AIBN

ANNUAL REPORT 2012

THE UNIVERSITY OF QUEENSLAND
AUSTRALIA

VICE-CHANCELLOR'S MESSAGE

It is my pleasure to welcome you to the 2012 Annual Report of the Australian Institute for Bioengineering and Nanotechnology (AIBN), an institute that helps drive UQ's ambition to couple excellent research with effective industry and government partnerships.

Since becoming UQ President and Vice-Chancellor in October 2012, I have enjoyed opportunities to deepen my knowledge of AIBN. Its researchers show exciting capacity to develop scientific and engineering frontiers, all the while being aware of the practicalities of industry practice.

AIBN is part of why UQ is globally respected as a top 100 university, and the institute's outcomes helped us secure the highest ratings possible in five specialised fields in the 2012 Excellence in Research for Australia evaluation.

By combining this high-quality research with links to the market, AIBN contributes towards progress in the health, environment and prosperity of people worldwide.

Its many contributions in 2012 included a licensing deal between Merck and AIBN spin-off Vaxxas, and new funding from the National Breast Cancer Foundation for AIBN-led work on personalised breast cancer treatments.

Partnerships with some of the biggest names in aviation, manufacturing and pharmaceuticals, among other sectors, elevate the opportunities for AIBN researchers to have a global impact.

The institute's Industrial Affiliates Program (IAP) is a standard-bearer for engagement between UQ researchers and businesses, large and small. While giving companies access to the latest research, it helps AIBN to maintain the industrial relevance of its projects.

The IAP has successfully seeded collaborations that target domestic and global challenges, bring research and development income to Queensland and Australia and add vibrancy to the state and national innovation economies.

Fine examples of this are the relationships with The Dow Chemical Company and DSM Biologics, which are both industrial affiliates. Thanks in part to the goodwill built through IAP, we now have the Dow Centre for Sustainable Engineering Innovation at UQ, and DSM is establishing a Brisbane base, attached to the new Translational Research Institute.

For Australia to sharpen its competitive edge and productivity, I maintain that we, as a nation, must intensify interactions between universities and business.

AIBN is showing how it can be done, but this is only possible because of strong partnerships with businesses, funding agencies and philanthropists.

So, while congratulating AIBN's leadership and its team for their high-calibre work and their enthusiasm for industry engagement, I thank all our partners, without whom our mission and vision would not be sustained.

Together, you have helped enable success stories such as those featured in this report. I am confident that, in future, we will jointly celebrate the benefits these and other AIBN projects are delivering to society.

Professor Peter Høj
President and Vice-Chancellor
The University of Queensland

DIRECTOR'S MESSAGE

AIBN researchers and higher degree research students have had an outstanding year. This report summarises many of the achievements and successes. While extensive, the report cannot include the full spectrum of activities that make AIBN such an exciting research environment.

AIBN welcomed more than 7000 visitors to the institute in 2012, including eminent scientists such as Sir Gregory Winter, FRS, who developed the world's first fully human monoclonal antibody. Such visitors provide vision and inspiration to people such as our own Amanda Pearce, winner of UQ's final of the Three Minute Thesis competition; and Associate Group Leader Dr Kris Thurecht, recipient of a Queensland Young Tall Poppy Science Award.

During the year we welcomed Professor Debra Bernhardt as a new Group Leader and AIBN Centre for Theoretical and Computational Molecular Science director. Debra's skills in developing theoretical and computational approaches to understanding nanoscale systems and molecular reactions are complementary to research conducted in other AIBN groups.

After six years as a Group Leader, Dr Krassen Dimitrov left to concentrate his efforts on building the spin-off company Digital Diagnostics, based on intellectual property developed at AIBN.

We were very pleased in October to welcome UQ's new Vice-Chancellor and President, Professor Peter Høj, and are delighted he has so rapidly engaged with AIBN's activities and style.

In 2012, AIBN held the first International Conference on BioNano Innovation (ICBNI) at the Brisbane Convention and Exhibition Centre, a three-day conference incorporating a symposium for early career researchers, organised by the AIBN Student Association.

ICBNI attracted more than 500 delegates and 74 invited speakers from nine countries. The conference was judged an outstanding success, and we accepted the kind invitation from Chinese Academy of Sciences President Professor Chunli Bai to host ICBNI 2013 in Beijing.

The Vice-Chancellor has commented on AIBN's Industrial Affiliates Program (IAP) and the strong links between the institute and a wide range of innovative companies, ranging from Brisbane technology-intensive companies to large multinationals. AIBN has a philosophy of ensuring our high-quality research, as evidenced by 303 peer-reviewed journal articles in 2012, is successfully translated into new products and processes.

Australia ranks near the bottom of OECD tables in collaboration between business and the public research sector. The IAP gives us a creative new model, and we know we have the right, highly motivated, people to ensure the institute's talent and ideas are successfully applied.

To help us achieve these goals we particularly appreciate the advice and wisdom of AIBN Board Chairman Euan Murdoch and his fellow board members Kathy Hirschfeld, Professor Chris Lowe, Professor Max Lu, Dr Susan Pond and Bob McCarthy.

Finally I would like to thank UQ's senior management and particularly Professors Peter Høj, Debbie Terry, and Max Lu for the interest and support shown to the institute during the year, which has been instrumental in achieving the outcomes summarised in this report.

Professor Peter Gray
AIBN Director

NEW BOARD TO RAISE AIBN'S INTERNATIONAL PROFILE

The AIBN Board was established in 2012 as an advisory body to assist the Director, Professor Peter Gray, in matters relating to the institute's governance, defined strategic goals, progress against goals, and levels of funding required to support ongoing operations and strategic initiatives.

The board met for the first time in July, co-inciding with the first International Conference on BioNano Innovation in Brisbane.

AIBN Board members are high-calibre representatives with broad-ranging experience and expertise in the university, industry, community and government sectors.

The board has a broad ambit, including providing advice on funding opportunities, commercialisation paths, extension activities and growth strategies for AIBN on a strategic and operational basis.

It reviews AIBN's progress in research, internationalisation, commercialisation, governance and management.

The board is charged with advising on matters such as raising AIBN's international profile to maximise benefits to Queensland and Australia generally, and with assisting to maintain the institute's high visibility and reputation in research, industry, government and public domains.

Board Chairman Euan Murdoch is the founder of Herron Pharmaceuticals. His career has included positions 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.

Board members are Kathy Hirschfeld, Professor Chris Lowe, Professor Max Lu, Bob McCarthy, Dr Susan Pond, Professor Gray and board secretary Janice Besch.

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LEADERSHIP

AIBN has a dynamic and cohesive group of talented research group leaders, all recognised experts in their fields, who are committed to the institute's vision and underlying research philosophy.

Leadership is provided by Director Professor Peter Gray and five Deputy Directors, two of whom marked their first full year in their positions in 2012.

Dr Ian Nisbet is AIBN's Deputy Director (Commercialisation), with responsibility for commercialisation, creating closer ties with industry and ensuring technology makes it onto the market. Dr Nisbet steers the Industrial Affiliates Program, which gives industry partners access to AIBN facilities; involves them in symposiums and networking events; and offers them staff training.

AIBN Group Leader Professor Darren Martin is Deputy Director (Graduate Studies). His responsibilities include acting as Postgraduate Coordinator for research higher degree (RHD) students and chairing AIBN's RHD Committee.

He took over the responsibilities from fellow Group Leader Professor Michael Monteiro, who oversaw the expansion of RHD student numbers from 2008 to 2012.

Deputy Director (Bioengineering) Professor Anton Middelberg provides leadership in research policy, processes and infrastructure. Deputy Director (Nanotechnology) is Professor Matt Trau, with responsibility for advancement, engagement and public relations.

OUR VISION

To build a nationally and internationally acknowledged bioengineering and nanotechnology institute recognised for sustained research excellence, with strong collaborative links to leading global research groups and corporations

2012 Highlights

STRATEGIES AIM TO COMBAT CELL TRANSFORMATIONS

Researchers from four UQ laboratories have started a five-year program in membrane interface biology targeting cancer and auto-immune diseases.

The National Health and Medical Research Council (NHMRC) announced in 2012 that UQ's lead consortium, together with a group from the University of New South Wales, would receive funding of more than $7 million.

A joint appointment between AIBN and UQ's Institute for Molecular Biosciences (IMB), Professor Kirill Alexandrov is part of the consortium. "The research program aims to gain a detailed understanding of the organisation of the cell surface at the molecular level," he said.

"The cell surface is organised into domains with distinct functions. Visualisation of the domains; identifying their important components; and understanding how they form and function will have huge importance for therapeutic strategies aimed at combating the changes associated with cell transformation in cancer and other human diseases, such as muscular dystrophy."

Professor Alexandrov said his researchers would examine a cell's ability to form, its conduct with others and its migration. That has immediate relevance to the progression of cancer in the body. They would also examine cases where the immune system attacked its own cells rather than foreign organisms.

"The end result will be that we can address the basic biology that underlies the diseases. We will have a better understanding and can devise molecules to mitigate these conditions. We can identify new targets that can be treated by small molecular compounds."

The Alexandrov research group has been working at the Australian Cancer Research Foundation Cancer Biology Imaging Facility at UQ. "We use the facility to analyse the interaction of proteins," Professor Alexandrov said. "We have developed a system for individual protein synthesis. We make protein in a test tube. We don't need cells or living organisms."

The researchers will ultimately gain a detailed understanding of the molecules and mechanisms associated with the transformation of healthy cells to cancerous cells – and the invasion of cancerous cells through the body. It will lead to better treatment of cancer and other serious diseases.

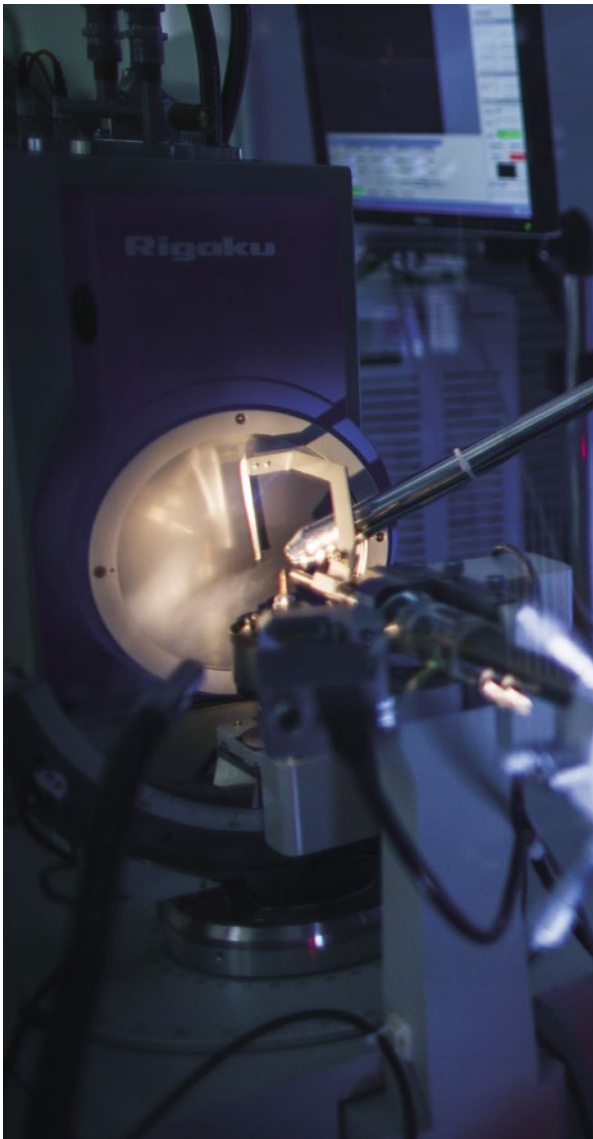
In a separate project, Alexandrov group researchers are working with colleagues at IMB to develop a way for patients to use smart phones to communicate diagnostic data to healthcare providers.

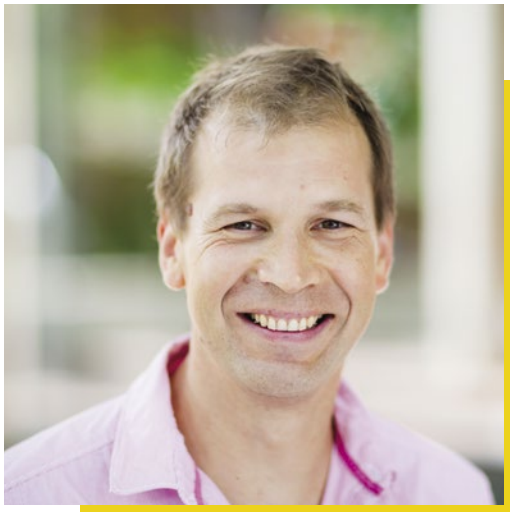
They are merging engineering and biology to develop biological semiconductors that could be used in diagnostic devices. The Alexandrov research group has filed a patent on one of its designs and hopes to interest private sector investors. Professor Alexandrov is confident the technology will eventually allow patients to monitor themselves and better manage their diseases.

"An ideal case would be for them to have a little chip connected to their smart phone," he said. "They could get a reading from their saliva or urine, rather than having to go to hospital to have their blood analysed.

"It increases patients' responsibility for handling their disease. The future of health care will see much greater patient self participation, but only if they can get data about their condition in real time and at very low cost. We hope this approach will find widespread application in biotechnology."

Professor Kirill Alexandrov's vision is to apply the principles of synthetic biology to the analysis and design of biotechnologically and medically important protein-based molecular machines





Professor Kirill Alexandrov

Group Leader

Research: **Next-generation technologies for protein research**

Professor Kirill Alexandrov is a co-founder of successful biotechnology company Jena Bioscience and credited with establishing the Dortmund Protein Production Facility at the Max-Planck Institute in Germany.

He introduced high–throughput molecular cloning technology to the UQ Protein Expression Facility. Professor Alexandrov has secured three Australian Research Council (ARC) and two National Health and Medical Research Council (NHMRC) project and program grants since 2008; and been awarded an ARC Australian Postdoctoral Fellowship and a Future Fellowship.

Professor Alexandrov has retained close collaborative links with the Dortmund Protein Production Facility. He has close collaborations with Brisbane biotechnology company Bioproton LLC and Perth biotechnology company Phylogica.

Professor Alexandrov has raised about $22 million in funding since 2008. He has filed six patents, including one that has reached international phase.

Professor Alexandrov has received more than 30 invitations to speak at national and international conferences. They include:

- 2011 PepTalk, US. Invited plenary speaker, chair of round table discussion
- 2011 9th Matsuyama International Symposium on Cell-Free Sciences, Japan. Invited plenary speaker
- 2011 FASEB Summer Research Conferences on Protein Lipidation, Signaling, and Membrane Domains, US. Invited plenary speaker
- 2011 Choroideremia disease Workshop, France. Invited plenary speaker
- 2011 9th Australian Peptide Conference, Australia. Invited plenary speaker

In 2004, Professor Alexandrov was awarded Germany's highest career development fellowship, the Heisenberg Award.

Key publications in the past five years:

Kovtun O, Mureev S, Johnston W, Alexandrov K. (2010) Towards the construction of expressed proteomes using a *Leishmania tarentolae* based cell-free expression system. *PLOS One* 5, e14388.

Mureev S, Kovtun O, Nguyen UTT, Alexandrov K. (2009) Species-independent translational leaders enable the rapid development of novel cell-free expression systems. *Nature Biotechnology* 27, 747-752.

Nguyen UT, Guo Z, Delon C, Wu Y, Deraeve C, Fränzel B, Bon RS, Blankenfeldt W, Goody RS, Waldmann H, Wolters D, Alexandrov K. (2009) Analysis of the eukaryotic prenylome by isoprenoid affinity tagging. *Nat Chem Biol* 5(4), 227-235.

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

** Joint appointment with UQ's Institute for Molecular Biosciences*

Dr Zhong Guo

Professor Debra Bernhardt

Group Leader

Research: **Theoretical and computational molecular science: nonequilibrium systems, fluids and materials**

Professor Debra Bernhardt is internationally recognised for her contributions to the development of nonequilibrium statistical mechanics and thermodynamics including far-from-equilibrium fluids and confined fluids.

She is a Fellow of the Royal Australian

Chemical Institute and director of the AIBN Centre for Theoretical and Computational Molecular Science. Professor Bernhardt's 30 years of research experience includes appointments at the University of Basel, Switzerland; the Australian National University; and Griffith University, where she was founding director of the Queensland Micro- and Nanotechnology Centre.

Professor Bernhardt's research interests focus on use of a range of theoretical and computational approaches to develop a fundamental understanding of the behaviour of matter, and application of those approaches to a wide range of problems including transport in nanopores, fluctuation phenomena, design of materials, gas separation, energy storage and conversion.

Professor Bernhardt has three current Australian Research Council (ARC) funding grants and has received ARC grant funding of more than $4.7 million since 1998. She has been involved in organising several conferences, including Nonequilibrium Processes: the Last 40 years and the Future in Obergurgl, Austria in 2011; First Australian-Italian Workshop on Statistical Physics on the Gold Coast in 2006; and International Union of Pure and Applied Chemistry's World Chemistry Congress 2001. She is co-chair of Molecular Modelling 2014, which will be in Queensland.

Professor Bernhardt has been plenary, keynote or invited speaker at many international conferences, including Fluid-Structure Interactions in Soft-Matter Systems: From the Mesoscale to the Macroscale (Prato, Italy, 2012); Gordon conference on the Chemistry and Physics of Liquids (New Hampshire, US, 2011); StatPhys-Kolkata VII (SINP, Kolkata, India, 2010); and the Warwick EPSRC Symposium on Challenges in Scientific Computing (University of Warwick, UK, 2009). In 2011, while at Griffith University, Professor Bernhardt was awarded the Vice Chancellor's Research Excellence Award for Research Leadership.

Key publications in the past five years:

Professor Bernhardt publishes using her maiden name, Debra J Searles.

Davie SJ, Reid JC, Searles DJ. (2013) Free energy calculations with reduced potential cutoff radii. *Journal of Chemical Theory and Computation* 9(4), 2083-2089

Reid JC, Evans DJ, Searles DJ. (2012) Beyond Boltzmann's H-theorem: Demonstration of the relaxation theorem for a non-monotonic approach to equilibrium. *Journal of Chemical Physics* 136, 021101.

Sun C, Searles DJ. (2012) Lithium storage on graphdiyne predicted by DFT calculations. *Journal of Physical Chemistry C* 116, 26222.

Bernardi S, Brookes SJ, Searles DJ, Evans DJ. (2012) Response theory for confined systems. *Journal of Chemical Physics* 137, 074114.

Michel G, Searles DJ. (2012) Contribution of the stochastic forces to the fluctuation theorem. *Physical Review E* 85, 042102.

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

Dr Qiao Sun with Professor Debra Bernhardt

AIBN research under the leadership of Professor Debra Bernhardt could go a long way to keeping new-generation passenger aircraft in the sky.

Professor Bernhardt joined AIBN as a Group Leader in July 2012. Her research group is interested in the study of matter to address a broad range of fundamental and practical problems. In simple terms, the group is developing theoretical and computational approaches to understand and predict the behaviour of matter, which will ultimately lead to new materials and devices with desired characteristics.

Professor Bernhardt said computational molecular science researchers in her group were developing a fundamental understanding of nanoscale systems and quantum descriptions of molecular reactions.

RESEARCH TO KEEP AIRCRAFT FLYING

The Bernhardt research group is investigating why lithium-ion batteries, used to power aircraft electrical systems, can overheat. The overheating has previously resulted in the grounding of aircraft. Professor Bernhardt's group is taking a theoretical and computational approach to the problem and hopes to provide fundamental understanding of the process and possible alternative materials for use in the batteries.

Professor Bernhardt said her group was using quantum chemical calculations and molecular dynamics simulations in the research. "We are considering different types of materials for the battery components to improve their efficiency, heat and current flow," she said.

"Using computers, simulation can give us insight into why lithium-ion batteries heat up. We hope we can provide manufacturers with some fundamental understanding."

Professor Bernhardt said similar theory and computation could be applied to test materials for hydrogen production, gas separation and carbon dioxide sequestration.

Her group is also considering desalination. Desalination plants are regarded as an answer to water shortages intensified by global climate change. However, they are expensive to build and operate.

Professor Bernhardt said her research group was interested in considering new materials that might make the plants more efficient and cheaper to run.

"We are trying to develop improved membranes to separate pure water from salty water. Before the membranes are developed, we can do controlled tests on the computer. We can also look at the mechanism of separation on high-performing membranes to understand what characteristics are required."

Work started in 2012 has resulted in funding from the Asian Office of Aerospace Research and Development for a project due to start in 2013, with a focus on investigating how to build stronger materials using metal matrix composites.

Bernhardt group researchers will examine whether inserting nanotubes into a metal, such as titanium, will make it stronger.

Professor Bernhardt said the nanotubes would act in a similar way to steel reinforcement in concrete. "It could have widespread use under extreme conditions where strong materials are required."

Researchers will examine how strongly the nanotube and metal bind and whether there are any reactions, such as the metal oxidising. Again, the work is conducted on computers rather than in the laboratory.

Professor Bernhardt said theory and computer simulation often provided a relatively cheap and effective way to predict the behaviour of new materials or examine them under conditions inaccessible to physical experiments.

For example, researchers can instantly make nanotubes in metals shorter, longer or wider on a computer. That would be time-consuming and costly if they had to be manufactured first for experiments.

Other areas of interest included separation of gases, melting, solubility, lubrication, design of ionic liquids, and design and assessment of materials for energy conversion and storage.

TISSUE REGENERATION A STEP CLOSER

Researchers working with Professor Justin Cooper-White have made discoveries in 2012 that have brought them closer to designing 'deterministic' tissue engineered scaffolds for cardiac, cartilage and bone tissue repair and generation.

It is part of his Tissue Engineering and Microfluidics (TEaM) lab's focus on developing bioengineered systems and device platforms that allows them to dissect the microenvironment in which stem cells 'live' during early tissue development. They have found that variations in the microenvironment lead to the generation of different tissues.

Using Australian Research Council (ARC) Discovery Project funding, Professor Cooper-White's research group determined the importance of spacing of adhesion peptides presented to mesenchymal stem cells (MSC) in influencing morphology, migration and differentiation. MSCs presented with closely-spaced peptides were predisposed to form bone, while those on widely-spaced peptides were more likely to differentiate into fat cells.

The research involved Professor Cooper-White; ARC Discovery Early Career Researcher Award recipient Dr Jess Frith; and recent Cooper-White research group graduate Dr Richard Mills – now working at Karolinska Institute's Department of Cell and Molecular Biology in Stockholm, Sweden.

The findings were published in *Journal of Cell Science* and the paper was an issue highlight.

Professor Cooper-White said the research showed, for the first time, that nanoscale spacing of adhesion peptides influenced stem cell differentiation and added to the understanding of how MSCs interacted with their surroundings.

"This knowledge could be used in the future to optimise differentiation of MSCs in tissue engineered therapies," he said.

"In recent years, it has been acknowledged that physical cues have a profound influence on stem cell fate. We are still learning which cues are important and how they influence cell behaviour. Knowledge of this will allow us to design better strategies for tissue regeneration."

In addition to work on engineered substrates for controlling MSC behaviours, Professor Cooper-White's research group has developed a microbioreactor array technology platform that permits cells to be cultured under hundreds to thousands of different conditions, to work out the best conditions for growing them or differentiating them into target cell lineages – all in a device the size of a credit card.

In a paper published in *PLoS ONE* in late 2012, the researchers showed how the new technology could be applied to study early differentiation in human embryonic stem cells, to a stage called 'primitive streak', from which other lineages, such as cardiac cells, ultimately emerged.

Development is complex – and developing a protocol to derive cells of interest, such as cardiac cells, means many parameters have to be optimised. The parameters to consider include which factors to use, and in what combination; the concentrations of each; the timing of treatment; and cell densities. The new technology lets that proceed in a more high-throughput manner, requiring fewer cells and reagents than a standard culture format would need to gain a snapshot of the differentiation process and the factors that contribute to it.

The multidisciplinary, collaborative research project brought together elements of microfabrication; stem cell and developmental biology; and genetic engineering.

It involved AIBN graduates Dr Drew Titmarsh and Dr James Hudson; PhD student Alejandro Hidalgo-Gonzalez; Group Leader Associate Professor Ernst Wolvetang; and collaborators Professor Andrew Elefanty and Professor Edouard Stanley from the Murdoch Children's Research Institute in Victoria. The research received financial support from Stem Cells Australia, an ARC Special Research Initiative. StemCore/Stem Cells Ltd provided cell culture services. The work would have been impossible without the microfabrication facilities at the Australian National Fabrication Facility – Queensland node.

Dr Jane Fitzpatrick with Ellen Otte and Jason Ross.

Dr Titmarsh, who developed the platform during his PhD thesis under the principal supervision of Professor Cooper-White, said the research showed the device platform was able to screen combinations of inducing factors and small molecules and also allowed screening of 'paracrine factors' – factors produced by the cells themselves that affected their differentiation.

"These factors and their impacts are really challenging to study with standard culture platforms, but were streamlined using the microfluidic control of culture medium in our device," Dr Titmarsh said.

"By identifying and modulating these paracrine signals with drugs, we could better understand the signals involved and optimise the primitive streak differentiation. This helps our understanding of how the complex human body is programmed to develop itself starting with just a few cells. Once we have this understanding, we can exploit the results to artificially induce cells or tissues of choice using stem cells as a starting material."

The technology has been patented and the Cooper-White research group is seeking to develop it in new applications with collaborators, with the aim of proving the value of data the technology can provide with industrial partners. Ultimately, the technology will accelerate research in stem cell development and regenerative medicine, drug screening, and bioprocess engineering, so the researchers want to take it to the world.

Professor Justin Cooper-White
Group Leader

Research: **Smart surfaces, scaffolds and diagnostic microdevices for stem cell expansion, tissue engineering and early disease detection**

Professor Justin Cooper-White is a global leader in using engineering to solve problems in biology. In addition to being an AIBN Group Leader, Professor Cooper-White is director of the Australian National Fabrication Facility – Queensland Node and is the Associate Dean (Research) of UQ's Faculty of Engineering, Architecture and Information Technology. He is a past president of the Australasian Society for Biomaterials and Tissue Engineering and the Australian Society of Rheology.

Professor Cooper-White has been chair or co-chair of three international conferences, focusing on either rheology or biomaterials and tissue engineering. He is on the Asian Biomaterials Council and the International Union of Societies for Biomaterials Science and Engineering. Professor Cooper-White is an inventor on six international patents and has successfully licensed technology from his lab to an Australian small-to-medium-sized enterprise. He has performed contract and sponsored research work for multinationals such as Mesoblast, Rhodia, Unilever and Nestlé International – and has received more than $45 million in competitive grant funding.

Professor Cooper-White has many past and currently active international collaborations with world-leading research groups at MIT (US); Stanford (US); ETH (Switzerland); EPFL (Switzerland); SNU (Korea); the University Of Grenoble (France); Politecnico di Milano (Italy); UCL (UK); and the Max Planck Institute (Germany).

Recognition of Professor Cooper-White's standing in the research field is reflected in the nine plenary and more than 25 keynote presentations he has been invited to give at national and international conferences since 2001.

Key publications in the past five years:

Frith JE, Mills RJ, Cooper-White JJ. (2012) Lateral spacing of adhesion peptides influences human mesenchymal stem cell behaviour. *Journal of Cell Science* 1252, 317-327.

Titmarsh DM, Hudson JE, Hidalgo A, Elefanty AG, Stanley EG, Wolvetang EJ, Cooper-White JJ. (2012) Microbioreactor arrays for full factorial screening of exogenous and paracrine factors in human embryonic stem cell differentiation. *PLoS One* 7(12), e52405.

Cameron AR, Frith JE, Cooper-White JJ. (2011) The influence of substrate creep on mesenchymal stem cell behaviour and phenotype. *Biomaterials* 32(26), 5979-5993.

Rowlands AS, George PA, Cooper-White JJ. (2008) Directing osteogenic and myogenic differentiation of MSCs: interplay of stiffness and adhesive ligand presentation. *American Journal of Physiology Cell Physiology* 295(4), C1037-1044.

Chau L, Doran M, Cooper-White JJ. (2009) A novel multishear microdevice for studying cell mechanics. *Lab Chip* 9(13), 1897-1902.

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Researchers are racing against time to determine why many famous oil paintings are deteriorating.

When oil-based paint containing zinc oxide (ZnO) is used in artworks, an irreversible reaction begins. Large, unsightly protrusions can form, cracking and severely damaging a painting.

Art conservators are trying to identify at-risk paintings and develop mitigation techniques to limit long-term damage. That requires ongoing research into the factors that determine when ZnO reactivity leads to deterioration.

ZnO was used as a white pigment in late 19th century and early-mid 20th century oil paintings. Today it has largely been replaced with titanium dioxide-based paints.

ZnO reacts with fatty acids from the oils in paint. The reaction forms "zinc soaps", such as zinc stearate. Aggregation of zinc carboxylates can lead to paint failure or lumps erupting through the paint surface.

AIBN and UQ's Centre for Microscopy and Microanalysis (CMM) are using detailed microstructural analysis to help AIBN PhD student and Queensland Art Gallery conservator Gillian Osmond investigate the mechanism behind zinc soaps.

CMM director and AIBN Professor John Drennan's research group received funding through a 2009-2012 Australian Research Council (ARC) Industry Linkage project. Ms Osmond is working on one of four research programs examining art practices in Australia and the Asia-Pacific region. Galleries, universities and research institutes in Australia, Asia, the UK and the US are participating.

Professor Drennan said UQ's world-class macrostructural analysis facilities gave scientists the ability to understand what was happening at a microscopic level. His research group uses various techniques, including electron microscopy, x-ray diffraction and infrared microspectroscopy, to analyse the soaps.

Professor John Drennan

Affiliate Group Leader

Research: **Materials development and characterisation**

Professor John Drennan is an internationally-recognised expert in advanced materials characterisation and has worked with the US Department of Energy; the National Institute of Materials Science, Japan; and IBM. He has held four Australian Research Council (ARC) Discovery grants.

Professor Drennan has been a member of the International Advisory Committee of the NanoCluster at Nanyang Technological University, Singapore; worked at Imperial College, London; been an external reviewer of the materials division of the Australian Nuclear Science and Technology Organisation (ANSTO); and a reviewer for international journals such as the *Journal of Materials Science, Solid State Ionics*, the *Journal of European Ceramic Society* and the *Journal of the Ceramic Society of Japan*.

Professor Drennan has been a visiting scientist at IBM's TJ Watson Research Centre in New York, US. He has been an associate editor of the *Journal of the American Ceramic Society*. He has been a key driver in obtaining more than $12 million in infrastructure funding from competitive sources, including the ARC and National Collaborative Research Infrastructure Strategy.

Professor Drennan is the recipient of the 2010 John Sanders Medal from the Australian Microscopy and Microanalysis Society; two travelling fellowships from the Science and Technology Agency, Japan; and a Commonwealth Post Graduate Scholarship. He was the invited plenary lecturer at the International Symposium on EcTopia Science at Nagoya University, Japan, in December 2011.

Key publications for the past five years:

Osmond G, Boon JJ, Puskar L, Drennan J. (2012) Metal stearate distributions in modern artists' oil paints: surface and cross-sectional investigation of reference paint films using conventional and synchrotron infrared microspectroscopy. *Applied Spectroscopy* 66(10), 1136-44.

Yuan P, Liu N, Zhao LZ, Zhou XF, Zhou L, Auchterlonie GJ, Yao XD, Drennan J, Lu GQ, Zou J, Yu CZ. (2008) Solving complex concentric circular mesostructures by using electron tomography. *Angewandte Chemie-International Edition* 47(35), 6670-6673.

Yuan P, Zhou XF, Wang HN, Liu NA, Hu YF, Auchterlonie GJ, Drennan J, Yao XD, Lu GQ, Zou J, Yu CZ. (2009) Electron-tomography determination of the packing structure of macroporous ordered siliceous foams assembled from vesicles. *Small* 5(3), 377-382.

Knibbe R, Auchterlonie GJ, Mori T, Lashtabeg A, Drennan J. (2010) Glass-phase movement in yttria-stabilised zirconia/alumina composites. *Journal of the American Ceramic Society* 93(5), 1494-1500.

Ou DR, Mori T, Togasaki H, Takahashi M, Ye FE, Drennan J. (2011) Microstructural and metal-support Interactions of the pt-CeO2/C catalysts for direct methanol fuel cell application. *Langmuir* 27(7), 3859-3866.

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MICROSCOPY HELPS ART CONSERVATORS PRESERVE VALUABLE ARTWORKS

This is part of the interests of Professor Drennan's research group in materials development and characterisation. The focus includes conduction of oxygen ions in materials, which has application in solid oxide fuel cells; tight microstructural control at the atomic level for developing materials with longer operating life; and novel materials for extreme environments, suitable for protecting critical components in hypersonic scram jets.

Research into zinc soap deterioration began in Amsterdam in the 1990s, when Vincent van Gogh's *Falling Leaves* developed surface defects. Since then other paintings have been identified with similar problems. ZnO is prevalent in many 20th century paintings, including those of Pablo Picasso and Australia's Sidney Nolan.

Identifying deterioration and predicting the severity is difficult because of the complexity of paint formulations and the many variables that influence subsequent drying and aging processes. "You need to analyse each painting individually," Ms Osmond said.

She has investigated some of the variables using naturally aged paint films of known composition, supplied by the Smithsonian Museum Conservation Institute in Washington DC. That has enabled the contributing influence of oil type, pigment combinations and specific paint additives to be considered.

Professor Drennan said the research had prompted more questions. However, they now know the reaction starts immediately ZnO is introduced; the availability of fatty acids in the paint is critical; the environment, including heat and humidity, plays a major role in how quickly soaps form; microscopic cracks in paintings facilitate soap formation; and the existence of other components in paint, such as aluminium stearate, influence the formation and location of zinc soaps.

The reaction is irreversible. "Once you have ZnO in there, you've effectively pulled the trigger. However, by improving understanding of the underlying mechanism, conservators can better identify vulnerable paintings and use this knowledge to inform design of controlled storage environments and appropriate conservation interventions. If you can identify how it all works, you can try to mitigate the damage," Professor Drennan said.

In 2012, the Drennan research group published a paper in *Applied Spectroscopy* and Ms Osmond presented the research internationally.

Ms Osmond said the ARC Industry Linkage project was a major step forward for art conservation science in Australia. "We are contributing to an international field of research but can now start applying it to the Australian context." The research was important in tackling ongoing conservation challenges specific to the region's tropical, humid climate.

Dr Elliot Cheng

Dr Trent Munro

KEY COLLABORATIONS DRIVE RESEARCH OUTCOMES

AIBN's biologics expertise is attracting important industry collaborators.

AIBN Director Professor Peter Gray said partnerships were vital to help transform research from the experimental stage to reality.

Biologics are medicines based on natural proteins, developed using DNA technology. They offer new treatment options for a wide range of diseases, including cancer and auto-immune disorders. Six of the world's top ten selling therapeutics are now biologics.

In 2012, a key collaboration with global biopharmaceutical manufacturer DSM Biologics progressed and a partnership was formed with Sydney-based Biosceptre International Ltd.

The Biosceptre partnership aims to develop a bio-process for producing monoclonal antibodies to treat cancer. Biosceptre develops and commercialises antibody technologies for cancer diagnosis and treatment. Its technology is based on the discovery of a subtly changed form of P2X7, called non-functional P2X7 (nf-P2X7), which is found on solid state cancer cells but not on normal cells.

P2X7 is a major cellular receptor responsible for normal cell death. When an aging cell is ready to die, P2X7 is expressed on the cell wall, triggering a sequence of biological processes that leads to apoptosis. But cancer cells have abnormal "death receptors" known as nf-P2X7, so programmed apoptosis does not occur.

Biosceptre's discovery prompted development of monoclonal, polyclonal and domain antibodies that target diseased cells, attaching to abnormal receptors, but have no adverse effects on healthy cells.

Professor Gray said the technology was unique in its ability to target solid and blood-based tumours and had the potential to radically change how cancer was diagnosed and treated.

Under the research collaboration, AIBN's National Biologics Facility (NBF), led by operations manager Dr David Chin, will characterise candidate therapeutic monoclonal antibodies that bind to nf-P2X7. Research and development will include antibody and cell line development; bioprocess development; and recombinant protein production in pre-commercial quantities ahead of preclinical trials.

The Biosceptre collaboration is a critical step towards preclinical and human clinical trials. The long-term goal is to

develop a therapeutic monoclonal antibody capable of specifically detecting nf-P2X7 and inducing cancer cell death without affecting normal healthy cells.

In recognition of NBF's important contribution to research infrastructure capability, it received $1.2 million in Queensland Government coinvestment funding in 2012 for the coming two years.

Funding aids DSM Biologics link

AIBN received $485,000 in funding from the Queensland Government's Research Partnership Program in 2012 to grow its strategic link with DSM Biologics.

DSM Biologics is a contract manufacturer that takes early-stage projects to the next stage of commercial development. NBF is developing mammalian cell lines, which form the basis for biologics production, and DSM will produce and commercialise them at a $65 million scale-up facility at Brisbane's Princess Alexandra Hospital, due to open in mid-2013.

AIBN Associate Group Leader Dr Trent Munro said the NBF had the expertise to drive biologics production. Established in 2007, it helps bridge the gap between experiments and the bioprocesses required to produce clinical grade material.

Professor Gray said working with DSM was important because the company had an excellent global reputation for biologics production. "Having DSM operating a scale-up facility in Brisbane means Queensland research can go from the lab, through manufacturing and to the market."

Invasive bacteria research

Dr Munro has been awarded a $720,000 Queensland Government fellowship to continue researching invasive bacterial infections. The three-year funding started in May 2012.

He is researching 'biologic bullets', recombinant monoclonal antibodies that target bacteria. The work focuses on drug -resistant strains, such as golden staph; and group A streptococcus. Both are acute or chronic infections on which antibiotics have little effect. Dr Munro hopes to conduct an efficacy assessment in late 2013.

He said although antibiotics were less effective against so-called superbugs, monoclonal antibodies may provide new treatment options.

Professor Peter Gray

AIBN Director and Group Leader

Research: **Bioengineering of mammalian cell protein expression and stem cell systems**

Professor Peter Gray is a pioneer of biotechnology research and development in Australia. In 2003 he was appointed AIBN's inaugural Director and has since overseen the institute's growth to 450 people and an annual turnover of $40 million. Before joining AIBN, he was Professor and Head of Biotechnology at UNSW.

Professor Gray has held academic positions at University College London and the University of California, Berkeley. He has had commercial experience in the US, working for Eli Lilly and Co and the Cetus Corporation. His research collaborations include groups at Stanford University; the University of California, Berkeley; and the University of British Columbia, Vancouver.

Professor Gray serves on several boards and government committees. He is on the board of Engineering Conferences International, New York, a group that runs global, multi-disciplinary engineering conferences, many of which have played key roles in developing emerging industry sectors. The conferences cover cell culture engineering; vaccine technology; and scale-up and manufacturing of cell-based therapies. Professor Gray also serves on the board of Biopharmaceuticals Australia Pty Ltd, the company established to build a GMP grade biopharmaceuticals manufacturing facility in Brisbane, and has been heavily involved in negotiations that led to DSM Biologics becoming the facility's operator.

Professor Gray is a Fellow and Vice-President of the Australian Academy of Technological Sciences and Engineering and a Fellow of the Australian Institute of Company Directors. He has chaired, served on organising committees for, and given plenary and keynote addresses at many key international conferences. In 2006 he attracted to Sydney and chaired the International Biotechnology Symposium – the first time a conference in the four-yearly series was held in the southern hemisphere. Professor Gray is a founder and past president of the Australian Biotechnology Association (Ausbiotech).

Professor Gray has graduated more than 60 PhD students from his research group, in fields including secondary metabolite bioprocesses; bioconversion of cellulosic substrates; mammalian cell expression of complex proteins; nanoparticles for drug delivery; and the development of stem-cell based bioprocesses. He has twice been listed by Engineers Australia among the top 100 most influential engineers in Australia, and in 2001 was awarded the Australian Government's Centenary Medal.

Key publications in the past five years:

Codamo J, Munro TP, Hughes BS, Song M, Gray PP. (2011) Enhanced CHO cell based transient gene expression with the Epi-CHO expression system. *Molecular Biotechnology* 48(2), 109-115.

Prowse ABJ, Chong F, Gray PP, Munro TP. (2011) Stem cell integrins: Implications for ex-vivo culture and cellular therapies. *Stem Cell Research* 6(1), 1-12.

Prowse ABJ, Doran MR, Cooper-White JJ, Chong F, Munro TR, Fitzpatrick J, Chung TL, Haylock DN, Gray PP, Wolvetang EJ. (2010) Long-term culture of human embryonic stem cells on recombinant vitronectin in ascorbate free media. *Biomaterials* 31(32), 8281-8288.

Ladewig K, Niebert M, Xu ZP, Gray PP, Lu GQ. (2009): Efficient siRNA delivery to mammalian cells using layered double hydroxide nanoparticles. *Biomaterials* 31(7), 1821-1829.

Pilbrough W, Munro TP, Gray PP. (2009) Intraclonal protein expression heterogeneity in recombinant CHO cells. *PLoS ONE* 4(12), e8432. doi:10.1371/journal.pone.0008432.

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

MAJOR SUCCESSES IN BIOPLASTIC RESEARCH

AIBN chemical engineer Professor Peter Halley has combined with industry and international collaborators in 2012 to secure funding to develop high-value bioplastics for use in farming, food packaging, solar cells and medical treatment.

Professor Halley's collaborations will develop polymers from a biological source with properties that allow for scaling up to industrially-relevant quantities.

"In 2012 our biopolymer research really came of age," Professor Halley said. "Building on our early successes in low-value industrial biodegradable polymers, we grew in three ways. We developed a broader biopolymer platform, focused on higher value applications and began projects that were closely linked with industry."

Polymers for agriculture

The Cooperative Research Centre (CRC) for Polymers extended funding from 2012 to 2017, with Professor Halley listed as node leader at UQ. The research involves Professor Halley's development of sustainable polymers for agriculture and Professor Lianzhou Wang's work on polymer solar cells.

Professor Halley's polymers for agriculture are tailored to address significant global problems of overuse of pesticides and water in non-sustainable farming practices. The films help retain soil moisture, prevent weed growth and maintain favourable growing temperatures.

The CRC links more than 20 industry and research providers both domestically and internationally, while the project within the CRC links UQ, Queensland University of Technology, Integrated Packaging, CSIRO and the Australian Nuclear Science and Technology Organisation.

Enhancing conductivity

In another project, Professor Halley collaborated with Queen's University Belfast and the University of Alabama to secure Australian Research Council (ARC) Discovery Project funding in 2012 for work on biopolymer nanomaterials for electronic applications.

The new biopolymer nanomaterials will incorporate ionic liquid and carbon nanotube technologies for the first time to enhance stability and conductivity. That will enable the materials to be used globally, including in the third world, for cheap, reliable drug delivery and detecting a range of diseases.

Bio-based films for food and drug delivery

A third major funding success in 2012 for Professor Halley's research group of seven post-doctoral research fellows and 12 PhD students was an ARC Linkage Project. In collaboration with former UQ spin-out company Plantic Technologies; UQ's Centre for Nutrition and Food Sciences; and the School of Chemical Engineering, the project will develop bio-based films for smart food packaging and biomedical films.

Donna Capararo

The films have a complex architecture and advanced barrier technology that will control the environment around foods by reducing oxidation and spoilage, and control delivery of active components in pharmaceuticals.

"We have done the groundwork. We are now looking to develop high-value applications," Professor Halley said. "Our new biomaterials' design is managed – together with our industrial partners in all these projects – so they can be readily scaled up and translated into products."

Professor Peter Halley

Group Leader

Research: **Biofluids characterisation and biopolymer processing**

Professor Peter Halley is a leading international expert in bio-based polymers and translational polymer research.

His initial work on Australia's first biodegradable thermoplastic starch polymers led to the establishment of spin-out company Plantic Technologies, more than $75 million in venture financing, sales of commercially-viable products and a continued research provider relationship with Plantic.

Professor Halley has led translational research projects in biopolymers and biofluid platforms for agrifood, biomedical and high-value manufacturing sectors that have attracted more than $14 million in government and industry funding; and produced patents, licences and new industrial knowledge.

Professor Halley is a fellow of the Royal Australian Chemical Institute and the Institution of Chemical Engineers. He is on the editorial board of three journals.

Professor Halley has been visiting or invited professor at Queen's University Belfast, Ireland, the University of Strasbourg and Institut National des Sciences Appliquées de Lyon in France.

He has strong international collaborations with Los Alamos National Labs, US; the Cadbury Research Centre, UK; the US Department of Agriculture; the Colorado School of Mines, US; AnoxKaldnes, Sweden; the University of Bradford, UK; the University of Warwick, UK; and TNO, in the Netherlands.

Key publications in the past five years:

Halley PJ. (2012) Rheology of thermosets, in *Thermosets*. Guo Q (Ed.), Oxford, UK: Woodhead Pub.

Laycock B, Halley PJ, Pratt S, Werker A, Lant P. (2012) The chemomechanical properties of microbial polyhydroxyalkanoates. *Progress in Polymer Science*, doi: 10.1016/j.progpolymsci.2012.06.003

Xie F, Halley PJ, Avérous L. (2012) Rheology to understand and optimise processability, structures and properties of starch polymeric materials. *Progress in Polymer Science* 37, 595-623

Liu W-C, Halley PJ, Gilbert RG. (2010) Mechanism of degradation of starch, a highly branched polymer, during extrusion. *Macromolecules* 43(6), 2855–2864.

Halley PJ, George G. (2009) Chemorheology of polymers: from fundamental principles to reactive processing, Cambridge University Press, Cambridge.

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Sally Yukiko

Professor Mark Kendall

ARC Future Fellow and Group Leader

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

Professor Mark Kendall is internationally-recognised as a leader in vaccine and drug delivery, culminating from his focused 15 years of research and development in the field. Professor Kendall and his research group advanced the Nanopatch needle-free delivery system at UQ, leading to the founding of spin-out company Vaxxas with $15 million in capital investment to commercialise it as a medical device product for widespread human use.

In 2012, Professor Kendall was made a Rolex Laureate, one of just five selected from more than 3500 international applications. He is using the award and associated funding to progress the Nanopatch for developing world use, including a usability trial in Papua New Guinea aimed at improving access to vaccines in low-resource regions.

Professor Kendall has received many prestigious accolades for his research, leadership and innovation. They include the 2011 Australian Museum Eureka Prize for Interdisciplinary Research; inaugural Australian Innovation Challenge overall winner in 2011; the 2008 Australian Medical Researcher Award; and the Younger Engineer of Britain Award in 2004.

The generation of novel ideas has led Professor Kendall to publish more than 200 papers. He is the inventor of 96 patents. While lecturing at the University of Oxford, he advanced technology leading to spin-out company PowderMed, which was sold to Pfizer for $400 million in 2006.

Key publications in the past five years:

Fernando GJP, Chen X, Primero CA, Yukiko SR, Fairmaid EJ, Corbett HJ, Frazer IH, Brown LE, Kendall MAF. (2012) Nanopatch targeted delivery of both antigen and

RESEARCH AND COMMERCIALISATION PUSH FOR NEEDLE-FREE VACCINATION

A licensing arrangement with pharmaceutical giant Merck and a prestigious 2012 Rolex Award for Enterprise are fast-tracking an AIBN invention aimed at delivering vaccines without the need for needles or syringes.

The two achievements are highlights of the first calendar year of operations for start-up company Vaxxas, established to advance vaccine delivery device the Nanopatch towards clinical testing and product development, and mark a productive year for AIBN Professor Mark Kendall and his research group.

Professor Kendall is driving the development, as Nanopatch inventor and a Vaxxas director and chief technology officer. He developed the Nanopatch to address issues with needle stick injuries, high costs and the need to refrigerate vaccines during transportation. The Nanopatch aims to improve the reach of effective vaccination to people around the world, including those in rural or remote areas and developing countries.

It builds on the scientific focus of Professor Kendall's research group on micro-nanoprojection drug delivery and diagnosis.

The Nanopatch has thousands of small projections designed to deliver the vaccine to abundant immune cells in the skin. Vaccines for various diseases including influenza and human papillomavirus (HPV) can potentially be dry-coated onto the Nanopatch, eliminating the need for refrigeration.

"There are more than 17 million deaths a year from infectious diseases worldwide," Professor Kendall said. "We are in a position to help reduce that number in a meaningful way. With the Nanopatch, we believe we have the potential to impact broadly on that number."

The licensing arrangement with Merck is a sign of confidence in the Nanopatch technology and an avenue for accelerating the process of delivering the revolutionary health technology to people throughout the world. Under the agreement Merck is funding an extensive development program to explore use of the Nanopatch for delivery of an important vaccine.

Earlier in 2012, Professor Kendall was one of only five recipients of a Rolex Award for Enterprise. The award and associated funding allows Professor Kendall to conduct a field trial in Papua New Guinea, where medical and climatic conditions mirror much of the developing world. Commercial funding is hard to obtain for vaccine distribution in the developing world.

The field trial in Papua New Guinea will follow the first human trials of the patch in Brisbane with 'blank' Nanopatches (without vaccine) in human volunteers. It aims to assess the usability of the patch and applicator under developing-country field conditions, as a precursor to potential clinical trials.

Professor Kendall sees tremendous potential to use the Nanopatch to deliver the HPV vaccine, which protects women against cervical cancer. The disease claims 270,000 lives a year and is the leading cause of cancer deaths among women in the developing world. The HPV vaccine is one of a new generation that is beyond the reach of many in developing countries – but could become affordable with the low-cost Nanopatch. Beyond that, Professor Kendall sees diseases such as influenza, malaria, West Nile virus, herpes, chikungunya and even HIV as promising targets.

Vaxxas was founded with $15 million in capital investment in 2011, which was one of Australia's largest investments in a start-up biotechnology company. The company has grown to a staff of 20. The Vaxxas board includes representation from co-investors OneVentures, Brandon Capital, HealthCare Ventures and UQ's main commercialisation company UniQuest.

adjuvant to skin synergistically drives enhanced antibody responses. *Journal of Controlled Release* 159(2), 215-221.

Crichton ML, Donose BC, Chen X, Raphael A, Huang H, Kendall MAF. (2011) The viscoelastic, hyperelastic and scale dependent behaviour of freshly excised individual skin layers. *Biomaterials* 32(20), 4670-4681.

Chen X, Fernando GJP, Crichton ML, Flaim C, Yukiko SR, Fairmaid EJ, Corbett HJ, Primiero CA, Ansaldo AB, Frazer IH, Brown LE, Kendall MAF. (2011) Improving the reach of vaccines to low-resource regions, with a needle-free vaccine delivery device and long-term thermostabilisation. *Journal of Controlled Release* 152(3), 349-355.

Corrie S, Fernando GJP, Crichton ML, Brunck MEG, Anderson CP, Kendall MAF. (2010) Surface-modified microprojection arrays for intradermal biomarker capture, with low non- specific protein binding. *Lab on a Chip* 10, 2655-2658.

Fernando GJP, Chen X, Prow TW, Crichton ML, Fairmaid EJ, Roberts MS, Frazer IH, Brown LE, Kendall MAF. (2010) Potent immunity to low doses of influenza vaccine by probabilistic guided micro-targeted skin delivery in a mouse model. *PLoS ONE* 5(4), e10266. doi:10.1371/journal.pone.0010266.

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Associate Professor Stephen Mahler
Affiliate Group Leader

Research: **Discovery and development of biologic medicines**

Associate Professor Stephen Mahler has made significant contributions to biopharmaceutical discovery, development and delivery, including development of technology for producing human antibody biopharmaceuticals.

Associate Professor Mahler has secured more than $2 million in Australian Research Council (ARC) funding during the past four years for projects principally associated with biologics discovery, recombinant protein production and development of targeted drug delivery systems.

Associate Professor Mahler has delivered short courses in biologics nationally and internationally to big pharma, biotechnology companies, regulatory agencies and universities, including Pfizer Australia; the National Pharmaceutical Control Bureau, Malaysia; and at the National Forum for Biosimilars, Brazil. He has consulted for a wide range of biotechnology companies nationally and internationally, including Pfizer and Abbott.

Associate Professor Mahler has been a member of the editorial board of the *Journal of Chemical Technology and Biotechnology* since 2004; and an OzReader for the Australian Research Council (ARC) since 2003, reviewing ARC Discovery, Linkage, Australian Federation Fellowship, Australian Future Fellowships and ARC Centre applications.

Before joining AIBN, Associate Professor Mahler was co-director of the Bioengineering Centre at the University of NSW, and secured $2 million in National Collaborative Research Infrastructure Strategy (NCRIS) funding for establishment of the Recombinant Products NCRIS node at UNSW.

Since 2007, Associate Professor Mahler has been interacting with biotechnology companies and has secured research funding from industry sources. Two provisional patent applications are in the process of being submitted.

Key publications for past five years:

Mahler SM. (2011) Biologics and biosimilars: emerging technologies driving global opportunity. *J Chem Technol and Biotechnol* 86(7), 893-894.

Pile KD, Graham GG, Mahler SM, Day RO. (2011) Disease-modifying antirheumatic drugs. In *Principles of immunopharmacology (third ed.)*. Nijkamp FP, Parnham MJ (Eds.), (pp. 585-619) Basel, Switzerland: Springer.

Munro TP, Mahler SM, Huang EP, Chin DY, Gray PP. (2011) Bridging the gap: Facilities and technologies for development of early stage therapeutic mAb candidates. *mAbs* 3(5), 440-452.

Falconer RJ, Jackson-Matthews D, Mahler SM. (2011) Analytical strategies for assessing comparability of biosimilars. *J Chem Technol and Biotechnol* 86(7), 915-922.

Nouwens A, Mahler SM. (2012) Evolution of proteomic methods for analysis of complex biological samples – implications for personalised medicine. In *Integrative Proteomics*. Hon-Chiu Eastwood L, Tsz-Kwong M, Ricardo JF (Eds.), (pp. 29-43) Croatia: InTech.

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AIBN researchers are collaborating with Sydney-based bioscience company EnGeneIC Ltd, which has developed a promising new cancer therapy that is now being tested in clinical trials.

The collaboration has enabled development of enhanced targeting ability for the therapeutic.

AIBN Associate Professor Stephen Mahler said although there had been considerable progress in cancer therapy, particularly with monoclonal antibodies now being used in front-line cancer therapy in combination with chemotherapy, there was still “much room for improvement”.

Chemotherapy is a non-targeted therapy and, although effective, results in unwanted general toxicity and, in many cases, severe side effects. Another problem is the development of multi-drug resistance (MDR), with some cancer cells becoming resistant to a drug therapy regimen.

EnGeneIC has developed a novel drug delivery vehicle, the EDV (EnGeneIC Delivery Vehicle), which is capable of being loaded with high concentrations of various potent cytotoxic drugs.

TROJAN HORSE APPROACH TARGETS CANCER CELLS

In papers published in international journals, including *Cancer Cell* and *Nature Biotechnology*, EnGeneIC founders Dr Jennifer MacDiarmid and Dr Himanshu Brahmbhatt demonstrated that EDVs, containing molecules of a relatively new anti-cancer therapeutic called small interfering RNA (siRNA) or cytotoxic drugs and targeted via bispecific antibodies to receptors on the surface of cancer cells, showed an enhanced anti-tumour activity compared to conventional drug therapies.

In a Trojan horse approach, EDVs are taken up by the cancer cells and release cytotoxins that can kill the cancer cells.

Associate Professor Mahler said EnGeneIC believed that, while EDVs had proved functional, the antibody targeting system needed to be optimised for ease of manufacture and to progress through the regulatory hurdles required in clinical development of a novel therapeutic.

Using antibody engineering techniques, Associate Professor Mahler and AIBN co-researchers Dr Trent Munro, Dr Martina Jones, Dr Chris Howard and PhD student Karin Taylor have developed single chain novel bispecific antibodies capable of targeting the EDVs to potentially many different types of cancer cells.

Their work enables targeting of the EDVs to be accomplished in a simpler manufacturing process. Simultaneously, the EDVs' targeting efficiency to tumour cells is enhanced.

"One arm of the bispecific antibody binds the EDV, while the other arm can be designed to bind specifically to cancer cells, analogous to the computer-controlled navigation system of a guided missile warhead," Associate Professor Mahler said.

"Since the cancer cell-specific arm can be designed to bind to many different types of cancer cells, potential exists for developing tailor-made cancer treatment by changing both the payload and the targeting warhead to attack the specific tumour."

EnGeneIC Ltd is now conducting clinical trials in end-stage cancer patients and Associate Professor Mahler said the "exciting" technology has the potential to change the strategy and approach to cancer therapy. "By safely packaging cytotoxic drugs, and combining with designer targeting antibodies, the side effects of systemic chemotherapy are negated.

"As EDVs can carry several different cytotoxic drugs and gene silencing molecules, the problem of MDR is potentially addressed. AIBN researchers are improving the design of the bispecific antibodies and, through protein engineering methodologies, can optimise properties such as stability and binding affinity to cancer cells."

A phase I multicentre trial, presented at the 2012 Symposium on Molecular Targets and Cancer Therapeutics and highlighted in *Cancer Discovery*, involved 28 patients with end-stage solid tumours and showed encouraging preliminary results.

The patients received five weekly infusions of EDVs filled with the chemotherapy drug Paclitaxel and coated with antibodies targeting the epidermal growth factor receptor protein found on the surface of many tumour cells.

EnGeneIC, founded in 2001, is a privately held Australian bioscience company formed to develop and commercialise novel concepts in the targeted delivery of chemotherapeutics for cancer drugs in vivo. It is funded by Australian Government-backed venture capital funds and private investors and has had previous support from the AusIndustry Commercial Ready Program, the Commercialisation Australia Program and the NSW Government.

EnGeneIC began working with AIBN as a client of the institute's National Collaborative Research Infrastructure Strategy Biologics Facility.

TENACIOUS PLASTICS BECOME REALITY

A nanoparticle additive that improves plastic properties and performance is rapidly moving towards commercialisation, following success in 2012 in attracting an industrial partner and starting full-scale manufacturing trials.

AIBN Professor Darren Martin and his research group began developing additives for more durable acrylic polymers, or poly(methyl methacrylate) (PMMA), building on their work in additives for conventional thermoplastic polyurethane (TPU) products.

The additives for TPU products date from 2011, when Professor Martin secured co-development partnerships with three companies. Commercial trials of the materials are progressing well.

His group began developing additives for PMMA in 2012 after an Australian PMMA products manufacturer showed interest.

TPU is a flexible plastic used in products such as shoe soles, seals, and rubber membranes. PMMA is a hard plastic used in products such as plasma television screens and vehicle tail lights.

Despite having worked with the acrylic for only a year, Professor Martin said PMMA additives were nearing commercialisation. "I'm confident we will have our first supply agreement signed and will be supplying goods to manufacturers before the end of 2013."

Additive development took a leap forward in 2012 after spin-out company TenasiTech Pty Ltd, established in 2007 to commercialise Professor Martin's research, received $1.4 million in funding: $925,000 from the Queensland Government and $475,000 from venture fund Uniseed.

"The funding is a great opportunity to fully translate our ideas into product applications, start generating revenue and grow our business into a self-sustaining and profitable enterprise," he said.

Professor Martin, who is also TenasiTech's chief scientific officer, said the company essentially manufactured nanoparticles, which are synthetic 'plates' only one nanometre thick. "We put a special surface chemistry on the plates, which allows them to easily mix into plastic. They are super-efficient reinforcing agents, so the particles make up only about 1 per cent of the resulting plastic's weight.

"Instead of making traditional layered, composite products, such as fibreglass, we just add the nanoparticles to the plastic, which improves properties including strength, toughness, tear resistance, scratch resistance and overall durability. A main benefit of using our additives is consumers won't have to replace products as often.

"We had developed lots of additives for rubber products. After some further modifications, a few of those worked in acrylic as well, more than doubling its scratch resistance. Hopefully the company (that has shown interest) will place orders with us and we will supply the additive soon."

PMMA manufacturers currently spray, brush or 'flood' protective coatings onto product surfaces. "Our additive is actually in the material, not just on the surface. It can handle all sorts of secondary manufacturing and forming processes – and it's cheaper than using coatings," Professor Martin said.

The Martin research group is also continuing its work on TPU additives. In 2011, TenasiTech formed co-development partnerships with US and Australian companies, including three interested in specific applications for elite sporting goods; rubber engineering components, including hydraulic seals; and membrane applications for water treatment.

Nanoparticle additives are melted into plastics or added as a liquid. For TPU, a liquid version of the additive, with the brand name Adaptive Polyol, is dispersed into the polyurethane during production. For acrylics, a pellet version of the nanoparticles is melted into the plastic during production.

Additives do not require supply chain variations. "Nobody has to invent a new machine to process the material," Professor Martin said. "You just drop in our nanoparticle additive and it doubles the scratch resistance or improves dimensional stability or durability."

Professor Martin said TPU and PMMA both presented major opportunities. "The total polyurethane market is worth more than $33 billion worldwide annually and acrylic about $8 billion. They are both significant market segments for polymers." There were "exciting opportunities" in the electronics market, as demand grew for telephone and television screens using PMMA.

Professor Darren Martin

Group Leader

Research: **Polymer nanocomposites and nanotoxicology**

Professor Darren Martin is the chief scientific officer for spin-out company TenasiTech Pty Ltd, which is commercialising a polymer nanocomposites platform as applied to large polyurethane and acrylic polymer markets and applications.

TenasiTech is the first Queensland spin-out to receive Commercialisation Australia funding; has won the prestigious iLab Prize in the national Enterprize Competition; and received the 2010 UQ EAIT Commercialisation Award. Professor Martin's research operates at the nexus of three key themes:

– strong fundamental materials science with global benchmarking;
– safe biomaterials and nanomaterials; and
– scalable advanced manufacturing.

His efforts in those areas during the past two decades have contributed to two successful spin-outs, numerous products and a strong platform for globally competitive nanocomposites innovation.

Professor Martin's international collaborators include US universities Pennsylvania State and Purdue. He also has several materials co-development projects and collaborations with companies such as Cochlear Ltd, Aortech Biomaterials, the EGR Group and several others in North America, Europe and Asia.

Professor Martin has been the recipient of three Australian Research Council (ARC) Discovery Grants and has secured more than $9 million in research and commercialisation funding since 1999. He has two granted patents and two provisional patents. He is working with Australian regulators, such as NICNAS and WorkSafe Australia, on policy for nanomaterials/nanocomposites occupational safety and hygiene.

Professor Martin is a member of the Engineers Australia Nanoengineering panel. During the past five years a large proportion of his research funding has been derived from the private sector.

Key publications for the past five years:

Belcher C, Marshall R, Edwards G, Martin DJ. (2012) The Commercialisation of Nanotechnology: The five critical success factors to a nanotech-enabled whole product, in *Nanotechnology Commercialisation*. Tsuzuki T (Ed.), Singapore: Pan Stanford Publishing. ISBN: 9789814303286.

Butler MK, Prow TW, Guo Y-N, Lin LL, Webb RI, Martin DJ. (2012) High-pressure freezing/freeze substitution and transmission electron microscopy for characterisation of metal oxide nanoparticles within sunscreens. *Nanomedicine* 7(4), 541-551. (Most direct quantitative approach for in-situ assessment of nanoscale metal oxide additives in sunscreen formulations).

Musumeci A, Gosztola D, Schiller T, Dimitrijevic NM, Mujica V, Martin DJ. (2009) SERS of semiconducting nanoparticles (TiO_2 hybrid composites). *JACS Communication* 131(17), 6040-6041. (First report of SERS phenomenon using a metal oxide nanoparticle rather than metal nanoparticle).

Osman AF, Edwards GA, Schiller TL, Andriani Y, Jack KS, Morrow IC, Halley PJ, Martin DJ. (2011) Structure-property relationships in biomedical thermoplastic polyurethane nanocomposites. *Macromolecules* 45(1), 198-210.

Deng ZJ, Mortimer G, Schiller TL, Musumeci A, Martin DJ, Minchin RF. (2010) Differential plasma protein binding to metal oxide nanoparticles. *Nanotechnology* 20(45), doi:10.1088/0957-4484/20/45/455101.

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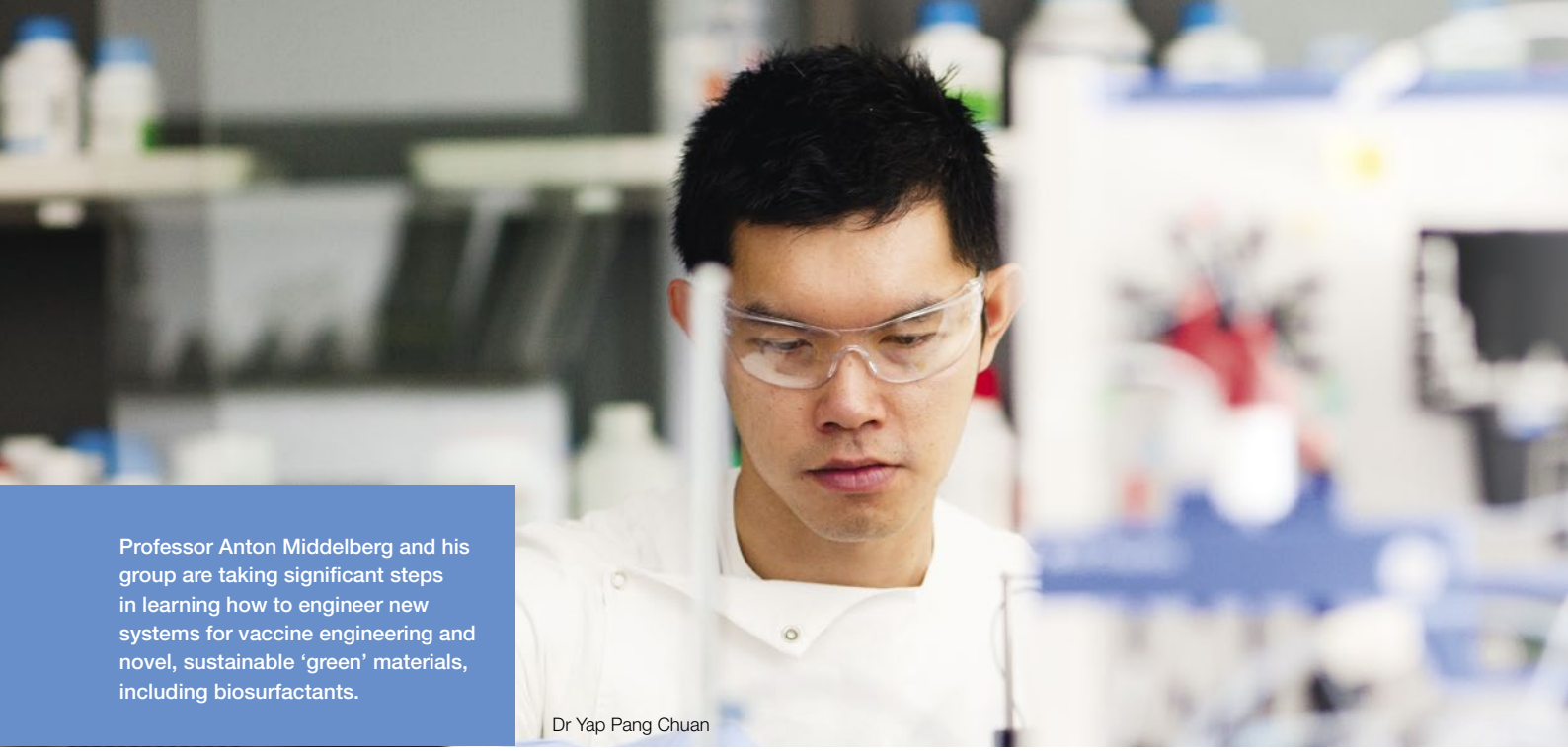
Nasim Amiralian and Khairatun Najwa Mohd Amin



Professor Anton Middelberg and his group are taking significant steps in learning how to engineer new systems for vaccine engineering and novel, sustainable 'green' materials, including biosurfactants.

Dr Yap Pang Chuan

The Chemical and Biomolecular Engineering group has an overarching intellectual goal of understanding how to better design new bio-inspired systems and products – and processes for their manufacture – based on control of biological interactions.

"Our focus on fundamental understanding is revealing a surprising number of emerging applications, from platforms for 'rapid-response' vaccine technology through to new foaming proteins that are stable in boiling water," Professor Middelberg said.

The research group made significant advances in 2012, including breakthrough publications, new funding and deepened collaborations.

"Some people find our array of applications difficult to comprehend," Professor Middelberg said. "However, it all makes sense if you look at the underlying scientific fundamentals. In an institute as significant as AIBN, we have the freedom to step beyond the traditional focus on applications, and drive a new future through truly bottom-up system re-design, opening new and unparalleled application opportunities.

"Innovation needs to be more than simply painting a mousetrap a different colour and calling it new, which is done too often in Australia."

That diversity has led to numerous research highlights for Professor Middelberg's group in 2012. "We published details of our vaccine engineering research in two key journals – *Vaccine* and *Chemical Engineering Science* – with great interest." Publication in *Vaccine* led to an invitation for Professor Middelberg to join the journal as an associate editor, with global responsibility for papers related to vaccine manufacture. He was also invited to present the research as a plenary lecture at the Asia Pacific Chemical Engineering conference in Singapore in February 2012.

The vaccine platform, invented by Professor Middelberg and Dr Linda Lua from the UQ Protein Expression Facility, has two key competitive advantages – speed and cost. A new vaccine for an emerging disease can potentially be developed within weeks, not months, at a cost of about one cent per dose. Available technologies are unable to match those numbers. The platform is unique and based on fundamental understanding of how to control virus assembly outside the cell environment.

As vaccines made with the platform are much cheaper to mass-produce than via traditional technologies, they represent an opportunity where cost is an issue – for example, in the developing world. Professor Middelberg received Grand Challenges Explorations funding in 2012, from the Bill & Melinda Gates Foundation, to explore vaccines for rotavirus. The grant established a new collaboration between UQ and Boston Children's Hospital. PhD student Alemu Tekewe Mogus joined the project from Addis Ababa University in Ethiopia to advance the platform toward use in Africa.

As the platform is much faster than existing approaches, it is possible to mass-produce

New approach for protein antigen delivery

Professor Anton Middelberg combined the vaccine engineering and biosurfactant arms of his research in 2012 to develop a new targeted drug delivery system for protein antigen delivery. The research uses non-covalent click chemistry based on bottom-up biomolecular self-assembly, and involves collaboration with the Walter and Eliza Hall Institute and UQ's Diamantina Institute. "We filed a patent on the approach and have had the work accepted for publication in *Small*," Professor Middelberg said.

"PhD student Bijun Zeng has delivered what could be the world's first targeted emulsion that can find a subset of dendritic cells in a full *in vivo* test."

The system relies on coating an oil droplet with a mixture of polymer and antibody to control how it interacts within a biological system. "It is enlightening that, through control of molecular self-assembly, we can take a simple drop of oil and turn it into something that can find a specific cell type in your body and 'instruct' it to do a desired function – in this case activate T cells. I believe it is a perfect example of bioengineering and nanotechnology working together."

Professor Anton Middelberg

Queensland Smart Futures Premier's Fellow, AIBN Deputy Director (Bioengineering) and Group Leader

Research: Biomolecular engineering

Professor Anton Middelberg is an internationally-leading chemical engineer conducting breakthrough engineering research at the interface between chemistry and the life sciences.

He was the youngest lecturer appointed in engineering at Adelaide University and established Adelaide's biochemical engineering laboratory, for which he was awarded the Engineers Australia's Uhde Shedden Medal for the best Australian chemical engineer aged under 40.

At Cambridge University he was rapidly tenured and promoted twice, against a strict quota, and pioneered new research into designer biosurfactants and vaccine manufacture. In 2003 he was awarded an

ADVANCING UNDERSTANDING AND EXPLOITATION OF BIOLOGICAL INTERACTIONS

vaccine quickly against re-emerging infectious diseases. In collaboration with partners in China and Vietnam, Professor Middelberg and his group are working to develop a 'rapid-response' pandemic avian influenza vaccine technology. In 2012, the project involved new PhD students from Thailand, Indonesia and Vietnam, emphasising the regional interest in breakthrough vaccination systems.

"People in our region are rightly concerned about the threat of influenza. We can now add H7N9 to H5N1 as recognised threats," Professor Middelberg said. The Australian National Action Plan for Pandemic Influenza, issued by the Department of the Prime Minister, recognises the threat explicitly. "We are working to turn this unique UQ research into technology that can help protect Australia and our region from re-emerging infectious disease. Queensland can certainly play its part in the national and international plan."

In sustainable materials work, Professor Middelberg and his group are at the international leading edge of research into designed biosurfactants. In 2012, they started a new project into a novel protein biosurfactant, funded through an Australian Research Council (ARC) Discovery Grant. The UQ-led grant involves collaboration with Monash University and Germany's Karlsruhe Institute of Technology, and brings together computational and experimental research efforts.

"This activity builds logically on my earlier research into peptide surfactants," he said. "Through that research it became clear that the high cost of peptides was a significant barrier to application." To address this problem, Professor Middelberg invented and patented a new family of four-helix bundle protein surfactants which interact with themselves and water in a unique way, so their structure can be stabilised even in boiling water. "This design allows pure protein to be made simply by heating cells, delivering a ten-fold reduction in the cost of biosurfactant protein manufacture."

Australian Research Council (ARC) Federation Fellowship and returned to Australia.

Professor Middelberg's intellectual property for peptide surfactants was licensed to AIBN's first spin-out company. Engineers Australia has named Professor Middelberg one of Australia's 100 most influential engineers.

Professor Middelberg is editor-in-chief of the leading international journal *Chemical Engineering Science*. He has joint publications with researchers from Tianjin University, China; Oxford and Cambridge Universities, UK; the University of California Berkeley, US; KAIST, Korea; and several companies, including Eli Lilly, Novartis and Dow. Professor Middelberg has served in scientific roles for numerous international conferences, including the International Biotechnology Symposium (Daegu, South Korea, 2012); the International Small-Angle Scattering Conference (Sydney, 2012); the Asian Congress of Biotechnology (Shanghai, China, 2011); and Recovery XIV (Lake Tahoe, USA, 2010).

Professor Middelberg is an elected Fellow of the Australian Academy of Technological Sciences and Engineering and a Fellow of the Institution of Chemical Engineers, UK. He has attracted more than $13 million in research funding since 2003 and been named as an inventor on 58 patents, including applications.

Key publications in the past five years:

Wibowo N, Chuan YP, Lua LHL, Middelberg APJ. (2013) Modular engineering of a microbially-produced viral capsomere vaccine for influenza. *Chem Eng Sci*. In press: http://dx.doi.org/10.1016/j.ces.2012.04.001.

Middelberg APJ, Rivera-Hernandez T, Wibowo N, Lua LHL, Fan YY, Magor G, Chang C, Chuan YP, Good MF, Batzloff MR. (2011) A microbial platform for rapid and low-cost virus-like particle and capsomere vaccines. *Vaccine* 29(41), 7154-7162.

Middelberg APJ, Dimitijev-Dwyer M. (2011) A designed biosurfactant protein for switchable foam control. *ChemPhysChem* 12(8), 1426-1429.

Zhao CX, He LZ, Qiao SZ, Middelberg APJ. (2011) Nanoparticle synthesis in microreactors. *Chem Eng Sci* 66(7), 1463-1479. (5th ranked 'hottest articles' for the journal in 2011).

Ding Y, Chuan YP, He L, Middelberg APJ. (2010) Modelling the competition between aggregation and self-assembly during virus-like particle processing. *Biotechnol Bioeng* 107(3), 550-560. (Front cover).

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

Md Daloar Hossain

Researchers working with AIBN Professor Michael Monteiro may have developed a potential weapon against cancer. While there is no talk of a cure, the researchers believe they are onto something special with engineered polymer nanoparticles.

DEVELOPING NOVEL POLYMER ARCHITECTURES FOR TARGETED APPLICATIONS

The results follow a three-year Australian Research Council (ARC) Discovery project, with $400,000 in funding, which aimed to develop a potent anti-cancer drug delivery device through use of engineered nanoparticles.

By combining novel polymer architectures with small interfering RNA (siRNA), delivery of the resultant self-assembled nanoparticle has shown the potential to kill cancerous cells found in tissues or organs, Professor Monteiro said. He said siRNA was a class of double-stranded RNA molecules, 20-25 base pairs in length.

Professor Monteiro said the research group had also discovered, in 2012, a new polymer that would act as a drug delivery device.

In testing, the cationic (positively charged) polymer delivered siRNA to a cancerous cell line and stopped the cancer from developing.

“We have been able to show that the polymer is non-toxic to the cells. The polymer releases its payload at the right time to good therapeutic effect. The tests have shown there are no side effects – and potentially no need for chemotherapy.”

The group has submitted a ground-breaking paper for publication that reveals the researchers have knocked down biological pathways specific to the growth of cancers.

“siRNA has shown real promise in treatment of cervical cancer. The research

has the potential to aid in the treatment of other cancers, infectious diseases and genetic disorders.

"There are a million ways to cure cancer in mice. Only 0.1 per cent of all that research can help humans. The challenge is to understand why it works and then to translate it to humans.

"What we do with mice is understand the process and what the factors are that drive it."

In a collaboration between Professor Monteiro and UQ School of Chemistry and Molecular Biosciences (SCMB) Professor Istvan Toth, researchers believe they have established a synthetic pathway to produce polymer-peptide conjugates as macromolecular vaccine candidates against human papillomavirus-related cancers, such as cervical cancer.

Professor Monteiro said while cervical cancer vaccines had been successful, a large proportion of women were already infected and others would be infected until there was worldwide vaccine coverage.

The researchers have investigated an alternative method of inducing T cells, the body's natural defence system, to act as a vaccine against the cancer rather than bombard the body with chemotherapy.

Professor Monteiro said tests in a mouse model were successful. "We can get a therapeutic effect after only one single immunisation. There was very good tumour knockdown.

"We are a long way from saying we have a cure for cancer, but we have the potential to cure certain cancers," Professor Monteiro said.

He said many cancer patients died from intensive chemotherapy, or secondary infections that hit when the body was vulnerable.

His research group hopes to develop a readily-available drug or vaccine delivery device that has no side effects and can target cancer more directly and quickly. The group has a patent on the device but needs support and funding.

"The next step is to go to different animal models that more closely resemble humans – and then to humans.

"Cancer is a very tough disease to cure. We still have a long way to go. That's why we are being very cautious. But I hope we would have clinical trials within five years."

Professor Monteiro said another research focus was on synthesising novel nanomaterials based on polymers by 'living' radical polymerisation in water. That would provide the enabling science so nanomaterials with targeted properties could be tailor made for biomedical and coatings applications.

The group is investigating how it can mimic features of enzymes to catalyse organic reactions in water using polymer nanoreactors for the production of environmentally friendly pharmaceutics.

The research involves further developing nanoreactors to produce linear and star polymers in water with controlled molecular weights, narrow distributions and a desired particle size — a significant advance on previous methods.

The group has also developed reversible nanostructures that form spheres, rods, worms, loops and vesicles that can be transformed at high solids content to other structures on demand.

Professor Monteiro said it would lead to 'green' synthesis of large-scale polymers for biomedical applications.

Professor Michael Monteiro

ARC Future Fellow and Group Leader

Research: **Designer polymers: Synthesis of complex polymer architectures**

Professor Michael Monteiro has established an international reputation in the field of 'living' radical polymerisation to create complex polymer architectures.

He is now building designer polymers for various biomedical applications, including vaccines, drug delivery and stem cells. He is dedicated to translating research into commercial outcomes, with seven PCT and provisional patents since 2005 and establishment of start-up company DendriMed Pty Ltd. He was awarded an Australian Research Council (ARC) QEII Fellowship in 2004 and an ARC Future Fellowship in 2009.

Professor Monteiro is the recipient of the 2011 Australian Leadership Award from the Australian Davos Connection. He has attracted more than $7 million in ARC and National Health and Medical Research Council (NHMRC) grants; and Queensland Government funding.

Professor Monteiro has built a strong collaboration with Professor Virgil Percec from the University of Pennsylvania to develop and understand the new SET-LRP. A collaboration with Professor Rachel O'Reilly, from the University of Warwick, has developed nanoreactors that mimic enzyme activity. In collaboration with Professor Eugenia Kumacheva, from the University of Toronto, Professor Monteiro has developed temperature-responsive micron-sized particles from encapsulation of cells.

Professor Monteiro is on the editorial advisory boards of *Biomacromolecules* (2013-) and the *Journal of Polymer Science, Part A: Polymer Chemistry* (2009-); and has been on the board of *Macromolecules* (2008-2010). He is editor of *European Polymer Journal*.

Key publications for the past five years:

Jia ZF, Lonsdale DE, Kulis J, Monteiro MJ. (2012) Construction of a 3-miktoarm star from cyclic polymers. *ACS Macro Letters* 1(6), 780-783.

Kessel S, Urbani CN, Monteiro MJ. (2011) Mechanically driven reorganisation of thermoresponsive diblock copolymer assemblies in water. *Angew Chemie – Int Ed* 50(35), 8082-8085.

Deng ZJ, Liang MT, Monteiro MJ, Toth I, Minchin RF. (2011) Nanoparticle-induced unfolding of fibrinogen promotes Mac-1 receptor activation and inflammation. *Nature Nanotechnology* 6(1), 39-44.

Bell CA, Bernhardt PV, Monteiro MJ. (2011) A rapid electrochemical method for determining rate coefficients for copper-catalysed polymerisations. *J Am Chem Soc* 133(31), 11944-11947.

Skwarczynski M, Zaman M, Urbani CN, Lin IC, Jia Z, Batzloff MR, Good MF, Monteiro MJ, Toth I. (2010) Polyacrylate dendrimer nanoparticles: a self-adjuvanting vaccine delivery system. *Angew Chem Int Ed* 49(33), 5742-5745.

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

Professor Max Lu
UQ Deputy Vice-Chancellor (Research) and AIBN Group Leader

Research: **Materials chemistry and nanotechnology**

Professor Max Lu is known for his work on nanoparticles and nanoporous materials for clean energy and environmental technologies.

Professor Lu's significant and sustained contributions include a new method for synthesis of highly reactive single crystal TiO^2, new insights into the surface chemistry and modifications of nanoporous materials, molecular engineering of membranes and efficient photocatalyst for clean energy and water.

With more than 450 journal publications in high impact journals including *Nature, J Am Chem Soc, Angew Chem* and *Adv Materials*, he is also co-inventor of more than 20 international patents. Professor Lu is an Institute for Scientific Information highly-cited author in materials science with 18,500 citations and a h-index of 68.

Professor Lu has received numerous prestigious awards nationally and internationally, including the China International Science and Technology Award, Chinese Academy of Sciences International Cooperation Award, Orica Award, RK Murphy Medal, Le Fevre Prize, ExxonMobil Award, Chemeca Medal, Top 100 Most Influential Engineers in Australia (2004, 2010, 2012) and Top 50 Most Influential Chinese in the World (2006). He won the prestigious ARC Federation Fellowship twice (2003 and 2008).

He is an elected Fellow of the Australian Academy of Technological Sciences and Engineering; a Fellow of the Australian Academy of Science; and a Fellow of the Institution of Chemical Engineers. He is editor and editorial board member of several international journals including *Colloid and Interface Science* and *Carbon*.

Professor Lu has served on many government committees and advisory groups including the Prime Minister's Science, Engineering and Innovation Council (2004, 2005, 2009) and Australian Research Council (ARC) College of Experts (2002-2004). His other previous board memberships include Uniseed Pty Ltd, ARC Nanotechnology Network, National Emerging Technologies Forum and Queensland China Council. He is currently board member of the Australian Synchrotron; National eResearch Collaboration Tools and Resources; and Research Data Storage Infrastructure.

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Abhijit Shrotri

NANOMAC HAS CHANGE OF LEADERSHIP

AIBN Affiliate Group Leader and UQ Professor of Chemical Engineering, Professor Lianzhou Wang, took over leadership of the Nanomaterials Centre (Nanomac) from founding director Professor Max Lu in 2012.

Nanomac's principal research focus has been to address major global challenges of clean and sustainable energy and water supply – and to advance innovative and equitable health care. To successfully meet those challenges, the centre brings together expertise from chemistry, biology, engineering and pharmacy. Several groups work and collaborate within the centre, with Professors Lu and Wang leading work in clean energy; Associate Professor Zhi Ping (Gordon) Xu a leader in health care; Dr Jorge Beltramini a leader in biofuels and clean energy; and Dr Denisa Jurcakova a leader in energy storage.

Nanomac has been part of the Australian Research Council (ARC) Centre of Excellence for Functional Nanomaterials since 2003. While ARC funding ceased at the end of 2010, membership of the ARC centre remains active. In addition to financial support from UQ, key centre researchers have been successful in securing major research grants and awards in 2012, ensuring continuation and development of the core research themes.

Materials for clean energy

New-generation solar cells

Professor Wang and his research group joined the Cooperative Research Centre (CRC) for Polymers in the Solar Cells sub-program investigating new barrier layer and photoanode materials for new-generation solar cells. The CRC sub-program will focus on one of the key challenges of cell encapsulation and stability of third-generation solar cells. The sub-program aims to develop a new class of composite thin films as better sealing materials for solar cell applications.

Professor Wang also received an ARC Future Fellowship to continue his work designing new layered materials for efficient solar energy conversion. The fellowship enables Professor Wang to focus on some exciting research programs in new nanomaterial design and development for efficient solar energy use, including photocatalytic water/air purification, solar fuel generation and self-cleaning coatings.

A new discovery project was granted to his group, supporting research into self-cleaning thin films for anti-reflective solar cell coatings until 2015. The project addresses an important industry need by designing a new class of functional composite coatings for improving solar cells' efficiency and durability. A successful outcome could provide an important

continued overleaf…

breakthrough in thin film technology, applicable not only to solar panels but other coating applications.

Energy storage development

An ARC Linkage project led by Dr Jurcakova; and Professors Lu and Wang; was awarded in 2012, focusing on new cathode materials development for rechargeable lithium ion battery applications.

Thermoelectrics

Professor Lu and Dr Zhen Li were awarded an ARC Discovery Project to advance their research in thermoelectrics. The project aims to develop high-performance thermoelectric semiconductor nanowires for recovering waste heat from automotive exhausts and industrial processes. Successful development of the technology would save energy and reduce carbon emissions.

Catalysts for biofuels

Dr Beltramini's research group formed two new important partnerships during 2012. In a partnership with the Sugar Research and Development Corporation, the group will investigate using sugar cane feedstock in fuel additives and chemicals – and conversion to furan derivatives by catalytic processes. The project aims to develop novel materials for use as catalysts for producing furan derivatives from sugar waste components. Furan derivatives are a promising product, with potential to achieve a secure energy supply through production of gasoline additives and chemicals from renewable biomass.

A second partnership for the group is with Baoshan Iron and Steel Co in China, which is supporting research into nano and microscale engineering of MoS_2 based catalysts for conversion of syngas to ethanol.

Environment

Efficient water purification

Centre research in clean water technologies received a significant boost with a new ARC Discovery Project, led by Professor Wang, securing funding for 2013-2015. The project will work to develop a new class of composite photocatalysts for efficient water purification using sunlight.

Catalytic oxidation to cut emissions

Dr Li Li is building a bridge between researchers in Australia and China as she works to reduce vehicle emissions using

high-performance nanoengineering. Dr Li is working with experts from the Chinese Academy of Sciences to reduce emissions of volatile organic compounds. With support through a Queensland International Fellowship, Dr Li will travel to China to develop a catalytic oxidation process, in collaboration with the Research Centre for Eco-Environmental Sciences Professor Zhengping Hao.

Health care

Associate Professor Xu, who leads research into innovative drug delivery at the centre, was awarded an ARC Future Fellowship and a Discovery Project grant in 2012 to advance his work in engineering layered double hydroxide nanoparticles towards an efficient, targeted clinical delivery system and the safety of nanoparticle skin penetration.

Professor Lianzhou Wang

ARC Future Fellow and Affiliate Group Leader

Research: Characterisation and application of functional nanomaterials

Professor Lianzhou Wang has an international reputation in the characterisation and application of functional nanomaterials for use in cleaner and more efficient energy conversion/storage systems, including photocatalytsts, rechargeable lithium batteries and water treatment membranes.

Professor Wang is an Australian Research Council (ARC) Future Fellow; a past recipient of an STA Fellowship of Japan; and an ARC Queen Elizabeth II Fellowship. He has attracted more than 10 ARC grants; two CSIRO Flagship Cluster projects; major Queensland Government funding; a CRC program; and several UQ grants.

Professor Wang has built long-term collaborations with world leaders in material science, including Professor Michael Hoffmann from the California Institute of Technology; Professor Guozhong Cao from the University of Washington; Professors Takayoshi Sasaki and Jinhua Ye and Dr Kiyoshi Ozawa from the National Institute for Materials Sciences, Japan; Professor Michael Wark from Ruhr-University Bochum, Germany; and Professors Huiming Cheng, Yingchun Zhu and Can Li from the Chinese Academy of Sciences.

Professor Wang is a member of the American Chemical Society, the Institute of Chemical Engineers and the Australian Nanotechnology Network.

Key publications in the past five years:

Bai Y, Yu H, Li Z, Amal R, Lu GQ, Wang L. (2012) In-situ Growth of ZnO Nanowire Network within TiO_2 Nanoparticle Film for Enhanced Dye-sensitised Solar Cell Performance. *Advanced Materials* 5849-5853 (Frontispiece).

Mukherji A, Seger B, Lu GQ, Wang L. (2011) Nitrogen Doped Sr2Ta2O7 Coupled with Graphene Sheets as Photocatalysts for Increased Photocatalytic Hydrogen Production. *ACS Nano* 5 (5), 3483–3492.

Wu X, Chen ZG, Lu GQ, Wang L. (2011) Nanosized Anatase TiO_2 Single Crystals with Tunable Exposed (001) Facets for Enhanced Energy Conversion Efficiency of Dye-Sensitised Solar Cells. *Advanced Functional Materials* 21, 4167-4172.

Mukherji A, Marschall R, Tanksale A, Sun CH, Smith S, Lu GQ, Wang L. (2011) N-doped CsTaWO6 as a New Photocatalyst for Hydrogen Production from Water Splitting under Solar Irradiation. *Advanced Functional Materials* 21(1), 126-132 (Frontispiece, highlighted by *Nature Photonics*, 2011).

Wang L, Tang FQ, Ozawa K, Chen ZG, Mukherj A, Zhu YC, Zou J, Cheng H, Lu GQ. (2009) A General Single Source Route for Nanoporous Hollow Structure Preparation. *Angew Chem Int Ed*, 7048-7051.

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TRASH TO TREASURE

AIBN researchers are turning trash into treasure. Under the leadership of Professor Lars Nielsen, they are developing ways to make sustainable chemicals, such as polypropylene plastics used for Australia's bank notes, from bioderived feedstocks including sugar cane.

Professor Nielsen's research group received $478,284 in funding through an Australian Research Council (ARC) Linkage Project scheme and began work in 2012 with the Dow Chemical Company on the three-year project.

"Fossil fuels provide us with essential chemicals for our lifestyles," Professor Nielsen said. "The chemical industry recognises limited supply and a need to reduce carbon emissions. Microbes can produce green chemicals but efficiencies are often low. This project will develop microbes and improve the fermentative processes for producing plastic precursors from sugar cane."

Polypropylene banknotes have a significantly longer lifespan than paper notes but, like most plastics, are made from traditional fossil sources. Researchers are seeking viable alternatives from renewable resources.

AIBN Systems and Synthetic Biology Group business manager Dr Robert Speight said using sucrose from sugar cane could make bio-plastic production more efficient, sustainable and cheaper. As well as bank notes, the technology would be applicable to a wide variety of plastic products.

In a separate project, researchers are investigating expanded uses for more parts of sugar cane plants. Sugar cane juice for sugar production is derived from the stem, with the plant's leaves discarded. But Dr Speight said AIBN researchers were examining how they could use the leaves to produce bio-plastics.

"The leaves are known as sugar cane trash – a waste product. They are typically burnt or just left on the field," he said. AIBN researchers are working on ways to engineer the plants so bio-plastic is produced in the leaves at sufficiently high levels to be economically viable to recover and use.

Professor Lars Nielsen
Group Leader

Research: **Systems and synthetic biology**

Professor Lars Nielsen is leading the development of experimental and computational tools to analyse and design complex biological systems.

His expertise in metabolic modelling and flux analysis is available nowhere else in Australia – and in few labs across the world. Professor Nielsen's studies of biological systems as diverse as bacteria, baker's yeast, sugarcane, insects and mammals have attracted industrial partnerships with companies including Dow, Metabolix, Amyris, LanzaTech, Boeing, Virgin Australia and GE. The metabolic engineering partnerships have focused on developing new ways of producing aviation fuel, various materials and bioactives (antibiotics, biopesticides and monoclonal antibodies).

Professor Nielsen is also applying system analysis and design approaches to tissue engineering, including novel strategies for generating microtissues for drug screening and using stem cells to produce red and white blood cells for transfusion.

Professor Nielsen collaborates with some of the world's pre-eminent metabolic engineers. A joint project with Professor Sang Yup Lee (KAIST, Korea) enabled several extended mutual visits to explore use of sugar for higher value products. A separate project focusing on producing synthetic aviation fuel based on isoprenoids involves Professor Nielsen collaborating with global synthetic biotechnology company Amyris and leading isoprenoid metabolic engineer Professor Jay Keasling, from the University of California, Berkeley.

Professor Nielsen has been granted four patents – two in stem cells and the others in metabolic engineering. He is on the Scientific Advisory Board of InSphero (2009–), a Swiss company commercialising microtissue technology originating in the Nielsen laboratory.

He is an editorial board member of *ACS Synthetic Biology, Metabolic Engineering, Biotechnology Journal, Biotechnology and Bioengineering* and *Bioprocess and Biosystems Engineering.*

Professor Nielsen has served as an expert adviser to governments, research bodies and domestic and major international companies such as Dow Chemical, DuPont and GS Caltex. In the past decade, he has been part of successful research grant applications totalling $56 million.

Key publications in the past five years:

Fearnley LG, Nielsen LK. (2012) PATHLOGIC-S: A scalable Boolean framework for modelling cellular signalling. *PLoS ONE* 7(8), e41977.

de Oliveira Dal'molin CG, Quek LE, Palfreyman RW, Brumbley SM, Nielsen LK. (2010) AraGEM – a genome-scale reconstruction of the primary metabolic network in *Arabidopsis thaliana*. *Plant Physiol* 152, 579–589.

Quek L-E, Dietmair S, Krömer JO, Nielsen LK. (2010) Metabolic flux analysis in mammalian cell culture. *Metabolic Engineering* 12, 161-171.

Timmins NE, Palfreyman E, Marturana F, Dietmair S, Luikenga S, Lopez G, Fung YL, Minchinton R, Nielsen LK. (2009) Clinical scale ex vivo manufacture of neutrophils from hematopoietic progenitor cells. *Biotechnol Bioeng* 104, 832-840.

Chen W, Marcellin E, Hung J, Nielsen LK. (2009) Hyaluronan molecular weight is controlled by UDP-N- acetylglucosamine concentration in *Streptococcus zooepidemicus*. *J Biol Chem* 284, 18007-18014.

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"The concept is that we have to take advantage of as much of our natural resources as possible and try to add value to parts of plants that would not normally be used. The research is delivering promising results."

Professor Nielsen's research group is focusing on another waste product in a new project with US company LanzaTech, which produces fuels and chemicals from carbon-containing gases. LanzaTech's technology mitigates carbon emissions from industry without adversely impacting on food or land security. Dr Speight said LanzaTech was already making good use of waste carbon monoxide produced by steel factories in China to make ethanol.

AIBN systems biology researchers are working with LanzaTech's synthetic biology team in investigating microbes that can grow on gases that would otherwise be pollutants and convert them into valuable, useful products. "We are using our systems biology expertise to improve the understanding of the gas fermenting microbe and the fermentation process to allow better yields and potentially a variety of new chemical products. Using systems biology to understand and improve biological processes is a common theme that runs through all our work," Dr Speight said.

Biofuel business case in development

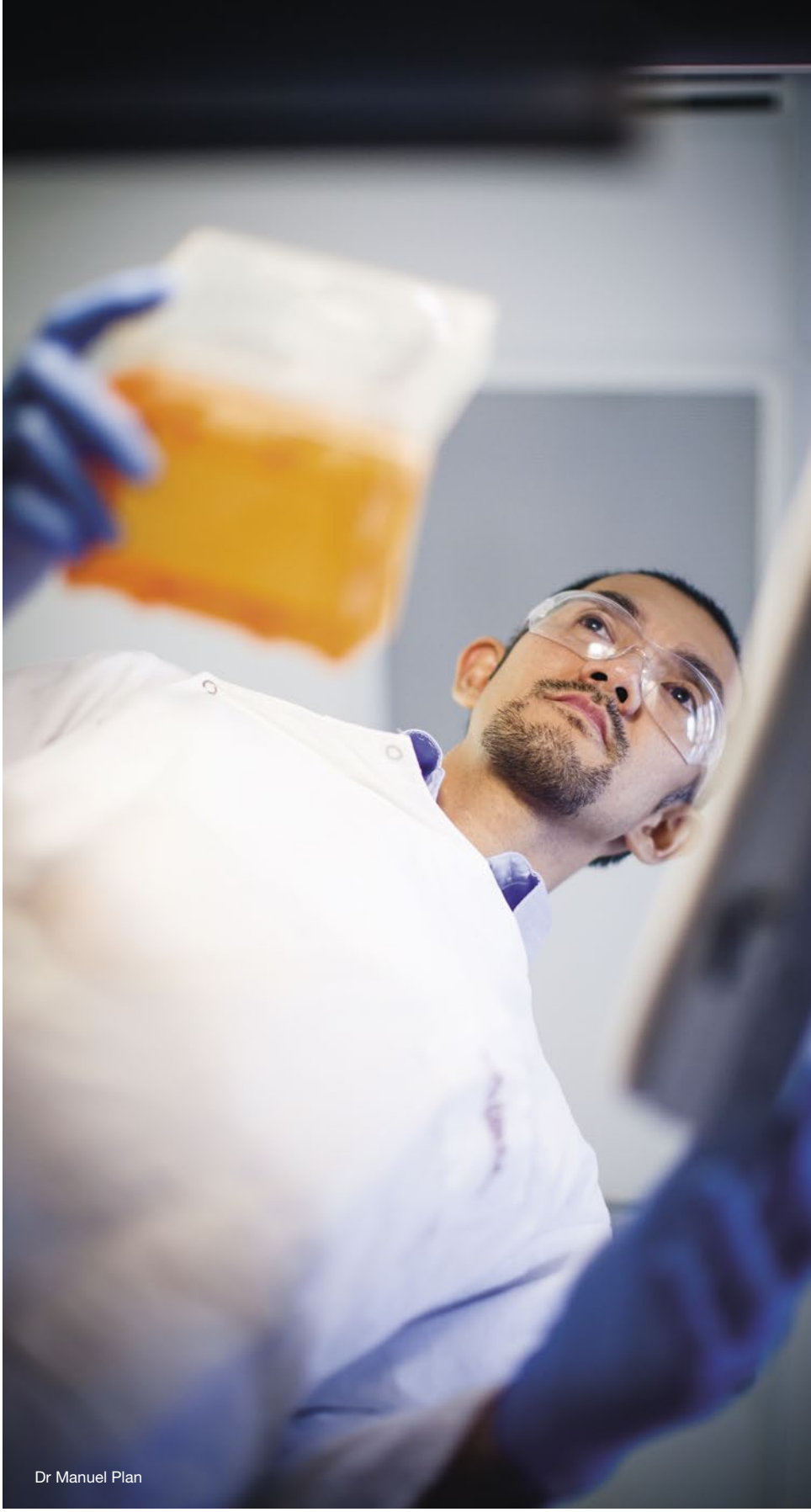
AIBN researchers are winding up the first phase of the Queensland Sustainable Aviation Fuel Initiative. They have submitted key findings from their techno-economic analysis of bio-aviation fuel production to leading industry journal *Biofuels, Bioproducts & Biorefining.* The findings have been accepted for publication in 2013.

Dr Speight said work began in 2012 on the second phase of the project, which is investigating the business case for bio-aviation fuel production from sugar cane in Mackay. AIBN researchers are also using the project to apply systems and synthetic biology techniques to improve the performance of microbial production strains in fermentation.

"The overall aim of this multi-stage program is to manufacture sustainable aviation fuel components and diesel from Queensland sugar cane; supply the aviation fuel market in Australasia; and help seed a strong, sustainable domestic advanced biofuel industry," he said.

A 2012 highlight was a visit from the US Navy's Director for Operational Energy Chris Tindal for discussions on the Nielsen Group's world-leading biofuels research. The US Department of Defense intends to pursue new green fuel sources and has committed to halving its energy use from renewable sources by 2020.

The US Navy has expressed keen interest in AIBN's work and Dr Speight said research had shown promising early results.



Dr Manuel Plan

AIBN researchers are working on a solution for the large number of breast cancer patients who do not respond to chemotherapy, using $5 million in new funding.

PERSONALISING BREAST CANCER TREATMENT THROUGH NANOTECHNOLOGY

It is the second time the National Breast Cancer Foundation (NBCF) has funded AIBN Professor Matt Trau's research into developing new nanotechnology-based diagnostics, understanding the epigenetics of breast cancer biology and moving towards specialised treatment methods.

Researchers hope their work will reduce the onset of advanced breast cancer and recurrence rates; stop disease progression; and significantly increase survival rates.

"Early detection and personalised treatment is one of the greatest weapons we have against breast cancer. Survival and remission rates for breast cancer patients are drastically increased when the disease is caught early," Professor Trau said.

"If the disease is caught later, the major clinical question is which chemotherapy (if any) should be used to treat the specific type of breast cancer present. After surgery and treatment, the major challenge is to detect whether the disease has recurred.

"All these areas are major clinical needs that must be solved if we are to radically improve patient outcomes and overall breast cancer care."

Professor Trau is the project's lead chief investigator and will work with a multidisciplinary team of researchers in nanotechnology, epigenetics, oncology and pathology from seven other institutions and organisations around Australia.

Professor Trau said the second tranche of funding would enable research to translate new discoveries and nanotechnology innovations into the clinic. The work involves refining diagnostic tools to pinpoint markers for cancer sub-types and monitoring patients during treatment.

The research will dramatically expand on the current breast cancer treatment regime, with recognition that the disease is not the same in all patients.

Ramanathan Pudhukode Vaidyanathan, Dr Sakandar Rauf and Dr Laura Garcia Carrascosa

"It's not one disease. Research suggests it is at least nine different diseases, each of which requires a different treatment regime. In the clinic, we currently do not have a very good way of distinguishing between them effectively," he said.

"Because of this, only a small percentage of cancer patients derive any benefit from chemotherapy. With the fusion of modern genetics, epigenetics and nanotechnology, we dream of being able to do much better."

He said the new funding would allow for clinical trials, with researchers collecting biopsy and serum samples to determine how cancerous tumours responded to chemotherapy.

New technology will be used to evaluate the epigenetic biomarkers during a patient's treatment, enabling researchers to track the tumours. Researchers will also develop diagnostic devices and processes for breast cancer screening and move towards introducing them in certified clinical pathology labs.

The research will build on NBCF-funded work in the past four years, which discovered epigenetic changes in the human body that point to the presence of breast cancer.

While the first decade of the genomic era identified key molecular subtypes in breast cancer, the improvements in classification have not yet been translated into useful clinical practice. "A more radical approach is required to make primary research relevant to those most directly affected by this disease," Professor Trau said.

His aim is that surgery would be a later step in the treatment process, informed by diagnostic analysis using innovative nanotechnologies.

Pre-operative chemotherapy or neo-adjuvant therapy has traditionally been used to treat larger operable and advanced breast tumours, but is increasingly being used to treat patients with early-stage breast cancers, since it offers the potential to substantially reduce the size of the primary tumour, thus allowing breast-conserving surgery and surgical resection of previously inoperable tumours.

A key strategic advantage of neo-adjuvant chemotherapy is that it allows an individual tumour's sensitivity to specific chemotherapeutic or targeted agents to be assessed, in contrast to adjuvant therapy which typically constitutes a blind approach.

The new research has a neo-adjuvant clinical trial to collect biopsy and serum samples to evaluate disease progression and tumour response to chemotherapy treatment; the use of next-generation technologies to evaluate epigenetic biomarkers for disease progression and tumour response to chemotherapy during treatment, providing unique data that characterises each patient to construct a personalised medical therapy; the development of nanodiagnostics, protocols and processes for breast cancer screening and diagnosis; and implementation of technologies and processes as in vitro diagnostics in certified clinical pathology laboratories.

Professor Trau said the "holy grail" was a blood test to screen for breast cancer. "That would be an incredible lifesaver."

Professor Matt Trau
AIBN Deputy Director (Nanotechnology) and Group Leader

Research: Nanoscience, nanotechnology and molecular diagnostics

Professor Matt Trau is internationally recognised for his innovative and cross-disciplinary research at the interface between chemistry, nanotechnology, biology and medicine.

He has held positions in industry and academia across the globe, including a Fulbright Research Fellowship at Princeton University, US; and research scientist at Dow Chemical and ICI Pty Ltd. Professor Trau has been a visiting professor at two of the largest cancer research centres in the world: the Dana Farber Cancer Research Institute at Harvard Medical School in Boston; and the Fred Hutchinson Cancer Research Centre in Seattle.

Professor Trau has raised more than $22 million in competitive national and international grant funding in the past decade. He has initiated and led several large international research programs in the past five years, involving close collaboration between leading nanotechnologists, molecular biologists, geneticists and commercial researchers, with the goal of creating cutting-edge diagnostics.

He has co-authored more than 100 refereed publications, many of which appear in the highest impact journals in his field – including two *Nature* and two *Science* publications. His major honours include an Australian Research Council (ARC) Federation Fellowship, one of the most prestigious scientific fellowships in Australia; a Fulbright Research Fellowship to the US; a Queensland Young Tall Poppy Award; a UQ Foundation/Vice-Chancellor's Research Excellence Award; a Paul Harris Fellowship; and a Pink Circle Award for breast cancer research excellence.

Selected publications from the past five years:

Grewal YS, Shiddiky MJA, Gray SA, Weigel KM, Cangelosi GA, Trau M. (2013) Label-free electrochemical detection of an *entamoeba histolytica* antigen using cell-free yeast-scFv probes. *Chem Commun* 49, 1551-1553.

Wee EJH, Shiddiky MJA, Brown MA, Trau M. (2012) eLCR: Electrochemical detection of single DNA base changes via ligase chain reaction. *Chem Commun* 48, 12014-12016.

Shiddiky MJA, Kithva PH, Rauf S, Trau M. (2012) Femtomolar detection of a cancer biomarker protein in serum with ultralow background current by anodic stripping voltammetry. *Chem Commun* 48, 6411-6413.

Kozak D, Anderson W, Vogel R, Chen S, Antaw F, Trau M. (2012) Simultaneous size and -potential measurements of individual nanoparticles in dispersion using size-tunable pore sensors. *ACS Nano* 6, 6990-6997.

Connolly AR, Trau M. (2011) Rapid DNA detection by beacon-assisted detection amplification. *Nature Protocols* 6, 772-778.

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

CONTINUOUS GREEN ENERGY MOVES CLOSER TO REALITY

AIBN researchers are using solar energy to develop carbon-neutral liquid fuels.

They hope to develop a device that will be sufficiently powerful to run vehicles and household items, right down to personal smart phones.

Under the leadership of Professor Ajayan Vinu, an Australian Research Council (ARC) Future Fellow, the researchers recorded good progress in 2012, and are about 60 per cent of the way to completing their high-tech project.

Clean energy for a sustainable environment is Professor Vinu's motivation. He has been working on nanomaterials with functional moieties and hierarchically-ordered pores to be used in novel technology for eliminating CO_2 and converting it into fuel.

"My ultimate goal is to create a continuous supply of energy by combining fuel cells, solar cells and supercapacitor technology," he said.

He has been developing multifunctional and highly-ordered nanoporous semiconductors with that vision in mind.

A 13-strong AIBN group working with Professor Vinu has a target of developing a portable, low-cost, nanoporous energy storage and conversion device before 2015. The work began in 2011.

Professor Vinu said the first step involved taking CO_2 from the atmosphere and converting it into methanol. It uses semiconducting nanostructures with a highly-ordered porous system that absorbs the CO_2 and converts it into clean methanol.

The methanol is then used to run a fuel cell, with clean energy from the fuel cell stored in supercapacitors. The stored energy is used again to convert the CO_2 electrochemically to increase the system's efficiency and the circle of nano life starts again.

Professor Vinu said a single fuel cell could run electrical equipment, such as smart phones, laptops, computers and calculators. Or cells could be stacked together to run a car or large household electrical items. The same material could also be used for solar cells, supercapacitors and a broad range of other applications.

Professor Vinu's expertise in developing fuel cells was garnered during eight years with the National Institute for Materials Science, Japan's leading materials institute, before he came to AIBN in 2011.

He established a sub-group headed by Professor Javaid Zaidi at AIBN to work specifically on developing electrodes for polymer electrolyte membranes and direct methanol fuel cells.

Professor Vinu said the novel technology would be the ultimate clean, green machine. The cells would be developed

Professor Ajayan Vinu
ARC Future Fellow and Group Leader

Research: **Multifunctional nanoporous materials for energy and a clean environment**

Professor Ajayan Vinu is recognised as one of the top international researchers in the field of nanoporous materials.

His research work introduced a new field of nanoporous nitrides and developed novel methods for making nanoporous materials with different textural parameters and multiple functions. He discovered numerous novel materials, such as carbon nanocage, mesoporous carbon nitride, mesoporous boron nitride and boron carbon nitrides, carbon nanocoops and silica nanocoops.

The research has led to 255 papers in high-impact journals with more than 6500 citations and a h-index of 45. At least 16 of his papers have been cited more than 100 times and 40 papers have been cited more than 50 times. Many of his works were published in top journals, including *Angewandte Chemie, JACS, Advanced Materials* and *Advanced Functional Materials*.

Professor Vinu has received the Friedrich Wilhelm Bessel Research Award from the Humboldt Foundation; an Australian Research Council (ARC) Australian Future Fellowship (2010-2014); the Indian Society of Chemists and Biologists Award for Excellence (2010); the Chemical Society of Japan Award for Young Chemists (2008); and Iran's top science prize, the Khwarizmi International Award for applied research in nanotechnology (2008).

to convert harmful CO_2 into a clean fuel, then into clean energy, which was reused to remove the harmful gas from the atmosphere again.

"It has very high efficiency. It will clean the CO_2 and provide clean energy with no harm to the environment. It is the perfect device," he said.

The solar industry is also on the verge of a revolution, thanks to joint work by AIBN researchers and Yonsei University in Seoul, Korea. Under Professor Vinu's leadership, Australian and Korean researchers have combined their expertise in polymer patterning and materials science in a bid to develop new-generation solar cells.

Professor Vinu said the collaboration, involving a Memorandum of Understanding signed in 2012, would encourage the creation of new science and new products, including efforts to improve solar cells' efficiency.

AIBN would contribute expertise in materials science, in particular porous semiconducting and bio-nanomaterials, while Yonsei would bring knowledge of polymer patterning and fabrication.

"We have expertise in the fabrication of porous functionalised semiconducting nanostructures that will maximise quantum efficiency of dye sensitised or organic solar cells, while the Yonsei researchers have know-how in designing various types of solar cell devices," Professor Vinu said.

"The fusion of materials development and device fabrication can help us achieve a new solar cell technology or product with a low cost, which will generate a huge revolution in the solar industry." The technology will be integrated into a nanodevice that can offer a continuous supply of energy in the future.

Dr Christoph Seubert

The innovative nature and commercial potential of research from his group is shown by 18 national and international patents. He has also secured funding of more than $US3.6 million from industry and government funding agencies.

Key publications in the past five years:

Kim J, Anand C, Talapaneni SN, You J, Aldeyab SS, Kim E, Vinu A. (2012) Catalytic Polymerization of Anthracene in a Recyclable SBA-15 Reactor with High Iron Content by a Friedel–Crafts Alkylation. *Angew Chemie International Edition* 51, 2859-2863.

Datta KKR, Subba BV, Ariga RK, Vinu A. (2010) Gold Nanoparticles Embedded in Nanoporous Carbon Nitride Stabiliser for Highly Efficient Three Component Coupling Reaction. *Angew Chem Intl Ed* 49, 5961-5965.

Jin X, Balasubramanian VV, Selvan ST, Sawant DP, Chari MA, Lu GQ, Vinu A. (2009) Highly Ordered Mesoporous Carbon Nitride Nanoparticles with a High Nitrogen Content: a Novel Metal-free Basic Catalyst. *Angew Chemie Intl Ed* 48(42), 7884-7887.

Alam S, Anand C, Ariga K, Mori T, Vinu A. (2009) Unusual Magnetic Properties of Size-Controlled Iron Oxide Nanoparticles Grown in a Nanoporous Matrix with Tunable Pores. *Angew Chemie Inter Ed* 48(40), 7358-7361.

Ariga K, Vinu A, Ji Q, Ohmori O, Hill J, Acharya S, Koike J, Shiratori S. (2008) A Layered Mesoporous Carbon Sensor Based on Nanopore-Filling Cooperative Adsorption in the Liquid Phase. *Angew Chem Int Ed* 47, 7254-7257.

www.aibn.uq.edu.au/ajayan-vinu

Understanding how information in human DNA interacts with environmental factors to influence healthy development has massive implications in treating, and potentially preventing, a range of diseases.

AIBN Associate Professor Christine Wells and her research group are part of important international and domestic collaborations researching the networks of genes that drive stem cell differentiation and immune activation.

The FANTOM (Functional Annotation of the Mammalian Genome) project is a global effort to map the critical gene regions that best describe each cell in the body. The Wells group's efforts in the consortium focus on the immune system. The group's key collaborators are in Japan, Germany, Denmark and the US.

In a demonstration of the important role Associate Professor Wells plays in the collaboration, she was invited to chair the session on immediate early response genes at FANTOM's annual conference in Yokohama, Japan in October 2012. Associate Professor Wells said such conferences were important, given the gaps in understanding of human DNA and the rapid pace of advances in the research linked to infection and the immune system.

"We've been examining the 'library' of genes that are switched on by immune cells in the first few hours after they identify an infection," she said. "We now understand the wiring of the immune system and what happens at the cellular and molecular levels when you get an infection."

Her research has implications for new diagnostic treatments for infections – and for chronic conditions such as arthritis, diabetes and arterial sclerosis, where the immune system is inappropriately activated. "While the immune system is like a set of soldiers ready to fight foreign invaders, it also maintains balance in the body,

Associate Professor Christine Wells

Queensland Government Fellow and Group Leader

Research: **Cellular differentiation and activation**

Associate Professor Christine Wells is an internationally-recognised pioneer of genomics in its application to innate immunity and stem cell biology.

She has driven programs to identify the genetic elements that define the innate immune system, contribute to the regulation of immune genes and describe the functions of new gene products. During the past decade Associate Professor Wells has made key contributions to several seminal papers that mapped out mammalian genome architecture and transcriptional complexity. Through gene-discovery programs in macrophage biology she characterised a role for the C-type lectin Mincle in host-fungal interactions, and has identified novel proteins that modify inflammatory signalling.

Associate Professor Wells is leading international efforts to model robustness in gene regulatory networks, driving insight into the impact of genetic and environmental variables. In 2011, she established Stemformatics.org – a collaborative hub for Australian and international stem cell researchers.

Associate Professor Wells has an ongoing and senior role in the international genome consortium Functional Annotation of the Mammalian genome (FANTOM), with Riken Omics Sciences Centre in Yokohama, Japan. She is a member of the Canadian-led Project Grandiose, in collaboration with Dr Andras Nagy. She has close collaborations with Professor John Quackenbush from the Dana Farber Cancer Research Institute in Boston, US; Professor Winston Hide from the Harvard School of Public Health; Dr Jessica Mar from the Albert Einstein School of Medicine, New York; Professor Albin Sandelin from the University of Copenhagen, Denmark; and Professor Michael Rehli from University Hospital Regensburg, Germany.

Associate Professor Wells is on the editorial board of *Genomics* and the open access journals *Genomics, Proteomics & Bioinformatics* and *Biology Direct*.

Key publications in the past five years:

Stem cell informatics

Wells CA, Mosbergen R, Korn O, Seidenman N, Matigian NA, Vitale AM, Shepherd J. (2013) Stemformatics: visualisation and sharing of stem cell gene expression. *Stem Cell Research* 10(3), 387-395.

Mar J, Matigian N, Quackenbush J, Wells CA. (2011) attract: A method for identifying core pathways that underlie cell state. *PLoS ONE* 6(10), e25445.

Innate immunity

Vijayan D, Radford KJ, Beckhouse A, Ashman RB, Wells CA. (2012) Mincle polarises human monocytes and neutrophils responses to *Candida albicans*. *Immunology and Cell Biology* 90(9), 889-895 (Editorial highlight July 2012).

FANTOM consortium including Wells CA. (2009) The transcriptional network that controls growth arrest and differentiation in a human myeloid leukemia cell line. *Nature Genetics* 41(5), 553-562.

Wells CA, Salvage-Jones J, Li X, Hitchens K, Butcher S, Murray R, Beckhouse A, Lo Y, Cobbold C, Ma B, Orr S, Stewart L, Lebus D, Sobieszczuk P, Hume D, Stow J, Blanchard H, Ashman B. (2008) The macrophage inducible c-type lectin, Mincle, is an essential component of the innate immune response to *Candida albicans*. *Journal of Immunology* 180(11), 7404-7413.

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FANTOM GLOBAL COLLABORATION RESEARCHING GENE NETWORKS

regulating body weight, circadian rhythms – perhaps even sexual attraction," she said.

Another collaboration, Project Grandiose, asks the same question from a different angle. Can cells reprogram or revert to their original cell type? Scientists in Canada; South Korea; the Netherlands; the Australian National University, in Canberra; Sydney's Victor Chang Institute; and AIBN are working together to understand how the reversion occurs.

A collaboration closer to home is with UQ School of Biomedical Sciences neurologist Dr Thiruma (Garrie) Arumugam, who is working with the Wells research group to determine how the Mincle protein operates within the human brain.

Associate Professor Wells discovered the macrophage inducible C-type lectin (Mincle) in 2008, a critical player in defence against fungal infection, including thrush, and mycobacteria such as TB. Mincle helps recruit the right white blood cells to a fungal infection, so triggering the protein can fight infection faster.

But there are also advantages in 'turning off' Mincle. In stroke patients, parts of the brain die because of blood vessel blockages. The immune system triggers a sterile inflammation to clear the dead cells, which can intensify the stroke's impact.

Blocking Mincle production can modulate the severity of the inflammation, thus improving stroke outcomes and that is the area where Dr Arumugam's expertise is vital.

Associate Professor Wells aims to drive that work to clinical trials within five years. "This collaboration is very important and very practical," she said.

The Wells group has also identified an additional 12 proteins similar to Mincle and is working in the lab to understand how they function.

Edward Huang and Elizabeth Mason

The Wells research group's domestic collaborations have resulted in significant advances on the www.stemformatics.org portal that provides an important public and proprietary database of experiments describing human and animal stem cells and how they differentiate to become more mature cells, tissues and organs.

The group worked with collaborative entity Stem Cells Australia in 2012 to help its participants organise and understand the data generated and navigate it to identify significant signatures and overarching patterns.

The portal was the focus of a major publication accepted in 2012 for *Stem Cell Research*, detailing the challenges the stem cell research community faces as it adopts genome-scale technologies and tries to share and visualise data derived from different laboratories or derived under different experimental conditions.

Stemformatics hosts a large collection of exemplar stem cell data that is carefully curated and provides fast visualisation of gene expression across a range of mouse and human datasets, with transparent links back to the original studies.

One difficulty in the analysis of stem cell signatures is the paucity of public pathways/gene lists relevant to stem cell or developmental biology. Stemformatics provides a simple mechanism to create, share and analyse gene sets, providing a repository of community-annotated stem cell gene lists that are informative about pathways, lineage commitment, and common technical artefacts.

TEAM TARGETS SMALLER, SMARTER COMPUTER CHIPS

It was not so many years ago when computers were the size of a room. Today AIBN researchers are working towards computers that operate on the molecular level.

A team led by AIBN Professor Andrew Whittaker and Associate Professor Idriss Blakey is developing a new generation of computer chips. Professor Whittaker's research group is making materials that will help industry build faster, smaller, cheaper and more powerful super computers.

"We work in the field of polymers for photolithography," Professor Whittaker said. "That's the process used for manufacturing integrated circuits – that is, computer chips.

"Put very simply, the polymers are an essential part of the manufacturing process. When exposed to laser light in a manufacturing tool, the solubility of the polymer changes, allowing the exposed polymer to be washed away to reveal the underlying silicon wafer.

"It is then possible to deposit a metal into the silicon to make a conducting circuit. The process is repeated many times to generate a complex three-dimensional pattern that's a computer chip.

"We work at the cutting edge of this technology, developing new polymers to allow printing of circuits consisting of very fine lines, about 20 nanometres or smaller in size.

"The smaller size is required for a high density of transistors, meaning greater computing power, faster chips and smaller devices. Our research success is based on detailed knowledge of the chemistry and physics of these polymers."

Professor Whittaker referred to the well-known Moore's Law. Intel Corporation co-founder Gordon Moore in 1965 predicted the number of transistors that could fit onto a computer chip would double every 18 months. It has become a guiding principle for an industry continually developing more powerful chips.

"If we keep going down this dramatically improving path, we'll need new technologies. That's what we are ultimately aiming for," Professor Whittaker said.

Professor Andrew Whittaker
ARC Australian Professorial Fellow and Group Leader

Research: **Polymer chemistry, nanotechnology, photolithography, biomaterials science and magnetic resonance**

Professor Andrew Whittaker is an Australian Research Council (ARC) Australian Professorial Fellow, a Fellow of the Royal Australian Chemical Society and a member of the ARC College of Experts.

He directs research funded through more than $26 million in competitive grants since 2002. Professor Whittaker's work in synthesis and characterisation of polymeric materials has underpinned major development programs in several key areas. In the field of materials for photolithography, it has been supported by funding from leading semiconductor companies Intel, Sematech and the Dow Chemical Company.

Outcomes include novel high-index resists for 193nm immersion lithography, new concepts for design of non-chemically amplified resists for EUV lithography, and novel approaches to healing roughness in IC features.

In the field of biomaterials science, Professor Whittaker is most active in developing novel imaging agents for MRI, and introduced a new class of 19F polymeric agents. He is an expert in the fundamentals of diffusion process in complex solids. He has an international reputation in the field of NMR and MRI of polymeric systems.

Dr Simon Puttick

The research may lead to improved human-device interfaces with smaller and smarter sensors for disease identification and treatment. Computer chips could read signs from the body and respond or control biological responses.

"Miniaturisation allows us to do amazing things at the interface between chemistry and biology," Professor Whittaker said.

Work in the Whittaker research group was supported in 2012 through a $360,000 Australian Research Council (ARC) Linkage Project grant, awarded jointly with Associate Professor Idriss Blakey, to work with the Dow Chemical Company in a three-year program to introduce new methods of printing smaller features on wafers.

The work is partly based on PhD student Yami Chuang's new method of healing the roughness of lithographic features using a class of novel polymers called amphiphilic block copolymers. "The method has shown considerable promise. Recently part of her work has been protected by filing of a provisional patent," Professor Whittaker said.

In 2012, Professor Whittaker and collaborators Dr Kevin Jack and Dr Hui Peng received $420,000 from the ARC Discovery grant program to study in detail the structure of very thin polymer films such as those used in photolithography.

"The structure of the thin films may contribute to the quality of the pattern achieved on the silicon wafer. The study promises to provide a detailed understanding of an important class of materials and, in particular, for manufacturing integrated circuits," Professor Whittaker said.

Researchers use fine metal wires that conduct electricity to make the circuits. The wires are 10 to 20 nanometres wide. By comparison, a human hair measures 50,000 to 100,000 nanometres in diameter.

Professor Whittaker said the work involved identifying and repairing errors on the patterns of the integrated circuits. It has the potential to improve the quality of integrated circuits considerably. "The real challenge is to make even smaller lines for integrated circuits. We are developing a completely new chemical process for smaller devices."

Key publications in the past five years:

Chuang Y-M, Jack KS, Cheng H-H, Whittaker AK, Blakey I. (2012) Using directed self assembly of block copolymer nanostructures to modulate nanoscale surface roughness: towards a novel lithographic process. *Advanced Functional Materials* 23(2), 173-183.

Keen I, Yu A, Cheng H-H, Jack KS, Nicholson T, Whittaker AK, Blakey I. (2012) Control of the orientation of symmetric poly(styrene)-block-poly(D,L-lactide) block copolymers using statistical copolymers of dissimilar composition. *Langmuir* 28(45), 15876-15888.

Munnemann K, Kolzer M, Blakey I, Whittaker AK, Thurecht KJ. (2012) Hyperbranched polymers for molecular imaging: Designing polymers for parahydrogen induced polarisation (PHIP). *Chemical Communications* 48(10), 1583-1585.

Peng H, Thurecht KJ, Blakey I, Taran E, Whittaker AK. (2012) Effect of solvent quality on the solution properties of assemblies of partially fluorinated amphiphilic diblock copolymers. *Macromolecules*. 45(21), 8681-8690.

Truong V, Blakey I, Whittaker AK. (2012) Hydrophilic and amphiphilic polyethylene glycol-based hydrogels with tunable degradability prepared by 'click' chemistry. *Biomacromolecules* 13(12), 4012-4021.

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REPROGRAMMING A PATH TO UNDERSTANDING BRAIN DISEASE

Associate Professor Ernst Wolvetang's research in 2012 has taken major steps in identifying steps in overcoming two neurodegenerative diseases: Down syndrome and ataxia-telangiectasia.

The research resulted in world-first identification of altered brain development in Down syndrome, allowing researchers in Associate Professor Wolvetang's lab to focus on treatments to improve the lives of children with trisomy 21.

Building on work that earned Professor Shinya Yamanaka and Sir John Gurdon a Nobel Prize, the research involved reprogramming skin cells from people with Down syndrome into induced pluripotent stem (iPS) cells to study the first month of foetal brain development in a lab dish.

The researchers investigated how the extra copy of chromosome 21 in Down syndrome interfered with early brain development. They found the Down syndrome brain produced too many glial cells and neurons died more readily. The features are likely to affect brain architecture and function and may be related to the impaired motor co-ordination and cognitive impairment common in people with Down syndrome.

The researchers found antioxidants could rescue the cell death of the Down syndrome neurons.

The research was published in the journal *Stem Cells* in 2012 and involved collaboration with AIBN colleague

Samah Alharbi

Associate Professor Ernst Wolvetang

Group Leader

Research: **Induced pluripotent stem cells, in vitro disease models and novel regenerative medicine approaches**

Associate Professor Ernst Wolvetang is leading the derivation of footprint-free induced pluripotent stem cells (iPSC) in Australia, with a particular focus on neuronal and cardiac disease models.

He is the inaugural director of the collaborative reprogramming network Cell Reprogramming Australia and organises the only annual Australian iPSC workshop. Associate Professor Wolvetang is a chief investigator for the Australian Research Council's Special Research Initiative in Stem Cell Science, Stem Cells Australia and two National Health and Medical Research Council project grants (2013-2015).

He is a senior reprogramming scientist in Stem Cells Ltd; chaired the Genetic Stability of Stem Cells session at the 2007 International Society for Stem Cell Research (ISSCR) conference in Cairns; and organises, among other conferences, the Frontiers in Reprogramming conference.

Associate Professor Wolvetang has given 25 lectures and was an invited speaker at 23 platform meetings, including giving two keynote addresses. He spoke at the ISSCR conference in Toronto, Canada in 2006; and the 2nd Annual World Congress of Regenerative Medicine & Stem Cells in Dalian, China in 2009. Associate Professor Wolvetang organised a masterclass on iPS cells at the 2nd Annual World Stem Cells & Regenerative Medicine Congress in Seoul, Korea in 2010.

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

Key publications in the past five years:

Wolvetang E, Herszfeld D, Langton-Bunker E, Chung T, Filipczyk A, Houssami S, Koh K, Laslett AL, Michalska A, Nguyen L, Reubinoff BE, Tellis I, Auerbach JM, Ording CJ, Looijenga LHJ, Pera MF. (2006) CD30 is a survival factor and a biomarker for transformed human pluripotent stem cells. *Nat Biotech* 24(3), 351-357.

Chung T-L, Brena RM, Kolle G, Grimmond SM, Berman BP, Laird PW, Pera MF, Wolvetang EJ. (2010) Vitamin C promotes widespread yet specific demethylation of the hESC epigenome. *Stem Cells* 28(10), 1848-1855.

Nayler SP, Gatei M, Kozlov S, Gatti R, Mar JC, Wells CA, Lavin M, Wolvetang EJ. (2012) Induced pluripotent stem cells from ataxia-telangiectasia recapitulate the cellular phenotype. *Stem Cells Translational Medicine* 1, 523-535.

Briggs JA, Sun J, Shepherd J, Ovchinnikov DA, Chung TL, Nayler SP, Kao LP, Morrow CA, Thakar NY, Soo SY, Peura T, Grimmond SM, Wolvetang EJ. (2012) Integration-free iPS cells identify genetic and neural developmental features of Down syndrome etiology. *Stem Cells* 31(3), 467-478.

Briggs JA, Mason E, Ovchinnikov DA, Wells CA, Wolvetang EJ. (2012) New paradigms for Down syndrome research using iPSCs: tackling complex human genetic disease. *Stem Cells Translational Medicine* 2(3), 175-184.

Associate Professor Christine Wells and UQ's Institute for Molecular Biosciences (IMB) Professor Sean Grimmond.

Associate Professor Wolvetang said understanding a multigenic disease such as Down syndrome was challenging but advances in cell reprogramming and genome editing allowed researchers unprecedented insights into the molecular basis of complex human disease.

Reprogramming has enabled a better understanding of ataxia-telangiectasia, a condition in which a gene that recognises and repairs DNA damage is inactive, resulting in cancer and brain degeneration. Reprogramming supports moves to study the effectiveness of potential treatments.

As part of a collaborative project with Professor Martin Lavin, from the Queensland Institute of Medical Research and UQ's Centre for Clinical Research, Associate Professor Wolvetang's lab has reprogrammed, for the first time, skin cells from people with ataxia-telangiectasia.

Associate Professor Wolvetang said the ability to reprogram skin cells from children with ataxia-telangiectasia provided a renewable resource to study the neurodegeneration and find medicines to combat it.

"The next step is to correct the genetic mutations in the iPS cells from patients; turn the corrected stem cells into brain and blood cells; and demonstrate these can replace the defective cells that cause the problems in this disease," Associate Professor Wolvetang said.

"Delivery of such corrected cells, which is still some years away, or novel drugs discovered using the cells generated in this study, may help treat the disease."

With support from two National Health and Medical Research Council (NHMRC) project grants totalling more than $1.2 million, researchers could start screening medicines in one to two years.

The focus of Associate Professor Wolvetang's lab during coming years will be using genome editing technology and cell reprogramming to both correct and generate human neurological disease models in the dish, such as is in progress for Prader-Willi syndrome in a collaboration with IMB Professor Ryan Taft.

"Future innovation in health care will come from combining DNA- and RNA-sequencing technologies with cell reprogramming and genome editing capabilities," Associate Professor Wolvetang said. "This provides a clear path from disease discovery to uncovering the underlying cellular disease mechanisms and subsequent development of novel therapeutic approaches for currently poorly understood and untreatable brain diseases."

SPICE MAY HOLD CLUE TO CURING BRAIN TUMOURS

World-renowned materials scientist Professor Chengzhong (Michael) Yu is making rapid progress in developing new vehicles for drug and vaccine delivery.

Professor Yu and his AIBN research group believe they are looking at a significant breakthrough that may lead to more effective treatment of brain tumours and other cancers. They have found that curcumin, a derivative from the Indian spice plant turmeric, is a promising anti-cancer agent for treating many cancers, including glioblastoma.

Glioblastoma is the most malignant brain tumour and is incurable. About 1200 people die from it in Australia every year.

Professor Yu said curcumin was insoluble, which limited its therapeutic efficacy and clinical applications. Scientists in global labs have previously used an organic solvent to make curcumin sufficiently soluble, but the method has limitations in human treatments.

"Due to limited success in current treatment regimes and side effects associated with synthetic compounds, there is a compelling need to investigate natural anti-cancer compounds with minimal side effects at very high dose and/or targeting the blood-brain barrier," Professor Yu said.

His research group took a novel approach to the problem in 2012 using a spray dryer, common in the food industry, to prepare functional nanomaterials. With the addition of three new members in 2012, Professor Yu's research group developed a low-cost, large-scale method to produce a delivery vehicle that made curcumin soluble.

"We can make it soluble and small. Our delivery vehicle has big potential and, in the coming years, my aim is to see it attract commercial interest," Professor Yu said.

The research extends beyond cancer treatment. Professor Yu said nanomaterials were vital for drug and vaccine delivery, but they were usually produced in the laboratory on a small scale. Trying to transfer the expertise to large-scale, low-cost production was problematic.

"It is difficult to produce functional nano-materials on a bigger scale because it can change the materials' structure and performance. We have been using methods from the food and pharmaceutical industries that have allowed us to prepare functional nanomaterials on a bigger scale."

He said his work could be simply described: "We make nano-vehicles for efficient delivery. We don't make the vaccine, the drug molecules, the antibodies or the therapeutics. We are like the drivers. We know which direction we want the vehicle to go."

The Yu research group is finding solutions in balancing the development of varied materials that can target specific cancer cells and deliver drugs or vaccines quickly and efficiently – yet producing the materials more cheaply.

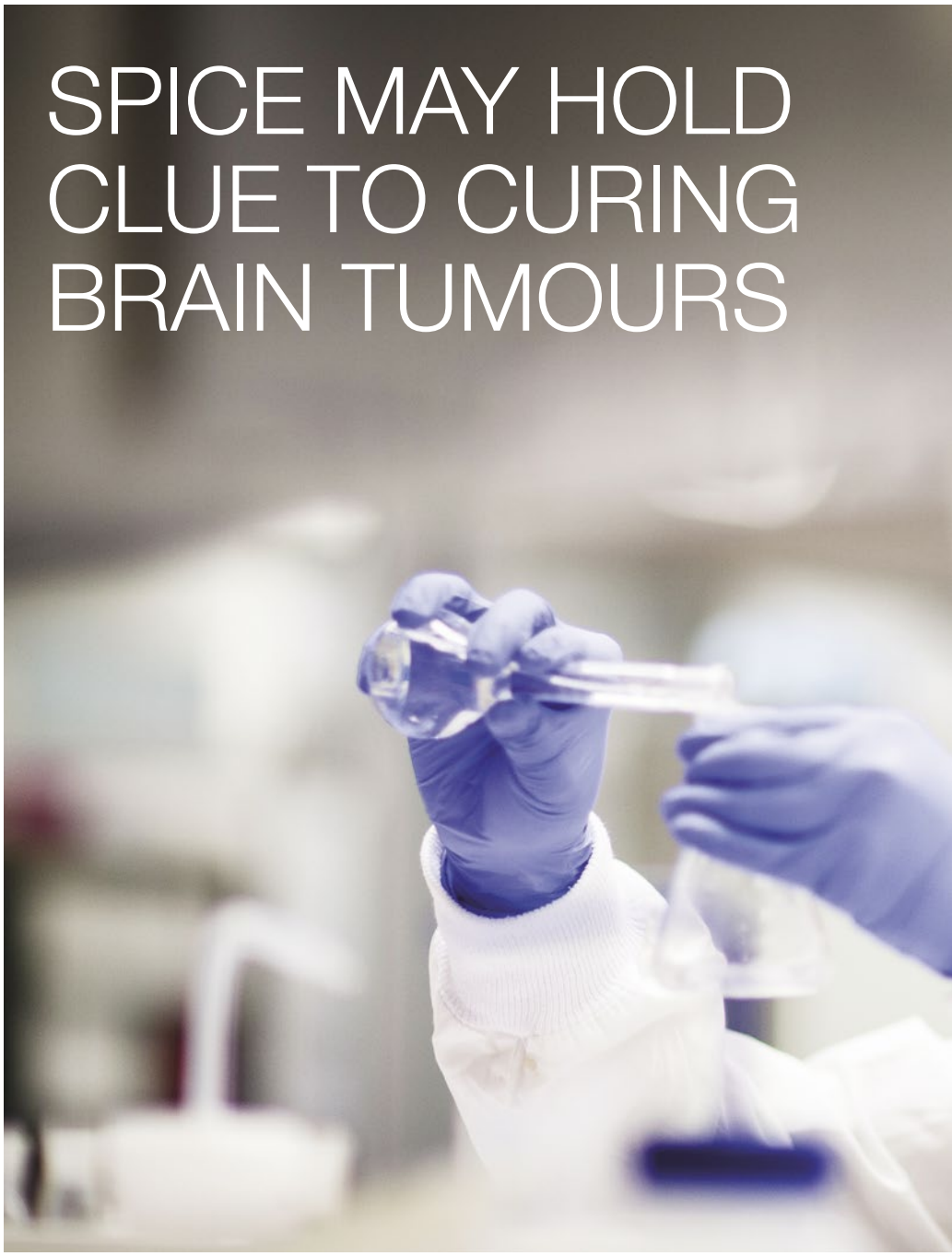
Professor Yu said his research group had to consider the vehicles' shape, size and composition; their interaction with the cargo; their ability to withstand an attack by enzymes in the body; and the subsequent interaction with target cells.

The Yu research group is creating new nanomaterials and smart devices with specific characteristics, allowing doctors to determine when the material should release a cancer drug inside a patient to target tumours.

The group's broad research interests include projects in clean energy and environmental protection, such as lithium ion batteries; bio-diagnostics; and toxin removal from water.

Professor Yu said nanomaterials could also be used to absorb ions, such as phosphate and arsenic, in polluted water or detect biomolecules for clinical applications, including disease diagnosis and treatment.

The Yu research group has solid partnerships with governments and the private sector, and several patents have been filed for devices the group has developed.



Professor Chengzhong (Michael) Yu

ARC Future Fellow and Group Leader

Research: Applied functional nanomaterials

Professor Chengzhong (Michael) Yu is an internationally recognised expert in materials science.

He is an Australian Research Council (ARC) Future Fellow; a referee for more than 50 international journals; and a reviewer for the ARC and National Health and Medical Research Council (NHMRC).

Professor Yu has collaborations with scientists in chemistry, material science and chemical engineering from the US, Japan, Scotland, Sweden, France and China. Through these collaborations, more than 30 international journal papers have been published.

Since he joined AIBN in 2010, Professor Yu has attracted four ARC grants and funding from Cancer Council Queensland; and the Queensland Government's Research Partnership Project, with a total of more than $6.2 million in three years. Before he joined AIBN, he attracted 12 grants from the National Science Foundation of China; the Chinese Ministry of Science and Technology; the Chinese Education Ministry; and the Shanghai Government.

Professor Yu is the recipient of the 2009 Innovation Award of the Chemistry Academy of China; the 2009 Young Scientist Award of the Ceramic Society of China; the 2005 New Century Scientist Award from the Chinese Ministry of Education; and the 2004 Young Scientist Award from the Chemistry Academy of China. Professor Yu received the National Excellent Doctoral Dissertation Award in China (2004); the second prize of the National Science Award of China (2004); and the Shanghai Science & Technology Progress Award (2002). He has been invited to give more than 30 plenary, keynote and invited talks.

Key publications in the past five years:

Yang J, Zhou L, Zhang J, Zou J, Yuan ZG, Yu CZ. (2013) Confinement of Chemisorbed Phosphates in Controlled Nano-space with Three-dimensional Mesostructures. *Chem Eur J*. doi: 10.1002/chem.201300273.

Zhou L, Zhou XF, Huang XD, Liu ZP, Zhao DY, Yao XD, Yu CZ. (2013) Designed Synthesis of LiMn2O4 Microspheres with Adjustable Hollow Structures for Lithium-Ion Battery Applications. *J Mater Chem A* 1, 837-842.

Yu MH, Jambhrunkar S, Thorn P, Chen JZ, Gu WY, Yu CZ. (2013) Hyaluronic Acid Modified Mesoporous Silica Nanoparticles for Targeted Drug Delivery to CD44-overexpressing Cancer Cells. *Nanoscale* 5(1), 178-183.

Huang XD, Qian K, Yang J, Zhang J, Li L, Yu CZ, Zhao DY. (2012) Functional Nanoporous Graphene Foams with Controlled Pore Sizes. *Adv Mater* 32, 4419–4423.

Qian K, Gu WY, Yuan P, Liu F, Wang YH, Monteiro M, Yu CZ. (2012) Enrichment and Detection of Peptides from Biological Systems Using Designed Periodic Mesoporous Organosilica Microspheres. *Small* 8, 231.

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

Irene Emmanuelawati

ASSOCIATE GROUP LEADERS

AIBN recognises the work of early and mid-career researchers through the appointment of Associate Group Leaders. They are senior members of the AIBN research community and are fundamental to the institute's ongoing success and long-term viability. Associate Group Leaders' activities may develop to a level where they can be considered for promotion to AIBN Group Leader.

Associate Professor Idriss Blakey

Associate Professor Idriss Blakey

ARC Future Fellow and Associate Group Leader

Research: **Rational design, synthesis and self assembly of functional polymers and nanomaterials for nanofabrication, sensors and biomedical imaging agents**

Associate Professor Idriss Blakey is an Australian Research Council (ARC) Future Fellow (2010-2014) and a chief investigator on an ARC Linkage project in partnership with the Dow Chemical Company.

His contributions to polymer science have been published by leaders such as Wiley, the American Chemical Society and the Royal Society of Chemistry. Associate Professor Blakey is a regular reviewer and adjudicative reviewer for more than 20 journals, and for granting bodies including the ARC, the Wellcome Trust, the US Department of Energy and the Australian Synchrotron. He has been lead chief investigator on three ARC Discovery grants and chief investigator on three ARC Linkage projects grants in partnership with Intel Corporation and Sematech, a consortium of leading semiconductor companies.

Associate Professor Blakey has been a recipient of a Queensland Government Fellowship, working with Sematech on developing advanced polymers for use in computer chip manufacture. He has one fully granted patent and patents at the PCT and provisional stages.

Key publications in the past five years:

Chuang Y-M, Jack KS, Cheng HH, Whittaker AK, Blakey I. (2013) Using directed self assembly of block copolymer nanostructures to modulate nanoscale surface roughness: Towards a novel lithographic process. *Advanced Functional Materials* 23, 173-183.

Keen I, Yu A, Cheng H-H, Jack KS, Nicholson T, Whittaker AK, Blakey I. (2012) Control of the orientation of symmetric poly(styrene)-block-poly(D,L-lactide) block copolymers using statistical copolymers of dissimilar composition. *Langmuir* 28, 15876-15888.

Blakey I, Merican Z, Rintoul L, Chuang Y-M, Jack KS, Micallef AS. (2012) Interactions of iodoperfluorobenzene compounds with gold nanoparticles. *Physical Chemistry Chemical Physics* 14, 3604-3611.

Chen L, Goh YK, Cheng HH, Smith BW, Xie P, Montgomery W, Whittaker AK, Blakey I. (2012) Aqueous developable dual switching photoresists for nanolithography. *Journal of Polymer Science Part A: Polymer Chemistry* 50, 4255–4265.

Thurecht KJ, Blakey I, Peng H, Squires O, Hsu S, Alexander C, Whittaker AK. (2010) Functional hyperbranched polymers: Toward targeted *in vivo* 19F magnetic resonance imaging using designed macromolecules. *Journal of the American Chemical Society* 132, 5336-5337.

Dr Simon Corrie

ARC Discovery Early Career Research Award Fellow and Associate Group Leader

Research: **Design, fabrication and testing of microprojection array technology for rapid, multiplexed biomarker detection via skin application**

Dr Simon Corrie is a recipient of the Australian Research Council's (ARC) prestigious Discovery Early Career Researcher Award (2013-2016).

He has developed several molecular technologies with applications in diagnostics, publishing the work in Royal Society of Chemistry and American Chemical Society journals and presenting it at international conferences. He regularly reviews journal articles for a range of publications and reviews ARC fellowship and grant applications.

After completing his PhD in physical chemistry, Dr Corrie received an American Australian Postdoctoral Fellowship in 2007 to work in Professor Nancy Kiviat's HPV Research Laboratory at the University of Washington in Seattle, gaining experience in developing clinically-relevant diagnostic technologies. Dr Corrie returned to Queensland as a lead chief investigator on an ARC Discovery Project and Smart Futures Fellowship to join Professor Mark Kendall's research group at AIBN, developing novel diagnostics technologies based on micropatches applied to the skin.

Key publications in the past five years:

Liang F, Lai R, Arora N, Zhang KL, Yeh C-C, Barnett GR, Voight P, Corrie SR, Barnard RT. (2012) Multiplex-microsphere-quantitative polymerase chain reaction: nucleic acid amplification and detection of microspheres. *Analytical Biochemistry* 422, 89-95 (Front cover image).

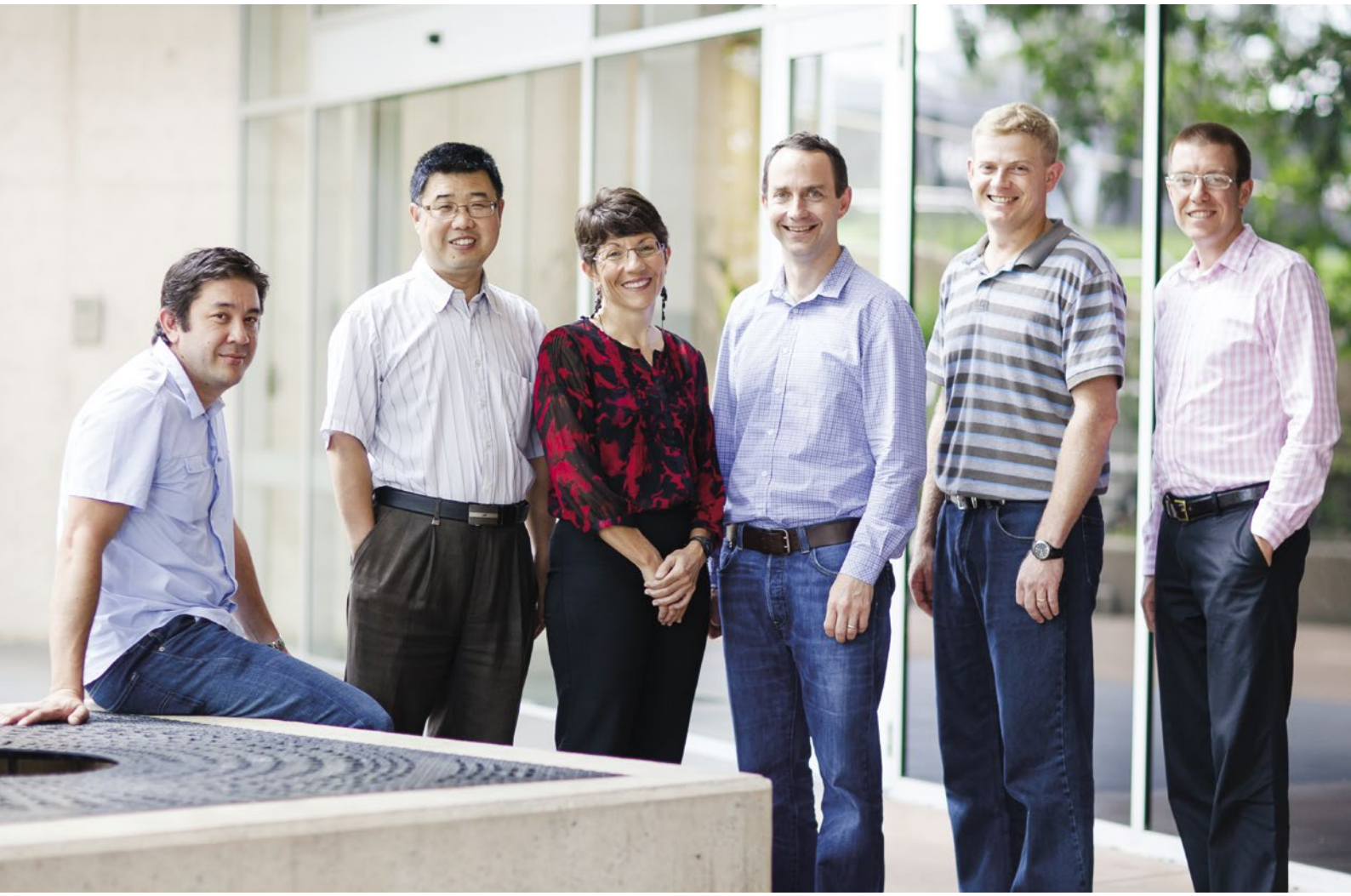
Bhargav A, Muller DA, Kendall MAF, Corrie SR. (2012) Surface modifications of microprojection arrays for improved biomarker capture in the skin of live mice. *ACS Applied Materials and Interfaces* 4, 2483-2489 (Front cover image).

Muller DA, Corrie SR, Coffey J, Young PR, Kendall MAF. (2012) Surface modified microprojection arrays for the selective extraction of the dengue virus NS1 protein as a marker for disease. *Analytical Chemistry* 84, 3262-3268 (To be featured in an upcoming issue of the American Chemical Society's *Chemical and Engineering News*).

Corrie SR, Fernando GJP, Crichton ML, Brunck MEG, Anderson CP, Kendall MAF. (2010) Surface-modified microprojection arrays for intradermal biomarker capture, with low non-specific protein binding. *Lab on a Chip* 10, 2655-2658 (Featured in Highlights in Chemical Technology series, October 2010).

Corrie SR, Sova P, Feng Q, Blair T, Kiviat NB, Trau M. (2011) Bisulfite-free analysis of 5MeC-binding proteins and locus-specific methylation density using a microparticle-based flow cytometry assay. *Analyst* 136, 688-691 (Front cover image).

Dr Simon Corrie



Dr Annette Dexter

Dr Trent Munro

Dr Annette Dexter

ARC Future Fellow and Associate Group Leader

Research: **Design and bioproduction of helical peptides as functional surfactants and responsive gelling agents for cell growth and drug delivery; specific ion effects in the control of self-assembling systems**

Dr Annette Dexter is a founder and ongoing consultant to AIBN's first start-up company, Pepfactants Pty Ltd.

At the TechConnect Summit in Boston in 2006, Pepfactants received an Emerging Technology Award. The company won the Queensland Government's Best Technology Award and the UQ Business School Enterprize Competition in the same year.

Dr Dexter is sole or joint inventor on three patents comprising the key intellectual property of Pepfactants. She has presented data at two national meetings of the American Chemical Society, the seventh World Congress of Chemical Engineering and the annual meeting of the American Institute of Chemical Engineers.

Reports in *Australasian Science*, *New Scientist*, *Materials Today* and *The Economist* have highlighted Dr Dexter's work and a video of rapid-phase emulsion separation has been receiving hits on YouTube.

Key publications in the past five years:

Fletcher NL, Lockett CV, Dexter AF. (2011) A pH-responsive coiled-coil peptide hydrogel. *Soft Matter* 7, 10210.

Dexter AF. (2010) Interfacial and emulsifying properties of designed -strand peptides. *Langmuir* 26, 17997.

Malcolm AS, Dexter AF, Katakdhond JA, Karakashev SI, Nguyen AV, Middelberg APJ. (2009) Tuneable control of interfacial rheology and emulsion coalescence. *Chem Phys Chem* 10, 778 (Front cover image).

Kaar W, Hartmann BM, Fan Y, Zeng B, Lua LHL, Dexter AF, Falconer RJ, Middelberg APJ. (2009) Microbial bio-production of a recombinant stimuli-responsive biosurfactant. *Biotech Bioeng* 102, 176.

Middelberg APJ, He L, Dexter AF, Shen H-H, Thomas RK. (2008) The interfacial structure and Young's modulus of peptide films having switchable mechanical properties. *J Roy Soc Interface* 5, 47.

Dr Trent Munro

Queensland Government Fellow and Associate Group Leader

Research: **Production of complex therapeutic recombinant proteins known as biologics or biopharmaceuticals and engineered scaffolds for stem cells**

Dr Trent Munro is a Queensland Government Fellow. He has given presentations at a large number of national and international conferences. He won UQ's Trailblazer competition in 2011 and was awarded the Sanofi-Aventis Vision Award for Better Health at the national final. Dr Munro obtained his PhD in protein biochemistry from UQ in 2001. He completed postdoctoral studies at the Department of Cell Biology, Harvard Medical School; and at the Wellcome Trust and Cancer Research UK Gurdon Institute, University of Cambridge. Dr Munro returned to Australia in 2006 to take up a position at AIBN, where he is an Associate Group Leader and a founding member of the National Biologics Facility. Dr Munro has published widely in the fields of mammalian cell therapeutics and stem cell bioengineering.

Key publications in the past five years:

Zhu J, Wooh JW, Hou JJ, Hughes BS, Gray PP, Munro TP. (2012) Recombinant human albumin supports single cell cloning of CHO cells in chemically defined media. *Biotechnol Prog* 28(3), 887-891.

Codamo J, Munro TP, Hughes BS, Song M, Gray PP. (2011) Enhanced CHO cell-based transient gene expression with the Epi-CHO Expression System. *Mol Biotechnol* 48(2), 109-115.

Prowse AB, Doran MR, Cooper-White JJ, Chong F, Munro TP, Fitzpatrick J, Chung TL, Haylock DN, Gray PP, Wolvetang EJ. (2010) Long-term culture of human embryonic stem cells on recombinant vitronectin in ascorbate free media *Biomaterials* 31(32), 8281-8288.

Jones ML, Seldon T, Smede M, Linville A, Chin DY, Barnard R, Mahler SM, Munster D, Hart D, Gray PP, Munro TP. (2010) A method for rapid, ligation-independent reformatting of recombinant monoclonal antibodies. *J Immunol Methods* 354(1-2), 85-90.

Pilbrough W, Munro TP, Gray PP. (2009) Intraclonal protein expression heterogeneity in recombinant CHO cells. *PLoS One* 4(12), e8432.

Dr Kristofer Thurecht

ARC Future Fellow and Associate Group Leader

Research: Design and synthesis of architectural polymers applied to molecular imaging and drug delivery in nanomedicine

Dr Kristofer Thurecht is an Australian Research Council (ARC) Future Fellow with appointments at AIBN and UQ's Centre for Advanced Imaging.

Dr Thurecht has been recognised for scientific excellence with a 2012 Queensland Young Tall Poppy Science Award and a 2010 UQ Foundation Research Excellence Award for his work in developing polymer 'theranostics'. Since obtaining his PhD in 2005, he has been the recipient of four competitive national and international fellowships, including an Australian Postdoctoral Research Fellowship in 2008; and simultaneous awarding of a British Ramsay Centenary Fellowship and an 1851 Research Fellow in the UK in 2007.

He has contributed scientific and review articles to various leading journals in his field, including invited articles in the Emerging Young Investigator issue of *Chemical Communications* and a Young Talent article in *Macromolecular Chemistry and Physics*. Dr Thurecht has been chief investigator on grants from various funding bodies, including ARC Discovery grants; ARC Linkage Grants, with international pharmaceutical company Eli Lilly; a National Health and Medical Research Council (NHMRC) grant; and funding from the Prostate Cancer Foundation of Australia. He is co-inventor on two patents.

Key publications in the past five years:

Coles D, Rolfe BE, Boase NRB, Veedu RN, Thurecht KJ. (2013) Aptamer-targeted hyperbranched polymers: Towards greater specificity for tumours in vivo. *Chem Commun* (Camb) 49(37), 3836-3838.

Thurecht KJ. (2012) Polymers as probes for multimodal imaging with MRI. *Macromol Chem Phys* 213, 2567-2572.

Boase NRB, Blakey I, Thurecht KJ. (2012) Molecular imaging with polymers. *Polymer Chemistry* 3(6), 1384-1389.

Munnemann K, Kolzer M, Blakey I, Whittaker AK, Thurecht KJ. (2012) Hyperbranched polymers for molecular imaging: designing polymers for parahydrogen induced polarisation (PHIP). *Chemical Communications* 48(10), 1583-1585.

Thurecht KJ, Blakey I, Peng H, Squires O, Hsu S, Alexander C, Whittaker AK. (2010) Functional hyperbranched polymers: Toward targeted in vivo 19F magnetic resonance. *Journal of the American Chemical Society* 132(15), 5336-5337.

Associate Professor Zhi Ping (Gordon) Xu

ARC Future Fellow and Associate Group Leader

Research: Clay nanomaterials for drug delivery and vaccines

Associate Professor Zhi Ping (Gordon) Xu is an Australian Research Council (ARC) Future Fellow (2013-2016). Since 2004, he has received several fellowships and awards, including an ARC Australian Postdoctoral Fellowship (2005-2007), an ARC Australian Research Fellowship (2008-2012) and the UQ Foundation's Research Excellence Award (2009).

Associate Professor Xu and his colleagues have received funding from the ARC and the National Health and Medical Research Council (NHMRC) totalling more than $5 million. Associate Professor Xu is an ARC and a NHMRC referee.

Key publications in the past five years:

Gu Z, Rolfe BE, Xu ZP, Campbell JH, Lu GQ, Thomas AC. (2012) Antibody-targeted drug delivery to injured arteries using layered double hydroxide nanoparticles. *Adv Healthcare Mater* 1, 669-673.

Zhu Y, Li Z, Chen M, Cooper H, Lu GQ, Xu ZP. (2012) Synthesis of robust sandwich-like SiO_2@CdTe@SiO_2 fluorescent nanoparticles for cellular imaging. *Chem Mater* 24, 421-423.

Gu Z, Rolfe BE, Thomas AC, Campbell JH, Lu GQ, Xu ZP. (2011) Cellular trafficking of low molecular weight heparin carried with layered double hydroxide nanoparticles in rat vascular smooth muscle cells. *Biomaterials* 32, 7234-7240.

Wong YY, Markham K, Xu ZP, Chen M, Lu GQ, Bartlett PF, Cooper HM. (2010) Efficient delivery of siRNA to cortical neurons using layered double hydroxide nanoparticles. *Biomaterials* 31, 8770-8779.

Gu Z, Rolfe BE, Xu ZP, Thomas AC, Campbell JH, Lu GQ. (2010) Enhanced effect of low molecular weight heparin carried by layered double hydroxide nanoparticles on rat vascular smooth muscle cells. *Biomaterials* 31, 5455-5462.

Ladewig K, Niebert M, Xu ZP, Gray P, Lu GQ. (2010) Efficient siRNA delivery to mammalian cells using layered double hydroxide nanoparticles. *Biomaterials* 31, 1821-1829.

Xu ZP, Niebert M, Porazik K, Walker TL, Cooper HM, Middelberg APJ, Gray PP, Bartlett PF, Lu GQ. (2008) Subcellular compartment targeting of layered double hydroxide nanoparticles. *J Control Release* 130, 86-94.

Dr Kristofer Thurecht

Associate Professor Zhi Ping (Gordon) Xu

STATE FELLOWS TO FURTHER INFECTION RESEARCH

Prestigious Queensland Government fellowships were awarded in 2012 to two researchers at AIBN, recognising work in diagnosing and treating infections.

Associate Professor Christine Wells

Dr Trent Munro

AIBN Associate Group Leader **Dr Trent Munro** received a fellowship to develop a treatment for invasive bacterial infection, using recombinant monoclonal antibodies that target bacteria, especially disease-causing, drug-resistant strains such as the golden staph superbug and group A streptococcus.

"The benefit of antibodies is that they are highly specific for their target," Dr Munro said. "It means they often have less side-effects and high rates of efficacy.

"The antibody molecules we produce essentially mimic proteins produced by the immune system. In this way they work synergistically with a typical immune response."

Dr Munro said superbugs had evolved to evade detection so the body's immune system did not adequately respond to fight them off. Antibody therapy could give the immune system a boost to enable clearance of the infection.

Antibiotics were becoming less effective against superbugs, but monoclonal antibodies, which have already been very successful in treating cancer and auto-immune diseases, may provide a new treatment.

Biologics, a new generation of therapeutics including antibodies, have shown great potential for treating infectious disease, accounting for five of the top 10 selling drugs worldwide.

"Antibiotic drug resistance is a major issue," Dr Munro said. "We hope that, within the next 12-18 months, we can come up with some proof of principle results, with pre-clinical studies to follow after that."

A Queensland Government Fellowship for AIBN Group Leader **Associate Professor Christine Wells** will support her research into ways to boost natural immunity to infectious diseases.

Associate Professor Wells will use the funding for an in-depth study of the genetic basis for a healthy immune system and the way the immune system recognises infection.

Her research group will use several research disciplines to identify the genes important to immune function, including stem cell biology; statistics and bioinformatics; molecular biology; and computer modelling.

"We want to know what the genetic basis for a healthy immune system is; what happens when these genes don't do their job; and, ultimately, how we can boost a healthy immune response."

The group focus is to identify a reaction in the body and help with early diagnosis.

"It is hard to diagnose some infections," Associate Professor Wells said. "There is a gap between the generalist symptoms most of us present with at a doctor's surgery and the specific tests needed to diagnose. I hope my work will make it easier for doctors to bridge that gap.

"I am very motivated to find ways of boosting natural immunity to infectious diseases. Infectious diseases are the number one killer world-wide, particularly of children under the age of five."

"Using nanotechnology, a delivery system represents the most advanced and promising way of treating various fatal diseases, such as neurodegenerative and cardiovascular diseases, cancers and infectious diseases."

Associate Professor Xu

Zhi Ping Xu

Dr Simon Corrie

ARC FELLOWSHIPS

Three AIBN researchers received Australian Research Council (ARC) fellowships in 2012 to further their work in enhanced the delivery of medicines, tissue repair and disease detection.

Materials scientist **Zhi Ping (Gordon) Xu** was awarded an ARC Future Fellowship to continue studies on layered double hydroxide nanoparticles to more effectively deliver medicines to patients with a range of diseases, including cancers.

Associate Professor Xu aims to engineer a nanoparticle delivery system using serum proteins to target diseased parts of the body, but leave healthy cells untouched. Clay nanoparticles will prevent a mass forming when the system is injected into the blood.

Associate Professor Xu expects the targeted delivery to reduce the side effects of broad-spectrum treatments such as chemotherapy, in which medicines flood the entire body and also destroy healthy cells.

One challenge is to slow the body's clearance rate, so it doesn't break down the nanoparticle until after the medicine has reached the diseased part.

Dr Jess Frith will use her ARC Discovery Early Career Researcher Award (DECRA) to determine the role of specific molecules in cell development, with potential application in repairing bones and cartilage in patients with osteoporosis, osteoarthritis or intervertebral disc degeneration.

Dr Frith will work in the tissue engineering and microfluidics lab of Professor Justin Cooper-White, combining cells with biomaterials to reconstruct body tissues.

"Regenerative medicine has the potential to transform medicine in the future but a major hurdle in achieving this is our ability to make cells behave as we want," she said.

"We are working with specific stem cells derived from people's bone marrow. They can be used to generate bone, cartilage, muscle and fat cells. The cells need to turn into the correct tissue type, but controlling this is difficult. We know stem cells are very sensitive to the environment around them."

Dr Frith will investigate whether molecules called microRNAs play an important role in how the response of cells to their environment determines cell development – and use biomaterials to see if they can influence the microRNAs.

Dr Jess Frith

Dr Simon Corrie will focus on a way to detect diseases without blood tests or lab analysis, using his ARC DECRA.

Dr Corrie will work in Professor Mark Kendall's lab to determine if technology used for vaccine delivery device the Nanopatch can be tailored for disease detection. The work combines materials chemistry with molecular biology.

Dr Corrie aims to prove that thousands of microscopic needles on a small polymer wafer can be used to quickly detect biomarkers that point to the presence of infectious diseases such as dengue fever and malaria.

The device will be designed to sit on the skin, draw in fluids to react with antibodies and reporter probes and turn a particular colour, similar to a litmus test, if biomarkers are present.

"Diagnostic tests are crucially important in many areas of medicine. Early and accurate diagnosis of disease has proven time and again to drastically improve outcomes and survival," Dr Corrie said.

Future Fellowship funding aims to address opportunity gaps for mid-career researchers and academics, many of whom would otherwise be lost to international competitors. The DECRA scheme aims to provide more focused support and create more opportunities for early career researchers.

GRANT TO DEVELOP INNOVATIVE NANOTECHNOLOGIES FOR BREAST CANCER

Professor Matt Trau will lead a $5 million multidisciplinary collaborative grant from the National Breast Cancer Foundation (NBCF), announced in 2012.

Professor Trau is the lead chief investigator of a project involving researchers in nanotechnology, epigenetics, oncology and pathology from around Australia.

The project will develop nanotechnology-based diagnostics, work to understand the epigenetics of breast cancer biology and move towards specialised treatment methods.

It builds on a $5 million NBCF-funded project researching novel strategies for predicting and controlling advanced breast cancer using nanoscaled epigenetic-based biosensors, dating from 2008.

The new funding will secure the project until 2018 and allow for continued collaborations with high-calibre domestic and international scientists.

As well as UQ, the project will include Queensland Health, the Garvan Institute of Medical Research, the University of Newcastle, the Peter MacCallum Cancer Centre, Haematology and Oncology Clinics of Australasia, the Royal Brisbane and Women's Hospital and Holy Spirit Northside Hospital.

The new funding will support clinical trials, with researchers collecting biopsy and serum samples to determine how cancerous tumours respond to chemotherapy.

Professor Trau said new technology would be used to evaluate epigenetic biomarkers during a patient's treatment, enabling researchers to track the tumours.

Diagnostic devices and processes for breast cancer screening would be developed and researchers would move towards introducing them in certified clinical pathology labs, he said.

The research will build on work in the past four years that discovered epigenetic changes in the human body that pointed to the presence of breast cancer.

NBCF Director of Research Investment Dr Alison Butt said large-scale, collaborative research projects were important in accelerating progress in breast cancer research.

"Bringing scientists together across multiple disciplines is critical to provide new perspectives on current clinical challenges in breast cancer treatment," she said.

"The NBCF is delighted to fund this exciting research program that has great potential to make a significant impact on those living with a diagnosis of breast cancer and their families."

PHILANTHROPY ADVANCES AIBN RESEARCH

Grants from philanthropic organisations are supporting AIBN endeavours in biologics and stem cell research, with applications in regenerative medicine and therapeutics.

The JEM Research Foundation, a private philanthropic organisation, provided AIBN postdoctoral researcher Celena Heazlewood with funding to continue her stem cell research in 2012.

It enables Ms Heazlewood to work with amniotic membrane derived mesenchymal stem cells (MSC) in the lab of AIBN Associate Professor Christine Wells.

The cells can be steered to turn into different tissue types, specifically bone and cartilage. They show promise as a therapy for injured and inflamed areas of the human body.

"These cells are promising for cellular therapy because they can differentiate into mesodermal lineage to form bone and cartilage and can migrate to sites of inflammation and injury without the need for immune suppression," Ms Heazlewood said.

"However, identification of specific markers and their use in isolating these cells remains elusive. My aim is to identify and characterise the core MSC biomarkers."

AIBN has also received funding from the Alister Rodgers Memorial Fund to produce a batch of high-quality monoclonal antibody, used to finalise pre-clinical and animal studies to determine its efficacy as a therapeutic for the deadly Hendra virus.

The antibody production has been approved by the family of Dr Rodgers, who was the first person to receive the antibody in a desperate bid to save his life. Dr Rodgers died of Hendra virus in 2009, after his work as a vet brought him in contact with an infected horse.

AIBN's state-of-the-art biologics facility has the capability to produce high-quality therapeutic monoclonal antibody protein for the pre-clinical and animal studies.

AIBN Director Professor Peter Gray said the funding greatly enhanced understanding of the therapeutic potential and development of the antibody.

Professor Gray said the antibody was a protein-based therapeutic manufactured by cell culture, rather than through a chemical synthesis.

The antibody remained an experimental therapeutic and Hendra virus was not used at any stage of the production, he said.

It was an honour for AIBN to be given the chance to continue research in the field using money from the memorial fund, Professor Gray said. "People's fundraising money is now going to be used at the front line of disease research."

The Alister Rodgers Memorial Fund honours the life of Dr Rodgers and was established through UQ's School of Veterinary Science, at the request of his family, to raise money for research into Hendra virus.

AIBN was established with financial support from Atlantic Philanthropies and the Queensland Government.

Celena Heazlewood

RECOGNITION FOR AIBN'S INNOVATIVE RESEARCHERS

Research at AIBN in vaccine delivery, polymeric imaging, nanocomposite membranes and high-performance catalysts was recognised in 2012. The awards acknowledge work in the lab and moves to progress research towards commercial outcomes.

Chinese state leaders presented UQ Senior Deputy Vice-Chancellor (Research) and AIBN Group Leader **Professor Max Lu** with a prestigious science and technology award in 2012.

President Hu Jintao, Premier Wen Jiao Bao and vice premiers Li Keqiang and Liu Yandong presented Professor Lu with the accolade at a ceremony in the Great Hall of the People in Beijing. Professor Lu, an international nanotechnology expert, was among six laureates recognised for their "distinguished and sustained contributions to collaboration with China in science and technology".

Professor Mark Kendall was one of only five recipients globally of a prestigious Rolex Laureate, recognising pioneering efforts to expand knowledge and improve human life.

Professor Kendall is the driving force behind developing needle-free vaccine delivery device the Nanopatch.

The $100,000 prize money will be used to conduct a field trial in Papua New Guinea, following the patch's first human trials in Brisbane with blank Nanopatches (without vaccine) in volunteers. It aims to assess the patch and applicator's usability under developing-country field conditions, as a pre-cursor to potential clinical trials.

Polymer chemist **Dr Kristofer Thurecht** was recognised for scientific excellence with a 2012 Queensland Young Tall Poppy Science Award.

Dr Thurecht's award celebrates Australian intellectual and scientific excellence and encourages younger Australians to follow in the footsteps of outstanding achievers.

He will use the award to explain his work in developing polymeric imaging devices, which aim to simultaneously diagnose and treat diseases such as cancer, though engagement activities such as school visits.

Professor Mark Kendall was named Young Alumnus of the Year at UQ's annual alumni awards.

The awards recognise UQ alumni who have achieved outstanding success in their fields and made exemplary contributions to their communities.

Work on developing high-energy batteries that keep smart phones charged longer has earned **Dr Da-Wei Wang** a UQ Foundation Research Excellence Award.

The award is designed to nurture early career researchers across UQ and support the continuation of their work.

Dr Wang will use funding associated with the award to investigate how to create nanocomposite membranes made up of functionalised nanocarbons and polymers. He will also study the ionic conductivity and mechanical strength of the new solid electrolytes.

Materials scientist **Dr Li Li** was the recipient of a Queensland International Fellowship to travel to China to cement a collaboration with Chinese Academy of Sciences researchers.

Her collaboration involves developing a high-performance catalyst to reduce volatile organic compound emissions from cars.

Assisting Dr Li in developing a catalytic oxidation process is Professor Zhengping Hao from China's Research Center for Eco-Environmental Sciences.

Dr Chamindie Punyadeera also received a Queensland International Fellowship, which will support developing strategic alliances with leaders in the field of saliva-based early diagnostics for cancer.

She is working to replace blood tests with quicker, easier saliva tests for early disease diagnosis, by screening a patient's saliva to determine if their DNA contains markers that point to potentially cancerous cells.

The fellowship will enable Dr Punyadeera to develop alliances with leading research institutes the John Hopkins Hospital; the Albert Einstein College of Medicine and Cold Spring Harbor Laboratory in New York, US; the University of California in Los Angeles; and Philips Electronics in the Netherlands.

Dr Linda Lua was recognised in Portugal at the international conference Vaccine Technology IV.

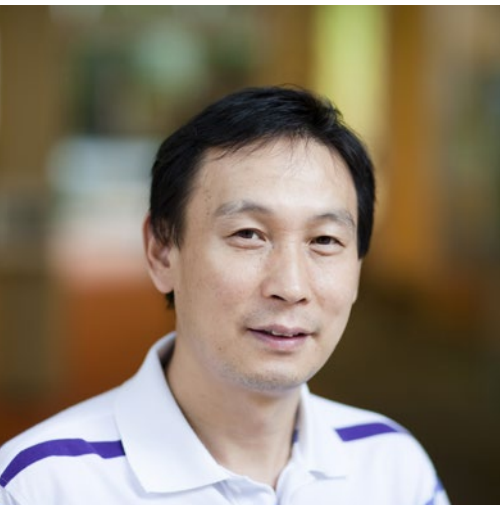
Dr Lua, who directs UQ's Protein Expression Facility at AIBN and collaborates with AIBN's Professor Anton Middelberg on the virus-like particle vaccine platform, was the conference's poster winner.

AIBN students were recognised with a host of prestigious awards and scholarships during 2012. They are detailed in the Student Experience section of this report.

Professor Mark Kendall

SENIOR RESEARCHERS DEPART

Dr Krassen Dimitrov



Associate Professor Aijun Du

AIBN has farewelled two senior researchers in 2012. Dr Krassen Dimitrov started a company to advance his research for market. Associate Professor Aijun Du continues to collaborate with AIBN after accepting a specialist position at another computational modelling lab in Queensland.

Associate Professor Aijun Du accepted a continuing position at the School of Chemistry, Physics, Mechanical Engineering, Energy and Process Engineering at Queensland University of Technology (QUT).

Associate Professor Du is a leader in research on computational modelling of materials for clean energy and nanoelectronics. He will work closely with experimentalists in the field at QUT and continue his close collaborations with Professor Max Lu's and Professor Debra Bernhardt's AIBN research groups.

While at AIBN, he was an Associate Group Leader and Australian Research Council (ARC) QEII Fellow, working closely with Group Leaders Professor Bernhardt and Professor Sean Smith.

Density functional theory, molecular dynamics and Monte Carlo simulations are used in Associate Professor Du's research to examine materials such as nanotubes, nanoribbons and nanodots for application as fuel cells; hydrogen storage; carbon dioxide capture, storage and conversion; gas separation; charge and spin transport; spin and magnetism; solar photovoltaics; and photocatalysis.

One of Associate Professor Du's joint research projects with AIBN is focused on developing hydrogen storage materials. The work involves Yu Huize from Professor Bernhardt's research group, who has support from the China Scholarship Council to study in Australia as a joint PhD student with Harbin Institute of Technology.

Promising results are also being shown in continued joint research projects on magnetism and carbon dioxide sequestration.

Group Leader **Dr Krassen Dimitrov** left AIBN to become principal of spin-off company Digital Diagnostics and advance research towards a diagnostic reader for the market.

Digital Diagnostics aims to develop devices capable of detecting metastasising tumours or monitoring treatment of life-threatening blood clots or brain haemorrhages.

Dr Dimitrov spent six years at AIBN working through a "proof of principle" stage for the devices, which combine biochemistry and nanoscience by measuring enzymes found in blood. Some of the enzymes degrade blood clots, while others degrade a protective cellular matrix.

A metastasising tumour will degrade the links of the matrix to invade new tissues, so detecting the enzyme in blood is an indication of the spread of a tumour.

In the brain, the cellular matrix holds cells together to form a protective barrier around blood vessels. Breaking the barrier is a prerequisite for bleeding in the brain and can be detected with the same test.

Dr Dimitrov said the digital diagnostic device had been designed so a drop of blood on a strip could be inserted and a diagnostic reading provided within a minute.

"The target is for point-of-care applications," he said. "We want to provide doctors with tests that provide high sensitivity and accuracy that can be performed anywhere – not just in a lab."

Dr Dimitrov will continue to collaborate with AIBN researchers, with plans to develop a highly multiplexed single molecule barcoding system based on electrical detection.

Commercialisation activities and industrial engagement

Translating cutting-edge research into commercial outcomes and societal benefits is core to the AIBN mission.

Successful commercialisation is not the final step in a linear process, but is ongoing and iterative.

At AIBN, active engagement with commercial partners and potential collaborators facilitates mutual awareness and ensures research is aligned with 'real world' challenges.

AIBN's engagement with industry is multi-faceted, including collaborative research projects; consulting; commercial contracts; and networking through the Industrial Affiliates Program (IAP).

Where there is no established or accessible company for AIBN's technology, the institute nurtures the creation of start-up companies.

Highlights of AIBN's commercialisation and industrial engagement activities during 2012 are described in this section.

AIBN's commercialisation activities are led by a strong team, consisting of embedded UniQuest personnel Dr Aoife Cullen (Manager of Innovation and Commercial Development (MICD), biotechnology), Dr Phil Nelson (MICD, nanotechnology) and patent manager Michiyo Matsuda, along with AIBN Deputy Director (Commercialisation) Dr Ian Nisbet.

DEVELOPING NEXT-GENERATION SMART MEDICINES

AIBN is part of an international collaboration working towards a fully integrated biotechnology industry in Queensland, including developing next-generation smart medicines.

Dutch pharmaceutical manufacturer DSM Biologics is operating Australia's first global, high-tech contract manufacturing facility using mammalian cells for biologic medicines and therapeutics at a $65million scale-up facility in Brisbane.

The company indicated one of the critical factors in its decision to invest in Queensland was the research facilities and expertise available at AIBN.

AIBN received $485,000 in Queensland Government research partnership funding in 2012 to build on the strategic link with DSM. It laid the groundwork for a collaboration in which AIBN develops biologic medicines and DSM produces them at the new scale-up facility at the Princess Alexandra Hospital, constructed using Federal Government funding.

Previous Queensland Government funding was used to establish BioPharmaceuticals Australia Pty Ltd (BPA), underpinned by the establishment of the National Biologics Facility at AIBN and leadership and support from UQ.

Through the partnership with DSM Biologics, BPA will bridge the chasm between the fundamental discovery of potential biopharmaceuticals and biologics, and the ability to prepare clinical grade material for human trials.

Biologics are medicines based on natural proteins made using DNA technology, offering exciting new treatment options for a wide range of diseases including cancer and auto-immune disorders.

They offer the only known potential treatment for Hendra virus infection.

AIBN Director Professor Peter Gray said the collaboration was fitting recognition of the skill base and facilities developed in the state and provided a capability to develop next-generation smart medicines in Queensland for the first time.

"Having DSM operating a scale-up facility in Brisbane means Queensland research can be taken from the lab, through manufacturing, to the market," Professor Gray said.

"Researchers want their work to make a difference to the lives of people outside the lab. Working on biologics at AIBN is about bringing about improvements in human health."

It will allow biopharmaceuticals to be produced, clinically tested and manufactured in one location, with a focus on cervical and breast cancer; melanoma; liver and kidney disease; malaria; HIV; osteoporosis; obesity; arthritis; and diabetes.

Considered to be at the forefront of biomedical research, biologics are created by biologic processes rather than being chemically synthesised. Biologics-based medicines now account for 17 per cent of total global therapeutic sales.

DOW CHEMICAL COMPANY AND AIBN JOIN FORCES

AIBN and the Dow Chemical Company have built a research alliance that unites AIBN's research expertise with Dow's market knowledge.

With the plastics industry almost exclusively dependent on fossil fuel feedstocks, escalating oil costs, concerns about carbon dioxide emissions and global warming make it imperative to develop new manufacturing processes.

AIBN's research excellence in metabolic engineering and polymer chemistry make an ideal fit with Dow's position at the forefront of sustainable chemistries.

Since the research alliance was announced in late 2007, AIBN and Dow have signed two contracts worth more than $500,000, enabling contract research in synthetic biotechnology investigating the feasible production of new, bioderived chemical building blocks.

More recently, AIBN and Dow successfully initiated two Australian Research Council (ARC) Linkage grants. The projects cover extreme UV lithography and fermentation routes to propionic acid and other C3 monomers. The projects involve regular interaction between AIBN scientists and their counterparts in Dow business units.

AIBN research to develop a new generation of materials for electronics components, such as computers, smart phones and hand-held devices, will involve Professor Andrew Whittaker and Associate Professor Idriss Blakey.

Professor Lars Nielsen and Dr Jens Kroemer will use advances in biosciences to genetically reprogram bacteria to produce the chemical building blocks of the future.

AIBN was also heavily involved in creating and establishing the Dow Centre for Sustainable Engineering Innovation at UQ in 2012.

The centre brings together cutting-edge research expertise in energy, water and carbon sustainability with world-class science and engineering education, funded through a Dow contribution of $10 million for the next six years. It is the first time Dow has signed such an agreement outside the US.

The new centre will pursue an imaginative program of research and collaboration aimed at harnessing solutions designed to confront major sustainability challenges of the 21st century.

The centre will feature labs at AIBN and collaboration with UQ's Global Change Institute and the School of Chemical Engineering.

AIBN Director Professor Peter Gray said the Dow collaboration gave the institute's researchers a real opportunity to progress their life's passions beyond the confines of the lab to potential commercial outcomes.

VACCINE DELIVERY AT CORE OF LICENSING AGREEMENT

Pharmaceutical giant Merck has licensed a technology originating from AIBN to explore its use for delivery of an important vaccine.

Under the licence agreement signed in 2012, Merck will fund an extensive development program to explore the use of vaccine delivery device the Nanopatch.

The Nanopatch has thousands of small projections designed to deliver a dry-coated vaccine to abundant immune cells in the skin.

Nanopatch delivery can improve the efficiency of vaccines, including pre-clinical work achieving protection against influenza, with only 1/100th of the dose used with a traditional needle and syringe.

It is designed for thermostability and, because it is used with dry-coated vaccine, may not need refrigeration, potentially making transport much cheaper and easier, particularly to developing nations.

Nanopatch inventor and AIBN Group Leader Professor Mark Kendall said the Merck partnership had the potential to accelerate the process of delivering a revolutionary health technology to people throughout the world and lead to the relief of serious health problems.

In the immediate term, would employ more people in Brisbane's innovation economy and boost the global reputation of Queensland and Australian research and development, he said.

"It is exciting to start this important partnership – a big step forward towards the Nanopatch becoming a vaccine delivery product," Professor Kendall said.

"This directly builds on intensive and outstanding research on the Nanopatch, conducted by my research group at AIBN, taking the Nanopatch from an idea to achieving unprecedented immune responses in animals. Our research has been supported by competitive research grants from both the Australian and Queensland governments."

The Nanopatch technology is being developed by spin-out biotechnology company Vaxxas, with Professor Kendall involved as company founder, director and chief technology officer.

Professor Kendall co-founded Vaxxas in 2011 with a $15 million investment from Australian and US investors to advance the Nanopatch towards clinical testing and product development.

UQ's main commercialisation company, UniQuest, led the Nanopatch technology's initial commercialisation before Vaxxas was created.

Through the Merck partnership, Vaxxas will be eligible to receive payments for up to two additional vaccines developed by Merck using the Nanopatch platform; milestone payments on Merck vaccine development and regulatory approvals; and royalties on sales of any Merck vaccines that ultimately use the Nanopatch platform.

Dr Simon Corrie, Dr Michael Crichton and Professor Mark Kendall

Tim Brennan

INTERNATIONAL COMPANIES ON BOARD WITH BIO JET FUEL RESEARCH

AIBN Group Leader Professor Lars Nielsen has a pivotal role in a collaboration aiming to make Queensland a leader in cleaner, greener aviation fuel production, which entered a new phase in 2012.

Queensland Government funding to the Queensland Sustainable Aviation Fuels Initiative in 2012 will progress AIBN research to turn sucrose from sugarcane into an advanced aviation biofuel. It will also be used to investigate a business case for the technology.

The business case will investigate issues such as site requirements and scale of production on behalf of potential investors. It will assess whether diversifying and adding new products such as advanced biofuels would make economic sense for the sugarcane industry.

The initiative's new phase involves AIBN working with Boeing Research & Technology – Australia, GE, Mackay Sugar Ltd and IOR Energy.

It builds on AIBN research, conducted with $6.5 million in previous support from the Queensland Government, UQ and industry partners, which showed promising early results in use of sucrose fermentations to produce advanced biofuels.

Researchers used systems and synthetic biology techniques to improve the performance of microbial production strains in the process.

Success would allow the sugar industry to diversify its product portfolio, with the potential for a fermentation facility to be established near Australian sugarcane fields.

Professor Lars Nielsen said there was a clear focus on "delivering real benefits to Queensland".

"The overall aim of the multi-stage program is to manufacture sustainable aviation fuel components from Queensland sugarcane, supply the aviation fuel market in Australasia and help seed a strong and sustainable domestic advanced biofuel industry," he said.

Economics and sustainability are important because aviation fuels account for 5 per cent of the world's transport fuel use and 15 per cent of Australia's transport use.

Unlike ground transport, where electric or hydrogen cars can be used, aviation will continue to depend on liquid fuels that have a high energy content.

FUNCTIONS SHOWCASE RESEARCH AND INDUSTRY COLLABORATIONS

The value of the Industrial Affiliates Program (IAP) as a vehicle for engagement and networking was confirmed at three events in 2012: the third and fourth gatherings in the AIBN Thought Leaders' Dinner Series and a new end-of-year Showcase and Network Function.

The events attracted a strong contingent of senior members of AIBN staff and guests representing executive management from domestic and international companies, government departments and university leaders.

They also demonstrated the support for AIBN and its industrial engagement initiatives from the guest speakers, who brought to the occasions their well-considered thoughts and their prestige and prominence as leaders in their fields.

Events linked to the IAP provide members with exclusive networking opportunities, bringing together key representatives from the fields that will derive the greatest benefit from collaboration.

The successful Thought Leaders' Dinner Series continued with events in March and July. Each featured guest speakers, question-and-answer sessions and significant discussion among diners.

Lucy Turnbull, AO, spoke on March 15 about her role as chairman of cell therapy company Prima Biomed, which is developing new immunotherapy for treating ovarian cancer, and the development and commercialisation of science.

On July 12, Resmed chairman and chief executive officer Dr Peter Farrell shared insights on the creation and development of Resmed and offered his thoughts on entrepreneurship and innovation, based on his success as an academic, large company executive and entrepreneur.

About 75 people were at AIBN on November 22 to hear details from three senior researchers about projects that exemplified the institute's focus on outcomes delivering benefits to industry and society. The three presentations were part of the IAP's Showcase and Network Function.

The session was prefaced by introductory remarks from UQ Vice-Chancellor Peter Høj, who reinforced the need for a link between academia and industry as a key to innovation and gains in productivity.

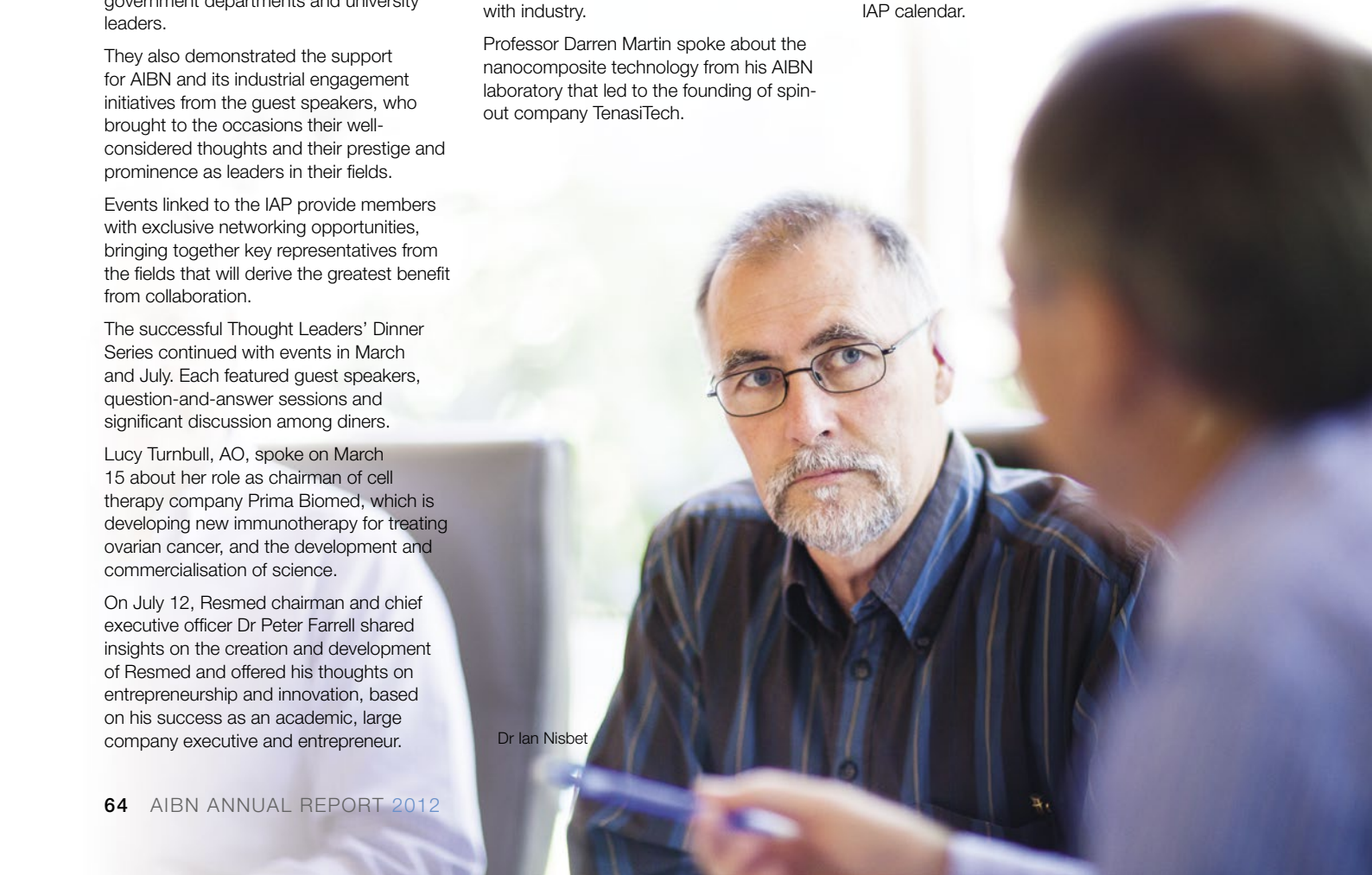
Queensland MP Dale Shuttleworth then described his interest in, and enthusiasm for, scientific research. He noted the Queensland Government's strong support and praised AIBN for its efforts to engage with industry.

Professor Darren Martin spoke about the nanocomposite technology from his AIBN laboratory that led to the founding of spin-out company TenasiTech.

Dr Claudia Vickers described the work on developing biofuels in Professor Lars Nielsen's research group, using metabolomics to sucrose from Queensland sugarcane into jet fuels for the 21st century as part of a larger project involving partners from the aviation, energy and sugar industries.

Associate Professor Christine Wells provided an overview of her work, speaking about the web portal Stemformatics and its important role in providing stem cell researchers around the world with a database of experiments describing animal and human stem cells and how they differentiate.

Based on the function's success, AIBN has decided to make it an annual event on the IAP calendar.



Dr Ian Nisbet

AIBN has a wealth of know-how and intellectual property derived from its team of leading-edge researchers who are committed to translating their research outcomes into processes and products to address human health, industrial and environmental problems.

BUILDING LINKS WITH INDUSTRY

The Industrial Affiliates Program (IAP) is designed to bring AIBN and industry closer together; for partner companies to obtain awareness of – and access to – AIBN's research and expertise; and for the institute to improve the industrial relevance of its research programs through direct engagement with IAP members.

The IAP has been operating for just over two years and has 20 member companies, ranging from large multinationals to small domestic start-up companies. The IAP provides a project-independent basis for interaction between AIBN and industry, with the ultimate identification of collaborative projects one of the program's critical success factors.

The IAP also provides educational and networking opportunities for its members, such as the successful Thought Leaders' Dinner Series, which are attended by senior industry executives, representatives of government departments and university leaders.

AIBN Director Professor Peter Gray said the IAP's activities reflected the institute's commitment to promoting and developing the growth of innovative industries; and ensuring research does not remain at the laboratory bench, but is translated into positive outcomes.

"AIBN's focus is on developing enduring relationships with Australian and international industry, underpinning a vibrant innovation economy in Queensland and Australia," he said.

"The IAP allows companies to make the most of the facilities and capabilities AIBN has available to support their growth and innovation."

Brisbane-based Very Small Particle Company Ltd (VSPC) has been involved with the IAP since 2010.

VSPC chief technical and operations officer Dr Shelley Brown-Malker said the IAP provided an opportunity to engage with academic and industrial contacts at events organised to showcase commercially-relevant technological innovation.

"The program provides VSPC with access to the expertise AIBN offers, including state-of-the-art materials characterisation tools and highly competent technicians and scientists," Dr Brown-Malker said.

"Being a small company, access to the type of external expertise AIBN can provide is crucial to the commercial development of VSPC's technology."

The IAP offers multiple avenues through which members can interact with AIBN.

While the extent of member benefits varies according to the level of membership, all members obtain access to exclusive networking events; invitations to seminars, symposia and conferences organised by AIBN; the opportunity to nominate suitably qualified peoples as Academic Adjuncts of UQ; and access to AIBN public disclosures. IAP members receive acknowledgement and recognition of their membership in AIBN's Annual Report and on the membership board in the AIBN foyer. Premier members are also acknowledged at selected AIBN functions and events.

Premier members and Members receive a customised IAP access package. It includes an initial consultation with relevant AIBN personnel, along with substantial discounts on fees charged for subsequent consulting advice from AIBN personnel and access fees for AIBN-managed facilities.

The IAP is designed to cater for small, medium and large companies. The program offers three levels of membership. They are:

Premier member:
This level of membership affords major engagement with AIBN. Companies receive the greatest level of flexibility and options when interacting with institute researchers. That translates as more opportunities to benefit from the ideas, expertise and capabilities at AIBN.

The level of engagement is most suitable for an organisation looking to aggressively drive research and development activities in areas where access to state-of-the-art facilities and know-how is critical to its mission. Companies can become premier members of the IAP by applying for membership via the AIBN prospectus or by entering into a major, strategic or financially significant collaborative project with AIBN.

Member:
Members are offered a high level of engagement with AIBN and opportunities to interact directly with groups and facilities within AIBN. This level of engagement is most suitable for a small to medium enterprise seeking to augment its in-house activities with access to know-how and facilities.

Associate member:
Associate member is an entry level membership designed to give companies an introduction to the breadth and depth of AIBN. Associate members have opportunities to interact with AIBN researchers and explore the range of services and capabilities offered. Associate membership is available to select non-research organisations, such as service providers operating in areas relevant to AIBN, whose primary interest is access to IAP networking functions.

www.aibn.uq.edu.au/aibn-industrial-affiliates-program

Industrial Affiliate Program members

- Agilent Technologies Australia Pty Ltd
- Alere Australia Ltd
- Allied Healthcare Group
- Anteo Diagnostics Ltd
- Australian Red Cross Blood Service
- BCS Innovations Pty Ltd
- BioPharmaceuticals Australia (Network) Pty Ltd
- CBio Ltd
- Cellestis Ltd
- Cochlear Ltd
- Creative Polymers Ltd
- The Dow Chemical Company
- DSM
- Hospira Adelaide Pty Ltd
- Intel Corp
- Magnetica Ltd
- Patrys Ltd
- PharmaSynth Pty Ltd
- Queensland Clinical Trials Network Inc
- Unilever
- Very Small Particle Company Ltd
- William A Cook Australia Pty Ltd

AIBN START-UP COMPANIES

AIBN has established an enviable track record in developing products and creating companies based on AIBN technology. Start-up companies have been formed across diverse fields including drug delivery, vaccines and advanced materials.

During 2012, four start-up companies operated largely or exclusively out of AIBN. Institute researchers founded three companies to develop AIBN technology, while ACYTE, founded by Professor Peter Gray, was brought to AIBN from UNSW.

The start-up companies are distinct entities, with their own management structures, boards and finances. AIBN provides facilities, equipment and, through UQ's commercialisation company UniQuest, a level of specialist support, such as management of patents and commercial advice. Institute researchers are intimately involved with the companies, ensuring a close connection between ongoing research within AIBN and development and commercialisation of each company's technology.

Vaxxas Pty Ltd

Vaxxas was founded in 2011 to develop and commercialise the Nanopatch technology created in AIBN Professor Mark Kendall's laboratory. Nanopatch is a novel, needle-free means of delivering vaccines via the skin. Animal studies demonstrated a Nanopatch can deliver 100 times less vaccine compared to conventional vaccine delivery and still achieve an effective immune response.

Vaxxas received strong backing from a syndicate of venture capital investors, comprising One Ventures, Medical Research Commercialisation Fund, Brandon Capital and Healthcare Ventures, with a commitment of $15 million in Series A financing. It has also entered into a research partnership with Merck and Co, a major international pharmaceutical company in the vaccine business. Vaxxas is extremely well placed, financially and technically, to lead development of the next generation of vaccine delivery.

TenasiTech Pty Ltd

TenasiTech is an advanced materials technology company, arising from research in AIBN Professor Darren Martin's laboratory. TenasiTech develops nanocomposites and nanofillers, improving the mechanical properties and performance of polymers such as polyurethanes and acrylics. The company was founded in 2007 and financed through an investment from Uniseed and grants from the Queensland Government and Commercialisation Australia.

TenasiTech has demonstrated that incorporating its 'adaptive polyols' and masterbatches to polyurethanes and acrylics leads to substantial improvements in strength, flexibility, dimensional stability, thermo-stability and scratch resistance. The technology has the potential to deliver tangible and valuable improvements to a wide range of moulded or extruded products and foams. TenasiTech is collaborating with domestic and international companies to identify and develop the most compelling applications for its technology.

Pepfactants Pty Ltd

Pepfactants is a materials science company developing a novel class of reversible surfactants based on patented research from AIBN's Professor Anton Middelberg and Dr Annette Dexter. The company uses helical peptides with the unique ability to reversibly stabilise or break emulsions and foam by controlling the interfacial layer's behaviour.

The Pepfactants technology has potential applications in industrial and pharmaceutical settings. Initial efforts have focused on industrial applications, such as use in the oil industry. For example, the switchable surfactants could be used to improve the yield of oil from wells, thereby increasing the well's profitability or life cycle.

ACYTE Biotech Pty Ltd

ACYTE was founded by Professor Peter Gray at UNSW as a vehicle for developing and commercialising cell culture technologies created in his laboratory. When Professor Gray was appointed AIBN's founding director, he moved ACYTE and integrated its activities into his AIBN research group.

ACYTE is focused on enhancing the productivity and yield of high-value products from Chinese hamster ovary (CHO) cells. ACYTE's proprietary technologies in CHO cell expression allow for rapid generation of recombinant protein for early drug development studies, and the generation of highly-productive CHO cell lines for therapeutic production of recombinant protein.

The company conducts fee-for-service activities and licences its technology to clients. ACYTE's co-location with the National Biologics Facility at AIBN leverages the pre-eminent skills and equipment of the Gray research group.

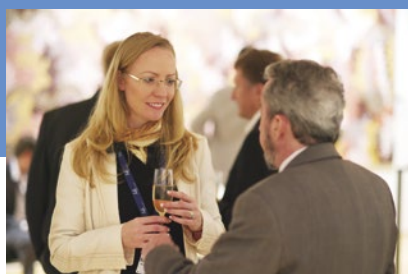
www.aibn.uq.edu.au/startups

International collaborations

INTERNATIONAL COLLABORATIONS

Engagement with collaborators internationally is critical to AIBN's success. They fulfill multiple objectives, including:

- ensuring AIBN research is relevant and competitive on the world stage;
- encouraging the growth and development of AIBN personnel through two-way exchanges of people and ideas;
- raising the institute's international profile as a means of attracting potential international students and employees;
- accessing financial support and facilities unavailable, or not readily accessible, in Australia;
- providing training and development for international scientists in cutting-edge technologies;
- supporting Australia's aid programs to less developed countries; and
- establishing links with potential commercial partners.



Alexandra Depelsenaire

Professor Kirill Alexandrov, Professor Chris Lowe and Petrina Gilmore

Professor Michael Monteiro, Dr Ezio Rizzardo and Associate Professor Cyrille Boyer

During 2012, AIBN was involved in an extensive range of international collaborations, including a biofuel study with the US Navy, research into spinal cord injuries with Canadian surgeons and vaccine development projects with South-East Asian and Pacific Rim countries.

It is part of ongoing engagement with industry leaders, researchers and academic partners in 33 countries, including China, India, Indonesia, Brazil, Chile, the US, Canada, South Africa, Spain, Italy, France, Germany, Finland and the UK.

AIBN's international collaborations have totalled more than 280 since 2004 and include work with industry partners such as The Dow Chemical Company, Boeing, Intel, Merck and Amyris.

Academic links have been made with the National Institute for Materials Science in Japan; the University of California in the US; and the University of London in the UK.

AIBN's project-based international collaborations were complemented by two major international conferences in Brisbane in 2012.

The first was an AIBN-initiated and managed event, the first International Conference on BioNano Innovation (ICBNI), on July 19-20. AIBN Deputy Director (Nanotechnology) and Group Leader Professor Matt Trau chaired the conference.

Also held in 2012 was the first International Conference on Emerging Advanced Nanomaterials (ICEAN), hosted by AIBN and chaired by Group Leader Professor Ajayan Vinu. ICEAN 2012 was on October 22-25.

COMPUTATIONAL MODELLING AT THE CORE OF GLOBAL NETWORKING

Computational modelling has opened the door to new insights for AIBN Professor Anton Middelberg's research group and laid the foundations for ongoing collaboration with institutions in China and Germany.

Dr Natalie Connors

The collaborations aim to add fundamental insight into biomolecular interactions and open new product and process design opportunities.

Queensland Government National and International Research Alliances Program funding in 2010 provided support for the research group to employ computational modelling to further work in vaccine development.

Since then, an Australian Research Council (ARC) Discovery Grant has enabled modelling work to be introduced in another of Professor Middelberg's research areas: tailoring industrial biosurfactants.

The funding enabled the establishment of relationships with Tianjin University in China and Karlsruhe Institute of Technology (KIT) in Germany, with researcher exchanges, joint PhD supervision and vital sharing of skills and knowledge.

Vaccine development

Dr Natalie Connors is heading the computational bioengineering theme for Professor Middelberg's research group and uses modelling to simulate how antigenic proteins taken from viruses, such as influenza, are presented when placed on virus-like particles (VLPs). The work can also be applied to viruses such as Group A Streptococcus and Hendra virus.

VLPs are the shells of a virus designed to elicit a strong immune response while being inherently safe because they contain no viral genetic material.

Dr Connors is working closely with a group headed by Tianjin University's Professor Yan Sun, a world leader in the simulation of bioprocessing.

The collaboration is built on a memorandum of understanding with Tianjin University, negotiated through UQ's Confucius Institute, and links AIBN to a partner with expertise in vaccine manufacturing in the country with the largest global vaccine market.

"Computational modelling assists us in understanding the fundamentals of biomolecular interactions for our modular VLP platform," Dr Connors said. "It helps us appreciate what antigenic peptides will look like on the VLP. That is important because if the peptide is not the same as in the native virus, it may not illicit the appropriate immune response."

The collaboration has already resulted in three visits by the UQ vaccine team to China, return visits from the Tianjin University collaborators, two joint publications in *The Journal of Physical Chemistry B* and Professor Sun's presentation at AIBN's first International Conference on BioNano Innovation in Brisbane in 2012.

Dr Connors received a boost to her modelling work when the Queensland Cyber Infrastructure Foundation allocated her access to the National Computational Infrastructure High Performance Clusters.

Tailored industrial surfactants

Tailoring industrial surfactants involves Dr Mirjana Dimitrijev Dwyer working in Professor Middelberg's lab and PhD student Andrea Schaller providing input through computational modelling.

Ms Schaller graduated from KIT with a Master's degree and started her thesis at AIBN in 2012 with joint supervision. AIBN hosted an information-sharing visit in 2012 involving KIT research group leader Professor Jürgen Hubbuch, a long-time collaborator with Professor Middelberg; biomolecular engineer Dr Stefan Oelmeier; and PhD student Christopher Ladd.

The ARC funds the research collaboration to understand the biological interactions that underpin the design of biosurfactants as superior alternatives to existing low-tech, non-renewable chemical surfactants.

Foams stabilised using surfactants form the basis of a $24 billion industry. The foaming agents developed are protein based, bringing to the fore the expertise of AIBN and KIT research groups in protein design, bioprocessing, food manufacture and analysis.

KIT brings to the collaboration a wealth of industrial biotechnology expertise, while Queensland is in the early stages of developing such a capability. AIBN, through Professor Middelberg's research group, shares its expert knowledge in biomolecular engineering.

"Molecular modelling will help us understand the fundamentals involved in forming four-helix bundles," Professor Middelberg said. "The bundles ensure the formed surfaces are stable and can be tailored for the correct foaming properties needed in industry.

"While the molecular modelling is supporting a greater understanding of fundamentals of biomolecular interactions, nothing can be developed without the experimental validation – and that is where AIBN has its expertise.

"Working collaboratively on molecular modelling brings fundamental insight and capability to industrial biotechnology and biomolecular engineering efforts, at the leading edge of international developments. If we worked in isolation we would find it hard to achieve at the same level. Science is international – so is AIBN."

STEM CELL RESEARCHERS BENEFIT FROM GLOBAL NETWORK

AIBN researchers are providing valuable input and reaping the benefits, with leading roles in an international network of genome biologists, bioinformaticians, biostatisticians and stem cell biology researchers.

Three AIBN research groups are actively involved in the Functional Annotation of the Mammalian Genome (FANTOM) consortium.

AIBN Associate Professor Christine Wells contributes findings from her research group's work into the networks of genes that drive stem cell differentiation and immune activation. Working closely with AIBN Associate Professor Ernst Wolvetang, her group also provides FANTOM with a set of high-quality stem cell libraries, studying neural differentiation.

Associate Professor Wolvetang's group has key strengths in stem cell research, with a focus on induced pluripotent stem cells, in vitro disease models and novel regenerative medicine approaches.

"In FANTOM we've hooked up with researchers from the US, the Netherlands and Scotland to look at stem cell differentiation to neural, cardiac, blood and skin cells," Associate Professor Christine Wells said. "It means conclusions we can draw are much broader in their application – and this increases the significance of our findings. We can hook into an international network for specialist tools and protocols.

"We collaborate with a group in Copenhagen for cutting-edge bioinformatics, to understand chromatin state at a resolution that would otherwise be impossible – because we lack the expertise or facilities to look at this question ourselves."

AIBN PhD student Liam Fearnley, a member of Professor Lars Nielsen's research group, is working with computational scientists in Sweden and Norway on analysing aspects of FANTOM research datasets.

Involvement in FANTOM also includes UQ School of Chemistry and Molecular Biosciences Professor Mark Walker, contributing work on pathogen-activated monocytes via an Australian infectious diseases consortium. Material has been processed in Japan and forms part of the atlas of human expression information at FANTOM.

Associate Professor Christine Wells said the collaboration with FANTOM members went beyond furthering AIBN research projects.

"The interactions provide important experience on how research is conducted in a collaborative framework. They open up a raft of opportunities for the institute, and for interactions that stretch far beyond the FANTOM program itself," she said.

Associate Professor Wells has been part of FANTOM since 2002 and became a lead investigator in 2005, while AIBN has been a partner since 2011. Her involvement came after hosting FANTOM lead principal investigator Prof Yoshihide Hayashizaki from Japan's Riken Omic Sciences Centre in 1999. Later she completed her PhD under the supervision of Professor David Hume, who established UQ's involvement and has become a major partner in subsequent rounds of the consortia.

Kelly Hitchens, Dipti Vijayan, Ashley Waardenberg and Anthony Beckhouse are foundation members from Associate Professor Wells's research group. Edward Huang and Suzy Butcher are new members covering validation aspects of the project. Rowland Mosbergen and Othmar Korn provide bioinformatics support and support data exploration through the collaborative hub Stemformatics. Essential input from Associate Professor Wolvetang's research group comes from Dr Dmitry Ovchinnikov and honours student James Briggs.

"On an academic level, we are working together to address fundamentally philosophical questions about how our genome works," Associate Professor Wells said.

"I would argue that this is the most pressing question in biology today – and the foundation for genomic-based medicine, or genome-based technologies.

"FANTOM is bringing together leading expertise in very diverse disciplines and working together to tackle some foundation questions in genome biology. It's exciting to work on this scale and challenges us to think beyond our own boundaries and expertise. It opens up a scale of research that we can be otherwise blinkered to when working on our own small patch in isolation."

Dr David Chin

Since Hendra virus (HeV) was first detected in the Brisbane suburb of Hendra in 1994, there have been 14 outbreaks in Queensland.

AIBN GAINS HENDRA FUNDING

The virus was fatal for four of the seven people who contracted it. HeV can be passed from bats to horses and, occasionally, from horses to humans.

US scientist Professor Chris Broder is an expert on HeV who has developed a monoclonal antibody active against the virus. He has conducted extensive work examining whether the antibody works in animal models, using ferret and monkey models of Hendra infection.

The work has involved the CSIRO and US-based groups and resulted in very promising results. Professor Broder and the CSIRO have been investigating the mechanism of action of the drug and the virus.

Queensland Health (QH) became aware of the work and knew of AIBN's capability to make high quality therapeutic antibodies. It became a natural fit to manufacture emergency stockpiles of the antibody in Queensland.

In 2010, QH contracted AIBN researchers to develop a process to produce clinical grade batches of the antibody, including some to be used as a potential therapeutic for HeV infection in humans.

Because there has been no large-scale clinical testing of the antibody, the experimental therapy can be used only in emergency situations with approval from an ethics committee and the Therapeutic Goods Administration.

In 2012, AIBN received a $400,000 grant from the National Health and Medical Research Council (NHMRC) as seed funding to start the process for conducting a Phase I human clinical trial.

Princess Alexandra Hospital's Dr Geoffrey Playford, who has been supervising treatment of HeV-infected people to date, will be the clinical lead for the trial.

AIBN biotechnologist Dr Trent Munro said the Phase I trial would involve a safety assessment of the antibody in humans. "We are looking to receive more government funding for the efficacy trial, to be conducted in late 2013," he said.

The additional funding needed for the trial is being sought from the National Hendra Virus Research Program and the Intergovernmental Hendra Virus Taskforce, established in 2011 to address the risks posed by HeV.

Professor Broder and his US colleagues developed the antibody, which binds to a protein on the surface of HeV, potentially blocking entry to healthy human cells and allowing the immune system to fight the virus.

Under an agreement with QH, Professor Broder's lab provided the cells that produce the antibody and AIBN's National Biologics Facility developed the process to produce larger amounts of the antibody needed for emergency compassionate use and the clinical trial.

LEADING ACADEMICS GATHER AT CONFERENCE

The first International Conference on BioNano Innovation (ICBNI) in 2012 showcased the research excellence of a large number of top scientists from around the world.

The conference program included plenary addresses from Chinese Academy of Sciences President Professor Chunli Bai; Lockheed Martin's Travis Earles; the University of Toronto's Professor Peter Zandstra; CSIRO's Dr Ezio Rizzardo; and Harvard University's Dr Kenneth Chien.

More than 500 delegates registered to attend the three-day conference at the Brisbane Convention and Exhibition Centre. It featured 74 invited speakers from nine countries.

AIBN Deputy Director (Nanotechnology), Group Leader and 2012 conference convenor Professor Matt Trau said it connected scientists, researchers and entrepreneurs in the rapidly expanding areas of bioengineering and nanotechnology.

During the preceding six years, AIBN had run a successful series of annual symposia in July. As the size, scale and range of AIBN research activities grew, it became imperative for the institute to expand into an international conference format.

ICBNI attracted international leaders and experts working at the intersection of biology and nanotechnology.

As well as plenary and keynote sessions, the conference hosted parallel symposia on nanostructured polymers; vaccines; nanomaterials; regenerative medicine; and synthesis of biological systems.

To encourage young researchers in the field, the conference held a special event for early career researchers, the BioNano ECR Symposium.

The ECR Symposium's 44 speakers included representatives from Harvard Medical School and UC Berkeley in the US; the Agency for Science, Technology and Research (A*STAR), Singapore; CSIRO; and the University of NSW.

Professor Trau said the conference aimed to connect scientists, researchers and entrepreneurs in the rapidly expanding areas of bioengineering and nanotechnology.

"The intersection of biology with nanoscience and nanotechnology represents one of the most exciting wellsprings of scientific innovation," he said.

The conference's success prompted an invitation from Professor Bai to host ICBNI in China in 2013, cementing a mutually-beneficial international relationship.

INTERNATIONAL MATERIALS SCIENTISTS SHARE THEIR RESEARCH

Materials scientist and AIBN Group Leader Professor Ajayan Vinu brought together researchers from around the world in 2012 as conference chair of the first International Conference on Emerging Advanced Nanomaterials (ICEAN).

AIBN hosted the conference, co-organised by South Korea's Yonsei University and France's Centre National de la Recherche Scientifique.

ICEAN featured speakers from Germany, the US, China, Japan and Australia and attracted more than 650 scientists from countries including South Korea, France, Taiwan, Singapore, Malaysia, India, the Czech Republic, Poland, Canada, Italy, Saudi Arabia and South Africa.

Max Planck Institute of Colloids and Interfaces Professor Markus Antonietti, from Potsdam in Germany, opened the conference with details of research into artificial photosynthesis to convert light into chemical energy for storage and use.

Other speakers included Ewha Woman's University Professor Jin-Ho Choy, from Seoul, South Korea; Professor Susumu Kitagawa, from Kyoto University, Japan; Professor Dongyuan Zhao, from Fudan University, China; and Professor Mietek Jaroniec, from Kent State University in the US.

ICEAN covered fundamentals and technological aspects of various advanced materials and their industrial, biomedical, electronic, photonic, energy and environmental applications.

Professor Vinu said ICEAN provided an important opportunity to share knowledge and hear of developments across the fields of research.

"Discovery of novel materials can offer solutions to various problems facing society, such as greenhouse gas emissions, depletion of fossil fuels and pollution," Professor Vinu said.

"These discoveries provide for greater quality of life, comfort and stability and are only made possible by the novel technologies that emerge from scientific research.

"ICEAN aims to ensure material scientists do not work in isolation, but can share their knowledge and bring the fruits of their labour closer to commercial outcomes.

"The aim of the conference has been to bring together from all over the world scientists active in the fields of advanced nano- and biomaterials."

After peer reviewing, the proceedings of the accepted papers will be published in *Science of Advanced Materials*, which has an impact factor of 3.3.

Positive feedback on ICEAN has resulted in plans for another conference, potentially scheduled for early 2015.

ENGAGING WITH INTERNATIONAL RESEARCHERS

Regenerative medicine experts and students from around the world attended major events at AIBN in 2012, strengthening professional networks and providing an important exchange of information.

Experts in spinal cord injury and repair gathered at AIBN in December for a one-day symposium covering stem cell research, materials science, patient rehabilitation and social support networks.

University of Ottawa neurosurgeon and scientist Dr Eve Tsai spoke at the symposium, involving AIBN and UQ's Centre for Advanced Imaging.

She spent time in Professor Andrew Whittaker's AIBN labs to further work being conducted as part of a Queensland Government National and International Research Alliances Program grant collaboration.

Dr Tsai's research focuses on spinal cord repair strategies, axonal regeneration, MRI imaging of spinal cord tracts in humans and animals, and clinical outcomes after spine surgery.

Her collaboration with AIBN's Dr Firas Rasoul involves multidisciplinary research into ways of stimulating the body to repair itself, providing stem cell therapies to regenerate and repair injured areas.

Dr Rasoul said his research involved designing biomaterials that could target injured spinal areas, stimulate cell regrowth and encourage repairs.

That complemented Dr Tsai's work, which examined how patients responded to the medicines or genes to ensure safe, effective tissue repair or regrowth.

In August, AIBN hosted the Induced Pluripotent Stem Cell Training Workshop, with a focus on providing practical experience in generating, identifying and analysing the cells; and lectures to explain their application in regenerative medicine.

Among the researchers, students and doctors attending the workshop was Professor Sang Gu Kang from Yeungnam University, South Korea.

He has applied the new knowledge of small molecules and cell reprogramming to his work at the School of Biotechnology in small molecule expression and synthesis.

Facilities and research environment

Dr Lauren Butler

INFRASTRUCTURE FACILITATES RESEARCH

National Research and Development Infrastructure housed at AIBN has continued to prove invaluable during 2012.

Expertise in nanofabrication, metabolomics and biologics played a part in progressing cutting-edge research in medicines, vaccine delivery and antibody production.

The infrastructure supported Queensland and Australian businesses undertaking research, development and innovation. Staff expertise and facility equipment is available to the broader Australian research community, which includes industry, academia and private organisations.

Nanofabrication

The Australian National Fabrication Facility, Queensland node (ANFF-Q) worked closely with researchers around the country in 2012, including those at the University of Western Australia, the University of South Australia, the University of NSW and Queensland University of Technology.

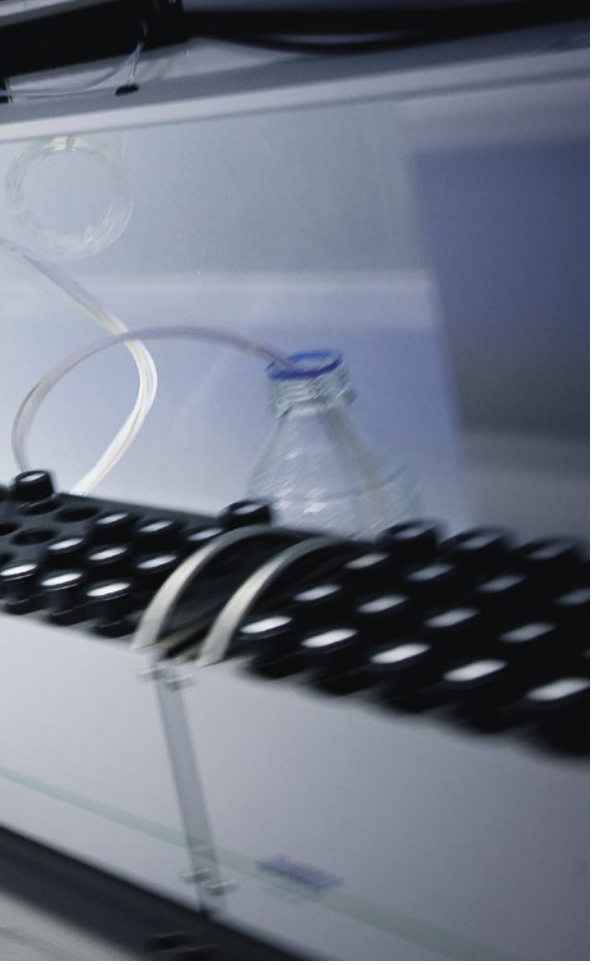
Incorporation of facilities at Griffith University's Queensland Micro and NanoTechnology Centre into the ANFF-Q node was achieved in 2012. That brought a new set of expertise in silicon carbide technology and Raman spectroscopy to clients.

A commitment to assisting industrial and academic clients achieve their outcomes was demonstrated by ANFF-Q's continued support of new technologies such as the Nanopatch, through the biotechnology spin-out company Vaxxas, and through industry clients such as mining consultancy SkillPro Services.

With federal and Queensland government funding, ANFF-Q secured additional equipment, including deposition and metrology tools, and further clean room space to enhance and develop the node's capabilities.

Client numbers and hours of usage continued to grow in 2012, underlining the unique and high-quality service provided to the Australian research community.

ANFF-Q's professional officers can support clients at every stage of their projects by leveraging the expertise, full range of tooling and experience of their network.



Dr Hiui Peng

Biologics

Biologics research continued to demonstrate its industry relevance in 2012. The National Biologics Facility (NBF) worked with government, research organisations and industry during the year.

The NBF continued to build on support received from the federal and Queensland governments in 2011 for its creation, with 15 staff members now housed in the AIBN building.

The NBF's world-class experience in cell line development and state-of-the-art facilities were instrumental in AIBN securing a share of $400,000 in National Health and Medical Research Council (NHMRC) funding in 2012 to study the safety of a promising treatment for humans infected with Hendra virus.

The funding will be used for the NBF to produce a monoclonal antibody and supply it to Princess Alexandra Hospital infectious diseases expert Dr Geoffrey Playford, who will lead the safety study. It is part of a collaboration with Queensland Health, CSIRO's Australian Animal Health Laboratories and the Uniformed Services University of the Health Sciences in the US.

Queensland Government funding in 2012 boosted an international collaboration involving AIBN and the NBF in developing the next-generation of smart medicines in Brisbane.

The NBF has collaborated with more than 25 biotechnology companies and research organisations, completed more than 450 projects and produced more than 750g of high-quality recombinant biologics for research and pre-clinical use. It continues to work closely with, and provide expert services to, the Australian biotechnology industry.

The NBF received a further $1.2million in Queensland Government co-investment funding.

A collaboration between AIBN and Biosceptre, established with a deal through investment company Medigen, continues to involve significant input from the NBF, with development of a bio-process for antibody production ahead of pre-clinical trials for biologics targeting cancers.

Researchers led by NBF operations manager Dr David Chin are using cultured mammalian cells to develop therapeutic-grade biologics for clinical studies.

AIBN secured the deal with Biosceptre in late 2011 because of the institute's specialised facilities, ensuring mammalian cells can be grown in sterile areas with minimal chance of contamination.

The NBF continues its strategic partnership with CSIRO in Melbourne and the creation of a second node of the facility, using Federal Government Education Investment Fund and Super Science Initiative support. The partnership further enhanced the capability and knowledge base that exists in early stage biologics technology in Australia.

Metabolomics

Metabolomics Australia, Queensland node (MA-Q) continued to supply key analytical support in 2012 for projects requiring the discovery, identification and quantification of endogenous and exogenous biochemicals and metabolites. MA-Q recruited a new analyst in 2012, with Dr Manuel Plan bringing more than 10 years of analytical experience to the team.

With federal and Queensland government funding, MA-Q expanded its bioanalytical capabilities by buying additional high-resolution mass spectrometry equipment for metabolomic analysis.

MA-Q projects in 2012 covered a wide spectrum of metabolomics applications. AIBN projects included analysis needed for producing industrial chemicals, bioplastics from sugarcane, biopesticides from insect cell viruses and biofuels from yeast fermentations.

Analysis of biofuel production is an integral part of the Queensland Sustainable Aviation Fuel Initiative's work to develop the production of advanced aviation biofuel from sugarcane. The yeast engineering and analysis is performed in partnership with the US biotech company Amyris.

Collaborations within UQ included assessing *Streptococcus pneumoniae* strains, measuring anaesthetic levels in Drosophila, or fruit fly, and analysing anti-epileptic drug and nucleotide concentrations in plasma and brain tissue.

In the wider community, MA-Q provided metabolomic analysis for groups within CSIRO and the Australian Wine Research Institute in Adelaide. Dr Louise Conwell, at the Royal Children's Hospital in Brisbane, collaborated with MA-Q in 2012 on research on juvenile diabetes and the Dow Chemical Company took advantage of MA-Q facilities through collaboration with Professor Lars Nielsen's AIBN research group.

ENABLING CUTTING-EDGE RESEARCH WITH PROTEIN EXPERTISE

The Protein Expression Facility (PEF) based at AIBN has continued to achieve in 2012, with successful research collaborations, a three-day symposium and membership of a top protein network.

PEF is a unique facility in Australia, enabling cutting-edge research through comprehensive services in recombinant protein production, including molecular cloning, microbial expression, animal cell culture and protein purification.

Efficient protein production requires different strategies and broad technical expertise, dedicated equipment and considerable expenditures of time and effort.

In 2012, PEF expertise underpinned engagement with 56 academic research groups and companies, completing 229 projects that expedited achieving of research objectives and milestones.

The engagement included researchers from global biopharmaceutical company CSL, clinical-phase biotechnology company Lipotek, global animal health company Zoetis, CSIRO, the Queensland Institute of Medical Research, the University of Sydney, Griffith University and Monash University.

International collaborators are Nanyang Technology University, Singapore; the Protein Sciences Corporation in the US; the Dortmund Protein Facility at the Max Planck Institute, Germany; the Oxford Protein Production Facility in the UK; and the Institut Agronomique neo-Caledonien in New Caledonia.

PEF staff continued to work closely with AIBN research groups, demonstrating the advantages of co-location and building a hub of research excellence.

The engagement enabled PEF to achieve a record year in 2012, with revenue up more than 40 per cent in five years. PEF provided 30 per cent of its 2012 services to external users, including universities and companies.

PEF hosted the Australian Protein Production Symposium at UQ in July, with a three-day program featuring 19 presentations from world-leading national and international speakers and 14 trade displays. Presentations covered topics in fields such as vaccine development, protein therapeutic production and bioprocessing.

Staff members also presented at a workshop linked to the symposium, covering protein design, molecular cloning, expression, purification and characterisation.

Sentinext Therapeutics chief scientific officer Dr Jane Cardosa represented the Malaysian biotechnology company at the symposium and entered into a research collaboration with PEF during the visit.

The collaboration enables PEF to continue to provide Sentinext Therapeutics with support to optimise bioprocesses and product characterisation for developing efficacious vaccines for tropical infectious diseases.

In another 2012 highlight, PEF was invited to join the Protein Production and Purification Partnership in Europe, a network based in Germany which is establishing a platform to exchange information, know-how and materials between core facility labs.

PEF director Dr Linda Lua said 2012 was an important year, with the facility demonstrating a continued annual growth and taking steps to secure its future by becoming a UQ central facility.

“Every year we have grown, in terms of technical development, staff expansion and capabilities,” Dr Lua said.

“We started with a small number of services and built in molecular cloning, microbial work with bacteria and yeast, insect and mammalian cell systems. Every year, we can offer additional elements. Staff increases and professional development have enabled us to add capacity.”

Stem cell research in Australia continued to develop during 2012, with Stem Cells Ltd providing support in its first calendar year of operations at its StemCore facility at AIBN.

The facility works closely with research organisations from around Australia providing expert staff, support services, training and technology platforms to sustain and grow Australia's capacity in the stem cell field.

Using $470,000 secured from a Queensland Government co-Investment fund in 2012, the facility has been enabling scientists to access valuable stem cell strategies for modelling human diseases.

StemCore manager Victoria Turner said her team worked with stem cell scientists to advance research into diseases such as schizophrenia, Down syndrome, Parkinson's disease and ataxia telangiectasia.

The team continues to work closely with AIBN Associate Professor Ernst Wolvetang, whose research and leadership provides a scientific foundation for Stem Cells Ltd's generation of induced pluripotent stem (iPS) cell lines.

The team also collaborated with AIBN Associate Professor Christine Wells and the Stemformatics team to further develop critical stem cell research infrastructure.

The two key stem cell researchers were appointed the facility's Senior Scientists in 2012 and became advisers to the operations, enabling the facility to remain at the forefront of cutting-edge stem cell research in Australia.

Stem Cells Ltd has been focused on developing networks with other stem cell research organisations including Cell Reprogramming Australia and the Stem Cells Australia research consortium.

In 2012, Stem Cells Ltd and Cell Reprogramming Australia held the inaugural Induced Pluripotent Stem Cell Training Workshop at AIBN. During one week, eight participants attended hands-on practical training sessions covering the generation, culture and characterisation of iPS cells.

In addition to the practical elements of working with stem cells, workshop participants were invited to a series of seminars from leaders in the field of reprogramming. The workshop was a success, attracting participants from across Australia and internationally.

Training workshops are an important component of Stem Cells Ltd's activities, providing future scientists with the skills necessary to effectively use stem cells in their research programs.

FUNDING SECURED FOR SPECIALIST FACILITY

Nishta Ramnoruth

MICROSCOPY AND MICROANALYSIS

Microscopy and microanalysis services are available to AIBN researchers within the institute's building.

The Centre for Microscopy and Microanalysis (CMM) promotes, supports and initiates research and teaching in microscopy and microanalysis, as well as developing the disciplines themselves.

Purpose-built laboratories at AIBN house six state-of-the-art electron microscopes and a range of sample preparation facilities catering for materials and biological disciplines.

The laboratory is equipped with a sophisticated optical microscopy suite, featuring three optical microscopes in various configurations, under the supervision of AIBN Affiliate Group Leader and CMM manager Professor John Drennan.

The CMM acquired instrumentation in 2012 that is unique in Australia, with the potential to significantly impact on the imaging available to AIBN users.

The Gatan 3-View enables serial sections of material to be cut within the microscope and images recorded. The aim is to build three-dimensional sections at a resolution in the nanometer scale and applicable to biological and physical science programs.

During 2012, CMM's scanning electron microscopy capabilities assisted fellow AIBN Group Leader Professor Mark Kendall in developing the vaccine delivery device the Nanopatch as part of a push to advance the technology towards clinical testing and product development.

CMM's cryo-transmission electron microscopes were used to support Professor Anton Middelberg in further developing Virus-Like Particles, a platform with the potential to mass-produce vaccines quickly for re-emerging infectious diseases.

AIBN's Professor Michael Monteiro benefited in 2012 from CMM's scanning electron microscopes to analyse polymer structures being developed for biomedical applications such as anti-cancer drug delivery.

CMM bridges the sciences and is dedicated to an understanding of the structure and composition of all materials at atomic molecular, cellular and macromolecular scales.

The understanding arises primarily from the application of optical and electron-optical techniques to biological and non-biological materials, but also includes use of x-rays, ions and surface signals.

Primary fields of research associated with materials sciences include microstructure investigations of processing parameters in ceramics, metals and polymers; interface studies on a range of metals, ceramics and composites; and the characterisation of catalysts and substrates.

Mentoring and career development

Dr Jess Frith had only worked in biology labs when she arrived at AIBN in 2010, but the institute's multidisciplinary nature made such an impression, she now has her sights set on a career in stem cells and tissue engineering.

MULTIPLE DISCIPLINES BOOST CAREER ASPIRATIONS

Dr Frith joined Professor Justin Cooper-White's Tissue Engineering and Microfluidics (TeaM) lab at AIBN after undergraduate studies in biology, working in plant biology, and completing a PhD in mesenchymal stem cell cultures.

With support from Professor Cooper-White to attend conferences and career workshops, tap into a network of collaborators and incorporate other disciplines in her research, Dr Frith quickly found her feet.

She received a boost in late 2012, with the announcement of an Australian Research Council (ARC) Discovery Early Career Researcher Award.

The award will support her research, from 2013 onwards, into how microRNA signalling in stem cells derived from bone marrow affects their response to different biomaterials and how it may be used to promote the formation of specific tissues, such as bone, cartilage, muscle and fat.

The research relies on integrating cell biology, genomics and biomaterials, adding further weight to the importance of AIBN's multidisciplinary nature and the breadth of Professor Cooper-White's research group.

"I have learnt many new techniques, including some polymer chemistry, surface functionalisation and rheology," Dr Frith said. "The opportunity to work alongside people from different disciplines has opened my eyes to new areas and different styles of thinking.

"Key opportunities at AIBN come from the ability to mix with people from so many different disciplines and to have excellent facilities to be able to follow these ideas through."

As well as working closely with Professor Cooper-White and fellow Group Leader Associate Professor Christine Wells at AIBN, Dr Frith is collaborating with researchers at the University of Adelaide, leading stem cell company Mesoblast and Professor Alpha Yap from UQ's Institute for Molecular Biosciences.

Dr Frith has presented her work to specialist international audiences at conferences in Vienna, Boston, Sydney, Adelaide and Brisbane; been selected as one of four UQ representatives at an early career workshop at the University of Birmingham; and was first author on key publications in *Journal of Cell Science* and *Stem Cells and Development*.

She hopes the ARC award, which aims to provide more focused support and create more opportunities for early career researchers, will take her closer to the aim of one day heading her own research group in stem cells and tissue engineering.

"I like to think my research will one day lead to the tissue engineering of replacement tissues that are fully functional. I think regenerative medicine has the potential to transform medicine."

BUILDING THE BASIS FOR A SUCCESSFUL CAREER

Dr Simon Corrie is taking steps in building what he hopes is a successful research career. He has a prestigious award to support a new area of research, adding to previous fellowships that enabled him to work in an American lab. Dr Corrie is also seeing technology from AIBN labs move towards commercialisation as part of Professor Mark Kendall's research group.

Dr Corrie received an Australian Research Council (ARC) Discovery Early Career Researcher Award in 2012, enabling his research on a way to detect diseases without needing blood tests or lab analysis.

The award will help Dr Corrie combine materials chemistry with molecular biology to investigate if technology used for vaccine delivery device the Nanopatch can be tailored for disease detection.

He is working in the same labs where Professor Kendall is leading a team towards rapid research and product development for the Nanopatch, through spin-out company Vaxxas and $15 million in capital investment.

Dr Corrie gained experience in developing clinically-relevant diagnostic technologies in 2007-08, when he received an American Australian Postdoctoral Fellowship to work in Professor Nancy Kiviat's HPV Research Laboratory at the University of Washington in Seattle.

He returned to Queensland as a lead chief investigator on an ARC Discovery Project and Queensland Fellowship to join Professor Kendall's research group, developing novel diagnostics technologies based on micropatches applied to the skin.

Since 2009, he has worked alongside Professor Kendall, an inaugural ARC Future Fellow and Australia's second Rolex Laureate, who has a track record of commercialisation. Professor Kendall was instrumental is building up PowderJect/PowderMed, which was sold to Pfizer for $US400 million. His Nanopatch technology was licensed to pharmaceutical company Merck & Co in 2012.

Dr Corrie said the high standard of research and industrial relevance found at AIBN provided him with a constructive and stimulating environment to further his ambitions.

From a scientific perspective, Dr Corrie aims to prove the thousands of microscopic needles on the Nanopatch can be used to quickly detect biomarkers that point to the presence of infectious diseases such as dengue fever and malaria.

He is designing a device to sit on the skin, draw in fluids to react with antibodies and reporter probes and turn a particular colour, similar to a litmus test, if biomarkers are present.

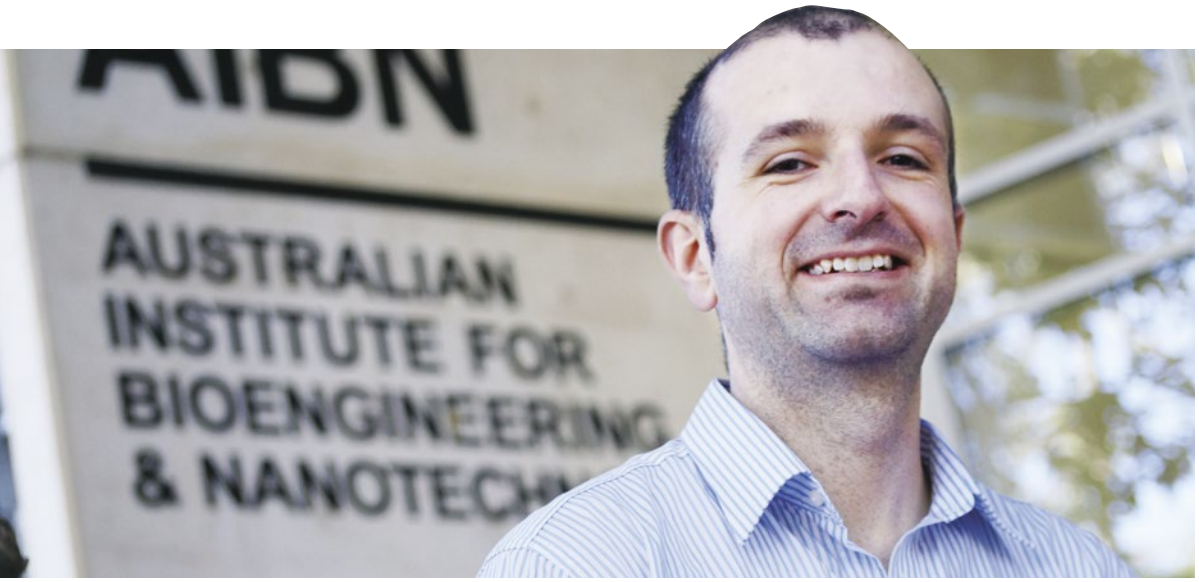
"Diagnostic tests are important medical tools, but could be more useful if they were faster, cheaper and simpler to use," Dr Corrie said.

"While billions of dollars are spent each year developing drugs for treatment, only a fraction is spent on diagnostics. However, early and accurate diagnosis of disease has proven time and again to drastically improve outcomes and survival."

As an AIBN Associate Group Leader, Dr Corrie is working towards running his own research group, focusing on combining materials chemistry and molecular biology to produce novel medical devices.

"AIBN provides the perfect combination of top-quality research and facilities and a commercialisation culture to ensure translation to products and services, which assist me in reaching my goals," Dr Corrie said.

INDUSTRY RELEVANCE A GOOD GROUNDING



As well as gaining research capabilities at AIBN, Dr Joe Codamo credits the institute with skilling him in manufacturing through its industrial partnerships and focus on commercial relevance.

Since his PhD was awarded in July 2011, Dr Codamo has worked in bioprocess engineering for biopharmaceutical manufacturer DSM Biologics, first in the Netherlands and more recently at a new facility in Brisbane.

Skills and experience have assisted Dr Codamo in being promoted to senior bioprocess engineer at the new $65 million scale-up facility nearing completion at Brisbane's Princess Alexandra Hospital.

He can now take a leading role in building the biopharmaceutical industry in Queensland, involving continued collaboration with AIBN and Director Professor Peter Gray.

Dr Codamo has a long-standing working relationship with Professor Gray. After completing a Bachelor of Science in Biotechnology at the University of NSW in 2003, Dr Codamo worked on campus as a research assistant and facility manager with Professor Gray's research group until 2006.

He started his PhD studies and moved to Brisbane to join AIBN in July 2007, with Professor Gray and Dr Trent Munro as his supervisors.

"There were several reasons why I chose AIBN. It was (and still is) the first institute of its kind in Australia, having a strong focus in biotechnology and commercialisation. It suited my aspirations of eventually moving into a biotechnology-related industry position," he said.

"The greatest benefits of working at AIBN have included access to the extensive range of specialised equipment and resources, and extensive training in operating the instruments, which is of vital importance when moving into the workforce.

"A critical benefit is the ability to work and collaborate with experienced researchers from diverse backgrounds, which contributed significantly towards me successfully completing my PhD and in my training as a research scientist.

"Many of the experiences I had at AIBN prepared me for my time at DSM, including the interactions I had with industry and the importance of understanding the research and process development."

At DSM's new Brisbane facility, Dr Codamo's role involves designing large-scale biopharmaceutical production processes and co-ordinating process transfers from the Netherlands to Brisbane, while ensuring compliance with Good Manufacturing Practices.

DSM will use AIBN facilities to perform process development for Australian customers, with Dr Codamo managing the activities.

He will also take a leading role in collaborating with AIBN to develop a cell line generation platform for rapid and efficient production of biologics that can be used in large-scale biologics manufacturing processes such as those in Brisbane.

"DSM is the first contract manufacturing organisation of the type in Australia. What I have learned in the Netherlands will be used in establishing and operating the DSM facility in Brisbane, which will hopefully foster further biotech development in Queensland."

RAPID PROGRESS TOWARDS SALIVA DIAGNOSTICS

Support at AIBN has aided Dr Chamindie Punyadeera's rapid progress in developing early diagnosis of heart disease using a simple saliva test.

Dr Punyadeera joined Professor Justin Cooper-White's Tissue Engineering and Microfluidics (TeaM) lab in 2009 as part of an Australian Research Council (ARC) Linkage grant, looking at measuring the physical properties of saliva with a microfluidic device.

During that time, the idea of using a microfluidic device for saliva diagnostics was born and, with Professor Cooper-White's support, a Queensland Fellowship application was submitted to expand the scope of the research.

Dr Punyadeera received financial support, had access to state-of-the-art equipment and was mentored as part of Professor Cooper-White's group.

Work at the Princess Alexandra Hospital's Heart Failure Clinic and the Mater Outpatient Clinic provided an opportunity to collect saliva and blood samples from patients.

Two further major awards boosted Dr Punyadeera's research.

She received a UQ Research Excellence Award in 2010, recognising her work at AIBN and UQ's School of Chemical Engineering. At that time, the research focussed on developing a saliva test to detect heart disease in its early stages.

Receiving a Queensland International Fellowship in 2012 enabled Dr Punyadeera to travel overseas to develop strategic alliances with leaders in the field and broaden the diagnostic applications of saliva to include head and neck cancers.

The same year, she was part of a team successful in securing $15 million to establish the Queensland Centre for Head and Neck Cancer. One of the centre's nodes is based at the newly-constructed Translational Research Institute.

"Professor Cooper-White provided me with a supportive environment to conduct my research, expand my focus and build an international network of collaborators. Without those elements, it would have been a challenge to progress my career at this rapid rate," Dr Punyadeera said.

"The work at AIBN allowed me to build a foundation that has taken me a step closer to my aim of developing a saliva test to replace blood tests and diagnose cancers much earlier."

At the new centre, Dr Punyadeera will continue research she started at AIBN, with a specific focus on detecting biomolecules including DNA, RNA and proteins, which point to potentially cancerous cells.

"At the moment there are no early detection methods for head and neck cancers. When diagnosed, the cancer is at an aggressive stage," Dr Punyadeera said.

"Saliva is an ideal biological fluid for diagnosing head and neck cancers because saliva sampling is non-invasive, quick and easy. Tiny tumours can be hidden in the oral cavity but a saliva test has the potential to pick up biomolecules secreted by the tumours."

In Queensland alone 500 new cases of head and neck cancers are diagnosed every year, with a poor five-year survival rate of less than 30 per cent. That can be reduced with early detection.

STUDENT BECOMES AWARDED RESEARCHER

In less than a year, Nani Wibowo has gone from a PhD student at AIBN to a postdoctoral researcher leading a team in vaccine engineering in Professor Anton Middelberg's AIBN lab.

On graduating in 2012, she received a Dean's Award for Research Higher Degree Excellence, recognising excellence in a research higher degree and a substantial contribution to the field of research.

Since then, Dr Wibowo has started her research career with a handful of publications already under her belt, a role in student supervision and a growing network of collaborators.

During the first months of her PhD studies in 2008 she realised how much benefit could be derived from being at a multidisciplinary research institute such as AIBN.

The time at AIBN broadened her outlook, allowing her to share knowledge with leaders at the forefront of research in engineering, chemistry, biology and computational sciences.

She learned under the supervision of Professor Middelberg, a 2010 Queensland Premier's Fellow with a global network of collaborators, including in China, Vietnam and Germany.

"I broadened my knowledge base, learned many experimental techniques, learned to supervise students and came to appreciate cultures from all around the world," Dr Wibowo said.

"AIBN has a world-class level of research, so your project relates directly to global problems that need addressing. What happens around the world can also affect your research."

An example of the relevance of the research in Professor Middelberg's labs has been the focus on important problems current technology has failed to address satisfactorily, for example the re-emergence of influenza in different forms, including H5N1 and H7N9.

No commercial product or technology delivers a tailored vaccine within weeks of such a new disease emerging.

In her new role, Dr Wibowo is working to engineer virus-like particles (VLPs) and their subunits, capsomeres, for rapidly-manufactured, low-cost vaccines.

The VLP platform has the potential to one day deliver vaccines in days, by engineering the shell of an emerging virus without containing infectious DNA and providing at-risk people with immunity.

Dr Wibowo is building a network of collaborators and has attended conferences in Japan, Italy, the US and Vietnam.

She credits AIBN with giving her a head start in her career through its cutting-edge facilities, high level and breadth of expertise and range of opportunities for all staff and students.

Her research has instilled in Dr Wibowo an appreciation of the importance of commercialisation, in line with AIBN's specific aim of combining research excellence with an industry focus.

"I came to AIBN because I was looking for a research group that works in biomolecular engineering. UQ is one of Australia's top universities and AIBN seemed a cool place.

"I really like what I do in the lab. I have new skills in research – but also in supervising research assistants and students. I have opportunities to travel and a network of collaborators."

Engagement

RESEARCHERS TAKE SCIENCE INTO THE COMMUNITY

Exposing the public to cutting-edge science motivated AIBN researchers to be involved in community engagement activities in 2012.

Researchers focusing on areas such as stem cells, microfluidics and pre-clinical drug screening were involved in the activities, expanding on the work of AIBN colleagues in school engagement.

Science Week

Stem cell researcher and Group Leader Associate Professor Christine Wells led a discussion of Year 10 students from around Australia during Science Week in August.

Co-hosted by Quantum Victoria and Stem Cells Australia, the discussion forum involved 80 students in Melbourne and others joining electronically from rural and remote parts of Victoria.

Associate Professor Wells and CSIRO stem cell researcher Dr Andrew Laslett covered topics such as genomics, bioinformatics and stem cell research.

"Science is really the next great place for moving forward and having important discussions about the world we will inhabit in years to come," Associate Professor Wells said.

"I love having students who want to be part of the dialogue. I want them to push scientists to new discoveries. There is so much we don't yet know about the human body, for example, but that will change dramatically in the coming years."

Associate Professor Wells said students needed to seriously consider studying science at school, even if they did not plan a career in traditional flow-on areas such as medicine, pharmacy, dentistry or research.

Skills needed in science, such as analysis and critical thinking, were also valuable in business, law and politics. Studying science at school could open doors to a life-long interest in science and involvement in discussions about future scientific endeavours.

Associate Professor Wells is researching the networks of genes that drive cellular differentiation and activation. She has discovered the function of several genes involved in the fight against infection, and that regulate inflammation. Her group works to understand stem cell biology and innate immunity.

Lab-on-a-Chip workshop

Researchers from AIBN and the Australian National Fabrication Facility, Queensland node explained microfluidics at a Lab-on-a-Chip workshop at the State Library in June.

The audience learned how microfluidics helped AIBN researchers move towards a new era of disease detection and develop characterisation tools.

Dr Jane Fitzpatrick said the workshop gave the audience exposure to a field of science they were unlikely to come across during schooling, working lives or leisure time.

"It was about getting them excited about science and giving them an idea that science is useful. It is a wonderful opportunity to share our cutting-edge research with the broader community," Dr Fitzpatrick said.

The workshop involved people making moulds of microfluidic structures, sealing them and flowing liquid through them.

Microfluidics deals with the behaviour, control and manipulation of fluids at very small length scales – similar to the thickness of a human hair. One application can produce a suitable environment for growing cells, which can then be used in research in areas such as regenerative medicine.

It combines the expertise of engineering, physics, chemistry, microtechnology and biotechnology, with uses in inkjet printheads, DNA chips, lab-on-a-chip technology, micropropulsion and microthermal technology.

Associate Professor Christine Wells talks to research group members

Mad Scientist Tea Party

Post-doctoral researcher Dr Drew Titmarsh was a guest at a Mad Scientist Tea Party at the State Library in June as part of a program called Bioscience: Other Nature.

The program aimed to bring scientists, science aficionados and newcomers together to discuss everything from micro-organisms and DNA to art and ethics.

Dr Titmarsh detailed his research in Professor Justin Cooper-White's AIBN laboratory, with a focus on a technology to aid stem cell medical therapies, pre-clinical drug screening and basic biological research.

The multidisciplinary project, funded with a UniQuest Pathfinder Grant, involved working with commercial partners and leading laboratories on microbioreactor array technology that Dr Titmarsh developed in his PhD studies.

It combined microfluidic design and fabrication; pluripotent stem cell culture and differentiation; and modelling.

Dr Titmarsh said the tea party was a perfect way to educate people because it was interactive and fun.

"What we do at AIBN will hopefully have a major impact in the field of medicine in years to come," he said. "It could improve the health of people around the world. Yet many people are unaware of our research and the transformational impact stem cells are poised to have during our lifetime.

"It is rewarding to educate people about the possibilities of that future and dispell common misconceptions. The best way to do that is through an interactive program where the scientist is accessible and easy to understand."

AMBASSADOR TO MAKE SCIENCE ACCESSIBLE

AIBN researcher Dr Amir Popat aims to make science accessible to everyone, with his appointment in 2012 as an Australian Nanotechnology Network Young Nanoscience Ambassador.

Dr Popat will use the appointment to demonstrate his research to high school students in regional Queensland in 2013, while presenting science as a rewarding career and showing the relevance of research in daily lives.

"Few schools outside the metropolitan area have the opportunity to engage with scientists and be in touch with cutting-edge technology, especially nanotechnology," Dr Popat said.

"I want to promote science and higher education to students. It is important for students to know they can become researchers and come to AIBN. Students may not think of research as an employment area, but it is satisfying work.

"What we are developing at AIBN is part of technology that is already in every-day use, such as tennis racquets with carbon nanotubes and better cancer medicines with nanoparticles. That is nanotechnology."

Dr Popat is working in Professor Chengzhong (Michael) Yu's research group to develop intelligent nanocarriers that can deliver medicines specifically to cancer cells.

As part of his vision to share the benefits of science and technology, he is also a part-time lecturer to undergraduate students at the Pharmacy Australia Centre of Excellence at UQ.

Dr Popat has an active role in AIBN student outreach activities, providing guidance to students on placement in labs for up to a week and demonstrating his research as part of building tours.

The Young Nanoscience Ambassador program has funding from the Federal Department of Industry, Innovation, Science, Research and Tertiary Education.

AIBN continues to foster relationships with schools around Queensland as part of its outreach activities. Researchers and students were involved in engaging with a growing number of students in 2012 through school visits, placements in AIBN labs and guided tours of institute facilities.

SCHOOL ENGAGEMENT ACTIVITIES EXPAND

Queensland Academy for Science, Mathematics and Technology (QASMT) placed 35 students in AIBN labs in 2012, offering them an insight into cutting-edge research and the life cycle of research from experimentation and collaboration to commercialisation.

Places were also offered to students from Anglican Church Grammar School and Proserpine State High School during the year.

Researchers and students travelled to schools. PhD student Clementine Pradal visited Atherton State High, Gordonvale State School and Gordonvale State High in September 2012 with support from the Australian Academy of Technological Sciences and Engineering's Young Science Ambassador program.

Miss Pradal explained her work in tissue engineering, conducted in AIBN Professor Justin Cooper-White's lab, and used simple experiments to demonstrate the beneficial properties of hydrogels.

PhD student Amanda Pearce visited Borrowes State School in August to conduct basic science experiments with Year 4 students, including making slime and bouncy balls.

In May, a group visited Indooroopilly State High School to chat casually to students during their lunch break about UQ, PhD studies, the research environment and careers in science.

More formal lectures were presented during visits to QASMT as part of the school's Like Minds program, with students receiving an insight into research undertaken to develop next-generation vaccines and intelligent nanocarriers to deliver medicines to cancer cells.

As part of the AIBN Ambassador Program, researchers and students conducted tours of the institute's facilities with equipment demonstrations and explanations of research projects, detailing real-life applications.

Among the groups conducted through AIBN were students involved in Young Scientists of Australia's The Science Experience; those enrolled in Corinda State High School's gifted and talented program; and those who came to UQ to hear a lecture from Nobel Laureate Elizabeth Blackburn.

AIBN's outreach activities aim to foster an interest in science; create an understanding of the value of science in the lives of Queenslanders; and present science to students as a potential area of study and a career path.

PhD student Clementine Pradal has presented her research to school students in North Queensland as part of her role as an Australian Academy of Technological Sciences and Engineering (ATSE) Young Science Ambassador.

STUDENT TAKES SCIENCE TO THE CLASSROOM

Miss Pradal visited Atherton State High, Gordonvale State School and Gordonvale State High in September 2012 to explain her work in tissue engineering, conducted in AIBN Professor Justin Cooper-White's lab.

She told students her focus was to ensure hydrogels were designed to ensure they elicited the correct response before they could be introduced in a human body for regenerative therapies.

Miss Pradal also helped students prepare presentations for ATSE's regional interschool science competition Wonder of Science, with entries covering topics such as energy transfer, solar vehicle design and the impact of salt levels on water ecosystems.

The visits expanded Miss Pradal's previous work as an active member of the AIBN Ambassador Program, involving demonstrations for visiting school groups during tours of institute facilities.

"I enjoy explaining scientific concepts, trying to break it down and make it simple for people to understand," Miss Pradal said.

"I want people to understand advances in science and what it will mean for them in the future. At school, students learn basic scientific principles but don't necessarily hear about the latest developments that will improve their lives."

Miss Pradal also wants students in regional and remote areas to understand there are few barriers to their entry into science or research.

"I don't want students to think science is inaccessible. Even if they don't want to take it up as a career option, science is something they can become informed about.

"I want to give them the facts about stem cell research so they can think about it and form their own opinions."

In Professor Cooper-White's lab, Miss Pradal is designing hydrogels for stem cell-based tissue engineering. She is developing hydrogels with optimal mechanical, chemical and biological properties to direct the fate of the stem cells and produce biological tissues.

She completed a Masters at UQ's School of Chemistry and Molecular Biosciences before starting her PhD project with Professor Cooper-White.

Miss Pradal was selected as a Young Science Ambassador on personal qualities and scholarly excellence. As well as using the appointment to promote science and science education through school visits, she met parliamentarians and addressed ATSE Fellows.

Student experience

RHD REPORT

Anna Gemmell and Yosephine Andriani

AIBN's student research program has continued to grow and develop in 2012.

Professor Darren Martin has been appointed AIBN Deputy Director (Graduate Studies) and been involved in formally embedding AIBN top-up funding into the institute's over-arching funding policy for domestic and international research higher degree (RHD) students.

The policy demonstrates a commitment to RHD support and progress as a distinguishing feature of AIBN.

RHD completions were strong at AIBN, with 15 students awarded in 2012. They were Andrew Cameron, Natalie Connors, Michael Crichton, Stefanie Dietmair, Mirjana Dimitrijev Dwyer, Tao Ding, Jeff Hou, Hui Hui Lee, Jane Mooney, Geety Nabi, Amir Popat, Anthony Raphael, Oliver Squires, Nani Wibowo and Hidayatul Zakaria.

Dr Dietmair and Dr Wibowo were recipients of the Dean's Award for Research Higher Degree Excellence in 2012.

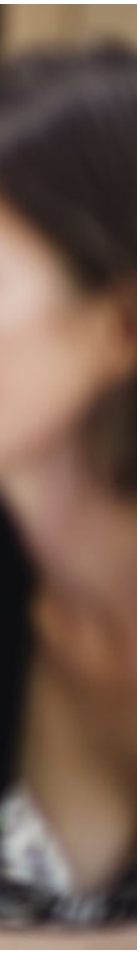
The award recognises outstanding PhD and MPhil graduates who have demonstrated excellence in a research higher degree and who have been commended by advisers and independent examiners for substantial contribution to their field of research.

Fewer than 10 per cent of PhD and MPhil graduates are recognised this way each year.

Dr Wibowo was recognised for her work in engineering microbially-synthesised viral capsomeres and their demonstrated potential as a rapid-response, low-cost vaccine platform to target the influenza virus.

Dr Dietmair's commendation was for her work in characterisation of mammalian cells during protein production, using a systems biology approach.

PhD student Kebaneilwe Lebani was one of 63 women around the world awarded a Schlumberger Foundation Fellowship and



a $13,000 scholarship, in recognition of leadership capabilities and scientific talent.

Miss Lebani will use the scholarship to complete a Graduate Certificate in Higher Education, in addition to her PhD studies at AIBN in next-generation dengue fever diagnostics.

She hopes to use the dual qualifications to teach the next generation of researchers in Palapye, Botswana, in partnership with bigger universities abroad.

A prestigious State Government PhD Top Up Scholarship was awarded to Li-yen Wong to work on a cardiac tissue engineering project under the guidance of AIBN Professor Justin Cooper-White and Associate Professor Ernst Wolvetang.

Using stem cells, biomaterials and growth factors, Miss Wong will work towards repairing damaged heart tissue. The research project is a joint collaboration with cardiologists at the Baker IDI Heart & Diabetes Institute in Melbourne.

Stefano Meliga secured two accolades in 2012.

Engineers Australia's National Committee on Applied Mechanics awarded Mr Meliga the Postgraduate Student Best Paper Award at the Australasian Congress of Applied Mechanics at the University of Adelaide.

It recognised Mr Meliga for his mathematical modelling work that simulates the application to skin of microscopic needles used on vaccine delivery device the Nanopatch.

The award will support Mr Meliga's travel to Singapore to build collaborations with Dr Keng-Hwee Chiam at the Institute of High Performance Computing and Professor Victor Shim at the National University of Singapore – and secure validation of his research.

The second accolade was the MMM2012 Student Scholarship, received from the Materials Research Society of Singapore to support Mr Meliga's travel to the Multiscale Material Modelling conference.

Mr Meliga was invited to speak at the conference in Singapore, at least partly because of the cutting-edge nature of his modelling work and its potential application in vaccine delivery.

Will Anderson was one of only five Australian students selected to attend the fourth Hope Meeting in Tsukuba, Japan in March.

The Australian Academy of Science provided funding for Mr Anderson's travel costs, while the Japan Society for the Promotion of Science covered his living expenses.

The meeting enabled Mr Anderson to hear from world leaders, including Nobel Laureate in Chemistry, Dr Akira Suzuki.

The Australian Academy of Technological Sciences and Engineering (ATSE) appointed Clementine Pradal a Young Science Ambassador in 2012.

Miss Pradal was selected on personal qualities and scholarly excellence and will use the appointment to promote science and science education through school visits, meeting parliamentarians and addressing ATSE Fellows.

AIBN PhD student Amanda Pearce represented UQ at the highly-competitive Trans-Tasman final of the Three Minute Thesis competition (3MT). She won the UQ 3MT Final and UQ's Combined Institute Final, where she was also named the People's Choice for her engaging and concise explanation of her polymer chemistry research.

The 3MT competition challenges students to strip away the jargon and explain their research in a compelling way to a general audience within three minutes. 3MT is a trade-marked UQ innovation in research communication now adopted by more than 80 universities in 12 countries.

Benoit Maisonneuve presented work at the XVIth International Congress on Rheology in Lisbon, Portugal in August – an impressive achievement given the congress is held only once every four years.

Mr Maisonneuve spoke about his PhD project in rheology, conducted under the joint supervision of AIBN Professor Justin Cooper-White and researchers at Laboratoire de Rheology in Grenoble, France.

UQ actively supports joint PhDs, such as cotutelle arrangements, as an integral part of a strategy to foster and expand global research collaborations.

Nasim Amiralian travelled to Purdue University in Indiana, US, as part of an exchange program, using more than $15,000 in competitive funding received from two sources.

Miss Amiralian was awarded a UQ Graduate School International Travel Award and a UQ-Purdue University Early Career Researcher Mobility Scheme Grant.

Top-up incentives developed

The Research Higher Degree (RHD) team at AIBN is implementing a system of top-up funding for domestic and international RHD students that provides an incentive for timely completion and support throughout candidature.

AIBN Deputy Director (Graduate Studies) Professor Darren Martin; RHD manager Tony Miscamble; and RHD program administrator Laurie Sendra developed the policy through deep consultation with the student body, the UQ Graduate School and AIBN Group Leaders.

Professor Martin said the top-up model struck a fair balance between providing a financial incentive to eligible RHD students at the attainment of each progress milestone and ensuring a financial safety net in cases where candidatures were extended.

"The top-up policy is not a quality tool, but it does reward bright students who win competitive scholarships – and it rewards students who work hard. We have many such students at AIBN," Professor Martin said.

The top-up applies to RHD students who started at AIBN after October 1, 2011.

The funding supported Miss Amiralian during a student exchange in September, allowing her to strengthen a collaboration with Purdue's Professor Robert Moon and Dr Jeffrey Youngblood involving development of nanocellulose from native grasses, with potential application as nanocomposite fillers, scaffolding for tissue engineering and packaging.

Donna Capararo won a section presentation at the DMTC Student Conference 2012, organised by the Defence Materials Technology Centre, in Melbourne in October.

The win secured an opportunity for Miss Capararo to present at the DMTC Annual Conference 2013 at Shine Dome Canberra in March. Her PhD project has a focus on polymers found in aeronautical paints and is contributing a fundamental understanding of what happens as it ages, both chemically and mechanically – valuable information in predicting when corrosion will begin.

Andrew Cameron

Qualifications: BEng (Hons) *UQ*, GCertResCom *UQ*, PhD *UQ*

PhD awarded: July 2012

Principal supervisor: Professor Justin Cooper-White

Thesis title: The influence of substrate creep on mesenchymal stem cell behaviour and phenotype

Research project: The research focused on the effects inherent mechanical properties of biomaterials have on adult stem cell behaviours, particularly properties pertaining to the viscous component of a material. Three major goals achieved during the research were developing a platform that could be used to isolate and tune viscoelastic mechanical properties not previously considered in mechanobiology; describing the effects of variations in these mechanical properties on numerous stem cell behaviours; and identifying the underlying cellular mechanisms that mediated the effects. The implications of this research are far-reaching, having relevance to tissue engineering and a broad range of other fields, including biomaterials, cell physiology, mechanobiology and developmental biology.

Graduate position: Postdoctoral researcher at the Royal College of Surgeons, Ireland, with a primary research project focused on developing collagen-based, tissue engineered scaffolds for corneal regeneration applications

Natalie Connors

Qualifications: BSc (Biochemistry/Hons I) *UQ*, PhD *UQ*

PhD awarded: May 2012

Principal supervisor: Professor Anton Middelberg

Thesis title: Identification of properties that affect in vitro virus-like particle assembly

Research project: The research involved computational analyses to better understand virus-like particle quaternary structure and protein heterogeneity, and the first known computational model for second virial coefficient prediction for the viral assembly process.

Graduate position: Postdoctoral researcher at AIBN

Michael Crichton

Qualifications: MEng (Aeronautical Engineering) *University of Glasgow*, PhD (Biomedical Engineering) *UQ*

PhD awarded: May 2012

Principal supervisor: Professor Mark Kendall

Thesis title: Measuring key mechanical properties of skin to engineer a micro-device for precise vaccine delivery into the epidermis and dermis

Research project: The research involved identifying the fundamental material properties of skin, using measurement techniques on a micro-scale. This fills a void that was hindering the ability to introduce more sophisticated design techniques for advanced medical devices relying on complex interaction with these properties – such as the Nanopatch vaccine delivery device.

Graduate position: Medical device engineer at Vaxxas, based at AIBN

Stefanie Dietmair

Qualifications: Dip Chem Eng *Technische Universitat Munchen*, PhD *UQ*

PhD awarded: September 2012

Principal supervisor: Professor Lars Nielsen

Thesis title: Characterisation of mammalian cells during protein production – a systems biology approach

Research project: Mammalian cells are used for producing a wide range of biopharmaceuticals but production costs are high due to their complex nutritional requirements and low productivities. To identify new avenues for reducing the costs associated with mammalian cell culture processes, it is necessary to improve understanding of the factors influencing mammalian cell product titers. The thesis paved the way the applying of a systems biology approach to mammalian cells and demonstrated how the combined application of global measurements, such as metabolomics, fluxomics and transcriptomics, can improve knowledge of cellular interactions.

Graduate position: Process improvement scientist at Sanofi Pasteur, Toronto, Canada

Mirjana Dimitrijev Dwyer

Qualifications: BE (Chem) *UQ*, PhD *UQ*

PhD awarded: August 2012

Principal supervisor: Professor Anton Middelberg

Thesis title: Properties of novel biosurfactants: linking the molecular, meso and macro length scales

Research project: The project studied the fundamental properties of surface-active proteins, focusing on how changes in their molecular structure (amino acid sequence) affected their material properties – and in turn their functional behaviour as surfactants. Such knowledge is required to fuel progress in materials development, which has matured beyond the polymer revolution and is looking toward bio-based building blocks, such as proteins, as future materials.

Graduate position: Postdoctoral fellow at AIBN, continuing work on biosurfactants, in particular trying to understand and develop molecules that are cheaply and easily produced and have good functionality

Dr Mirjana Dimitrijev Dwyer

Jeff Hou

Qualifications: BSc (Biotech, Hons) *UNSW*, PhD *UQ*

PhD awarded: November 2011

Principal supervisors: Professor Peter Gray, Dr Trent Munro

Thesis title: Modulating epigenetic and post-transcriptional regulation for increased recombinant protein production in mammalian cells

Research project: The thesis involved further development of stable CHO cell line development for producing biologics, such as monoclonal antibodies. The project's focus was on host cell line characterisation, specifically examining the epigenetic and post-transcriptional mechanisms of the host cell line to identify new alternatives for improvements in cellular productivity.

Graduate position: Postdoctoral research fellow at AIBN

Hui Hui Lee

Qualifications: BSc (Chem, Hons I) *UQ*, PhD *UQ*

PhD awarded: November 2012

Principal supervisor: Dr Bronwin Dargaville

Thesis title: Novel hydrogelators for the creation of supramolecular self-healing hydrogels as artificial vitreous substitutes

Research project: The research goal was to produce novel artificial substitutes for the eye's vitreous humour. These non-covalent hydrogels must be stable in water and

GRADUATES 2012

able to self-reform after being disrupted into viscous fluids following exposure to shearing forces. A library of supramolecular hydrogels based on multiple hydrogen bonds was created and investigated.

Graduate position: Corporate information manager at Australian Recruiting Group, Brisbane

Jane Mooney

Qualifications: BSc (Biochem/Biomed Sci, Hons I) *UQ*, PhD *UQ*

PhD awarded: May 2012

Principal supervisor: Dr Barbara Rolfe

Thesis title: Characterisation of myeloid cells in the peritoneal foreign body response: evidence for phenotypic plasticity

Research project: The thesis investigated the role of myeloid cells, specifically macrophages and neutrophils, in the peritoneal foreign body response. The research confirmed the involvement and importance of macrophages in the response, and showed that, while the cells do not transdifferentiate to myofibroblasts in the fibrotic tissue, they do adopt a 'fibroblastoid' phenotype characterised by morphological changes and co-expression of macrophage and myofibroblast genes. The results contribute to the growing body of knowledge demonstrating the remarkable plasticity of myeloid cells.

Graduate position: Research support coordinator, Science and Engineering Faculty, Queensland University of Technology

Amir Popat

Qualifications: BPharm, MPharm, GradCertResComm *UQ*, PhD (Nanomedicine) *UQ*

PhD awarded: July 2012

Principal supervisor: Professor Shizhang Qiao

Thesis title: Porous silica nanoparticles for controlled and targeted delivery of biomolecules

Research project: The studies involved developing a novel method to coat polymer onto nanoparticles for controlled release of drugs and biocides.

Graduate position: Postdoctoral research fellow with Professor Chengzhong (Michael) Yu at AIBN

Anthony Raphael

Qualifications: BBiot (Hons I) *UQ*, PhD *UQ*

PhD awarded: October 2012

Principal supervisor: Professor Mark Kendall

Thesis title: Dissolving Nanopatches for targeted vaccine delivery to the skin

Research project: The project addressed the shortcomings of current dissolving microneedles in relation to their fabrication, dissolution and use as a delivery platform. This was achieved by introducing a fabrication method for dissolving Nanopatches and analysing the mechanisms of administration, dissolution and diffusion of microstructures within skin. The PhD contained both applied and fundamental research. The applied focus related to developing an alternate vaccine/drug delivery platform for the targeted delivery of vaccines into the skin. The fundamental focus provided information on the structure-dependent diffusion characteristics of the skin and more specifically the diffusion of dissolving Nanopatches and Nanopatch-delivered payloads.

Graduate position: Postdoctoral research fellow at the Translational Research Institute, Brisbane

Nani Wibowo

Qualifications: BEng (Chem) *Widya Mandala Catholic University Surabaya*, Indonesia, MScEng (Chem) *National Taiwan University of Science and Technology*, PhD (ChemEng) *UQ*

PhD awarded: October 2012

Principal supervisor: Professor Anton Middelberg

Thesis title: Engineering viral capsomeres as a vaccine platform

Research project: The thesis demonstrates the potential of microbially-synthesised viral capsomeres as a rapid-response, low-cost vaccine platform to target influenza virus.

Graduate position: Research officer at AIBN

Alexandra Depelsenaire, Abdul Karim Al Sultan, Michael Song and Lei (Alice) Yu

STUDENT ASSOCIATION

An important support and advocacy network continues to be provided through the AIBN Student Association (ASA).

The ASA demonstrated its ongoing value in 2012, with a full program of engagement and social activities, leadership in providing a voice for students and vital input in a major early career researcher conference.

Overseeing the calendar of events in 2012 were ASA president Michael Song, vice president Marianne Gillard, secretary Amanda Pearce, treasurer Thomas Bennett and executive officers Yadveer Grewal, Lei (Alice) Yu, Nghia Truong Phuoc and Li-yen Wong.

A major undertaking for Mr Song and Mr Truong Phuoc in 2012 was involvement in organising the early career researcher symposium at AIBN's first International Conference on BioNano Innovation in July.

They worked with 2011 ASA members Alexandra Depelsenaire, Maria Buchsteiner and Yami Chuang in sourcing speakers, finalising the program and securing sponsors.

The symposium attracted 102 submissions and 44 speakers. It featured a full day of research presentations; plenary lectures from University of NSW polymer chemist Dr Cyrille Boyer and Cancer Institute NSW Fellow Dr Joshua McCarroll; poster sessions; and networking drinks.

Many AIBN students presented to a scientific audience for the first time at the symposium, giving them an opportunity to hone presentation skills in a familiar setting and obtain valuable feedback from their peers.

Mr Song represented AIBN through his appointment to the UQ Association of Postgraduate Students and the UQ Research Higher Degrees Committee, providing students with a voice in reports to the Academic Board and ultimately the UQ Senate.

He also lodged a submission to the McKeon Review of health and medical research on behalf of AIBN's student body, adding weight to a separate submission from AIBN Group Leader Associate Professor Christine Wells.

The ASA provided further support to students in 2012 through PhD skills workshops, with speakers sharing their knowledge of statistics, scientific writing and experiences as postdoctoral researchers. Among the workshop presenters were AIBN Group Leader Professor Lars Nielsen and Royal Society of Chemistry publishing editor Dr Hilary Burch.

The ASA continued to operate a buddy system to help new students settle into the institute, find their feet as PhD students and – in many cases – develop a support network in a new city or university.

Mr Song said the buddy system demonstrated to new students that AIBN understood the importance of their wellbeing, as well as their academic and research requirements.

"The challenge for international students, in particular, is that they are away from their homes and their support networks," he said. "We ensure the students do not feel they have to do everything by themselves."

Additional ASA activities included an all-of-institute Christmas function; Melbourne Cup festivities; a Halloween party; the annual staff versus students soccer match; a trivia night; student feedback sessions; and an active role in promoting, supporting and participating in the Three Minute Thesis competition.

The ASA took a leading role in the AIBN Ambassador Program.

ASA executive officers took numerous groups of visitors around the AIBN building during the year, presented demonstrations of their research and explained their relevance to improving people's lives. It was part of tours organised for school groups, prospective PhD students, industry delegations, visiting researchers and the public.

Marianne Gillard and Amanda Pearce gained recognition for their ASA activities, each receiving a 2012 Award for Outstanding Contribution to the AIBN Community from Director Professor Peter Gray.

INTERNATIONAL STUDENTS JOIN SUMMER INTAKE

Undergraduates studying at universities abroad have been attracted to AIBN for the first time to take part in the Summer Research Scholarship Program.

Students from India and Indonesia; Curtin University in Western Australia; and UQ came to experience life in an AIBN lab as part of a program run during the traditional end-of-year holiday break.

The program was established to allow highly motivated undergraduate students to spend eight to 12 weeks undertaking focused research projects.

As well as gaining valuable research skills, students had access to cutting-edge research facilities; received career mentoring; and some received credit towards an undergraduate degree. Some students qualified for scholarships, with UQ and AIBN sharing the costs.

The 2012-13 cohort of 34 students gave professional 10-minute presentations of their research and submitted written reports of their work.

Some will be co-authored on publications arising from their research – a testament to the quality of the projects provided by their AIBN advisers and to the talent and commitment of the students themselves.

They completed tasks such as customising mammalian cell lines to produce biotherapeutics; testing nanomaterials for potential in cancer detection and diagnosis; developing peptide-based solutions to produce foams for use in the drilling industry; and furthering computational studies for work in new technologies in electronics.

Ahmad Subkhi Aziz Agus was studying physics at the University of Indonesia when he came to AIBN to spend time in Professor Debra Bernhardt's lab to further his skills in computational studies.

"AIBN has lots of facilities that support my current – and upcoming – research in physics," he said.

"I am trying to develop new methods to progress technology in electronics; sustainable energy; and biomolecular and biomedical applications. For that, I needed resources and knowledge that AIBN had. I learned so many things. I will return again to enrich my research."

After a successful scholarship program, Ekatrina Edham is considering PhD studies at AIBN when she has completed her Masters at Curtin University. She was attracted to the program after meeting AIBN biologics expert Dr David Chin in Malaysia and hearing him speak about customising mammalian cell lines to produce biotherapeutic molecules.

"At AIBN, I gained a clearer picture of the entire process of a research project, from writing the research proposal to the execution of relevant experiments and how the findings are applied commercially," Miss Edham said.

"It is definitely not something that can be learned in a classroom. The hands-on aspects are really what make all the difference."

UQ student Ellyce Dickinson returned to AIBN for her second Summer Research Scholarship Program in 2012, citing the institute's multidisciplinary nature and the ability to combine her areas of undergraduate studies.

"My project was an overlap between biochemistry and chemical engineering. I am studying biological and chemical engineering, so it was right up my alley. I also like the fact it had practical applications."

Michael MacDonald, Lewis Chambers and Ellyce Dickinson

RESEARCH HIGHER DEGREE STUDENTS

Rufika Shari Abidin
Yusilawati Ahmad Nor
Suad Alateeq
Samah Alharbi
Eid Alosime
AbdulKarim AlSultan
Nasim Amiralian
Will Anderson
Melisa Anggraeni
Aditya Ardana
Luqman Atanda
Thomas Bennett
Mercy Rose Benzigar
Nathan Boase
Mareike Bongers
Timothy Brennan
Marion Brunck
Michele Bruschi
Maria Buchsteiner
Sandy Budi Hartono
Teera Butburee
Jessica Cameron
Donna Capararo
Liyu Chen
Xiaoli Chen
Xiaojing Chen
Panagiotis Chrysanthopoulos
Ya-Mi Chuang
Jacob Coffey
Holly Corbett
Licona Cuauhtemoc

Alexandra Depelsenaire
Stefanie Dietmair
Thanh Tam Doan
Hai-Yan Dong
Liam Fearnley
Erika Fiset
Nicholas Fletcher
Wanli Johnny Fu
Marianne Gillard
Stephen Goodall
Yadveer Grewal
Ryan Harrison
Alejandro Hidalgo-Gonzalez
Kelly Hitchens
Md Daloar Hossain
Hoai Huynh
Sani Saite Jahnke
Siddharth Jambhrunkar
Pamela Jaramillo Ferrada
Atikah Kadri
Sujith Kalluri
Li Pin Kao
Jakov Kulis
Geoffrey Lawrence
Kebaneilwe Lebani
Hui Hui Lee
Chang Lei
Peng Li
Mervyn Liew
Soo Lim
Chunli Liu

Derong Lu
Yiming Ma
Benoit Maisonneuve
Veronica Martinez Salazar
Elizabeth Mason
Sainimili Vaubula Mateyawa
Stefano Meliga
Khairatun Najwa Mohd Amin
Sean Muir
Geety Nabi
Jamileh Nabizadeh
Hoang Quan Nguyen
Yuting Niu
Huey Wen Ooi
Camila Orellana
Azlin Fazlina Osman
Gillian Osmond
Ramkumar Palanisamy
Amanda Pearce
Warren Pilbrough
Amirali Popat
Clementine Pradal
Ramanathan Pudhukode Vaidyanathan
Kun Qian
Samuel Richardson
Tania Rivera Hernandez
Suriana Sabri
Anne Sandstrom
Miriem Santander Borrego
Andrea Schaller

Jessica Schwaber
Khaled Sebakhy
Abhijit Shrotri
Michael Song
Frances Stahr
Karin Taylor
Alemu Tekewe Mogus
Nilay Thakar
Thi-Bich-Trinh Tran
Nguyen Tran Thi Dat
Nghia Truong Phuoc
Jennifer Turner
Kewei Wang
Yangyang Wen
David Wibowo
Nani Wibowo
Thomas Williams
Li-yen Wong
Chun Xu
Tianyu Yang
Jie Yang
Yosephine Andriani
Meihua Yu
Bijun Zeng
Cheng Zhang
Hongwei Zhang
Jun Zhang
Yao Zheng
Ruifeng Zhou
Yingdong Zhu
Yian Zhu

**List includes graduating students and those in a UQ RHD program undertaken at AIBN during 2012*

GRANTS

Type	Scheme	Lead AIBN Investigator	Other Chief Investigators	Project Title	Duration	2012 Income
Australian Competitive Grant Income	ARC Discovery Projects	Prof Anton Middelberg		Sustainable processes for next-generation surface coatings and core-shell nanoparticles based on biomolecular templating	2010-2012	$160,000
Australian Competitive Grant Income	ARC Discovery Projects	Prof Mark Kendall	Prof Ian Frazer, Prof Michael Roberts, Prof Davide Ambrosi	Improving immune response to vaccines by selective targeting of epithelial regions with the Nanopatch	2010-2012	$275,000
Australian Competitive Grant Income	ARC Discovery Projects	Dr Jian Liu		Nanostructured degradable polymer for drug delivery	2010-2012	$80,182
Australian Competitive Grant Income	ARC Discovery Projects	A/Prof Idriss Blakey	Dr Kristofer Thurecht, Peter Fredericks, Cameron Alexander	Multimodal biomedical imaging probes: development of advanced polymer nanocomposite devices for oncology	2010-2012	$85,000
Australian Competitive Grant Income	ARC Discovery Projects	Prof Justin Cooper-White	Prof Nicholas Fisk, Dr Lizbeth Grondahl, A/Prof Ernst Wolvetang	Scalable, high throughput microfluidic platforms for tissue specific biomaterials development and tissue genesis	2010-2012	$140,000
Australian Competitive Grant Income	ARC Discovery Projects	Prof Chengzhong Yu	Prof Max Lu, Dr Xinguo Jiang, Dr Jian Lu	Designer nano-carriers for targeted hydrophobic anticancer drug delivery with enhanced bioavailability	2011-2013	$140,000
Australian Competitive Grant Income	ARC Discovery Projects	Prof Justin Cooper-White		Elucidating surface-mediated permissive cues for cellular differentiation	2011-2014	$130,000
Australian Competitive Grant Income	ARC Discovery Projects	Dr Chunxia Zhao		Engineered nanoporous materials and composites having hierarchical structures by emulsion templating	2011-2014	$95,000
Australian Competitive Grant Income	ARC Discovery Projects	A/Prof Aijun Du	Prof Sean Smith, Prof Stefano Sanvito	Exploring electronic functionality in low-dimensional carbon and boron-nitride nanomaterials via advanced theoretical modelling	2011-2014	$145,000
Australian Competitive Grant Income	ARC Discovery Projects	Prof Peter Halley	Prof Rowan Truss, Prof Robin Rogers, Prof Tony McNally	Highly functional green materials platform: Starch-ionic liquid-carbon nanotube polymer melt nanocomposites	2012-2014	$120,000
Australian Competitive Grant Income	ARC Discovery Projects	Prof Michael Monteiro	Dr Trent Munro	On-Demand 3-Dimensional Polymer Scaffolds for Directed Stem Cell Differentiation	2012-2015	$145,000
Australian Competitive Grant Income	ARC Discovery Projects	A/Prof Gordon Xu	Dr Andrei Zvyagin, Prof Michael Roberts	Skin Penetration of Nanoparticles Promoted by Particle Design, Formulation and Application Method	2012-2016	$120,000
Australian Competitive Grant Income	ARC Discovery Projects	Prof Anton Middelberg	Dr Lizhong He, Dr Juergen Hubbuch	Sustainable Molecular and Chemical Engineering of Stimuli-responsive Soft Materials	2012-2017	$130,000
Australian Competitive Grant Income	ARC Discovery Projects	Prof Debra Bernhardt	Dr Barbara Kirchner	Computational studies of melting and the solvation properties of ionic liquids	2012-2013	$247,568
Australian Competitive Grant Income	ARC Discovery Projects	Prof Debra Bernhardt	Dr Denis Evans	Dissipation and Relaxation in Statistical Mechanics	2012-2014	$143,532

Type	Scheme	Lead AIBN Investigator	Other Chief Investigators	Project Title	Duration	2012 Income
Australian Competitive Grant Income	ARC Future Fellowships	Prof Michael Monteiro		Transformer 3D nanostructures: stimuli responsive polymers	2009-2013	$222,800
Australian Competitive Grant Income	ARC Future Fellowships	Prof Chengzhong Yu		Novel synthesis and bio-applications of functional macroporous ordered siliceous foams	2010-2014	$197,200
Australian Competitive Grant Income	ARC Future Fellowships	Dr Annette Dexter		Designed peptides as functional surfactants	2010-2013	$171,600
Australian Competitive Grant Income	ARC Future Fellowships	Prof Mark Kendall		Optimising the body's immune response with a Nanopatch that delivers biomolecules to the skin	2010-2014	$222,800
Australian Competitive Grant Income	ARC Future Fellowships	Prof Ajayan Vinu		Design of novel nanoporous semiconductor materials for clean environment and energy	2011-2015	$229,958
Australian Competitive Grant Income	ARC Future Fellowships	A/Prof Idriss Blakey		Smart magnetic resonance imaging (MRI) contrast agents: from early detection to assessment of drug delivery mechanisms	2011-2014	$176,527
Australian Competitive Grant Income	ARC Future Fellowships	Dr Kristofer Thurecht		Traceable theranostics: tools for visualising drug delivery and therapeutic benefit in vivo	2011-2015	$169,360
Australian Competitive Grant Income	ARC Future Fellowships	A/Prof Zhi Ping (Gordon) Xu		Engineering Layered Double Hydroxide Nanoparticles toward an Efficient Targeted Clinical Delivery System	2012-2016	$98,357
Australian Competitive Grant Income	ARC Discovery Early Career Researcher Award	Dr Muhammad Shiddiky		Circulating Tumor Cell Isolation and Detection: An Integrated Microfluidic Capture Device based on Alternating Current Electrohydrodynamics	2012-2015	$125,000
Australian Competitive Grant Income	ARC Linkage Projects	Prof Andrew Whittaker	Prof Maree Smith, Dr Bruce Wyse, Dr Kristofer Thurecht	Novel polymeric microparticles for slow-release intrathecal delivery of analgesics	2010-2013	$16,000
Australian Competitive Grant Income	ARC Linkage Projects	Prof Lars Nielsen	Dr Stevens Brumbley, Dr Kristi Snell	Redirecting carbon flow through mesophyll and bundle sheath cells of sugarcane to produce poly-3-hydroxybutyrate	2010-2014	$400,000
Australian Competitive Grant Income	ARC Linkage Projects	Prof Peter Halley	A/Prof Rowan Truss, Prof Mike Gidley	High performance thermoplastic starch polymer films for controlled barrier and delivery	2012-2015	$100,000
Australian Competitive Grant Income	ARC Linkage Projects	A/Prof Stephen Mahler	Dr Trent Munro, Dr Martina Jones, Dr Himanshu Brahmbhatt, Dr Jennifer MacDiarmid	Targeting the delivery of cytotoxic agents to tumour cells using novel minicells as drug delivery vehicles and engineered, bispecific antibodies.	2011-2014	$119,000
Australian Competitive Grant Income	ARC Linkage Projects	Prof Andrew Whittaker	A/Prof Idriss Blakey, Dr Peter Trefonas, Dr JamesThackeray	Next Generation High Sensitivity Polymeric EUV Resists	2012-2015	$120,000
Australian Competitive Grant Income	ARC Linkage Projects	Dr Jens Kroemer	Prof Lars Nielsen, Dr Susan Domke	Sustainable Dollar Notes and Other Polypropylenes from Bioderived Feedstocks	2012-2015	$160,284
Australian Competitive Grant Income	NHMRC Project Grant	A/Prof Christine Wells	Dr Robert Ashman, Prof Vicky Avery, Prof Sean Grimmond	Genomic characterisation of novel inflammatory regulators in a mouse model of disseminated Candidiasis	2011-2012	$177,887
Australian Competitive Grant Income	NHMRC Targeted Research	Prof Peter Gray	A/Prof Geoffrey Playford, Dr Deborah Middleton, A/Prof Stephen Mahler, Dr Trent Munro, Dr Christopher Broder	Safety of Hendra virus anti-G glycoprotein monoclonal antibody in humans	2012-21013	$400,000
Australian Competitive Grant Income	NHMRC Training (Postdoctoral) Fellowship	Dr Hang Ta		Bifunctionalised imaging agents for diagnosis and treatment of cardiovascular and inflammatory diseases	2012-2016	$43,818
Australian Competitive Grant Income	Queensland University of Technology (ARC Discovery Project administered by QUT)	Prof Darren Martin	Prof Lidia Morawska, Dr Thor Bostrom, Dr Congrong He	Detection, characteristics and dynamics of airborne engineered nanoparticles for human exposure assessment	2011-2013	$15,000

Type	Scheme	Lead AIBN Investigator	Other Chief Investigators	Project Title	Duration	2012 Income
Australian Competitive Grant Income	Queensland University of Technology (ARC Discovery Project administered by QUT)	Prof Andrew Whittaker	Prof Pam Russell, Dr Kris Thurecht	Simultaneous Imaging and Drug Delivery forProstate Cancer Theranostics	2012-2014	$40,000
Australian Competitive Grant Income	University of Melbourne (ARC Special Research Initiative administered by the University of Melbourne)	Prof Peter Gray	Prof Melissa Little, Prof Justin Cooper-White, Prof Sean Grimmond, A/Prof Ernst Wolvetang, Prof Lars Nielsen, Prof Perry Bartlett, A/Prof Christine Wells, Prof Martin Pera, Prof Trevor Kilpatrick, Prof David Gardner, Prof Doug Hilton, Prof Nadia Rosenthal, Prof Andrew Elefanty, Prof Ed Stanley, A/Prof Tiziano Barberi, Prof Richard Harvey, Prof Robert Graham, Prof Warren Alexander, Dr Andrew Laslett, Dr Susie Nilsson, A/Prof David Haylock	Stem Cells Australia	2011-2018	$656,250
Australian Competitive Grant Income	University of Sydney (NHMRC Project grant administered by the University of Sydney)	Prof Justin Cooper-White	Prof David Little, A/Prof Andrew Ruys, Dr Aaron Schindeler	Pre-clinical validation of a novel implant for bone tissue engineering	2012	$53,000
Australian Competitive Grant Income	Wesley Research Institute Limited (NHMRC Project Grant administered by Wesley Research Institute)	Dr Barbara Rolfe	Prof Julie Campbell, Prof David Johnson, Dr Ming Wei	Macrophages: A therapeutic target in peritoneal dialysis-induced fibrosis?	2011-2013	$95,565
National and International Grant Income	Bill & Melinda Gates Foundation	Prof Anton Middelberg	Dr Philip Dormitzer	A Transformational Vaccine Platform for Rotavirus	2012-2013	$96,480
National and International Grant Income	Cancer Council Queensland	Prof Chengzhong Yu	Dr Wenyi Gu	Novel photodynamic therapy for targeted skin cancer treatment: an integrated bionanotechnology	2012-2013	$100,000
National and International Grant Income	CRC for Polymers	Prof Peter Halley	Prof Mike Gidley, A/Prof Rowan Truss, A/Prof Darren Martin, Dr Fengwei Xie, Mr Luke Matthew, Mr Grant Edwards, Mr Stephen Coombs, Mr Robert Shanks	Degradable packaging materials derived from renewable resources	2005-2012	$196,640
National and International Grant Income	Foundation Jerome Lejeune	A/Prof Ernst Wolvetang	Prof David Ma	Use of induced pluripotent stem cells to define genetic factors involved in abnormal myeloproliferation and leukaemia in Down syndrome patients	2011-2014	$30,375
National and International Grant Income	Murdoch University	Prof Michael Monteiro	Prof Peter Gray, Dr Trent Munro, A/Prof Lianzhou Wang	Highly productive and selective bio-organic hybrid membrane water filters – National Centre of Excellence in Desalination	2011-2013	$106,378
National and International Grant Income	National Breast Cancer Foundation	Prof Matt Trau	Prof John Forbes, Prof Susan Clark, Prof Melissa Brown, A/Prof Glenn Francis, Prof Alexander Dobrovic, Prof Rodney Scott, Dr Bronwyn J Battersby, Dr Kymberley Vickery	Novel strategies for prediction and control of advanced breast cancer via nanoscaled epigenetic-based biosensors	2008-2013	$1,000,000
National and International Grant Income	Queensland Government Smart Futures Fellowships	Dr Zhen Li		Smart Futures Fellowship: Multifunctional magnetic nanomatrials: robust contrast agents for detection and treatment of cancers	2009-2012	$10,000
National and International Grant Income	Queensland Government Smart Futures Fellowships	Dr Chenghua Sun		Smart Futures Fellowship: Computer-aided synthesis of high-performance titanium dioxide for solar cells and photocatalysts	2009-2012	$10,000
National and International Grant Income	Queensland Government Smart Futures Fellowships	Dr Claudia Vickers		Smart Futures Fellowship: Engineering sucrose-based industrial isoprenoid production in yeast cells	2010-2014	$40,000

Type	Scheme	Lead AIBN Investigator	Other Chief Investigators	Project Title	Duration	2012 Income
National and International Grant Income	Queensland Government Smart Futures Fellowships	Dr Chamindie Punyadeera		Smart Futures Fellowship: Saving hearts with a simple saliva test	2010-2013	$80,000
National and International Grant Income	Queensland Government Smart Futures Fellowships	Dr Simon Corrie		Smart Futures Fellowship: Micropatches for non-invasive disease diagnostics	2009-2012	$10,000
National and International Grant Income	Queensland Government Smart Futures Fellowships	Dr Trent Munro		Biological bullets for beating antibiotic resistant bacteria	2012-2015	$120,000
National and International Grant Income	Queensland Government Smart Futures Fellowships	A/Prof Christine Wells		Fighting the good fight: How our immune systems recognise infection	2012-2015	$120,000
National and International Grant Income	Queensland Government Smart Futures Premiers Fellowships	Prof Anton Middelberg		Delivering smarter vaccines faster through nanotechnology	2010-2015	$250,000
National and International Grant Income	Queensland International Fellowships	Dr Li Li		High-performance nano-engineered catalysts for volatile organic compound (VOC) elimination	2012-2013	$13,000
National and International Grant Income	Queensland International Fellowships	Dr Chamindie Punyadeera		Saving Smokers from Cancer: Saliva DNA Test	2012-2013	$15,625
National and International Grant Income	Queensland Government Education Investment Fund	Prof Justin Cooper White		Australian National Fabrication Facility Qld Node	2011-2013	$1,500,000
National and International Grant Income	Queensland Government Co-Investment Fund	Prof Peter Gray		National Biologics Facility	2011-2013	$900,000
National and International Grant Income	Queensland Government Co-Investment Fund	Prof Lars Nielsen		Metabolomics Australia Qld Node	2011-2013	$125,000
National and International Grant Income	Queensland Government Smart State National and International Research Alliances Program	Prof Max Lu	Prof Sean Smith, Prof John Zhu, A/Prof Lianzhou Wiang, A/Prof Joe Diniz Da Costa	Queensland-China alliance in nanomaterials for clean energy technologies (QCANCET)	2008-2012	$97,500
National and International Grant Income	Queensland Government Smart State National and International Research Alliances Program	Prof Lars Nielsen	Prof Sang Yup Lee	Korea-Australia bio-product alliance	2008-2012	$70,404
National and International Grant Income	Queensland Government Smart State National and International Research Alliances Program	Prof Mark Kendall	Prof Ian Frazer, Prof Michael Roberts	International needle-free vaccination alliance (INVax)	2009-2012	$124,052
National and International Grant Income	Queensland Government Smart State National and International Research Alliances Program	Prof Andrew Whittaker	Dr Firas Rasoul, A/Prof John Forsythe, Dr Eve Tsai, Prof Ian Brereton, Dr David Nisbet, Prof George Simon, Dr Bronwin Dargaville	Spinal cord repair	2010-2013	$335,397
National and International Grant Income	Queensland Government Smart State National and International Research Alliances Program	Prof Anton Middelberg	Prof Sun Yan	Vaccine now – beating infectious disease with rapid response technology	2010-2013	$240,000
National and International Grant Income	Queensland Government Smart State National and International Research Alliances Program	Prof Lars Nielsen	Prof Peter P Gray, Mr Brad Wheatley, Dr Claudia E Vickers, Prof Rocky De Nys, A/Prof Ben Hankamer, Dr Ralf Dietzgen, Prof Peter M Gresshoff, Dr Neil Renninger	Queensland Sustainable Aviation Fuel Initiative	2010-2013	$600,000
National and International Grant Income	Queensland Government Smart Futures Research Partnerships Program	Prof Peter Gray	Dr Trent Munro, Dr David Chin	Cell line development for the biologics plant of the future	2012-2014	$194,000

Type	Scheme	Lead AIBN Investigator	Other Chief Investigators	Project Title	Duration	2012 Income
National and International Grant Income	Queensland Government Smart Futures Research Partnerships Program	Mr Bob McCarthy	Dr Robert Speight	Queensland's Sustainable Aviation Fuel Plant	2012-2015	$150,000
National and International Grant Income	Queensland Government Smart Futures Research Partnerships Program	Prof Anton Middelberg	Prof Chengzhong Yu	New Vaccines for Improved Animal Health	2012-2016	$62,102
National and International Grant Income	Seattle Biomedical Research Institute	Prof Matt Trau	Prof Gerard Cangelosi	Accelerated molecular probe pipeline	2009-2013	$67,805
National and International Grant Income	Department of Innovation, Industry, Science and Research (DIISR), Education Investment Fund	Prof Justin Cooper White		Australian National Fabrication Facility, Qld node	2011-2013	$1,500,000
National and International Grant Income	Department of Innovation, Industry, Science and Research (DIISR), Education Investment Fund	Prof Peter Gray		National Biologics Facility	2011-2013	$900,000
National and International Grant Income	Department of Innovation, Industry, Science and Research (DIISR), Education Investment Fund	Prof Lars Nielsen		Metabolomics Australia, Qld node	2011-2013	$125,000
Contract Research and other Industry Income	Uniquest Pty Ltd	Prof Mark Kendall		Nanopatch – delivery device	2011-2012	$1,820,221
Contract Research and other Industry Income	Uniquest Pty Ltd	Dr David Chin		Recombinant antibody manufacture	2011-2012	$529,987
Contract Research and other Industry Income	Uniquest Pty Ltd	Prof Justin Cooper-White		Encapsulating tea tree oil for incorporation into a stock feed	2012	$8,553
Contract Research and other Industry Income	Uniquest Pty Ltd	Dr Linda Lua		Expression of EV71 VLPs in insect cells	2012-2013	$56,629
Contract Research and other Industry Income	Uniquest Pty Ltd	Prof Anton Middelberg		PEGylated DAMP4 manufacture and supply	2012-2013	$16,240
Contract Research and other Industry Income	Uniquest Pty Ltd	Dr Annette Dexter		Peptide Surfactant Performance	2012	$23,530
Contract Research and other Industry Income	Uniquest Pty Ltd	Prof Justin Cooper-White		Production of Encapsulated TTO	2012	$33,328
Contract Research and other Industry Income	Uniquest Pty Ltd	Prof Darren Martin		TenasiTech plastics development and manufacture	2012-2013	$117,651
Contract Research and other Industry Income	Uniquest Pty Ltd Pathfinder proof-of-concept grant program	Prof Darren Martin		Non-polyurethane nanocomposites with a focus on acrylics and silicones	2012-2014	$48,973
Contract Research and other Industry Income	Uniquest Pty Ltd Pathfinder proof-of-concept grant program	Dr David Chin	Dr Martina Jones	Construction of a commercial human antibody phage library for therapeutic monoclonal antibody discovery	2012-2013	$48,792

Type	Scheme	Lead AIBN Investigator	Other Chief Investigators	Project Title	Duration	2012 Income
Contract Research and other Industry Income	Australian Coal Research Limited	Dr Krassen Dimitrov	Laurie Gibson	Application of nano particles to fine coal float sink test	2011-2013	$65,000
Contract Research and other Industry Income	LanzaTech New Zealand Limited	Prof Lars Nielsen		Reconstruction of a Genome Scale Model	2011-2013	$23,350
Contract Research and other Industry Income	Pfizer Australia Pty Limited	Prof Lars Nielsen		Clostridial Systems Biology	2012-2014	$237,750
Contract Research and other Industry Income	Stahmann Farms Enterprises Pty Ltd	Dr Polly Burey		The effect of processing on pecan nut texture and shelf life	2012	$1,451
Other	Research Donation Generic	Prof Mark Kendall		Nanopatches for the developing world	2012-2013	$55,000
Other	UWA-UQ Bilateral Research Collaboration Award	Prof Chengzhong Yu	Prof Colin Raston, Prof Michael Monteiro, Prof Jin Zou, Dr Jorge Beltramini, Dr Zhen Li, Dr Denisa Jurcakova, Dr Jian Liu, Dr Li Li, Dr Paul Eggers, and others	A general platform technology for functional nanocomposites with advanced applications	2012	$15,500
Other	UWA-UQ Bilateral Research Collaboration Award	Prof Lars Nielsen	Prof Ian Small, Prof Harvey Millar, Dr Cristiana Dal'Molin, Dr Lake-ee Quek, Dr Robin Palfreyman,Dr Ian Castleden, Dr Sandra Tanz	Plant Fluxomics Platform to understand the interplay of plant metabolic networks	2012	$18,200
Other	UQ - Purdue University Early Career Mobility Scheme	Prof Darren Martin	Nasim Amiralian, Jeffrey Youngblood, Robert Moon	Joint scale-up of nano-cellulose based polymer nanocomposites	2012	$10,627
Other	University of Dammam	A/Prof Ernst Wolvetang	Dr Amein Al-Ali	Towards curing of beta-thalassemia with iPS cells	2011-2013	$153,000
Other	JEM Research Foundation	A/ Prof Christine Wells		Understanding the molecular and functional properties of Amnion derived Stem Cells	2012-2014	$75,000

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Jegatheesan V, Virkutyte J, Shu L, Allen J, Wang Y, Searston E, Xu ZP, Naylor J, Pinchon S, Teil C, Navaratna D, Shon HK. 2012. Removal of lower molecular weight substances from water and wastewater: challenges and solutions. In *Wastewater treatment: Advanced processes and technologies*, pp. 275-318. Boca Raton, FL, United States: Taylor & Francis

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Peptide networks. Anton Middelberg, Annette Dexter. Australian patent granted August 2012.

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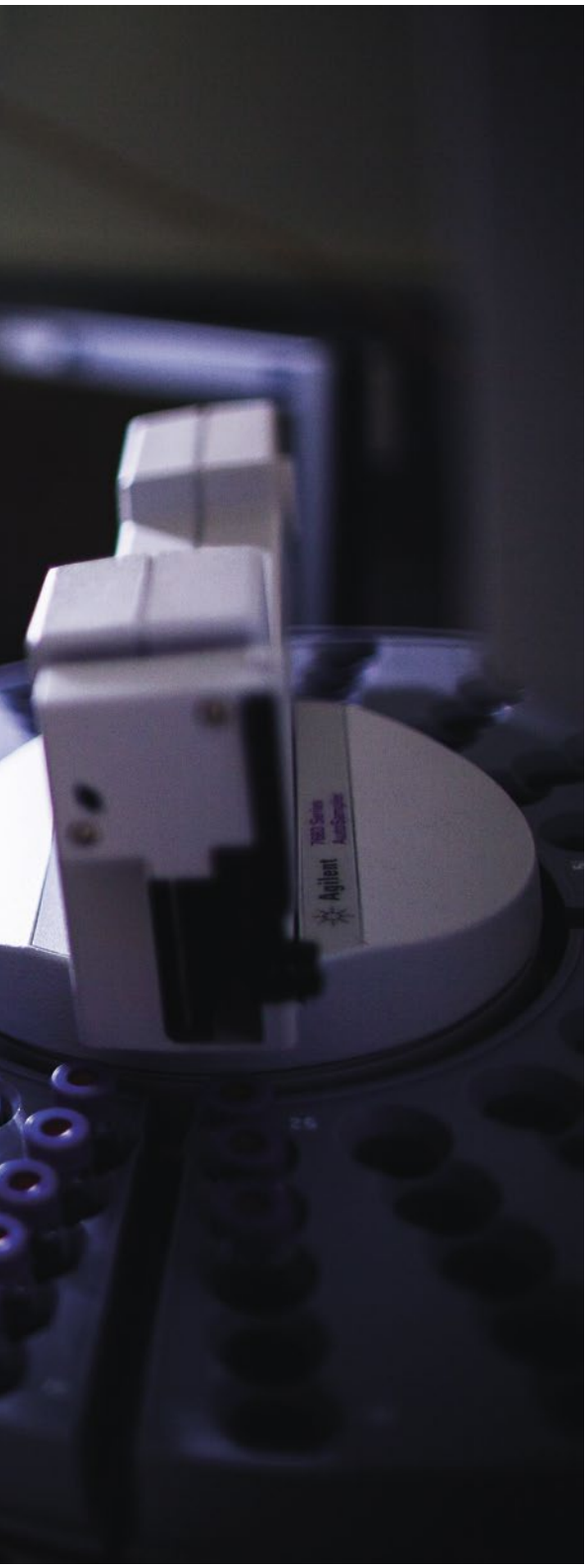
PATENTS GRANTED IN 2012

SEMINAR SERIES 2012



22 February: **Associate Professor Shuhei Furukawa**, Institute for Integrated Cell-Material Sciences, Kyoto University, Japan
Title: Porous coordination polymer hybrids

23 February: **Associate Professor Heather Maynard**, Department of Chemistry and Biochemistry, University of California, US
Title: From vault nanocapsules to multicomponent protein nanoarrays for applications in biomedicine

23 February: **Professor Cheolmin Park**, Associate Professor of Metallurgical System Engineering, Yonsei University, South Korea
Title: Organic electronics with self-assembled carbon nanotube networks

23 February: **Professor Eunkyoung Kim**, Department of Chemical and Biomolecular Engineering, Yonsei University; Director, Innovation Cluster for Bio-Fusion Industry based on Nanotechnology, South Korea
Title: Conjugated polymers for visible to near infrared photon energy conversion

1 March: **Dr Kouichi Hasegawa**, Institute for Stem Cell Biology and Regenerative Medicine, National Centre for Biological Sciences, India
Title: Wnt-dependent and FGF/TGF -independent human pluripotent stem cell renewal

9 March: **Professor Peter Gray**, Director, AIBN
Title: AIBN and protein production – from analysis of expression levels by a single mammalian cell, to the biologics production plant of the future

16 March: **Bob Atwill**, Executive, Allied Healthcare Group; CEO, Celxcel
Title: Allied Healthcare Group

23 March: **Professor Chris Greig**, Director, UQ Energy Initiative
Title: The global energy context and implications for research strategy at UQ

30 March: **Dr David Bull**, CEO, BCS Innovations
Title: BCS Innovations

20 April: **Professor Matt Trau**, Deputy Director (Nanotechnology), AIBN; Professor of Chemistry, UQ School of Chemistry and Molecular Biosciences
Title: Biomarkers and nanotechnology: new approaches to preventative, personalised and 'at home' medicine

27 April: **Professor Steven Orzack**, Fresh Pond Research Institute, Cambridge Massachusetts, US; Visiting Fellow, Sydney Centre for the Foundations of Science
Title: The demographic and genetic trajectory of the human sex ratio from conception to birth

9 May: **Dr Michael Koepke**, Director of Synthetic Biology, LanzaTech, New Zealand
Title: Synthetic biology

11 May: **Professor Leaf Huang**, Division of Molecular Pharmaceutics, Eshelman School of Pharmacy, University of North Carolina, US
Title: Nanoparticle delivery of genes and drugs to tumour and liver

14 May: **Dr Lily Pan**, Technology Director, Performance Materials and Technologies, Honeywell Technology Solutions, China
Title: Performance materials and technologies

18 May: **Dr Annette Dexter**, ARC Future Fellow and Associate Group Leader, AIBN; Affiliated Lecturer, UQ School of Chemistry and Molecular Biosciences
Title: Peptide hydrogels for biomedical applications

23 May: **Dr Martin Kirchner**, KRÜSS
Title: Surface tension of solids and liquids: contact angles of solids and liquids

25 May: **Dr Geoffrey Playford**, Director, Infection Management Services, Princess Alexandra Hospital, Brisbane
Title: Hendra virus, an emerging threat to humans and horses

6 June: **Professor Oliver Rackham**, Western Australian Institute for Medical Research, the University of Western Australia
Title: Re-engineering cellular gene expression

7 June: **Dr Krassen Dimitrov**, Group Leader, AIBN
Title: Farewell lecture

8 June: **Associate Professor Idriss Blakey and Dr Kris Thurecht**, Associate Group Leaders, AIBN
Title: Advanced polymeric materials: from nanomedicine to lithography

15 June: **Dr Alastair Hodges**, Chief Scientist, Universal Biosensors Pty Ltd
Title: Challenges in whole blood point of care assays: what it took to develop a more accurate glucose test

22 June: **Dr Colin Scott**, CSIRO Ecosystem Sciences
Title: Biotechnology at CSIRO

27 June: **Professor Gordon Wallace**, Intelligent Polymer Research Institute, the University of Wollongong
Title: Nanofabrication for organic bionics

29 June: **Associate Professor Jeffrey P Youngblood**, School of Materials Engineering, Purdue University, Indiana, US
Title: Superficial science: polymer surface science at Purdue

29 June: **Professor Eva Harth**, Department of Chemistry, Vanderbilt University, US
Title: Targeted nanosponges as superior delivery systems: practical synthesis and efficacy testing

6 July: **Professor Alan Trounson**, President, California Institute for Regenerative Medicine, San Francisco, California, US
Title: Stem cells in biomedicine: new opportunities in human therapeutics

25 July: **Dr Sandrine Henri**, Centre d'Immunologie de Marseille-Luminy, Université de la Méditerranée, Marseille, France

27 July: **Dr Ykelien L Boersma**, HFSP Fellow, CSIRO Materials Science and Engineering
Title: Targeting the EGF receptor: DARPins as potential anti-cancer therapeutics

27 July: **Professor Peter Zandstra**, the University of Toronto, Canada
Title: Informal Q&A discussions

31 July: **Adjunct Professor Hongyu Chen**, Fellow and Dow Asia Pacific Chief Scientist, Dow Chemical (China) Company Ltd
Title: Dow innovative solutions to energy challenges

6 August: **Professor Shigero Okamoto**, Department of Materials Science and Engineering, Graduate School of Engineering, Nagoya Institute of Technology, Japan
Title: Photonic crystals fabricated in semi-dilute solutions of ultra-high-molecular-weight block copolymers

10 August: **Associate Professor Ernst Wolvetang**, Group Leader, AIBN
Title: iPSC: tools for discovery and regenerative medicine

24 August: **Richard Grant**, Principal, Spruson & Ferguson, Patent and Trademark attorneys
Title: Patenting: an inventor's guide

31 August: **Dr Timothy Kastelle**, UQ Business School
Title: You can't innovate without business model innovation

31 August: **Professor Thomas Faunce**, the Australian National University, Canberra
Title: Governance challenges for global solar fuels

6 September: **Dr Ben Muir**, CSIRO Materials Science and Engineering
Title: Clickable nanometer thin plasma polymer films for biomedical applications and self-assembled lyotropic liquid crystal nanoparticles for gene therapy and medical imaging: a tale of two nano research areas at CSIRO

13 September: **Assistant Professor Christiana Boi**, Dipartimento di Ingegneria Chimica, Mineraria e delle Tecnologie Ambientali, Alma Mater Studiorum, Universita di Bologna, Italy
Title: Purification of biomolecules using corrective chromatography

14 September: **Associate Professor Stevens Brumbley**, Biochemistry and Molecular Biology, the University of North Texas, US
Title: Production of polyhydroxyalkanoates in plant peroxisomes

21 September: **Associate Professor Tiziano Barberi**, Associate Professor and Group Leader, Australian Regenerative Medicine Institute, Monash University
Title: Directing human pluripotent stem cells towards specific fates

26 September: **Dr Neil Hawkins**, Vice President of Sustainability and Environment, Health & Safety, the Dow Chemical Company
Title: Valuing ecosystem services in the private sector: challenges and opportunities

3 October: **Professor George Guo-Qiang Chen**, Department of Biological Sciences and Biotechnology School of Life Sciences, Tsinghua University, Beijing, China
Title: Blue water biotechnology and the polyhydroxyalkanoates industrial value chain

4 October: **Dr Ekaterina Pas**, 2011 RACI Physical Chemistry Division Lectureship awardee
Title: Lecture tour for the 2011 RACI Physical Chemistry Division Lectureship awardee

12 October: **Associate Professor Gordon Xu**, Associate Group Leader, AIBN
Title: Biomedical applications of layered double hydroxide nanoparticles

19 October: **Professor Zee Upton**, Institute of Health Biomedical Innovation, Queensland University of Technology
Title: Taking a wound healing product from discovery to market: the trials and tribulations

23 October: **Professor Krys Matyjaszewski**, Centre for Macromolecular Engineering, Carnegie Mellon University, Pittsburgh, US
Title: Solomon Lecture

24 October: **Associate Professor Linyun Zhao**, Department of Engineering Physics, Tsinghua University, Beijing, China
Title: Drug-loaded magnetic nanocomposite devices for cancer magnetic thermochemotherapy

26 October: **Professor Colin Raston**, Winthrop Professor/Director, Centre for Strategic Nano-Fabrication, the University of Western Australia
Title: Controlling the organisation of matter in dynamic thin films

2 November: **Professor Junhu Wang**, Dalian Institute of Chemical Physics, Chinese Academy of Sciences, Dalian, China
Title: Novel catalytic materials for environment and energy

8 November: **Professor Jürgen Hubbuch,** Head of Department, MAB Biomolecular Separation Engineering, Karlsruhe Institute of Technology, Germany
Title: High throughput process development: integration of screening, rapid analytics and model-based development

9 November: **Professor Justin Cooper-White**, Group Leader, AIBN
Title: Engineering stem cell microenvironments for regenerative medicine applications

9 November: **Professor Xiaodong Zou**, Department of Materials and Environmental Chemistry, Stockholm University, Sweden
Title: 3D structure determination of nano-sized crystals by electron crystallography: new methods and applications

9 November: **Dr Herbert Treutlein**, Co-founder and CEO, Computist Bio-Nanotech
Title: Advanced methods for molecular design

15 November: **Professor David Williams**, Wake Forest Institute of Regenerative Medicine, US; Editor-in-Chief, *Biomaterials*
Title: A unified theory of biocompatibility

22 November: **Professor Zhong Zhang**, National Centre for Nanoscience and Technology, Beijing, China
Title: Polymer nanocomposites based on nano-carbon materials

29 November: **Professor Shingo Matsukawa**, Associate Professor of Food Science & Technology at Tokyo University of Marine Science & Technology, Japan
Title: Studies on network structures in polysaccharide gels by using gradient NMR

4 December: **Dr Craig Cormick**, Federal Department of Industry, Innovation, Science, Research and Tertiary Education
Title: How public perceptions can interfere with your research

7 December: **Dr Eve Tsai**, Ottawa Hospital Research Institute, Canada
Title: A multidisciplinary approach to spinal cord injury repair: from bench to bedside and back to bench

10 December: **Dr Juergen Zanghellini**, Austrian Centre of Industrial Biotechnology, Graz
Title: How to design an optimal cell factory

12 December: **Professor Kevin Kendall**, Chemical Engineering, the University of Birmingham, UK
Title: Hydrogen and fuel cells for transport: an energy storage problem

18 December: **Professor Avesh Kumar Tyagi**, Bhabha Atomic Research Centre, Mumbai, India
Title: Design of new functional materials guided by crystallographic concepts and novel synthesis protocols

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OUR HISTORY

- AIBN was established by The University of Queensland Senate in December 2002.
- Construction of a custom-designed 15,689sq m AIBN research facility started in November 2004.
- First AIBN Group Leaders appointed in 2005.
- The $73.6 million AIBN research facility was completed in August 2006.
- Then Queensland Premier Peter Beattie opened the facility on October 23, 2006.

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