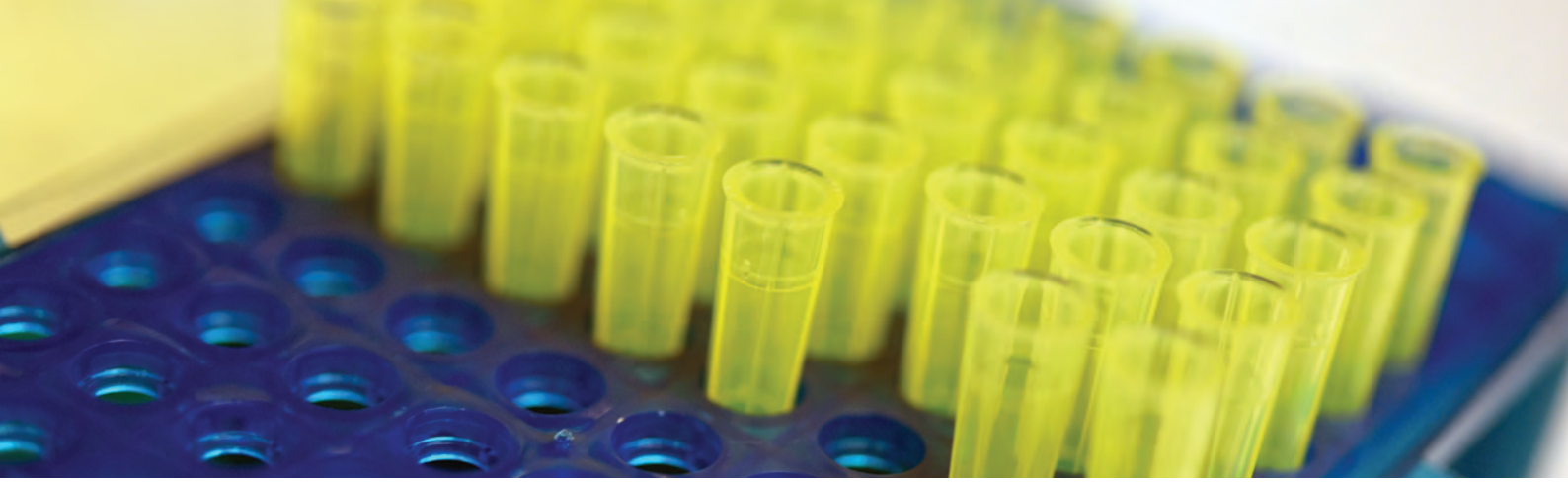
## Michael Mehlman

**Qualifications:**
**MPhil Awarded:** June
**Principal Supervisor:** Professor Justin Cooper-White
**Thesis Title:** Effects of hyaluronan-pentosan polysulfate and bone morphogenetic protein-6 on human mesenchymal stem cells

## Yuting Niu

**Qualifications:** Bachelor of Medicine - Wuhan University, Master of Medicine (Prosthodontics) - Wuhan University
**PhD Awarded:** December
**Principal Supervisor:** Professor Chengzhong Yu
**Thesis Title:** Bio-inspired Virus-mimicking Nanoparticles for Efficient Cellular Delivery
**Publications:**

- Niu, et al., (2015) Synthesis of silica nanoparticles with controllable surface roughness for therapeutic protein delivery. *Journal of Materials Chemistry B*, 3 43: 8477-8485. doi:10.1039/c5tb01405k.
- Ahmad, et al., (2015) Shaping nanoparticles with hydrophilic compositions and hydrophobic properties as nanocarriers for antibiotic delivery. *ACS Central Science*, 1 328-334. doi:10.1021/acscentsci.5b00199.
- Yang, et al., (2015) Biphasic synthesis of large-pore and well-dispersed benzene bridged mesoporous organosilica nanoparticles for intracellular protein delivery. *Small*, 11 23: 2743-2749. doi:10.1002/smll.201402779.
- Jambhrunkar, et al., (2014) Effect of surface functionality of silica nanoparticles on cellular uptake and cytotoxicity. *Molecular Pharmaceutics*, 11 10: 3642-3655. doi:10.1021/mp500385n.
- Yu, et al., (2014) An approach to prepare polyethylenimine functionalized silica-based spheres with small size for siRNA delivery. *ACS Applied Materials and Interfaces*, 6 18: 15626-15631. doi:10.1021/am503060n.
- Xu, et al., (2014) Rod-like mesoporous silica nanoparticles with rough surfaces for enhanced cellular delivery. *Journal of Materials Chemistry B*, 2 3: 253-256. doi:10.1039/c3tb21431a.
- Niu, et al., (2013) Nanoparticles mimicking viral surface topography for enhanced cellular delivery. *Advanced Materials*, 25 43: 6233-6237. doi:10.1002/adma.201302737.
- Niu, et al., (2012) Recent advance in silica-based engineered nanoparticles for gene therapy. *Therapeutic Delivery*, 3 10: 1217-1237. doi:10.4155/tde.12.98.



## Clementine Pradal

**Qualifications:** Bachelor of General Engineering - Ecole Centrale Paris, Master of General Engineering - Ecole Centrale Paris, Master of Biotechnology - University of Queensland
**PhD Awarded:** March
**Principal Supervisor:** Professor Justin Cooper-White
**Thesis Title:** Cellular Delivery
**Publications:**

- Pradal, et al., (2015) Hydrolytically degradable polyrotaxane hydrogels for drug and cell delivery applications. *Biomacromolecules*, 16 1: 389-403. doi:10.1021/bm501615p.
- Pradal, et al., (2013) Gelation Kinetics and Viscoelastic Properties of Pluronic and alpha-Cyclodextrin-Based Pseudopolyrotaxane Hydrogels. *Biomacromolecules*, 14 10: 3780-3792. doi:10.1021/bm401168h.

## Ramanathan Pudhukode Vaidyanathan

**Qualifications:** Bachelor of Technology (Biotechnology) - Arulmigu Kalasalingam College of Engineering, Master of Research Biomedical Science (Cell Engineering) - University of Glasgow
**PhD Awarded:** October
**Principal Supervisor:** Dr Muhammad Johirul Alam Shiddiky
**Thesis Title:** Nanoshearing: A Microfluidic Approach for Isolation and Enumeration of Cancer Biomarkers
**Publications:**

- Vaidyanathan, et al., (2015) Enhancing protein capture using a combination of nanoyeast single-chain fragment affinity reagents and alternating current electrohydrodynamic forces. *Analytical Chemistry*, 87 23: 11673-11681. doi:10.1021/acs.analchem.5b02490
- Wang, et al., (2015) Enabling rapid and specific surface enhanced raman scattering immunoassay using nano-scaled surface shear forces. *ACS Nano*, 9 6: 6354-6362. doi:10.1021/acsnano.5b01929.
- Vaidyanathan, et al., (2015) A multiplexed device based on tunable nanoshearing for specific detection of multiple protein biomarkers in serum. *Scientific Reports*, 5 9756.1-9756.7. doi:10.1038/srep09756.
- Lane, et al., (2015) Analysis of exosome purification methods using a model liposome system and tunable-resistive pulse sensing. *Scientific Reports*, 5 7639.1-7639.7. doi:10.1038/srep07639.
- Vaidyanathan, et al., (2014) Tuneable surface shear forces to physically displace nonspecific molecules in protein biomarker detection. *Biosensors and Bioelectronics*, 61 184-191. doi:10.1016/j.bios.2014.03.061.
- Vaidyanathan, et al., (2014) Detecting exosomes specifically: a multiplexed device based on alternating current electrohydrodynamic induced nanoshearing. *Analytical Chemistry*, 86 22: 11125-11132. doi:10.1021/ac502082b.
- Vaidyanathan, et al., (2014) Alternating current electrohydrodynamics induced nanoshearing and fluid micromixing for specific capture of cancer cells. *Chemistry: A European Journal*, 20 13: 3724-3729. doi:10.1002/chem.201304590.
- Vaidyanathan, et al., (2014) Tuneable "Nano-Shearing": a physical mechanism to displace nonspecific cell adhesion during rare cell detection. *Analytical Chemistry*, 86 4: 2042-2049. doi:10.1021/ac4032516.
- Shiddiky, et al., (2014) Molecular nanoshearing: an innovative approach to shear off molecules with AC-induced nanoscopic fluid flow. *Scientific Reports*, 4 3716.1-3716.7. doi:10.1038/srep03716.
- Vaidyanathan, et al., (2014). A Multiplex Device Based on Tunable Nanoshear Forces for Highly Specific Detection of Multiple Protein Biomarkers. In: Proceedings of the 18th International Conference on Miniaturized Systems for Chemistry and Life Sciences (MicroTAS). 18th International Conference on Miniaturized Systems for Chemistry and Life Sciences, San Antonio, TX United States, (1972-1974). 26-30 October 2014.
- Shiddiky, et al., (2014). Detecting Exosomes Specifically: a Microfluidic Approach Based on Alternating Current Electrohydrodynamic Induced Nanoshearing. In: Proceedings of the 18th International Conference on Miniaturized Systems for Chemistry and Life Sciences (MicroTAS). 18th International Conference on Miniaturized Systems for Chemistry and Life Sciences, San Antonio, TX United States, (674-676). 26-30 October 2014.
- Curtis, et al., (2013) Cell interactions at the nanoscale: piezoelectric stimulation. *IEEE Transactions On Nanobioscience*, 12 3: 247-254. doi:10.1109/TNB.2013.2257837.
- Shiddiky, et al., (2013). Tuneable "nanoshearing": an innovative mechanism for the accurate and specific capture of rare cancer cells. In: Roland Zengerle, The 17th International Conference on Miniaturised Systems for Chemistry and Life Sciences: TAS 2013. Proceedings. TAS 2013: The 17th International Conference on Miniaturised Systems for Chemistry and Life Sciences (MicroTAS 2013), Freiburg, Germany, (26-28). 27-31 October, 2013.

**Patents:** Device and method for the detection of target entities

## Michael Song

**Qualifications:** Bachelor of Applied Science (Biotechnology) - Queensland University of Technology, Master of Biotechnology - University of Queensland
**PhD Awarded:** November
**Principal Supervisor:** Professor Peter Gray
**Thesis Title:** Novel Cell Engineering of the Unfolded Protein Response to Achieve Efficient Therapeutic Protein Production Cell Line
**Publications**:

- Gillard, et al., (2014) Intracellular trafficking pathways for nuclear delivery of plasmid DNA complexed with highly efficient endosome escape polymers. *Biomacromolecules*, 15 10: 3569-3576. doi:10.1021/bm5008376.
- Hou, et al., (2012). Analysis of protein expression via alternate 3' Untranslated Region (UTR) signals through the use of site specific recombination. In Nigel Jenkins, Niall Barron and Paula Alves (Ed.), Proceedings of the 21st Annual Meeting of the European Society for Animal Cell Technology (ESACT), Dublin, Ireland, June 7-10, 2009 (pp. 47-51) Dordrecht, Netherlands: Springer.
- Codamo, et al., (2012). An optimised transfection platform for the Epi-CHO transient expression system in serum-free media. In Nigel Jenkins, Niall Barron and Paula Alves (Ed.), Proceedings of the 21st Annual Meeting of the European Society for Animal Cell Technology (ESACT), Dublin, Ireland, June 7-10, 2009 (pp. 19-23) Dordrecht, Netherlands: Springer. doi:10.1007/978-94-007-0884-6_3.
- Song, et al., (2011) Clonal selection of high producing, stably transfected HEK293 cell lines utilizing modified, high-throughput FACS screening. *Journal of Chemical Technology and Biotechnology*, 86 7: 935-941. doi:10.1002/jctb.2618.
- Codamo, et al., (2011) Enhanced CHO cell-based transient gene expression with the Epi-CHO expression system. *Molecular Biotechnology*, 48 2: 109-115. doi:10.1007/s12033-010-9351-9.

## Karin Taylor

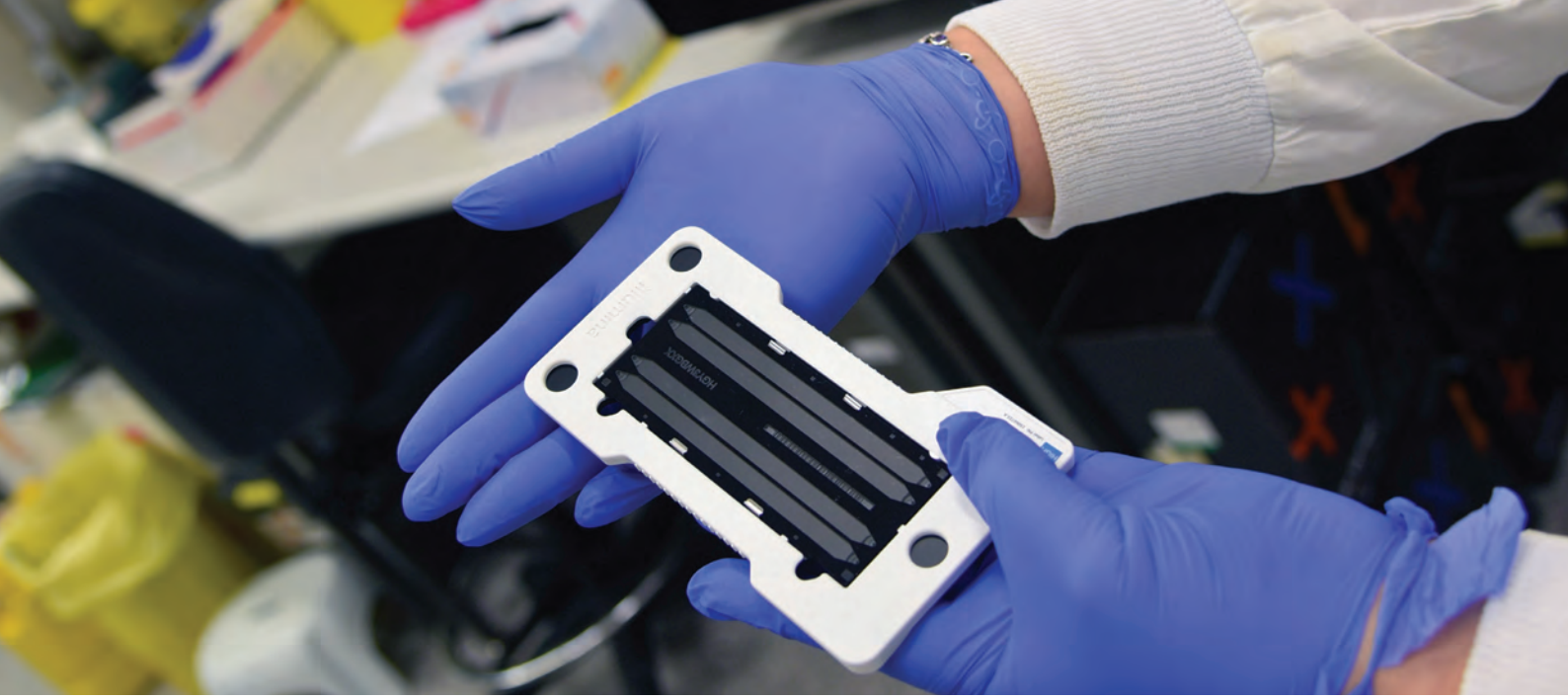
**Qualifications:** Bachelor of Science (Genetics) - University of Pretoria, Bachelor of Science (Honours Class IIA) - University of Queensland
**PhD Awarded:** August
**Principal Supervisor:** Associate Professor Stephen Mahler
**Thesis Title:** Engineering bispecific antibodies for targeted delivery of cytotoxin-loaded nanoparticles to tumour cells
**Publications:**

- Taylor, et al., (2014) Nanocell targeting using engineered bispecific antibodies. *mAbs*, 7 1: 53-65. doi:10.4161/19420862.2014.985952.

## Nguyen Tran

**Qualifications:** Bachelor of Science (Materials Science)
**PhD Awarded:** May
**Principal Supervisor:** Professor Michael Monteiro
**Thesis Title:** Synthesis of timed-release polymer nanoparticles
**Publications:**

- Tran, et al., (2013) Fine tuning the disassembly time of thermoresponsive polymer nanoparticles. *Biomacromolecules*, 14 10: 3463-3471. doi:10.1021/bm4007858.



## David Wibowo

**Qualifications:** Bachelor of Science (Chemical Engineering) - Widya Mandala Catholic University, Master of Science Engineering (Chemical Engineering) - National Taiwan University of Science and Technology
**PhD Awarded:** May
**Principal Supervisor:** Dr Chunxia Zhao
**Thesis Title:** Bio-inspired oil-core silica-shell nanocapsules for controlled-release applications
**Publications:**

- Wibowo, et al., (2015) Interfacial biomimetic synthesis of silica nanocapsules using a recombinant catalytic modular protein. *Langmuir*, 31 6: 1999-2007. doi:10.1021/la504684g.
- Wibowo, et al., (2014) Sustained release of fipronil insecticide *in Vitro* and *in Vivo* from biocompatible silica nanocapsules. *Journal of Agricultural and Food Chemistry*, 62 52: 12504-12511. doi:10.1021/jf504455x.
- Wibowo, et al., (2014) Emulsion-templated silica nanocapsules formed using bio-inspired silicification. *Chemical Communications*, 50 77: 11325-11328. doi:10.1039/c4cc04904g.
- Wibowo, et al., (2010) Nonleaching antimicrobial cotton fibers for hyaluronic acid adsorption. *Biochemical Engineering Journal*, 53 1: 44-51. doi:10.1016/j.bej.2010.09.002.
- Wibowo, et al., (2007) Adsorption of benzene and toluene from aqueous solutions onto activated carbon and its acid and heat treated forms: Influence of surface chemistry on adsorption. *Journal of Hazardous Materials*, 146 1-2: 237-242. doi:10.1016/j.jhazmat.2006.12.011.
- Patents: Silica Micro- and Nano-capsules and methods for making them

## Thomas Williams

**Qualifications:** Bachelor of Science (Biochemistry) - University of Waikato, Master of Science - University of Waikato
**PhD Awarded:** March
**Principal Supervisor:** Dr Claudia Vickers
**Thesis Title:** Separating Growth and Production Phases Using Synthetic Quorum Sensing in Saccharomyces cerevisiae
**Publications:**

- Peng, et al., (2015) Controlling heterologous gene expression in yeast cell factories on different carbon substrates and across the diauxic shift: a comparison of yeast promoter activities. *Microbial Cell Factories*, 14 91: 1-11. doi:10.1186/s12934-015-0278-5.
- Williams, et al., (2015) Quorum-sensing linked RNA interference for dynamic metabolic pathway control in Saccharomyces cerevisiae. *Metabolic Engineering*, 29 124-134. doi:10.1016/j.ymben.2015.03.008.
- Williams, et al., (2015) Dynamic regulation of gene expression using sucrose responsive promoters and RNA interference in Saccharomyces cerevisiae. *Microbial Cell Factories*, 14 43: 1-10. doi:10.1186/s12934-015-0223-7.
- Williams, et al., (2013) Engineered quorum-sensing using pheromone-mediated cell-to-cell communication in Saccharomyces cerevisiae. *ACS Synthetic Biology*, 2 3: 136-149. doi:10.1021/sb300110b.

## Yannan Yang

**Qualifications:** Bachelor of Science (Chemistry) - Wuhan University, Master of Engineering (Engineering Science) - University of Queensland
**MPhil Awarded:** March
**Principal Supervisor:** Professor Chengzhong Yu
**Thesis Title:** Synthesis of Self-assembled Nanoporous Silica for Therapeutic Delivery
**Publications:**

- Zhang, et al., (2015) Self-Organized Mesostructured Hollow Carbon Nanoparticles via a Surfactant-Free Sequential Heterogeneous Nucleation Pathway. *Chemistry of Materials*, 27 18: 6297-6304. doi:10.1021/acs.chemmater.5b01993.
- Niu, et al., (2015) Synthesis of silica nanoparticles with controllable surface roughness for therapeutic protein delivery. *Journal of Materials Chemistry B*, 3 43: 8477-8485. doi:10.1039/c5tb01405k.
- Yang, et al., (2015) Preparation of fluorescent mesoporous hollow silica-fullerene nanoparticles via selective etching for combined chemotherapy and photodynamic therapy. *Nanoscale*, 7 28: 11894-11898. doi:10.1039/c5nr02769a.
- Yang, et al., (2015) Biphasic synthesis of large-pore and well-dispersed benzene bridged mesoporous organosilica nanoparticles for intracellular protein delivery. *Small*, 11 23: 2743-2749. doi:10.1002/smll.201402779.
- Zhang, et al., (2014) Nanodispersed UV blockers in skin-friendly silica vesicles with superior UV-attenuating efficiency. *Journal of Materials Chemistry B*, 2 44: 7673-7678. doi:10.1039/c4tb01332h.
- Yu, et al., (2014) An approach to prepare polyethylenimine functionalized silica-based spheres with small size for siRNA delivery. *ACS Applied Materials and Interfaces*, 6 18: 15626-15631. doi:10.1021/am503060n.
- Yang, et al., (2014) Synthesis of SBA-15 rods with small sizes for enhanced cellular uptake. *Journal of Materials Chemistry B*, 2 30: 4929-4934. doi:10.1039/c4tb00595c.
- Yu, et al., (2014) Facile synthesis of ultra-small hybrid silica spheres for enhanced penetration of 3D glioma spheroids. *Chemical Communications*, 50 13: 1527-1529. doi:10.1039/C3CC48416E.
- Yang, et al., (2014) Synthesis of silica vesicles with small sizes and reduced aggregation for photodynamic therapy. *Chemistry Letters*, Article in press . doi:10.1246/cl.130930.

## Tianyu Yang

**Qualifications:** Bachelor of Science (Biotechnology) - Northwest University
**PhD Awarded:** July
Principal Supervisor: Professor Michael Monteiro
**Thesis Title:** Design, Synthesis and Applications of Functional Cabonaceous Nanospheres
**Publications:**

- Yang, Tet al., (2015) Hierarchical mesoporous yolk-shell structured carbonaceous nanospheres for high performance electrochemical capacitive energy storage. *Chemical Communications*, 51 13: 2518-2521. doi:10.1039/c4cc09366f.
- Yang, et al., (2014) N-doped mesoporous carbon spheres as the oxygen reduction reaction catalysts. *Journal of Materials Chemistry A*, 2 42: 18139-18146. doi:10.1039/c4ta04301d.
- Yang, et al., (2013) Facile Fabrication of CoreShell-Structured Ag@Carbon and Mesoporous YolkShell-Structured Ag@Carbon@Silica by an Extended Stober Method. *Chemistry-A European Journal*, 19 22: 6942-6945. doi:10.1002/chem.201300523.

## Bijun Zeng

**Qualifications:** Bachelor of Biotechnology - Ji Nan University, Master of Biotechnology - University of Queensland
**PhD Awarded:** February
**Principal Supervisor:** Professor Anton Middelberg
**Thesis Title:** Tailorable Nanocarrier Emulsion for Drug Delivery
**Patents:** Nanocarrier emulsions

## Jun Zhang

**Qualifications:** Bachelor of Science (Chemistry) - Fudan University
**PhD Awarded:** June
**Principal Supervisor:** Professor Chengzhong Yu
**Thesis Title:** Synthesis of Novel Silica Vesicles and Their Pharmaceutical and Cosmetic Applications
**Publications:**

- Mody, et al., (2015) Silica Vesicle Nanovaccine Formulations Stimulate Long-Term Immune Responses to the Bovine Viral Diarrhoea Virus E2 Protein. *PLoS One*, 10 12: . doi:10.1371/journal.pone.0143507.
- Shen, et al., (2015) Nitrogen-doped ordered mesoporous carbon single crystals: Aqueous organic-organic self-assembly and superior supercapacitor performance. *Journal of Materials Chemistry A*, 3 47: 24041-24048. doi:10.1039/c5ta06129f.
- Purwajanti, et al., (2015) Synthesis of Magnesium Oxide Hierarchical Microspheres: A Dual-Functional Material for Water Remediation. *ACS Applied Materials and Interfaces*, 7 38: 21278-21286. doi:10.1021/acsami.5b05553.
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- Niu, et al., (2015) Synthesis of silica nanoparticles with controllable surface roughness for therapeutic protein delivery. *Journal of Materials Chemistry B*, 3 43: 8477-8485. doi:10.1039/c5tb01405k.
- Ahmad, et al., (2015) Shaping nanoparticles with hydrophilic compositions and hydrophobic properties as nanocarriers for antibiotic delivery. *ACS Central Science*, 1 328-334. doi:10.1021/acscentsci.5b00199.
- Yang, et al., (2015) Biphasic synthesis of large-pore and well-dispersed benzene bridged mesoporous organosilica nanoparticles for intracellular protein delivery. *Small*, 11 23: 2743-2749. doi:10.1002/smll.201402779.
- Abbaraju, et al., (2014) Floating tablets from mesoporous silica nanoparticles. *Journal of Materials Chemistry B*, 2 47: 8298-8302. doi:10.1039/c4tb01337a.
- Mody, et al., (2014) Silica vesicles as nanocarriers and adjuvants for generating both antibody and T-cell mediated immune resposes to Bovine Viral Diarrhoea Virus E2 protein. *Biomaterials*, 35 37: 9972-9983. doi:10.1016/j.biomaterials.2014.08.044.
- Zhang, et al., (2014) Nanodispersed UV blockers in skin-friendly silica vesicles with superior UV-attenuating efficiency. *Journal of Materials Chemistry B*, 2 44: 7673-7678. doi:10.1039/c4tb01332h.
- Yang, et al., (2014) Synthesis of SBA-15 rods with small sizes for enhanced cellular uptake. *Journal of Materials Chemistry B*, 2 30: 4929-4934. doi:10.1039/c4tb00595c.
- Lei, et al., (2014) Sensitive detection of human insulin using a designed combined pore approach. *Small*, 10 12: 2413-2418. doi:10.1002/smll.201303748.
- Qian, et al., (2014) A combo-pore approach for the programmable extraction of peptides/proteins. *Nanoscale*, 6 10: 5121-5125. doi:10.1039/c4nr00633j.
- Popat, et al., (2014) Programmable drug release using bioresponsive mesoporous silica nanoparticles for site-specific oral drug delivery. *Chemical Communications*, 50 42: 5547-5550. doi:10.1039/C4CC00620H.
- Zhang, et al., (2014) Synthesis of silica vesicles with controlled entrance size for high loading, sustained release, and cellular delivery of therapeutical proteins. *Small*, 10 24: 5068-5076. doi:10.1002/smll.201401538.
- Jarnbhrunkar, et al., 2013) Stepwise pore size reduction of ordered nanoporous silica materials at angstrom precision. *Journal of the American Chemical Society*, 135 23: 8444-8447. doi:10.1021/ja402463h.
- Yang, et al., (2013) Confinement of chemisorbed phosphates in a controlled nanospace with three-dimensional mesostructures. *Chemistry-A European Journal*, 19 18: 5578-5585. doi:10.1002/chem.201300273.
- Patents: Silica nanovesicles and vaccine applications

## Ruifeng Zhou

**Qualifications**: Bachelor of Science (Physics) - Tsinghua University, Master of Science (Physics) - Tsinghua University
**PhD Awarded:** October
**Principal Supervisor:** Dr Shizhang Qiao
**Thesis Title:** Preparation and Mechanism Study of Non-precious Metal Catalysts for Electrochemical Oxygen Reduction
**Publications:**

- Zhou, et al., (2015) An Fe/N co-doped graphitic carbon bulb for high-performance oxygen reduction reaction. *Chemical Communications*, 51 35: 7516-7519. doi:10.1039/c5cc00995b.
- Yang, et al., (2015) Hierarchical mesoporous yolk-shell structured carbonaceous nanospheres for high performance electrochemical capacitive energy storage. *Chemical Communications*, 51 13: 2518-2521. doi:10.1039/c4cc09366f.
- Yang, et al., (2014) N-doped mesoporous carbon spheres as the oxygen reduction reaction catalysts. *Journal of Materials Chemistry A*, 2 42: 18139-18146. doi:10.1039/c4ta04301d.
- Zhou, et al., (2014) Silver/nitrogen-doped graphene interaction and its effect on electrocatalytic oxygen reduction. *Chemistry of Materials*, 26 20: 5868-5873. doi:10.1021/cm502260m.

# MILESTONE STUDENT DEVELOPS CAREER

In 2015 Dr Nick Fletcher completed his PhD in the Whittaker Group, and in the process became the one hundredth AIBN graduate. In a phase of rapid growth, AIBN's first research higher degree graduate completed their studies in 2008, making Dr Fletcher's graduation only seven years later a remarkable achievement for the Institute.

Now a Postdoctoral Researcher at UQ's Centre for Advanced Imaging supervised by AIBN Associate Group Leader Associate Professor Kristofer Thurecht, he continues to have ties with the Institute that date back to his time as an undergraduate student.

Dr Fletcher began his studies at AIBN in 2008 as a third year undergraduate science student completing a project in Professor Matt Trau's laboratory under the supervision of Dr Darby Kozak.

"It was really valuable as an undergraduate to see how a laboratory actually works, because it is completely different to what you experience in a science classroom," Dr Fletcher said.

He then continued his studies at AIBN, competing his Honours in the same laboratory working on a diagnostic for tuberculosis under the supervision of Dr Ashley Connolly.

"The diagnostic itself really wasn't successful at all, but the project was really working out why it didn't work, and that is a valuable lesson," he said.

"We have students now who are worried that they are not getting positive results, but at that stage of their development the focus is not necessarily about making discoveries, but rather bringing up their technical skills and learning to troubleshoot."

In 2010 he began a PhD under the supervision of Dr Annette Dexter, Dr Kevin Jack and Professor Andrew Whittaker. It was a joint project, firstly developing peptide bio-surfactants as a greener alternative to the petrochemical derived surfactants that are commonly used today. Secondly, it was discovered that some of the designer peptides he was using could form very soft, almost jelly-like hydrogels.

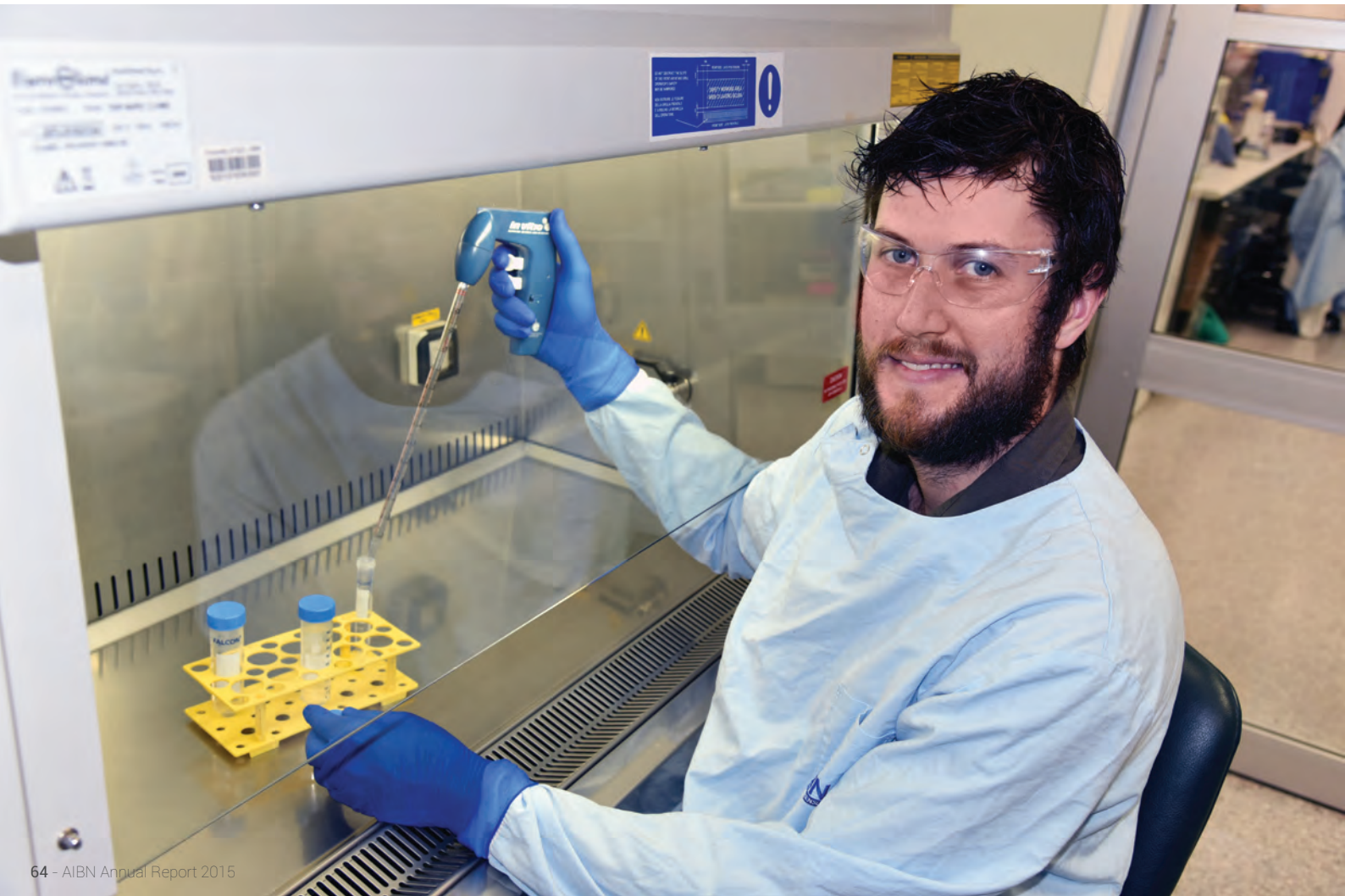
"We studied whether these hydrogels could have applications in wound healing by acting as a scaffold for regenerating tissue or nerves to reduce scar tissue or brain injury," Dr Fletcher said.

Reflecting on his time as an AIBN student, Dr Fletcher said he has fond memories.

"The AIBN has great equipment in the labs, and being able to access all of the facilities on the UQ campus is incredible; I don't know of anywhere else where you have so many capabilities in one place," he said.

"I was part of the AIBN Student Association, and it was a good experience to meet other students and find out more about them as individuals with diverse backgrounds and researchers working on a variety of projects."

The opportunities to develop his skills and career have now led him to making polymer-nanoparticles that specifically target breast cancer.



# HIGH ACHIEVING GRADUATE TAKES ON US CHALLENGE

Graduation from AIBN in late 2014 set off a chain of positive events for Dr Kewei Wang that have helped to firmly establish his career as a researcher.

Joining the Institute in 2011 from China, and having embraced the Australian way of life, Dr Wang's work was focussed on the development of multifunctional polymers as contrast agents for molecular imaging.

He achieved his PhD award and was also proudly a recipient of the UQ Dean's Award for Outstanding Research Higher Degree Theses.

Each year the Dean's Award is granted to no more than 10 per cent of the theses submitted by graduating research higher degree students.

"I felt very surprised when I received the news, because I knew there were hundreds of other PhD graduates who had done as well as me," Dr Wang said.

"I am glad and honoured to have been given this award."

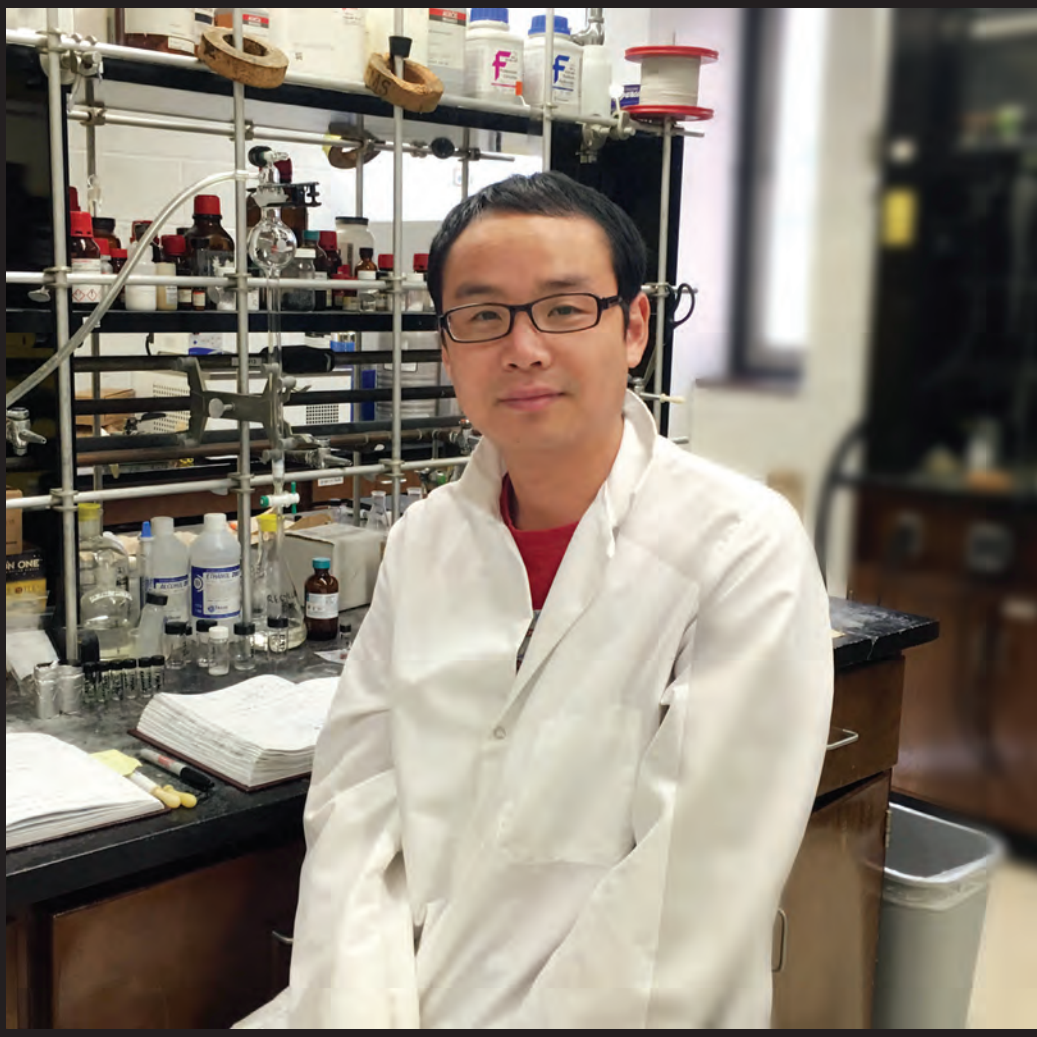
Dr Wang said that completing his PhD studies at AIBN has significantly shaped his career, which has landed him with a prestigious role at The University of Tennessee, Knoxville.

Now a Postdoctoral Research Associate in the Department of Chemistry, he is working on a project funded by the U.S. Department of Energy on the development of hybrid nanoparticles as new lubricant additives to improve fuel efficiency.

"UTK is one of the oldest universities in this country, and has a renowned reputation for outstanding teaching and research," Dr Wang said.

"In the past few months I have been enjoying my work and life in this beautiful place with a long history, and I think that working at UTK is an exciting beginning of my professional career."

Although he misses the people and natural environment of Australia, Dr Wang hopes he left his own mark through his work as a PhD student in the Whittaker Group.



"The knowledge and findings I gained from my PhD work were mainly the fundamental understanding and design concept for 19F MRI-based theranostic agents," he said.

"As cancer diseases have become a leading cause of death in the developed countries, our hope is to develop polymeric multimodal imaging agents for early and accurate cancer diagnosis, which is vital for successful treatment."

Dr Wang praises the facilities offered to him at AIBN as world-class enablers of his research.

"The access to modern equipment and facilities provided me with essential skills to work efficiently and safely in a modern research environment," he said.

"In addition, my wonderful supervisors, Professor Andrew Whittaker, Associate Professor Kris Thurecht and Dr Hui Peng, gave me the chance to work in an exciting research field and guided me in conducting high-quality research with a creative and critical attitude."

This solid foundation has provided Dr Wang the opportunity to develop his career as an early career researcher, which he has taken with both hands.

# ENGAGEMENT

# SCIENTIFIC ENGAGEMENT EXPANDS AIBN'S REACH

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

In December AIBN Group Leader and Inaugural Director Professor Peter Gray was appointed as Interim President of the Australian Academy of Technological Sciences and Engineering (ATSE).

He replaced outgoing President Dr Alan Finkel AO, who was appointed as Australia's Chief Scientist by Prime Minister Malcolm Turnbull.

ATSE is one of four learned Academies in Australia; advocating for technological and scientific development for social, environmental and economic benefit, it has more than 800 inducted Fellows within its ranks.

Professor Gray had been on the ATSE board for six years, including serving as Vice President, and was inducted as a Fellow in 1992.

Internationally, Professor Andrew Whittaker's long-term efforts in developing links with China were rewarded with the establishment of the Wuhan-Brisbane Research Alliance in Functional Polymeric Materials.

The alliance ties AIBN and the Queensland University of Technology with five Chinese institutions which include Wuhan Institute of Technology, Wuhan University, Huazhong University of Science and Technology, Hubei University, and the Chinese Academy of Sciences Institute of Intelligent Machines. Professor Whittaker will manage the Brisbane node of the alliance.

2015 also saw a number of high profile events organised by researchers at the Institute.

The 3rd Annual Cell Reprogramming Australia Conference 2015 was held at AIBN over 11-12 May, and was organised by the StemCore facility, which holds AIBN researchers on its Board of Directors and Scientific Advisory Committee.

Opened by AIBN Group Leader Professor Ernst Wolvetang, the conference featured a presentation by fellow AIBN Group Leader Professor Christine Wells and plenary lectures from two international speakers.

Dr Jacob Hanna of the Weizmann Institute of Science, Israel, spoke on the molecular mechanisms for assembling and resolving distinct pluripotent states, and Professor Philippe Collas of the University of Oslo, Norway, presented on cloning and induced pluripotent stem cells.

The conference featured 11 invited speakers, as well as presentations from students and early career researchers.

On 27 November AIBN researchers Associate Professor Stephen Mahler and Dr Simon Corrie co-organised the Biomedical Applications of Engineered Antibodies and Proteins workshop held in UQ's Advanced Engineering Building.

The workshop featured a number of speakers from Australian academic and research institutions, as well as speakers from industry. It was focussed on the field of antibody engineering, and the latest developments on how it can be applied to applications such as theranostics, reagents, biologic medicines and targeted nanomedicines.

*Each year AIBN researchers are involved in a number of engagements which further the Institute's work to their scientific peers. Their efforts increase the scientific profile of the work undertaken at AIBN, and regularly lead to research collaborations.*

AIBN researchers spoke during the proceedings, with Professor Matt Trau discussing cell membrane antibody fragments as a new class of affinity agents, and Dr Chris Howard presenting on the development of cancer targeted nanomaterials that use bispecific antibodies.

The event saw ECRs from 14 life science institutes and schools across Brisbane give oral and poster presentations. Oral presentations were made by AIBN's Dr David Wibowo and Dr Chris Howard, and poster presentations were made by 10 AIBN ECRs.

The AIBN Student Association also provided valuable experience for young researchers to present their work in a formal setting, hosting the annual AIBN Student Conference at Customs House on 2 October. The event featured oral and digital poster presentations by more than 30 AIBN students.

The Centre for Theoretical and Computational Molecular Science at AIBN led by Professor Debra Bernhardt organised a Student and ECR Mini Symposium on 21 May for researchers in that field.

The event featured a presentation by guest speaker Dr David Huang of University of Adelaide, who spoke about designing and identifying porous molecular materials for gas storage and separation.

Other presentations were made by student and ECR speakers, together with a poster presentation that was exclusively for PhD students to display their research.

AIBN's Early-Mid Career Researcher Committee was actively involved in the organisation of the 6th Annual ECR Symposium on 4 December at UQ's Advanced Engineering Building.

# COMMUNITY AND SCHOOL ENGAGEMENT ACTIVITIES

AIBN staff and students actively partake in broad community and school engagement activities to raise awareness of not only the work directly undertaken at the Institute, but also to promote the importance and value of scientific advances.

Through media appearances, school visits and community consultations, AIBN researchers are able to provide insights into their work, the current scientific landscape, and offer views of how their fields may positively impact society in the future.

A premier example of AIBN's efforts to raise public awareness during 2015 occurred during Stem Cell Week (11-17 May), with a number of events being held and attended by AIBN researchers.

Professors Peter Gray, Ernst Wolvetang and Christine Wells took part in UQ's premier public lecture platform, the Global Leadership Series, on 14 May at Customs House, Brisbane.

As part of a panel moderated by ABC broadcaster Dr Norman Swan, they joined Professor Alan Trounson of Monash University and Professor Martin Pera of Stem Cells Australia to discuss the topic of translating stem cell research into real health and economic benefits.

The panel debated the potential benefits of creating a personal body repair kit, the technical challenges that remain to be collared, and considered the potential ethical questions raised by stem cell based therapies.

A further initiative undertaken during Stem Cell Week was the StemCells@UQ event held at AIBN on 11 May for secondary school students in grades 9 and 10, which provided the students with an opportunity to meet UQ stem cell researchers.

Students engaged with a panel of experts, addressing how stem cell science has developed and how stem cells may impact people's lives in the future, in particular the realities behind the hopes and fears associated with stem cell science.

The event coincided with the 3rd Annual Cell Reprogramming Australia Conference, which was also held at AIBN.

During the year AIBN hosted other school visits, which involved tours of the facilities and laboratory demonstrations by AIBN researchers.

Further examples of community engagement included the 1 April launch of a new book at UQ, *Cracking the Code*, detailing the story of Stephen and Sally Damiani and their search to identify a diagnosis for their ill son, Massimo.

Genetic sequencing discovered a previously unknown form of childhood leukodystrophy, and the family has established the Mission Massimo Foundation. This has provided financial support for ongoing research within Professor Ernst Wolvetang's laboratory to search for treatments for the disease.

AIBN research by Professor Darren Martin's group into spinifex grass also took science interstate and into the gallery.

The 24 September – 6 November exhibition Ochre, Spinifex & Foil held at the Tin Sheds Gallery, The University of Sydney, investigated Indigenous and non-Indigenous science, with the Martin Group contributing through their research into nanocellulose derived from spinifex.

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

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

# AIBN SEMINAR SERIES

Each year AIBN hosts a number of seminars from both domestic and international guest speakers to promote novel science to the Institute's staff and students, fostering new ideas and collaborations.

23 February: ***Professor Ryan M. Richards***, Department of Chemistry and Geochemistry, Materials Science, Colorado School of Mines Joint Appointment at National Renewable Energy Laboratory
Nanostructured Materials with Unique Physical and Chemical Properties

13 March: ***Professor Christine Wells***, AIBN, UQ
Systems Biology of Stem Cells

20 March: ***Mr David Martin***, Research Connections Facilitator, AusIndustry
Shaping industry with your Research – Let us show you how!

27 March: ***Dr Esteban Marcellin***, Associate Group Leader, AIBN, UQ
Systems Metabolic Engineering for Industrial Process Improvements

13 April: ***Professor Jayakrishnan***, Department of Biotechnology, Bhupat and Jyothi Mehta School of Biosciences, Indian Institute of Technology
Polymeric Prodrugs of Amphotericin B and Primaquine

16 April: ***Adjunct Professor Jens Sommer-Knudsen***, Endoluminal Sciences
A novel Protein NanoParticle Technology

17 April: ***Professor Jan Recker***, Queensland University of Technology
Collaborate to Innovate: Lessons Learnt from Three Years of the Woolworths Chair of Retail Innovation

17 April: ***Professor Samuel S. Mao***, University of California at Berkeley, USA
Disorder-Engineered Titanium Dioxide Nanocrystals: Fundamentals and Application to Solar-Driven Hydrogen Production

23 April: ***Dr Noel Chambers***, Chief Executive Officer, National Foundation for Medical Research and Innovation (NFMRI)
A New Approach to Philanthropy Supporting Medical Research and Innovation

24 April: ***Professor Xuchuan Jiang***, Laboratory for Simulation and Modelling of Particulate Systems (SIMPAS), Department of Chemical Engineering, Monash University
Engineering Nanoparticles and their Nanocoatings for Energy and Environmental Applications

8 May: ***Associate Professor Mark Molloy***, APAF Director, Australian Proteome Analysis Facility (APAF)
A Protein-Centric View of Cancer Signalling: Therapies and Biomarkers

15 May: ***Professor Geoffrey Faulkner***, Translational Research Institute
Mobile DNA: Shuffling the Genetic Deck in Cancer, Stem Cells and Neurons

22 May: ***Professor Julian Rood***, Monash University
NetB Toxin and Avian Necrotic Enteritis: The Hole Movable Story

29 May: ***Dr Timothy Mercer***, Garvan Institute of Medical Research
Genes Under the Microscope: Targeted Sequencing of the Human Transcriptome

3 July: ***Professor Wey Yang Teoh***, Clean Energy and Nanotechnology Lab, School of Energy and Environment, City University of Hong Kong
Heterojunction Engineering and Charge Transport in Photoelectrochemical Water Splitting

10 July: ***Professor Mitchell A. Winnik***, Department of Chemistry, University of Toronto, Canada
One-Dimensional Block Copolymer Micelles and Their Hybrid Structures with Inorganic nanoparticles

13 July: ***Professor Leaf Huang***, University of North Carolina at Chapel Hill, USA
Lipid-Stabilized Calcium Phosphate Nanoparticles for Gene and Drug Delivery

17 July: ***Professor Jürgen Götz***, Foundation Chair of Dementia Research; Director, Clem Jones Centre for Ageing Dementia Research, Queensland Brain Institute, UQ
Lessons from Alzheimer's Disease Models - Novel Approaches to Remove Toxic Protein Aggregates from the Brain

24 July: ***Dr David Noon FTSE***, Vice President of Global Operations & Sales, GroundProbe Pty Ltd
Industry-focused Research: A Career Pathway Towards Innovation and Entrepreneurship

31 July: ***Professor Bernd H. A. Rehm***, Institute of Fundamental Sciences and MacDiarmid Institute for Advanced Materials and Nanotechnology, Massey University, New Zealand
*In vivo* Assembly of Functionalised Shell-core Nanobeads by Engineered Bacteria

10 August: ***Dr Roland Marshall***, Justus-Liebig-University Giessen, Germany
Mesostructured Mixed Oxides for Solar Energy Conversion

21 August: ***Dr Esther Levy***, Consulting Editor, Advanced Materials, Wiley, Australia
Materials Science Publishing: An Advanced Perspective

21 August: ***Professor Christoph Hagemeyer***, Head, Vascular Biotechnology Laboratory, Baker IDI
Molecular Imaging and Targeted Drug Delivery for the Prevention, Diagnosis and Treatment of Myocardial Infarction and Stroke

28 August: ***Professor Christopher J.H. Porter***, Professor of Pharmaceutics and Associate Dean (Research), Monash Institute of Pharmaceutical Sciences
Dendrimers as Enhanced Drug Delivery Vectors

3 September: ***Dr Steve D R Christie***, Senior Lecturer and Associate Dean (Enterprise) of the Department of Chemistry, Loughborough University, UK
The Additive Manufacturing of Chemistry and Biology: Towards 3D Printing of Science?

11 September: ***Professor Brett Neilan***, School of Biotechnology and Biomolecular Sciences, University of New South Wales
Engineering Cyanobacteria and their Toxin Biosynthesis Pathways for Unnatural Production

14 September: ***Chris Stowers***, Fermentation Technology Leader, Bioengineering and Bioprocess R&D, Dow AgroSciences LLC
The Challenges of Industrial Fermentation – From Primary to Secondary Metabolites

18 September: ***Professor Rob Capon***, Institute for Molecular Bioscience, UQ
Biodiscovery: In search of new Drugs to Treat Infectious Diseases, Cancer and Pain

25 September: ***Dr Matthew Kearnes***, University of New South Wales
NanoScience: Social Science Perspectives

6 October: ***Professor Jiming Hu***, Institute of Analytical Biomedicine, Wuhan University, China
Bio-Raman Spectroscopy: A Bridge between Pathological Research and Clinical Diagnosis of Disease

9 October: ***Professor Nancy Monteiro-Riviere***, Director of the Nanotechnology Innovation Center, Kansas State University (NICKS), USA
Physicochemical Properties of Nanoparticles that may Influence Skin Penetration and Toxicity

9 October: ***Professor Jim Riviere***, Director of the Institute of Computational Comparative Medicine, Kansas State University, USA
Development of a Physiologically Relevant Multivariate Nanoparticle Molecular Interaction Fingerprint

16 October: ***Dr Barbara Rolfe***, AIBN, UQ
The Complement Anaphylatoxins: Therapeutic Targets for Melanoma?

21 October: ***Professor Yasuhiro Sakamoto***, Department of Physics, Osaka University, Japan
Electron Microscopy Studies of Nanoporous Materials on the Micro- and Meso-scale

23 October: ***Professor Chris Goodnow***, Deputy Director, The Bill and Patricia Ritchie Foundation, Garvan Institute of Medical Research
Analysis of Mutations in Antibodies, Cancer, and Germ Line Genome

30 October: ***Professor Takayoshi Sasaki***, National Institute for Materials Sciences, Japan
2D Nanoarchitectonics with Metal Oxide and Hydroxide Nanosheets

30 October: ***Professor Shuming Nie***, Department of Biomedical Engineering, Emory University and Georgia Institute of Technology, USA
Nanotechnology and Precision Medicine: Image-Guided Surgical Resection of Microscopic Tumors

26 November: ***Kuan-Lin (Elly) Ku***, National Tsing Hua University, Taiwan
Development of the Potential of Polyanhydride Copolymers and Hydroxyapatite Ceramic Composites for Bone Applications

30 November: ***Prof I-Ming Chu***, Chemical Engineering Department, National Tsing Hua University, Hsinchu, Taiwan
Biodegradable Thermo-Sensitive Polymeric Hydrogels and Their Biomedical Applications

7 December: ***Dr Jeffrey Wiggins***, University of Southern Mississippi, USA
Next Generation Aerospace Composite Materials

10 December: ***Dr Lionel Hebbard***, Department of Molecular and Cell Biology, James Cook University
Adiponectin and its Role in Human Disease

# PUBLICATIONS

# PUBLICATIONS

## Book Chapter


Annamalai, P. K., and Depan, D. (2015) Nano-cellulose reinforced chitosan nanocomposites for packaging and biomedical applications, in *Green biorenewable biocomposites: from knowledge to industrial applications* (Vijay Kumar, T., and Michael, R. K., Eds.), pp 489-506, Apple Academic Press, Oakville, ON, Canada.

Fay, M., Bell, C., Dowson, N., Puttick, S., and Rose, S. (2015) Imaging of brain tumours, in *Molecular considerations and evolving surgical management issues in the treatment of patients with a brain tumor* (Dr. Terry, L., Ed.), pp 235-276, InTech Europe, Rijeka, Croatia.

Gu, W., McMillan, N., and Yu, C. (2015) Silencing of E6/E7 expression in cervical cancer stem-like cells, in *Cervical cancer: methods and protocols* (Daniel, K., and Athena, W. L., Eds.), pp 173-182, Springer, New York, NY United States.

Osborne, G. W. (2015) A brief introduction to neural flow cytometry from a practical perspective, in *Neural surface antigens: from basic biology towards biomedical applications* (Jan, P., Ed.), pp 15-26, Elsevier, London, United Kingdom.

Thakar, N. Y., and Wolvetang, E. J. (2015) Ascorbate as a modulator of the epigenome, in *Nutrition and epigenetics* (Emily, H., and Frederick, D., Eds.), pp 199-218, CRC Press, Boca Raton, FL, United States.

Vickers, C. E., Behrendorff, J. B. Y. H., Bongers, M., Brennan, T. C. R., Bruschi, M., and Nielsen, L. K. (2015) Production of industrially-relevant isoprenoid compounds in engineered microbes, in *Microorganisms in biorefineries* (Birgit, K., Ed.), pp 303-334, Springer, Berlin, Heidelberg.

Zong, X., Lu, G., and Wang, L. (2015) Nonmetal doping in TiO2 toward visible-light-induced photocatalysis, in *Environmental Photochemistry Part III* (Detlef, W. B., and Peter, K. J. R., Eds.), pp 87-113, Springer, Berlin, Germany.


## Journal Article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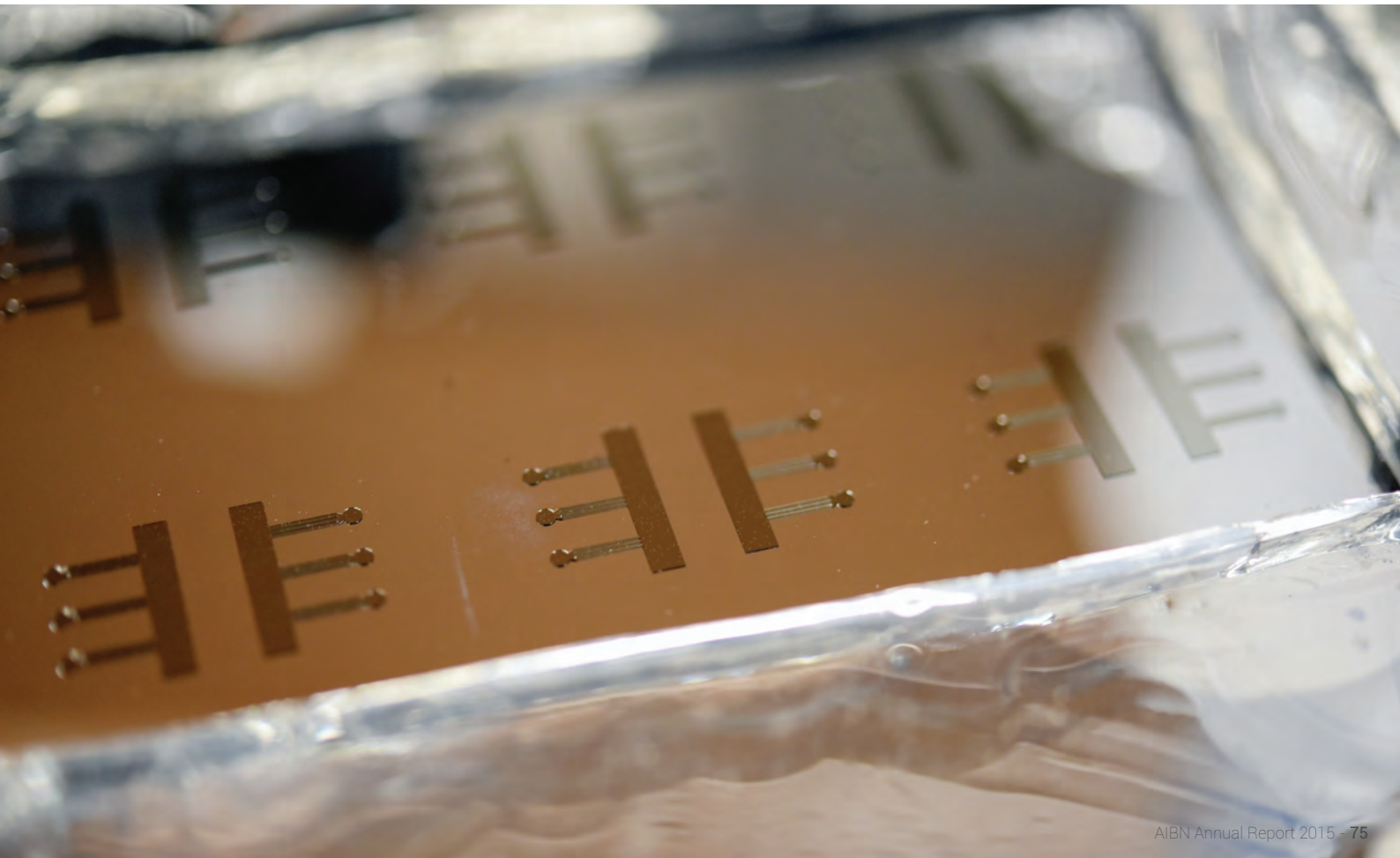

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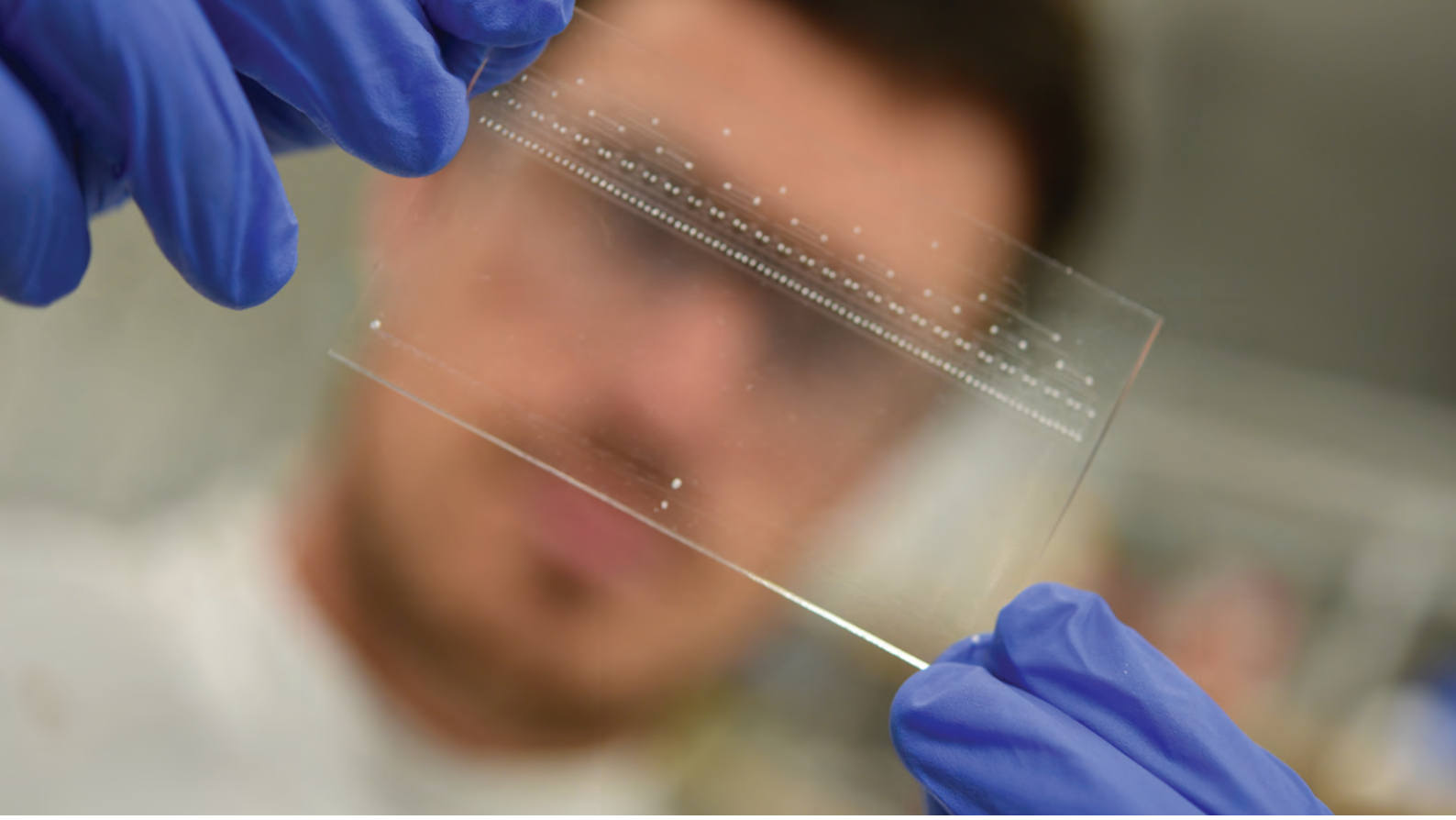


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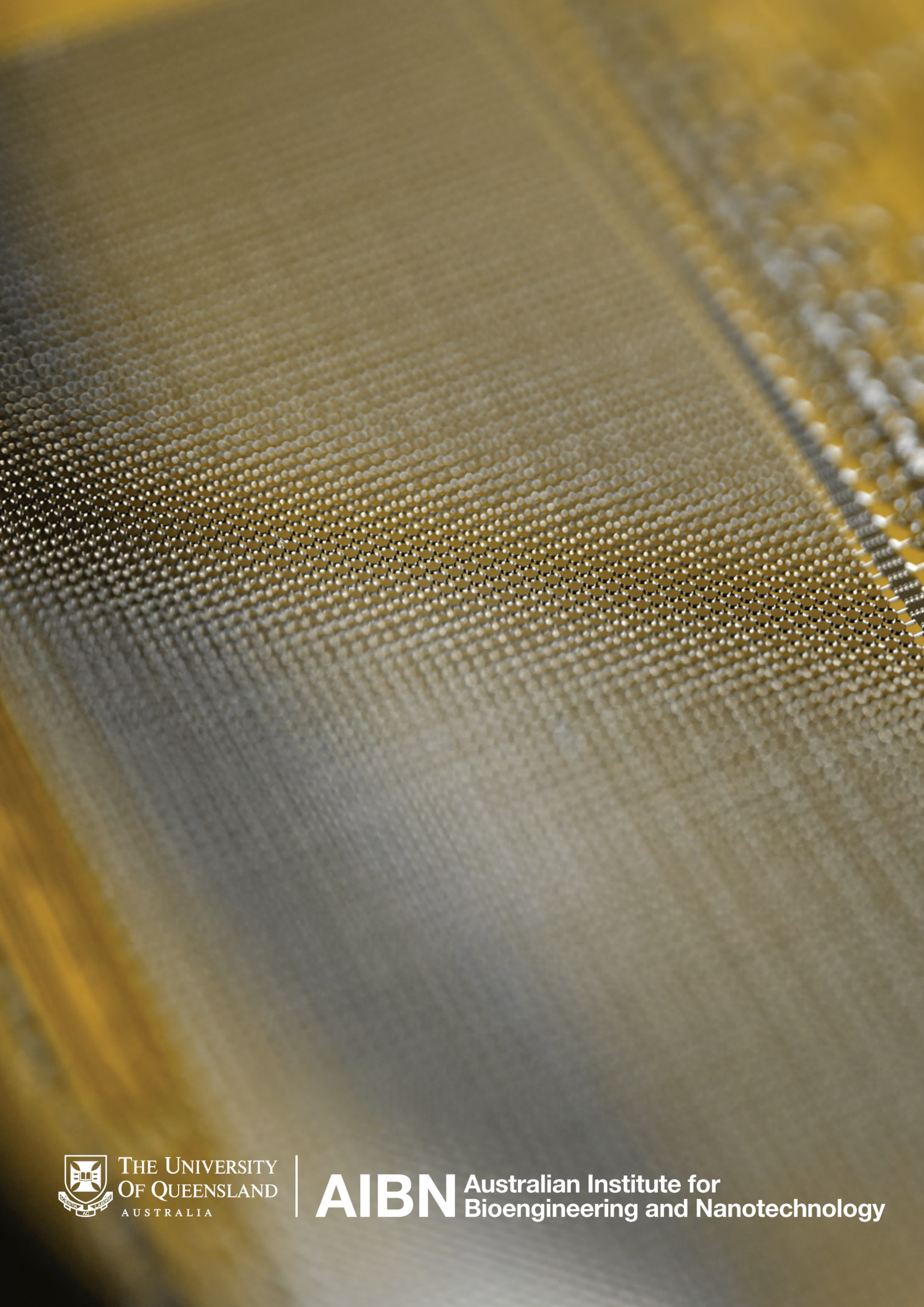

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