AIBN

ANNUAL REPORT 2010

THE UNIVERSITY OF QUEENSLAND
AUSTRALIA

VICE-CHANCELLOR'S MESSAGE

AIBN offers proof that high-quality research generates excellent results for society, industry and the economy.

In 2010 AIBN, in its eighth year, continued to build on its record of conducting excellent fundamental research and harnessing it to benefit health, the environment and industry.

By early 2011 the national litmus test of universities' research, the Excellence in Research for Australia (ERA) assessment, had confirmed AIBN as a national leader and a performer well above world standards in its fields. The University of Queensland's pinnacle ERA ratings in environmental biotechnology, industrial biotechnology and nanotechnology owed significant credit to AIBN.

What ERA did not show – but this annual report does – is the value added to high-quality discovery as it progressively transmutes into products and services that industry and communities demand.

An assessment in 2010 by the Allen Consulting Group clearly articulates the institute's economic impact. Using Queensland Government-approved methodology, the group found every additional dollar invested in AIBN during 2003-2009 would increase Queensland's economic output by $4.50 to $6.30, while the national multiplier effect would be in the range of $2 to $2.90.

The Allen Group report forecast that AIBN would boost state and Australia-wide consumption and investment, and remarked on the "strong practical application opportunities in existing major Queensland industries". It concluded that further state government investments would ensure the Queensland Government's ongoing leadership in bioengineering and nanotechnology.

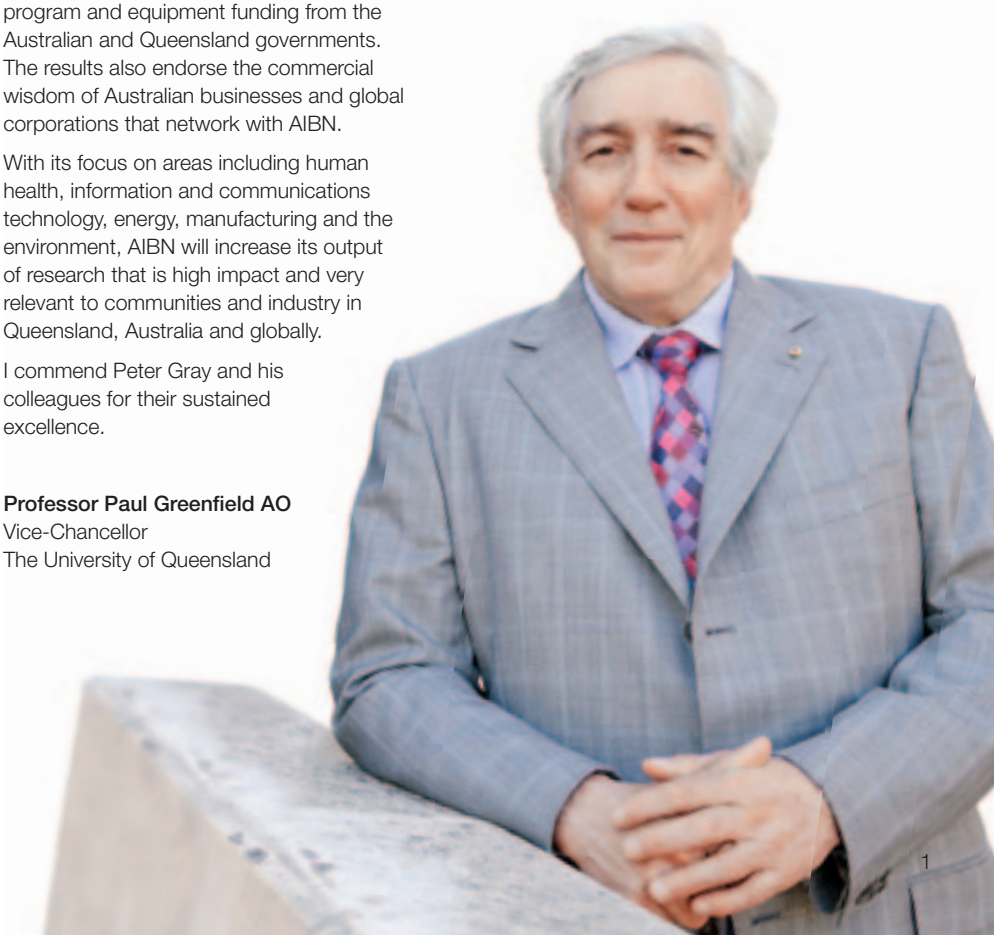
A third evaluation of AIBN, a seven-year review sanctioned by the UQ Senate and led by a global panel, including experts from Harvard and University College London, commended the Queensland Government, investors and UQ for "foresight in establishing AIBN with the remit to link translation of research to commercial use".

The results from ERA, the Allen Group and the seven-year review can all be read as vindicating the enabling investments by the Queensland Government and The Atlantic Philanthropies, as well as subsequent program and equipment funding from the Australian and Queensland governments. The results also endorse the commercial wisdom of Australian businesses and global corporations that network with AIBN.

With its focus on areas including human health, information and communications technology, energy, manufacturing and the environment, AIBN will increase its output of research that is high impact and very relevant to communities and industry in Queensland, Australia and globally.

I commend Peter Gray and his colleagues for their sustained excellence.

Professor Paul Greenfield AO
Vice-Chancellor
The University of Queensland



DIRECTOR'S MESSAGE

The year 2010 has turned out to be a milestone one for AIBN in many ways.

During the year the institute was involved in three important reviews. We were the first UQ research institute to be reviewed by UQ's Academic Board, a formal process the university conducts every seven years on all academic and research units; the Allen Consulting Group conducted a review of AIBN's economic contribution to Queensland and Australia; and AIBN's foundation group leaders' performance during the initial five years was reviewed as per the terms of their appointment contracts.

In this annual report we have summarised the main findings of these important reviews. In addition, we have used this opportunity to briefly summarise some of the main developments that have taken place since the institute began research activities in mid-2005, and then started to expand activities in a major way in 2006 with the move into the new AIBN building. Since the move to the new building there has been a rapid expansion in high-quality research and, pleasingly, many new multidisciplinary projects that have been instigated and grown successfully out of opportunities presented by the co-location of the range of expertise and disciplines in AIBN. Our numbers have grown from 56 people in the initial group leaders' groups to a headcount of more than 400.

The growing successes of AIBN's researchers resulted in the institute's income exceeding $37 million in 2010, with the majority of this raised from competitive sources. It included funding from companies for collaborative research programs, support from the full spectrum of Australian research funding schemes, and support from an expanding list of international funding agencies and foundations. There is a strong collaborative and international flavour to AIBN's research.

During 2010 we examined AIBN's international collaborations where there is a contractual agreement in place between the parties, such as a signed contract, a memorandum of understanding, a confidential disclosure agreement or a material transfer agreement, and found 157 such collaborations. Vice-Chancellor Professor Paul Greenfield has already commented that, in the recent Excellence in Research for Australia exercise, AIBN's research fields were all judged to be performing at levels well above world standard. The 233 papers published in peer-reviewed journals during 2010 is further evidence of a sustained, high-quality research output.

A measure of the impact of AIBN research is demonstrated by Queensland Premier Anna Bligh highlighting two AIBN-linked projects at a press conference at the prestigious US BIO conference. One was the announcement, with Boeing's chief technology officer John Tracy and then Amyris Biotechnology chief financial officer Dr Kinkead Reiling, of government support for the Queensland Sustainable Aviation Fuel Initiative. This research consortium is led by Professor Lars Nielsen.

The second, in association with DSM Biologics president Karen King, was that DSM was establishing in Brisbane a mammalian cell good manufacturing practice production facility, which would draw on AIBN's existing biologics expertise. During the same trip, the Premier announced support for Professor Anton Middelberg's collaboration with Tianjin University, in China, and Professor Andrew Whittaker's collaborative research project on spinal cord regeneration involving Ottawa Hospital and Monash University.

In a move certain to continue AIBN's success in international collaboration, the institute welcomed new Group Leader Professor Chengzhong (Michael) Yu, from Fudan University, China. Professor Yu has received several awards, including an ARC Future Fellowship.

Shanghai World Expo was a fitting place for UQ Deputy Vice-Chancellor (Research) and AIBN Group Leader Professor Max Lu to be recognised, during Queensland Week celebrations, with a Queensland Education and Training International Queensland-China Education and Training Award for Excellence. Within the awards, Professor Lu was named a joint winner in the Alumnus of the Year (Research) category.

In another 2010 achievement, the number of research higher degree students enrolled through AIBN passed 100 and AIBN's Student Association further consolidated its position as a key factor in the institute's academic, cultural and social activities. We were delighted that Dr Ian Nisbet joined us during the year to run the Industrial Affiliates Program, bringing to AIBN his extensive experience in commercialising technology.

Finally I would like to thank Euan Murdoch, who has so ably chaired our State Government review board, and our three senior colleagues and friends from UQ, Deputy Vice-Chancellor (Academic) Professor Debbie Terry, Deputy Vice-Chancellor (Research) Professor Max Lu and Vice-Chancellor Professor Paul Greenfield for their advice and guidance throughout the year.

Professor Peter Gray
AIBN Director

UNIQUE IDENTITY RECOGNISED IN MILESTONE REVIEW

In its first seven years, AIBN has established a unique identity in the Australian research community, working relentlessly to become a dynamic, integrated, multidisciplinary, research institute merging skills, technologies and ideas in the core fields of bioengineering and nanotechnology. At its core, AIBN is focused on research excellence and industrial relevance.

Membership of the review committee:

Professor Mike Hoare (Chair)
Department of Biochemical Engineering
University College London

Professor Tom Davis
Director, Centre for Advanced Macromolecular Design
School of Chemical Engineering
University of New South Wales

Dr Carrie Hillyard
Founder and Partner
CM Capital Investments
Brisbane

Professor Regis Kelly
Director, California Institute for Quantitative Biosciences (QB3)

Professor Pam Silver
Department of Systems Biology
Harvard Medical School

Professor Jennifer Stow
Deputy Director (Research)
Institute for Molecular Bioscience

Professor Alastair McEwan
Head, School of Chemistry and Molecular Biosciences
University of Queensland

Ms Helen Weir
Institute Manager
Queensland Brain Institute

A significant milestone for AIBN in 2010 was an independent review of its operations and achievements in the first seven years, commissioned by UQ's Academic Board and reporting to UQ Senate. The review found AIBN had grown from nothing more than a concept into a dynamic, accomplished organisation with 19 group leaders; 370 researchers, students and operational personnel; an annual budget of $34 million; and a 15,500sq m purpose-built, superbly equipped, research facility.

While those numbers are impressive on paper, it was AIBN's advances in research and its growing international reputation that were considered among its greatest achievements. The review commended AIBN for developing a superb international reputation by recruiting top quality staff and students; creating research facilities of international standard; nucleating hubs of research excellence; partnering with leading international entities; and securing significant research funding comparable with leading US institutions.

Professor Mike Hoare, from the Department of Biochemical Engineering at University College London, chaired the committee reviewing and assessing AIBN's performance, purpose, goals and priorities. The comprehensive review was based on interviews with internal and external stakeholders; building and facilities inspections; and written submissions.

The review outcomes supported AIBN's claim it had provided a critical mass of multidisciplinary researchers and a range of cutting-edge facilities unique to Australia; produced world-class research; and attracted world-class researchers. AIBN has leveraged external funds; provided a culture of commercialisation and entrepreneurial acumen; and contributed to educating and training a future generation of smart scientists and research leaders.

Beyond those achievements, AIBN has developed a research environment that is accessible to industry and contributes significantly to the Queensland and Australian economies.

Data presented to the review committee in June 2010 demonstrated AIBN's impressive research achievements during the first seven years, including developing collaborative programs between disciplines and with industry, with more than 150 active international research collaborations; $47.7 million in external research income, with national and international competitive grant schemes making up 85 percent of research income; and 25,000 citations recorded for group leaders. Those achievements continued during 2010, with external research income reaching $68 million since inception of the institute.

Researchers have collaborations in 25 countries and have forged links with leading international organisations, such as Dow Chemical Company, Boeing, Amyris, Intel and Sematech. Four start-up companies have been established on AIBN discoveries and innovations, with $1.755 million of equity raised for them. Data presented to the review committee showed AIBN researchers had 52 patent families under management and the Industrial Affiliates Program, established in 2009, had 17 members.

Among highlights in education and training were attaining close to 100 research higher degree students; hosting seven international conferences and workshops; and establishing a Weekly Research Seminar series and an Annual Institute Research Symposium. The institute's strong support for teaching has seen AIBN researchers actively engaged in teaching UQ undergraduate courses and participating strongly in the University's ResTeach Fellowship program. Recognition for AIBN researchers' leadership has seen three group leaders cited among Australia's 100 most influential engineers.

In completing the first review of a UQ institute, the committee found AIBN's approach to achieving excellence in research was embedded in its ability to demonstrate discovery-to-translation pathways. The review committee made commendations and recommendations covering research, internationalisation, commercialisation, governance, management and AIBN's future growth.

The Queensland Government, investors and the UQ Vice-Chancellor's Executive were commended for their foresight in establishing AIBN with the remit to link translation of research to commercial use.

AIBN Director Professor Peter Gray was commended for his leadership in developing the research direction and strong translational focus. AIBN's management was commended for creating international-standard research facilities and making resources available to the UQ community that would not otherwise have been possible.

Further specific commendations covered the creation of research excellence hubs that enriched the scientific community in important areas, including drug delivery, molecular diagnostics, tissue engineering, bioprocessing and functional nanomaterials, and AIBN's partnerships with outside organisations in strategically important areas.

AIBN BENEFITS THE ECONOMY

AIBN aims to have a strong technology and industry focus as a key point of difference from other academic research institutions. In the seven years since AIBN was established, the institute has developed, through domestic and international industry-led collaborations, technologies with commercial applications across a range of industries.

Developing innovations that can be commercialised to benefit human health, the environment, manufacturing, sustainable energy and information technology was a key aim when AIBN was established. An integrated, multidisciplinary framework ensured its research programs focused on the emerging disciplines of nanotechnology and bioengineering.

The result has been a strong performance across a range of areas, including research outcomes, attracting investment, commercialisation, training and employment. That performance has provided a significant contribution to the Queensland and Australian economies. In 2010, AIBN's economic contribution was extensively analysed by the Allen Consulting Group, one of Australia's leading economic and public policy analysts. AIBN commissioned the group to review the institute's economic contribution in its first seven years.The group found AIBN was highly successful in attracting additional investment to Queensland, with the funds making a significant contribution to the state's economy. Figures in the report showed every $1 invested in AIBN during 2003-2009 increased Queensland's economic output by $4.50 to $6.30. At a national level, the report suggested GDP increased between $2 and $2.90 for every additional $1 attracted by AIBN.

The report found AIBN's total income during 2003-2009 was $174 million. It estimated AIBN successfully attracted $61.5 million in additional investment to Queensland – that is, money that would not have been invested in research or other activities in the state without the institute's presence.

"The additional funds AIBN has attracted to date are expected to enhance the productivity of Queensland's economy and therefore stimulate further investment and economic activity," the report said.

"The additional funds attracted by AIBN during 2003-2009 are also expected to make a significant ongoing contribution to the Australian economy."

The report highlighted that AIBN had achieved a lot in the short period since it was created. It went beyond monetary figures to highlight the "strong practical application opportunities" of the institute's research in existing major Queensland industries, with the AIBN Industrial Affiliates Program flagged as a useful mechanism to facilitate those opportunities and applications.

The report concluded further State Government investments in AIBN would ensure Queensland's ongoing leadership in bioengineering and nanotechnology and ongoing economic contributions.

RESEARCH ACHIEVEMENTS

FAST FACTS

- AIBN achieved $68 million in external research income from formation until the end of 2010.
- 85 percent of research income in AIBN's first seven years was derived from national and international competitive grants.
- 233 papers were published in refereed journals in 2010.

INTEGRATED APPROACH TO IMPROVING HUMAN HEALTH

Personalised regenerative medicine is expected to transform health care globally and during the next five years alone is projected to be a $10 billion growth industry.

At the core of this transformation is the convergence of the rapidly advancing fields of transcriptomic, genomic, metabolomic and proteomic technologies, which is leading to unprecedented detailed insights into the molecular processes that govern stem cell behaviour. A strongly held belief at AIBN is that integrating cutting-edge stem cell biology with nanotechnology will be the next critical step in translating this knowledge into clinical and industrial applications, such as drug screening.

Challenges facing the development of stem cell-based therapies and drug screening applications include the need for defined culture systems that allow scale up of stem cell expansion and efficient, homogeneous generation of defined lineage restricted progenitor cells. There is also a need to deliver stem cells or stem cell-derived cells to specific sites in the human body and methods to address immune rejection.

With alleviating problems in human health identified as a primary aim of AIBN research, multiple integrated multidisciplinary projects have been established at the institute. One project pursues development of 'smart' surfaces and nanoparticles that can control and direct stem cell fate in bulk culture systems, such as bioreactors, and in microfluidic devices. Another involves developing biodegradable scaffolds and functionalised nanoparticles for targeted delivery of stem cells. A third deals with efficient, cost-effective generation of patient-specific induced pluripotent cells (iPS cells).

The 2007 discovery that any cell of the adult human body can be turned back into iPS cells that can generate every cell type of the human body has revolutionised the stem cell field. The iPS technology allows the production of stem, progenitor and somatic cells that are patient specific, and therefore unlikely to be immune rejected; and development of disease-specific personalised drug-screening platforms.

Having core facilities for the culture and generation of embryonic and iPS cells in the AIBN building – combined with bioinformatic, nanofabrication, microfluidic, protein production and metabolomic expertise – places the institute in a strong position to lead the regenerative medicine revolution of the 21st century.

Associate Professor Ernst Wolvetang's research group has made significant advances, creating a discovery platform for understanding the fundamental processes that underpin cancer and neuro-degeneration. The research group has generated iPS cells from people with ataxia telangiectasia, a rare neurodegenerative, inherited disease that affects the brain and other parts of the body. The generated cells are a renewable resource of cells that can be differentiated into all cell types of the human body, providing the basis for future patient-specific stem cell therapies, novel disease models and drug screening platforms.

In a world first, Associate Professor Wolvetang's stem cell engineering group has found a way to see how brain development can go awry in people who go on to show symptoms of Down syndrome. The group generated iPS cells from skin cells and stepwise differentiated them into mature neurons.

"This is a significant advance as it allows the deciphering of the fundamental molecular processes that underlie altered brain development in Alzheimer's disease and Down syndrome," Associate Professor Wolvetang said.

"This will provide valuable insights into the molecular basis of these conditions in the general population and constitutes a drug screening platform for testing small molecules that can intervene in those conditions' development."

Stem cell research is also a key element of Professor Justin Cooper-White's research group, which has made a significant impact in the way biomaterials scientists design smart surfaces for tissue repair.

Professor Cooper-White has developed new insights into how synthetic biomaterials and microfluidic devices may be tailored to direct stem cell behaviour and tissue genesis, with particular application to regenerating meniscal tissue and, more recently, heart tissue.

"Stem cells can turn into most or all tissues in the body," Professor Cooper-White said. "The challenge is to make sure they turn into the right tissue in the right location with an appropriate timeframe for functional repair of lost or damaged tissues.

"Our research aims to create synthetic microenvironments for optimised culture, expansion and eventual implantation of stem cells. Our research outcomes have had a significant impact in terms of informing the way biomaterials scientists design surfaces and scaffolds for tissue repair and informing the way biologists think about how cells currently grow in vitro.

"The outcomes of our research into regenerative medicine will eventually improve the quality of life of people suffering from degenerative joint diseases and cardiovascular diseases."

Tissue repair techniques developed at AIBN by Professor Julie Campbell are starting to be used in overseas laboratories, with expectations that people will one day grow different tissues in their own bodies to replace diseased or damaged body parts.

Professor Campbell has developed an autologous vascular graft in the peritoneal cavity, a technique now being used in overseas laboratories to grow autologous heart valves.

"In simple terms, it means that, in the future, patients may be able to grow, within their bodies, their own vascular graft to replace a diseased or damaged segment," she said. "This avoids either the sacrifice of a healthy blood vessel to act as a graft, or implanting foreign material as a prosthetic graft. It also means there would be no rejection of the graft as it is derived from the patient's own cells."

In a world first, AIBN's Professor Lars Nielsen and his research group have developed a bioprocess to manufacture neutrophils in therapeutic doses to protect cancer patients at risk of invading bacteria and fungi.

Professor Nielsen's research group is working with the Australian Red Cross and the Peter MacCallum Cancer Centre to arrest the risk of neutropenia in cancer patients undergoing chemotherapy.

The infections associated with neutropaenia cause about 200,000 cancer patients worldwide to be hospitalised each year and result in the death of one in 14 of those people. High-dose chemotherapy in cancer patients interferes with the body's ability to produce neutrophils, a type of white blood cell that is the body's first line of defence against invading bacteria and fungi.

Professor Nielsen's manufactured neutrophils, called TheraPhils, are not a stem cell therapy, but the product of expanded haematopoietic stem and progenitor cells (HPC) using either umbilical cord blood or peripheral blood donations as the cell source. The cells are fully functional, fully differentiated, non-genetically modified cell therapy products. The neutrophils are manufactured through a proprietary, patented process capable of achieving a minimum 2,000 fold expansion of initial HPC population. That is a more than 10-fold improvement in cell number expansion over current methods and produces up to 30 transfusable doses.

TheraPhils have been tested for their ability to respond to and kill microbes and behave similar to normal neutrophils. Like normal neutrophils, they express low levels of antigens and should be safe to transfuse without tissue typing.

The next step in Professor Nielsen's research is a small clinical study in patients with acute myeloblastic leukaemia to demonstrate that the manufactured neutrophils are safe for use in humans and behave like normal neutrophils when transfused.

LATEST IN VACCINE TECHNOLOGY

AIBN researchers have made significant inroads in the past seven years in identifying ways to potentially tackle H1N1 swine influenza and group A streptococcus, which can lead to rheumatic fever and rheumatic heart disease. They are working with global leaders in biochemistry to develop a vaccine platform. They have also developed a needle-free vaccine delivery device that has shown in preclinical trials to use 100 times less vaccine while still being protective.

A virus vaccine, but not a virus

Vaccines are a big business and save an estimated eight million lives annually. When Professor Anton Middelberg arrived at AIBN from the University of Cambridge in 2003, he looked carefully at vaccine developments and concluded that virus-like particles (VLPs) were the future. At the time, UQ was winning acclaim for the work of Professor Ian Frazer's breakthrough VLP Gardasil, while Professor Middelberg had been researching virus assembly at Cambridge. He wondered what might be possible if he could create a "generic" VLP that could be tailored for any disease.

"I looked first at Gardasil," Professor Middelberg said. "It's an absolutely brilliant VLP for cervical cancer, but not other diseases." So he established a strategy and team focused on a related VLP – polyomavirus. "VLPs are just fantastic. They cause an enhanced immune response that has both cell and antibody components. You can freeze dry them so there is no need for a cold chain in the developing world and they can be given by nasal puffer, overcoming the need for a syringe." As VLPs do not contain infectious DNA – they are a shell of the virus but not the virus itself – they are inherently safe.

Armed with a $2 million Australian Research Council Federation Fellowship, Professor Middelberg's first real breakthrough came when the pioneer of VLP assembly, Professor Robert Garcea, in Colorado, sent key materials and protocols to AIBN.

However, Professor Middelberg and his team quickly realised the yields of VLPs using those methods were far too low. "It was an interesting laboratory method, but a long way from being technologically useful." After careful research, AIBN PhD student Yap Pang Chuan and Protein Expression Facility manager Dr Linda Lua managed to achieve the highest expression of viral protein in bacteria to date. The result was published in a leading biotechnology journal and patented jointly with Professor Garcea.

With this early breakthrough, Professor Middelberg adopted a focused strategy of scientific platform development. In 2008 and 2009 a series of AIBN-led successes emerged. New techniques for the quantitative assessment of VLP size and structure were developed, leading to productive collaboration with the US National Institute of Standards and Technology. Bioreactor methods were devised that led to gram-per-litre levels of VLPs from bacteria – the highest in the world – and a new analysis of the thermodynamic drivers of virus assembly was published in the prestigious *Journal of the Royal Society*. In 2010, a cutting-edge mathematical model of VLP assembly was published by Professor Middelberg and his group and featured on the front cover of the leading journal *Biotechnology and Bioengineering*. A series of invitations followed, including one to publish the platform details in a special issue of the journal *Vaccine*.

After five years of scientific platform evolution, Professor Middelberg was delighted in 2010 to receive the Queensland Smart Futures Premier's Fellowship to further develop the VLP approach. "This $2.5 million grant will allow us to take the VLP technology to the next level and address specific diseases," Professor Middelberg said. "By grafting elements of a dangerous pathogen on our VLP, we will be able to direct the immune response towards a new or existing disease."

The opportunities for better technology are huge. "There is currently no commercial product or technology that can deliver tailored vaccines within weeks of a new disease emerging. Take, for example, H1N1 swine flu. Our VLP platform can potentially deliver vaccine in weeks, not months, stopping a pandemic before it starts."

Having recently secured a $1 million collaboration with a leading group in China through the Smart Futures NIRAP program, and a contract from a US pharmaceutical company, Professor Middelberg and his team are convinced the future of vaccines is indeed VLPs – and that AIBN will continue to lead developments internationally. "This approach to vaccines is ideally suited to Queensland and will add huge value to the state's biotechnology infrastructure. A billion plus people in Asia want a healthy future and deserve protection against new threats such as bird flu. This technology is ideally suited to those markets and the product can be manufactured in Australia and shipped more easily than coal."

Needle-free devices

Needle-stick injuries and cross-contamination are the major concern in vaccination programs, prompting the development of a relatively new research field in microneedle-based technology. Since arriving at AIBN five years ago, Professor Mark Kendall has established himself as a leader in the emerging field.

When Professor Kendall joined AIBN, there were no published articles anywhere in the world about microneedle-based technology for use as an alternative vaccination delivery technique. By 2010, there were more than 40, with about half coming from Professor Kendall's research group. In that time, the first microneedle-based device has been launched on the market.

While Professor Kendall has not been the first to launch a product on the market, his work is at the cutting edge in both vaccine delivery and biomedical engineering. In just five years, he has put together a research group, developed the Nanopatch and entered a joint partnership research and development project with an international vaccine company.

The Nanopatch overcomes inefficient needle delivery, which places vaccine in the muscle, where there are few immune cells. Instead, the Nanopatch has thousands of small projections designed to hit abundant immune cells in the skin. The projections, measuring less than 1000 nanometres at the outer tips, have led to seven patent applications.

Preclinical trials in mice have shown unprecedented efficiencies, with a 100-fold dose-sparing of influenza vaccine while achieving equivalent protection.

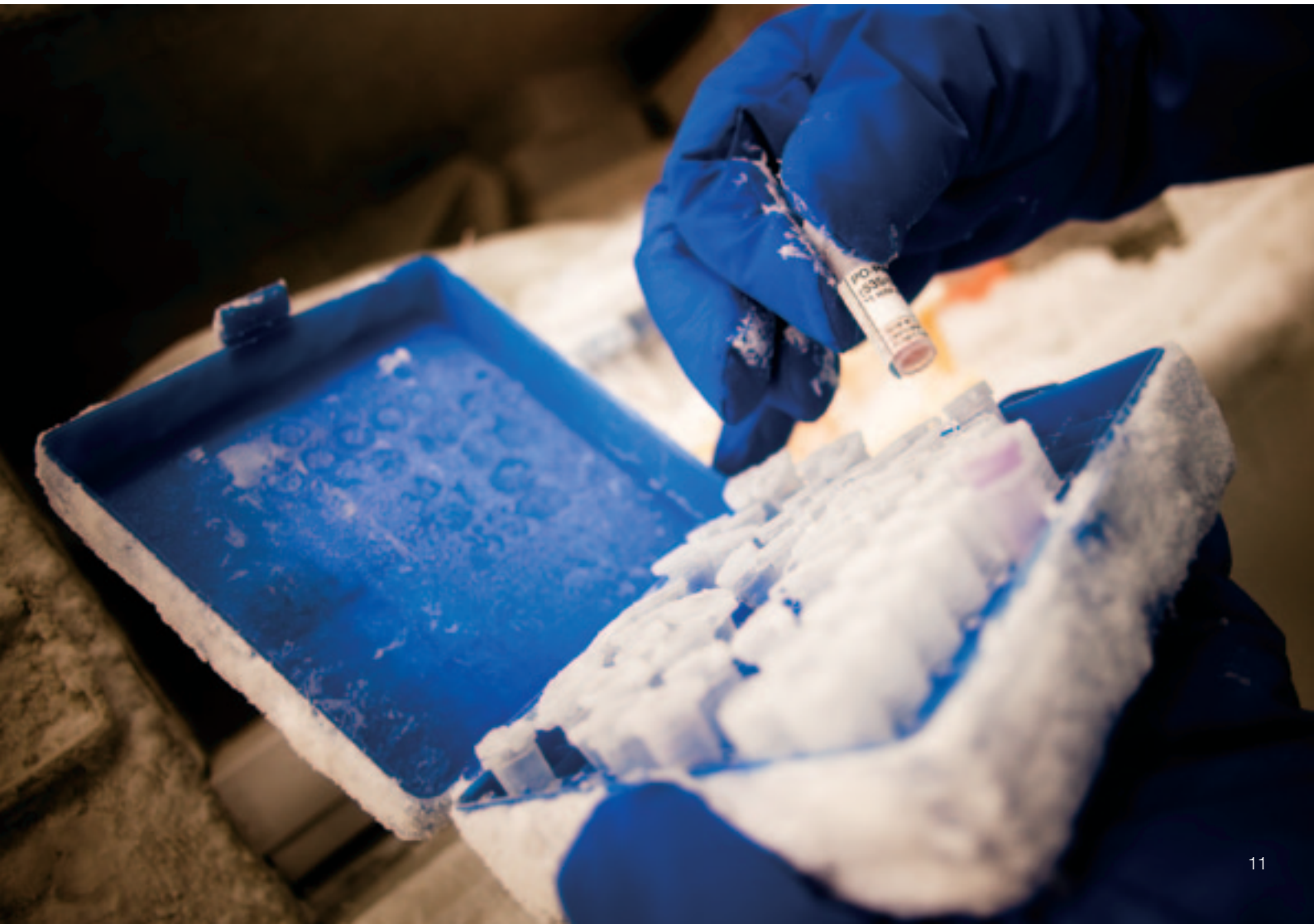
"This is at least 10 times better than anybody has achieved with any other delivery method," Professor Kendall said. "We are world leading. Indeed, we extended the Nanopatch and have shown it is applicable to particular disease test-cases of human papillomavirus, herpes simplex, West Nile and Chikungunya viruses."

Initial data on dry-coating the vaccine to the Nanopatch tips has shown the technology may not need refrigeration in vaccine transport and distribution. "This is hugely important," Professor Kendall said. "The World Health Organisation estimates 50 percent of vaccines in Africa do not work properly because the 'cold chain' has been broken."

Professor Kendall's group is part of the International Needle-free Vaccination Alliance, providing a vehicle for collaboration with world leaders at the Seattle Biomedical Research Institute, the Program for Appropriate Technology in Health and the World Health Organisation to investigate the Nanopatch's ability to vaccinate against three major diseases.

"To help optimise our delivery devices, we are performing fundamental research into key mechanical and biological properties of skin. Mechanical measurements are made with a range of tools, including a Nanoindentor. Our understanding of skin biology is enhanced with a range of tools, including a new in vivo multi-photon microscope, one of very few in the world capable of interrogating – in real time – in vivo interactions within the skin induced after delivery.

"If we succeed, we are well on the path to revolutionising the way we vaccinate."



BIOLOGICS RESEARCH GROWS AT AIBN

Since the advent of recombinant DNA technology, a new class of protein-based human therapeutics has been developed, based on the ability to produce any protein using modern biotechnology techniques.

Such therapeutics are sometimes referred to as biopharmaceuticals but, increasingly, the term biologics is being used. New biologics have gained rapid acceptance as human therapeutics, accounting for more than 17 percent of total global pharmaceutical sales. Much of the pharmaceutical industry's research is geared towards developing novel biologics. The majority of new biologics are large proteins that have been modified with the addition of complex carbohydrate chains to the protein backbone.

Because of the size and complexity of most biologics, they need to be produced in cultured mammalian cells that mimic processes that occur in the human body. The cells grow slowly and have relatively low productivity, resulting in high production costs. The AIBN building was constructed with specialist areas suitable for producing biologics, where mammalian cells can be grown in sterile areas to minimise the chance of contamination.

AIBN research involving Director Professor Peter Gray has been geared towards developing improved mammalian cell lines for producing biologics. The Chinese hamster ovary (CHO) cell line is most commonly used for research and commercial production. The research focuses on developing improved CHO cell lines and bioprocesses for transient and stable expression of biologics.

It is possible to introduce nucleic acids into mammalian cells, or transfect, using plasmid DNA, resulting in transient expression of the protein. The DNA plasmids do not integrate into the host cells' genome, but accumulate episomally and protein expression can occur until plasmids are cleared from the cells. Transient mammalian cell expression systems, such as HEK-293, have been engineered to produce sufficient protein for early stage testing and evaluation of therapeutic potential. The lack of such a transient expression system in CHO cells has been a limitation. AIBN research has further developed a CHO-based transient expression system called Epi-CHO to promote episomal plasmid replication and plasmid segregation on cell division so the cells can transiently express proteins for several weeks, rather than only days.

In 2010, Joe Codamo, Dr Trent Munro and Professor Gray published transient CHO expression data with the highest productivity of a monoclonal antibody reported globally to date. Episomal replication was shown to allow cultures to grow and still maintain high levels of protein expression, and with the Epi-CHO system it was possible to have a final culture volume six times that of the original starting volume. Patents covering the Epi-CHO invention have been issued in the US, Europe, Singapore and Australia. The technology is being commercialised by Acyte Biotechnology Pty Ltd, a UQ and University of NSW spin-off company.

In stable protein expression systems, the plasmid coding for the protein of interest is integrated into the host cell genome, so the host cell and its progeny will produce the protein of interest. Stable expression systems are used to produce clinical grade biologics during product manufacturing.

It usually takes six to nine months to produce stable mammalian cell lines, needed for complex biologics.

AIBN research has examined approaches to speed the isolation of highly expressing clones using fluorescence activated cell sorting (FACS) and automated robotic imaging. Such an approach is particularly useful when the desired protein is a multi-chain protein, such as a monoclonal antibody. The DNA coding for one chain of the antibody is placed in a plasmid and attached by a sequence called an attenuated IRES to a fluorescent marker, whereas the DNA coding for the other chain is placed in its plasmid and attached by an attenuated IRES to a second fluorescent marker. The host cells can be transfected with the mixture of the two plasmids and a very small percentage of the host cells will have the plasmid DNA stably inserted into their genome.

That is where the power of FACS comes in, as it can scan 70,000 cells a second to look for the very few cells with DNA inserted into the genome to give the correct ratio of the two chains. It can also allow any cells expressing both chains at high levels to be sorted from the bulk population and grown for further study. Warren Pilbrough's research at AIBN has shown the power of the technique, with its ability to analyse cultures cell by cell, to gain a much greater understanding of what is happening at the cellular level and the high degree of stochastic variation existing in supposed monocultures.

While bioprocess optimisation has facilitated significant increases in the level of recombinant biologic production, there remains untapped potential for rational cell line engineering approaches. Using a combination of metabolomics, fluxomics, and targeted genetic manipulation using zinc finger nuclease technology, Dr Munro is collaborating with AIBN's Professor Lars Nielsen to produce the next generation of host cells for biologics production. Using a systems biology approach, it is possible to model 'in silico' cells in culture to identify genetic pathways that can be modified to provide more efficient recombinant protein production. Preliminary work has attracted significant commercial interest and a research collaboration with a large US biologics company.

Mammalian cell research at AIBN has developed rapidly, complemented by the strong National Collaborative Research Infrastructure Strategy biologics group under the direction of Dr David Chin. AIBN is well set up with equipment, such as FACS for rapidly isolating highly expressing clones, and complementary robotic cell selection equipment, the ClonePix. Such equipment complements the extensive suite of cloning, cell growth, and protein purification facilities and the protein characterisation equipment built up by AIBN Professor Anton Middelberg and his colleagues.

AIBN staff members work closely with colleagues from contract manufacturers DSM Biologics and BioPharmaceuticals Australia, who are involved in building the new DSM Biologics plant in Brisbane.

DSM Biologics comes to Brisbane

Construction of the $345 million Translational Research Institute is in progress at Princess Alexandra Hospital, Brisbane. It includes a mammalian cell good manufacturing practice production facility that will be capable of producing clinical-grade biologics ready for clinical trials. The concept of having the ability to produce clinical-grade material alongside TRI has been advocated from the outset by the project champion, UQ's Professor Ian Frazer. The Queensland Government established BioPharmaceuticals Australia Pty Ltd, with Professor Frazer and AIBN Director Professor Peter Gray on the board, to design and build the $60 million facility.

In 2010, it was announced that DSM Biologics had been selected to run the facility, bringing with it high-level international contract manufacturing experience and credibility. That will ensure protocols, procedures and quality control at the facility will be acceptable to regulatory authorities, such as the FDA in the US, the EMEA in Europe and the TGA in Australia.

DSM is an experienced global contract manufacturing organisation. The parent company has an annual turnover of $10 billion. Senior DSM Biologics personnel have been quoted as saying one reason they were attracted to the Brisbane facility was the mammalian cell expertise existing at AIBN.

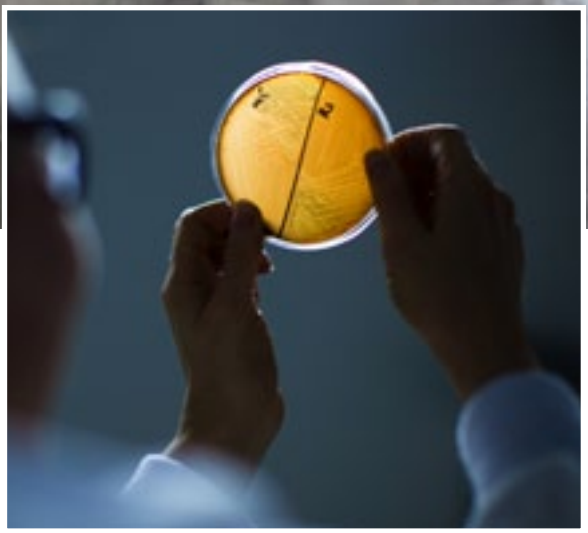
METABOLIC ENGINEERING THROUGH SYSTEMS AND SYNTHETIC BIOLOGY

Industrial biotechnology offers many advantages over conventional petrochemical production. Biocatalysis enables highly specific synthesis of complex chemicals and fuels from simple sugars with minimal losses. The system is engineered at micron scale (single cell) and readily scaled up in simple tank reactors using a benign solvent (water) at room temperature and low pressure. Until recently, however, industrial biotechnology was limited to products naturally produced at high levels.

Metabolic engineering – the purposeful design of living organisms for producing desired chemicals and fuels – has changed that. In the past decade, metabolic engineering has evolved from crude retrofitting using genetic engineering towards greenfield designs using systems and synthetic biology. Organisms used in producing the next generation of bio-chemicals are being purpose designed.

From the outset, AIBN identified metabolic engineering as a pillar of growth with an important nexus of local value, given Queensland's large sugar industry, and international significance. The strategy focused on leveraging group leader Professor Lars Nielsen's strong international profile in the narrow field of metabolic engineering of biopolymer production to create a comprehensive, internationally competitive metabolic engineering program. The process was facilitated by the appointment of Professor Sang Yup Lee from the Korea Advanced Institute of Science and Technology (KAIST) as AIBN's inaugural visiting professor. Professor Lee is one of the world's leading metabolic engineers and spent one year full-time and a second year part-time at AIBN. Professor Nielsen also spent half a year at KAIST.

The strategy was backed with substantial investments in infrastructure and foundation research projects by the Queensland Government Smart State Fund, the CRC



for Sugar Industry Innovation through Biotechnology, the National Collaborative Research Infrastructure Strategy (NCRIS), Australian and international companies and UQ. From 2006 to 2009, about $3 million in infrastructure and $5 million in research grants were invested.

The year 2010 was a break-through one for the initiative. Two companies that engaged early – Metabolix and Dow – signed new, larger contracts, while several pilot projects were successfully completed and expected to lead to new contracts in 2011. In total, more than $10 million in new research contracts was secured. Several key findings were published, including the first ever genome scale model for plants quickly followed by the first model for C4 grasses, such as sugarcane, sorghum and maize, and the first genome sequence and model for a sucrose using *E. coli*. The team was invited to present work at key conferences in the US, Korea, China, Europe, Brazil and Australia and the work of several team members was recognised through awards and research fellowships.

"Ultimately, we hope to measure the success of the metabolic engineering program in terms of industrial biotechnology companies established in Queensland," Professor Nielsen said.

"Facilitating linkages between international biotech and chemical companies and Queensland companies is an important role of the program."

Most recently, the Queensland Sustainable Aviation Fuel Initiative, headed by AIBN, is bringing together aviation companies Boeing and Virgin Blue; sugar producer Mackay Sugar; oil industry representative IOR Energy; and leading international biotech company Amyris to evaluate and ultimately develop sustainable solutions to aviation in collaboration with researchers at UQ and James Cook University.

The timing is right for a major infrastructure boom in Queensland industrial biotechnology.

NANO DEVELOPMENTS FOR DIAGNOSTIC ADVANCES

Developments in nanotechnology are helping AIBN researchers make rapid advances in medical diagnostics, with benefits for early detection and personalised treatment of diseases such as cancer, malaria and dengue fever.

Professor Matt Trau is at the forefront of developing flexible molecular reading systems to accurately and cheaply detect cancer, which he hopes will replace a variety of complicated tests using a range of expensive equipment. He has made major progress in miniaturising many of the present diagnostic molecular processing steps onto the surface of a single nanoparticle. Professor Trau has also devised novel methods to barcode these particles so each one can be used for a different diagnostic test.

That means quick, accurate diagnosis, hopefully when a disease such as cancer is in its early stage and most responsive to treatment.

"Unfortunately, current diagnostic protocols typically depend on a complicated variety of tests based on a wide range of different, and often expensive, technological platforms," Professor Trau said.

"Each different platform requires significant investment in single-use equipment and training. Despite this investment, results can be ambiguous and require multiple, different tests to produce a confirmed result for a single pathogen.

"Nanotechnology offers the promise of miniaturised, inexpensive, flexible and robust 'plug-and-play' molecular reading systems that can be effectively deployed in the field."

There has been rapid advancement in the field in the seven years since AIBN was established. At that time, the research field was focused on discovering new biomarkers that could be used to detect diseases. Now, with tens of thousands of promising biomarkers discovered worldwide, there is a dual need for validation of the biomarkers and for suitable nanodevices to perform the validation work rapidly, inexpensively and accurately.

Through Professor Trau's international collaborations, his research group has gained access to a range of clinical samples which has enabled testing and refining of nanodevices being developed at AIBN for diagnostics.

Professor Trau's group covers a host of research areas, including nanotechnology, genetics, proteomics and molecular diagnostics.

Associate Group Leader Dr Bronwyn Battersby's research focuses on developing biosensor technologies for molecular detection of cancer and infectious disease biomarkers.

The biosensors are platform technologies tailored for applications such as reading epigenetic signatures in breast and cervical cancer, and leukaemia; profiling the specificity of proteolytic enzymes associated with West Nile virus and dengue fever; detecting ovarian cancer protein biomarkers in blood; and detecting DNA mutations in cancer.

The biomarkers are being commercialised by spin off company Nanomics BioSystems Pty Ltd. Her involvement in the commercialisation activity resulted in Dr Battersby being appointed the company's general manager.

Dr Darby Kozak has been primarily involved in Professor Trau's lab in developing nanodevices for detecting protein-based biomarkers and advancing new elastic nanopore technology as a novel means of performing nanoparticle and biomarker readouts, in collaboration with New Zealand company Izon Pty Ltd.

Dr Ashley Connolly has been developing nanodevices for detecting DNA-based biomarkers and working on new methods for DNA amplification.

Research achievements and advances from Professor Trau's group have resulted in more than 60 refereed journal publications in the past seven years, along with eight patents and several important commercial spin-offs and engagements. As well as creating Nanomics BioSystems Pty Ltd, the group has engaged with companies such as Merck, Genetech, Digene, Beckman Coulter, Panbio and AI Scientific.

The group's research achievements have enabled the lab to secure more than $20 million in competitive national and international research funding during the past seven years. A $4 million Queensland Government National and International Research Alliances Program grant partnered Professor Trau's lab with leading biomarker researchers from the Fred Hutchinson Cancer Research Center, the University of Washington and the Seattle Biomedical Research Institute.

Research achievements have also been recognised through numerous awards to staff, such as an ARC Federation Fellowship, a Paul Harris Fellowship and a Pink Circle Breast Cancer Research Award to Professor Trau; and a Merck Fellowship and Smart State Fellowship to Dr Simon Corrie, who trained in his lab.

Dr Krassen Dimitrov is working to improve accuracy in diagnosis, with a focus on determining marker molecules associated with tropical infectious diseases, such as malaria and dengue fever.

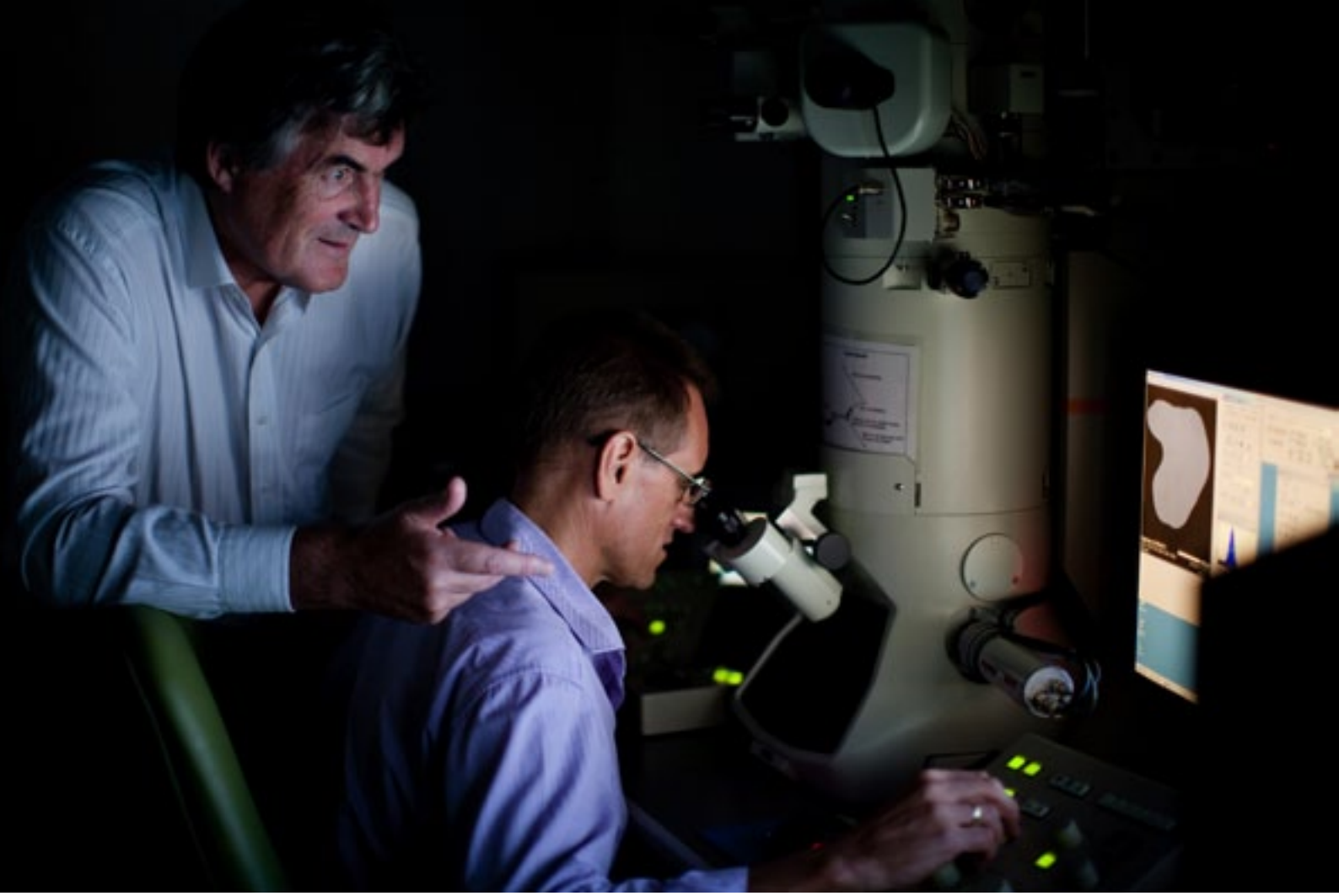
His pioneering concept of direct digital counting (DDC) of single biomolecules has demonstrated sizable advantages in sensitivity and accuracy over classical, dose-responsive detection of analogue signals.

That means single-molecule nanolabels can be used to determine marker molecules in small amounts of biological samples and provide an accurate diagnosis. The nanolabels are translocated with magnetic forces through a nanometer-sized electronic sensor for digital readout.

Dr Dimitrov's concept of a single-molecule labelling to a portable electronic format points to a new way of diagnosis. "Where this whole thing is headed is rapid, hypersensitive, point-of-care diagnostics with digital accuracy. In other words, tests with high sensitivity and accuracy that can be performed in a GP's office," he said.

Developing the diagnostic platform is a multidisciplinary endeavour, requiring integration of knowledge from electrochemistry, nanofabrication, electronics and electrical engineering, nanoparticle science, physics of magnetic fields, biochemistry, bioconjugation, surface chemistry and polymer chemistry. The research is loosely segmented into three components. There is the design, synthesis and characterisation of a single-molecule nanolabel, consisting of a magnetic particle, a non-magnetic particle, flexible DNA-linkers and affinity probes. Then there is nanosensor work featuring flat CMOS-compatible 20-50nm nanoelectrodes. Finally, there is the magnetic assembly for magnetophoretic translocation of the single-molecule labels to the nanosensor.

Following success in commercialisation with Dr Dimitrov's single-molecule start-up company NanoString Technologies, which has been placing DDC technology all over the world, AIBN hopes to develop his latest research for the market.



COLLABORATION ADVANCES ENERGY RESEARCH

Interdisciplinary and international collaboration have been the hallmark of many important scientific breakthroughs at AIBN, including developing alternative renewable energy sources.

UQ Deputy Vice-Chancellor (Research) and AIBN Group Leader Professor Max Lu and his researchers are working on various energy conversion and storage systems with particular focus on optimising the physical and chemical properties of nanomaterials.

Since being established seven years ago, AIBN has made notable advances in solar cell technology through crystal engineering of titania single crystals and the viability of supercapacitor technology for high power density and capacity has increased through nanostructured carbon research. Major breakthrough photocatalytic catalysts have been developed with promising applications in environmental pollution control.

Photocatalysis is an important chemical process that underpins development of critical environmental and renewable energy technologies, such as photocatalytic water purification, hydrogen production from splitting water and highly efficient, low-cost solar cells.

The search for more efficient photocatalysts has intensified in the past decade because of their great significance in clean energy and environmental applications. AIBN research has focused on design and fabrication of nanostructured materials for sustainable energy conversion applications, including efficient photocatalysts for water and air purification, solar cells, self-cleaning coatings and water splitting for hydrogen production. The measure of outstanding achievements in the field is highlighted with the research on novel photocatalysts for hydrogen production being published in *Nature Photonics* in May 2011.

In 2008, Professor Lu and his research group published breakthrough results in the publication *Nature*, describing their theoretical computational studies and experimental techniques to synthesise a highly reactive and efficient photocatalyst. According to the ISI Web of Science database, the *Nature* paper has since been cited 199 times, highlighting its impact on the scientific community.

The *Nature* paper demonstrated the collaborative strength of AIBN, with Professor Lu co-authoring the work with research group members Associate Professor Shizhang Qiao, Huagui Yang and Gang Liu; Chinese Academy of Sciences Dr Hui Ming Cheng; AIBN Group Leader Professor Sean Smith; computational scientist Dr Chenghua Sun; and Centre for Microscopy & Microanalysis Professor Jin Zou.

Professor Lu's group, including Associate Professor Qiao, successfully engineered the surface and crystallographic characteristics of crystalline materials to synthesise uniform anatase titanium dioxide (TiO_2) single crystals with a high percentage of reactive surfaces, using hydrofluoric acid as a morphology controlling agent.

The fluorated surface of the single crystals can easily be cleaned using heat treatment to render a fluorine-free, high-purity anatase TiO_2 surface without altering the crystal morphology. Inorganic single crystals with highly reactive surfaces have long been studied because of their scientific and technological importance as photocatalysts. But surfaces with high reactivity usually diminish rapidly during the crystal growth process.

A typical example is anatase TiO_2. Most available anatase TiO_2 crystals are dominated by thermodynamically stable surfaces, rather than more reactive surfaces, which account for only three percent of the total surface.

The work of Professor Lu's group illustrates AIBN's influence as a multidisciplinary institute to enabling combining theoretical computational studies and experimental techniques to achieve engineering of surface and crystallographic characteristics of crystalline materials.

Because photocatalysts underpin many renewable energy industries, the research has great potential to lead to economically viable alternative energy sources, including highly efficient and cheap photovoltaic cell systems.

AIBN has made a global contribution in the field during the past seven years, with cross-discipline collaborations, papers in high-ranking research journals and the number of invited keynote addresses presented by the institute's clean energy researchers a testament to the recognition achieved in this dynamic field.

Nanostructured materials, such as porous carbons, nanotubes, oxides nanoparticles and nanofilms, have been developed to offer tremendous potential in electrodes, energy storage media, catalysts and membranes for clean energy production, and CO_2 separation – all important for a clean energy future.

Research from Professor Lu's group in those fields includes clean energy and green chemistry, under the leadership of Dr Jorge Beltramini. His team's interest includes the synthesis, manipulation, and physical, chemical and catalytic characterisation of new nanomaterials for natural gas, coal, and biomass conversion into valuable chemicals and transportation fuels; clean hydrogen production; reformulation of heavy residues; waste plastic degradation into fuels; and heterogenisation of homogeneous catalysis for fine chemicals production.

AIBN's Dr Denisa Jurcakova has researched carbon and nanotechnology, specialising in nanostructured carbon for supercapacitors. As part of Professor Lu's group, Dr Jurcakova has a team developing several highly efficient nanostructured carbons from various low-cost precursors. Novel insights into the fundamental understanding of the effect of pore size and surface chemistry of carbons on their energy storage capacity were obtained in a very productive collaboration with Professor Teresa Bandosz, of City University of New York. Profound understanding of the energy storage mechanism in nanoporous carbons is critical for developing high performance supercapacitors for many applications, including hybrid vehicles and renewable energies.

AIBN Group Leader Professor Chengzhong (Michael) Yu and his team are working on the synthesis and characterisation of novel nanomaterials that can be used in biotechnology, clean energy and environment protection.

Funding from the Environmental Biotechnology Cooperative Research Centre and the Australian Research Council has given Professor Yu and his team the opportunity to consider fundamental and application-driven research, important for translating cutting-edge science and technology into commercial products.

The group has developed high-performance phosphate adsorbents for use in water treatment. The group is also developing a new generation of anti-cancer nano-carriers and cancer diagnosis tools for cancer detection and therapy.

"The next stage of our research is to get deep fundamental understanding, through which we can design better materials in delivery; cancer diagnosis and therapy; and water treatment," Professor Yu said.

AIBN Group Leader Professor John Drennan and his group are participating in a fruitful international collaboration with the National Institute for Materials Science, in Tsukuba, Japan. Professor Drennan's group collaborates with Professor Toshiyuki Mori and his researchers, developing a new way of looking at materials important in developing fuel cell technology.

Solid oxide fuel cells that operate at about 750°C are extremely efficient at consuming fuels ranging from hydrogen to natural gas. At the heart of the fuel cell is a dense ceramic electrolyte that can conduct oxygen ions. The ceramic electrolyte must have good mechanical strength at the operating temperature and be chemically stable for the life of the fuel cell.

"The challenge is that the present generation of electrolyte materials has a tendency to 'age' over time. The materials are doped ceramics and the dopants tend to phase separate under fuel cell operating conditions," Professor Drennan said.

That results in reduced efficiency through a drop in the ions' conductivity and influences various interfaces that make up the total fuel cell package. The ageing of the electrolyte material manifests itself through subtle changes in the material's microstructure when observed at the atomic level, which the researchers have called microdomains.

"Microdomains are found throughout the family of electrolytes, irrespective of composition, and appear to change over time, consolidating into separate phases. That change in the microstructure causes deterioration and an understanding of the process will allow us to control the initial microstructure to minimise the effects of ageing," Professor Drennan said.

"Our understanding of the microstructure, coupled with conductivity measurements, has given us a model of the process and we now have a predictive method that explains how the microdomains develop over time.

"By understanding the evolution of the microstructure, we have the first steps in understanding the mechanisms of conduction, which gives us a means of improving and controlling the materials' properties," he said.

NOVEL POLYMERS AND NANOSTRUCTURES FOR NEW GENERATION OF PRODUCTS

AIBN's novel polymer and nanostructure research spans a broad spectrum of potential benefits, such as earlier detection of diseases; bio-based polymers for applications including packaging; biomedical advances; biocompatible polymers; and nanomaterials that can outperform many existing commercially available materials.

Ground-breaking research in polymer architecture, biomaterials, polymer chemistry and nanocomposites has advanced beyond pure research with many developments very close to commercialisation.

Professor Andrew Whittaker's group is at the forefront of applying fundamental chemical knowledge to biology and nanotechnology, placing it in a perfect position to attract interest from international collaborations and commercial partners.

The group works in a dynamic field that has advanced enormously since AIBN was established, starting with exploration of major advances in synthetic chemistry: controlled radical and click chemistries for manufacturing complex, predictable molecules. The field has become more diverse. The scientific challenge now is to translate chemical knowledge to biological systems.

Meeting the challenges in biomaterials, Professor Whittaker's research group has introduced new concepts in molecular imaging and proposed novel materials for drug delivery and tissue regeneration. With the help of national and international collaborators, Professor Whittaker's group is applying fluorine magnetic resonance imaging agents to detect Alzheimer's disease; forms of cancer including melanoma, breast and prostate cancer; and malignant gliomas – tumours that start in the brain or spine. The advances will lead to early detection of disease and the ability to repair damaged, unhealthy tissue.

Showing the diversity of Professor Whittaker's group, the researchers are also world leaders in new materials for manufacturing faster, more efficient computer processors, attracting funding from major manufacturers in North America and research groups globally. The work in polymers for integrated circuits has strongly influenced directions adopted by the microelectronics industry, leading to some technologies being cancelled and others adopted. Faster, more environmentally sound computers are the end result.

The group's research achievements have been recognised with a prestigious Australian Research Council (ARC) Australian Professorial Fellowship for Professor Whittaker; an ARC Future Fellowship for Associate Professor Idriss Blakey; and a University of Queensland Research Excellence Award for Dr Kris Thurecht.

Polymer chemist Professor Michael Monteiro is recognised as a world leader in the field of 'living' radical polymerisation to produce highly complex polymer architectures and nanostructures in water. He recently was awarded the prestigious Future Leadership Award by the Australian Davos Connection. Professor Monteiro was one of the first researchers to synthesise complex polymer architectures using a combination of 'living' radical polymerisation and 'click' chemistries. His work has also led to the new 'living' radical polymerisation technique SET-LRP and the ultrafast 'click' reaction SET-NRC. His group developed a dual 'click' reaction that could direct the pathway of forming complex polymer architectures by modulating the catalytic activity of each 'click' reaction. That meant third generation dendrimers could be rapidly produced with very high efficiency in less than 30 minutes at room temperature.

Professor Monteiro's research group has also developed novel synthetic methodologies to prepare cyclic polymers and various cyclic topologies. The cyclic polymers have very interesting physical and behavioural properties. His contribution to those areas has been well recognised with an average of 30 citations per paper.

He has been at the forefront of major scientific breakthroughs in the synthesis of polymer nanostructures in water, leading to controlled particle size, structure, molecular weight and chemical composition. That has opened avenues for new drug and vaccine delivery carriers, stem cell 'on-demand' scaffolds, nanoreactors for organic and polymer reactions, paints, and pressure-sensitive adhesives. The work led to high impact publications in journals including *Nature Nanotechnology*, *Angewandte Chemie* and *ACS Nano*.

He was the first to prepare well-defined polymer nanoparticles with controlled molecular weight by emulsion and miniemulsion, and the first to prepare complex core-shell block copolymer nanoparticles via reversible addition-fragmentation chair transfer (RAFT) in emulsions.

That means Professor Monteiro provided critical mechanistic knowledge for the design of new nanoreactors that produced polymer particles with unprecedented control over both the particle size distribution and the molecular weight

distribution. His work has, for the first time, overcome many barriers of conducting RAFT in dispersion polymerisation, and has led to significant industrial interest.

Professor Monteiro has developed a novel method for creating micelle structures by using a mechanical stimulus. Many well-known structures, such as cylinders, spheres and vesicles, can be made instantaneously and in quite high amounts – a significant improvement on traditional self-assembly methods. The structures retain their morphology after freeze drying and are in a trial as 'on-demand' scaffolds for stem cells and drug and vaccine delivery carriers.

"This is an exciting period for my group, as we use our polymer nanostructures for many important biomedical and other industrial applications," Professor Monteiro said.

Applications for AIBN Group Leader Professor Peter Halley's work include starch-based polymers for dengue fever control, new lignin polymers for barrier applications, and polymers from wastewater streams. Group researcher Dr Bronwyn Laycock is focused on low-cost polyhydroxyalkanoate polymers from wastewater and degradable agricultural films.

Professor Halley's group has the ability to work on large, Cooperative Research Centre-funded projects with 20-person research groups, including government, university and industry research and development personnel, which means larger goals are achieved faster. "The work also showed me that achieving effective product development work required a combination of cutting-edge research work; applied scale up and technology transfer development; and project management skills," Professor Halley said.

The work builds on the experience of Professor Halley's success in a previous role in setting up spin-off company Plantic Technologies, which has launched biopolymer products such as chocolate and biscuit tray packaging. Dr Celine Chaleat is working to develop water-resistant starch polymers. Other researchers from Professor Halley's team are working on lignin polymers, aimed at replacing box coatings in industrial packaging and furniture's resin coatings. In the future, bio-based polymers will be used in biomedical applications for scaffolds and biodevices and capsule design for drug delivery.

Professor Halley said the next stage of the work required improving key properties. "Improvements in water resistance, mechanical properties and programmed degradation may be achieved by novel technologies like reactive processing, polymer blending and coating technologies."

Associate Professor Darren Martin's research group has progressed to commercialising nanotechnology-enhanced rubbers (polyurethane nanocomposites) that outperform existing, commercially available materials in many industrial and biomedical applications.

The group has engineered plate-shaped nanoparticles, about one nanometre thick and up to several hundred nanometres in diameter, and found clever, fully scalable ways of incorporating small amounts of the particles into polymers – typically making up only 2 percent of the weight of the resulting nanocomposites.

That ensures the nanoparticles add strength and barrier, dimensional stability or thermal properties, without compromising flexibility, transparency or processability.

Associate Professor Martin said the work demonstrated a thorough, systematic approach to "fine tuning" very complex multiphase systems.

With input from Dr Grant Edwards and Dr Anthony Musumeci, the work led to several patents and patent applications that form the intellectual property foundation of AIBN spin-off company TenasiTech Pty Ltd.

Although many researchers have investigated polymer nanocomposites, few academic teams have expanded their technologies through to industrial-scale manufacture while maintaining all the benefits demonstrated at laboratory scale.

In late 2010, Associate Professor Martin's group produced more than a tonne of material and demonstrated world's best performance levels.

Associate Professor Martin said the innovation and commercialisation process sometimes challenged university-based academics' traditional roles and perspectives.

All TenasiTech group members had been heavily involved in market and customer interactions, technology intelligence and information-sharing activities.

The activities were not typically associated with "a day in the life of an academic", but the professional development they generated was invaluable.

In the future, the team's nanomaterials could appear under car bonnets, in solar cells, in bullet-proof glass or even in next-generation cochlear implant devices.

The technology's commercialisation was close. "We are finalising large trials with major materials suppliers and end users. Within two to three years we hope to see industrial products made from TenasiTech's super-tough elastomers."

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.

ENGAGEMENT

FAST FACTS

- Four start-up companies based on AIBN discoveries and innovations.
- Total patent families managed in 2010 was 58.
- AIBN has more than 150 international collaborations.
- Independent review from the Allen Consulting Group confirms AIBN is a significant contributor to Queensland's economy.

NEW DOW PARTNERSHIP

AIBN has extended the relationship with Dow Chemical Company in 2010 to focus on researching sustainable sources for chemicals, new-generation circuitry for electronics and improved energy storage systems.

AIBN and Dow Chemical Company signed a Memorandum of Understanding (MOU) in November, with Dow to contribute about $1.74 million in the three-year alliance. This builds on the success of a relationship started in 2007, when AIBN and Dow signed the first research collaboration in the areas of bio-mimicry and a systems biotechnology approach to improving natural pesticides' productivity and decreasing the cost.

The MOU signed in 2010 covers projects involving AIBN Group Leaders Professor Max Lu, Professor Lars Nielsen and Professor Andrew Whittaker.

Professor Lu and Dr Denisa Jurcakova will lead a research project into high performance cathode materials based on low-cost nanocarbons. The project's objective is to develop improved cathode materials with high energy and power densities for applications in hybrid vehicles and renewable energy storage systems.

Professor Whittaker and Associate Professor Idriss Blakey will conduct research into new-generation circuitry for electronics. Researchers will use organic synthesis, physical chemistry and electrical engineering to craft functional plastics and polymers for manufacturing integrated circuits for use in computers, cameras, smart phones, hand-held gadgets and even fridges.

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

AIBN Director Professor Peter Gray said the institute had world-leading researchers, advanced capabilities and a strong record of industrial collaboration, which ensured the collaboration with Dow was a good fit.

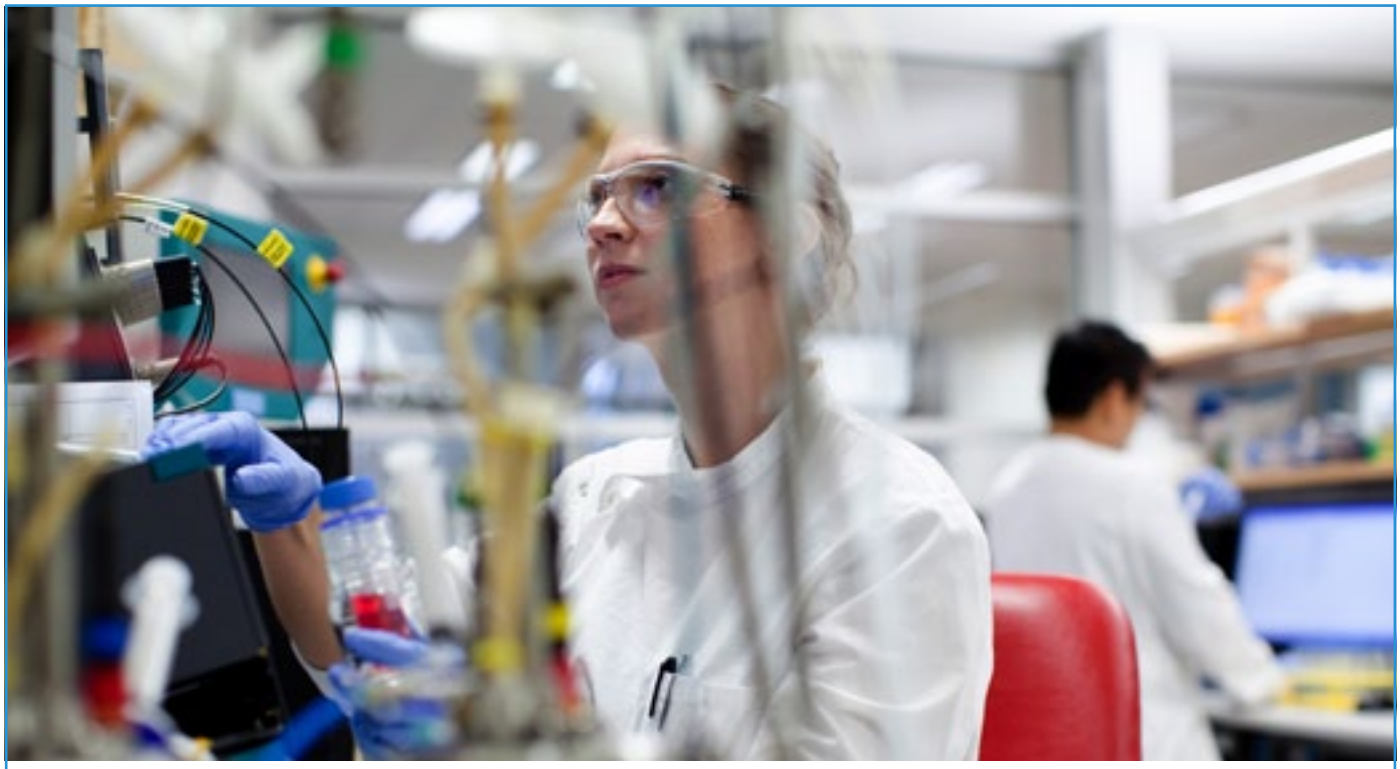
Dow is the second largest chemical manufacturer in the world by revenue, providing plastics, chemicals and agricultural products. It has a presence in more than 175 countries and employs 46,000 people worldwide. It lists innovation as the cornerstone of the company's success and uses the human element to inspire scientists to strive to improve those things essential to human progress.

Dow's research and development arm has more than 400 projects. Since 2005, annual patent disclosures have more than tripled. The company focuses on developing products and solutions that make sustainable improvements in the world in areas such as alternative energy, affordable and adequate food supply, decent housing, clean water, and improved personal health and safety.

Professor Gray said AIBN had experience in working with large international companies and had flexible arrangements, ensuring the institute was responsive to a company's needs and allowed valuable research to be conducted.

He said the MOU demonstrated Dow's appreciation of the quality of AIBN work and was a powerful indicator of the high estimation of the institute as a research partner for big business.

Collaborations such as the one with Dow gave AIBN researchers a real opportunity to progress their life's passions beyond the confines of the bench to a potential commercial outcome, Professor Gray said.



AVIATION FUEL FOR THE FUTURE

Researchers from AIBN are working in collaboration with world leaders to address issues covering areas as widely divergent as transport, sugar production and environmental sustainability.

Aviation giant Boeing, US renewable products company Amyris, airline Virgin, oil processing company IOR Energy and Mackay Sugar are working with Professor Lars Nielsen to develop a sustainable aviation fuel industry.

Professor Nielsen's research to identify the most efficient method of developing industrial processes for producing bio-derived jet fuel received $2 million in Queensland Government funding. Boeing, Amyris, The University of Queensland and AIBN jointly matched that amount.

The project has started with Professor Nielsen's feasibility study of biofuel production from sugar. It is part of a bigger project, which involves other research investigating the feasibility of using algae and oil seeds as alternative sources.

While Professor Nielsen will work on the fermentation and conversion of sugar cane juice, Boeing will bring its knowledge of sustainable aviation fuel and Amyris will work on the microbial conversion of sucrose to fuel. Mackay Sugar will bring with it knowledge of the sugar industry and IOR Energy will conduct final conversion steps to sustainable aviation fuel.

Professor Nielsen's research will involve systems and synthetic biology to improve the performance of yeast in fermentation. Strain performance, covering yield, productivity and titre, is the critical factor in cane juice fermentation, since it dictates capital costs.

Production of sustainable aviation fuel through fermentation of cane juice is by far the best understood of the three processes. Fermentation processes are well-developed and can be readily integrated with existing detailed models of sugar mill processes.

Professor Nielsen said the research was important for both the sustainability and continuity of the aviation industry and the health of the planet.

"The replacement of petroleum-derived transport fuels with renewable alternatives is an important step in mitigating greenhouse gas emissions and ultimately to meet transport needs once oil reserves have been exhausted," he said.

Jet fuels account for 5 percent of the world's transport fuel use and 15 percent of the transport use in Australia. Unlike ground transport, where electric or hydrogen cars may prove a preferable alternative, aviation depends fundamentally on liquid fuels with high energy content.

FABRICATION FACILITIES OPEN DOORS TO INDUSTRY

Industry partners are continuing to develop their research using AIBN facilities and capabilities, including the National Research and Development Infrastructure. AIBN houses the Australian National Fabrication Facility, Queensland node (ANFF-Q); the Queensland node of Metabolomics Australia; and the National Collaborative Research Infrastructure Strategy (NCRIS) Biologics Facility.

The infrastructure ensures AIBN plays a leading role in supporting Queensland and Australian businesses undertaking research, development and innovation. Its expertise and equipment is available to the broader Australian research community, which includes industry, academia and private organisations.

Among the organisations developing their research using the infrastructure are ANFF-Q industrial users Intel, Unilever, Xerocoat Ltd and SkillPro Ltd. Metabolomics Australia has industry partners such as Dow Chemical Company and collaborations with the Royal Children's Hospital in Brisbane and the Australian Wine Research Institute in Adelaide.

The three facilities have reported pleasing results in 2010, with a major expansion at ANFF-Q; the creation of new national and international links at Metabolomics Australia; and work on more than 100 projects at the Biologics Facility.

ANFF-Q further developed its capabilities in deposition, device packaging, silicon carbide technology and metrology tooling during the year. The facility incorporated the services and expertise from Griffith University's Queensland Micro and Nanotechnology Centre in 2010, resulting in a major expansion of the facility's capability in fabrication.

ANFF-Q also attracted more industrial users, with a 50 percent usage increase from 2009 to 2010 and more than 6000 hours of user access recorded during the year. The facility's five staff supported and trained more than 150 users on specialist, state-of-the-art equipment.

The staff's ability to support specialist research is also being recognised at other institutions, with partnerships involving the Queensland University of Technology, Griffith, the University of Western Australia, the University of South Australia, Flinders University and CSIRO. Staff have also worked with groups from seven diverse faculties and institutes from around The University of Queensland.

Metabolomics Australia expanded its collaborative reach in 2010, creating new links around the country and overseas. The facility's external focus was mainly on industrial microbiology, serving industry partners such as the Dow Chemical Company with systems and synthetic biology services. Staff were involved in a Bioplatforms Australia sponsored research project on the systems biology of wine making, in collaboration with the Australian Wine Research Institute in Adelaide.

Facility staff also supported research into health issues, looking into juvenile diabetes in collaboration with the Royal Children's Hospital in Brisbane and investigating the intracellular fluxes of *Leishmania major*, a parasite causing Leishmaniasis, in collaboration with the Bio21 Institute in Melbourne.

Internal projects with research groups at AIBN included the unravelling of metabolism of human embryonic stem cells in collaboration with the research groups of Professor Justin Cooper-White and Associate Professor Ernst Wolvetang. The facility provided key capabilities in metabolomics analysis for two major National and International Research Alliances Program grants from the Queensland Government, looking into using sucrose from sugar cane as a feedstock for biotechnological production of chemical feedstocks and jet fuels.

The Biologics Facility collaborated with more than 20 Australian and international biotech companies and research institutions in 2010. Facility staff worked on more than 100 projects and manufactured more than 100g of highly purified protein, mainly recombinant antibody, for research and early clinical uses.

The facility employs 13 staff with experience in molecular biology, antibody engineering, bioengineering/bioprocessing and protein chemistry. In 2010, the staff worked closely with Queensland Health, CSIRO and scientists from the US to manufacture a high-quality antibody which will be used to finalise pre-clinical and animal studies to determine its efficacy as a potential therapeutic for the deadly Hendra virus.

The facility plays an important role in narrowing the gap between research and clinics, providing expert knowledge in protein production and state-of-art equipment. Through its subsidised service for Australian researchers in protein manufacturing, the facility has also assisted many start-up biotech companies attract further funding for their drug development programs.

AIBN's national research and development infrastructure is valued at more than $30 million and was established with support from the NCRIS, the Queensland Government and The University of Queensland. The expertise and equipment enables AIBN to conduct globally competitive research in biologics, metabolomics and nanofabrication.

CONTINUING PROFESSIONAL DEVELOPMENT

AIBN Associate Professor Stephen Mahler continued to engage with industry through professional development in 2010, designing a course for the biologics industry and attracting audiences in Malaysia and Brazil.

Associate Professor Mahler designed the AIBN Short Course in Biologics Research and Development in 2010 to benefit the many stakeholders in the biologics industry.

It provided an appreciation of the many facets of biologics research and development for stakeholders employed in regulatory affairs; big pharmaceutical companies; small and medium-sized biotechnology enterprises; patent and legal services; research institutes; clinical medicine; and aligned organisations.

The course covered the many facets of biologic medicines, including a global overview of the industry, research leading to discovery, therapeutic modalities (the diseases they treat and how they work), how they are manufactured, regulatory issues and the future outlook for biologics.

It followed from previous continuing professional development courses Associate Professor Mahler has designed, starting with a successful collaboration with Pfizer Australia in August 2007. He helped develop a three-day biologics course for Pfizer staff.

Associate Professor Mahler went on to develop similar courses for Universiti Sains Malaysia in Penang in 2009; the Malaysian Government's National Pharmaceutical Control Bureau in May 2010; and the First National Symposium on Biosimilars at Curitiba, Brazil in November.

Associate Professor Mahler's professional development courses for industry and government are in line with AIBN's commitment to engaging with industry around the world. AIBN realises the longer-tem benefits of interacting with industry and the wider community and is expanding activities in the field.

Continuing professional development allows AIBN to engage with significant sectors in the economy and support key professions; provides new access pathways into postgraduate award programs; and, potentially, opens new income streams.

Biologics are recombinant DNA-derived therapeutic proteins, used for treating diseases including cancer, diabetes and inflammatory diseases, such as rheumatoid arthritis.

An increasing proportion of pharmaceutical company revenue is derived from biologics, with growth in new biologics exceeding that of pharmaceuticals. The growth is due to the increasing demand for new biologic entities and the expiry of several key patents, driving the emergence of biosimilars – the biologics equivalent of pharmaceutical generics.

ENGAGING THROUGH AFFILIATES PROGRAM

AIBN continues to pursue its mission to engage with industry and has made significant progress in this area in 2010. The Australian-first Industrial Affiliates Program (IAP), established in late 2009, has attracted a range of members from small Australian companies to large multinational organisations.

The IAP was initiated as a formal, non-project-specific mechanism to bring AIBN and industry closer together. It provides industry with an opportunity to access AIBN research and expertise, while the institute can improve the industrial relevance of its research programs.

The program aims to build long-term relationships with companies, promote collaborative research with those organisations and maintain AIBN's position at the forefront of developing cutting-edge technology.

AIBN Director Professor Peter Gray said it was part of AIBN's push to "build more bridges between the public and private research sectors, expand national capabilities, develop new industries and promote Australian innovation".

This was being achieved through various means, including the IAP, individual contracts and the National Research and Development Infrastructure program – a $30 million cluster of facilities.

Organisations signing up to the IAP have access to AIBN researchers and facilities; receive invitations to important symposiums and networking events; can receive staff training; and have staff considered for appointments as adjunct academics.

Brisbane-based contract drug manufacturer PharmaSynth, a subsidiary of Progen Pharmaceuticals, joined the IAP because it gave the company access to services it did not have in-house.

PharmaSynth chief executive officer Les Tillack said the ability to access AIBN's molecular biology facilities meant an expanded range of services was available to its clients. AIBN's proximity, relatively attractive costs and a streamlining of the ability to work with academics were positives for PhamaSynth.

"AIBN is keen to work with industry, and we can use AIBN in our marketing. It's a well-known, well-respected brand, so the relationship is useful to us," Mr Tillack said.

Wacol-based Very Small Particle Company Pty Ltd (VSPC) was one of the first to sign up to the program in 2010 and re-signed for another year in early 2011.

VSPC chief technical officer Peter Talbot said signing up helped his company understand and charaterise nanomaterials.

"We'd be blind without AIBN. It's integral to what we do. Small companies like ours don't have the resources and equipment. We gain access to library databases and people with current research knowledge."

Standard membership fees for the IAP start at $1500 a year.

There are three levels of IAP membership, designed to cater for small, medium and large companies. They are:

Industrial Affiliate: This is the premium level of engagement with AIBN. Companies receive the greatest level of flexibility when interacting with institute researchers, which means more opportunities to benefit from AIBN's ideas, know-how and capabilities. Industrial Affiliate is most suited to organisations looking to aggressively drive their research and development activities in areas where access to state-of-the-art facilities and know-how is critical.

Industrial Member: This membership has a high level of engagement with AIBN and opportunities to interact directly with groups and facilities within the institute. It is most suited to small-to-medium enterprises needing to augment in-house activities with access to knowledge and facilities.

Industrial Associate: This is an entry-level membership designed to give companies an introduction to the breadth and depth of AIBN. Industrial Associates have opportunities to interact with AIBN research and discuss the range of services and capabilities available.

www.aibn.uq.edu.au/industry-engagement

2010 HIGHLIGHTS

FAST FACTS

- Prestigious ARC fellowships awarded to six researchers to work at AIBN.
- Group Leader Chengzhong (Michael) Yu welcomed to AIBN.
- Successful external review of AIBN's first seven years of operation conducted.

Idriss Blakey

Aijun Du

Jian Liu

Chunxia Zhao

FELLOWSHIPS

Prestigious Australian Research Council (ARC) fellowships were awarded in 2010 to six researchers to work at AIBN, recognising work in cancer detection, drug delivery vehicles and next generation electronics.

AIBN Professor Andrew Whittaker was awarded an ARC Australian Professorial Fellowship and a Discovery-Project grant. The funds will help Professor Whittaker's research group determine how the design of molecules injected into the blood stream during magnetic resonance imaging (MRI) examinations can impact on the quality of the images received and improve accurate diagnosis. The work is detailed opposite.

Senior researcher at Japan's National Institute for Materials Science, Professor Ajayan Vinu, was awarded a Future Fellowship to undertake research at AIBN. The fellowship was awarded to Professor Vinu to develop a low-cost nanoporous semiconductor device for the capture and conversion of CO_2 into fuels by using water and sunlight. The novel approach is aimed at delivering low-cost technology offering clean energy and helping to mitigate global warming. Professor Vinu will take up the fellowship at AIBN in 2011.

In recognition of the important work of AIBN Associate Professor Aijun Du, the ARC awarded a QEII Fellowship, which formed part of an ARC Discovery-Project grant. Associate Professor Du was also awarded an ARC Future Fellowship, which he declined in order to take up the QEII Fellowship.

Associate Professor Du's work involves manipulating grapheme materials for smaller, faster and smarter next-generation electronics devices. Graphene is a film of carbon only one atom in thickness. Its strength, flexibility and electrical conductivity have opened new horizons, with the material seen as promising for everything from super-small computers to high-capacity batteries.

AIBN Associate Professor Idriss Blakey was awarded a Future Fellowship for his work on smart polymeric contrast agents for MRI.

Associate Professor Blakey said the contrast agents could be used to improve the ability to detect cancerous tumours using MRI. While MRI was already accurate in finding late-stage tumours, it did not have the sensitivity for early detection.

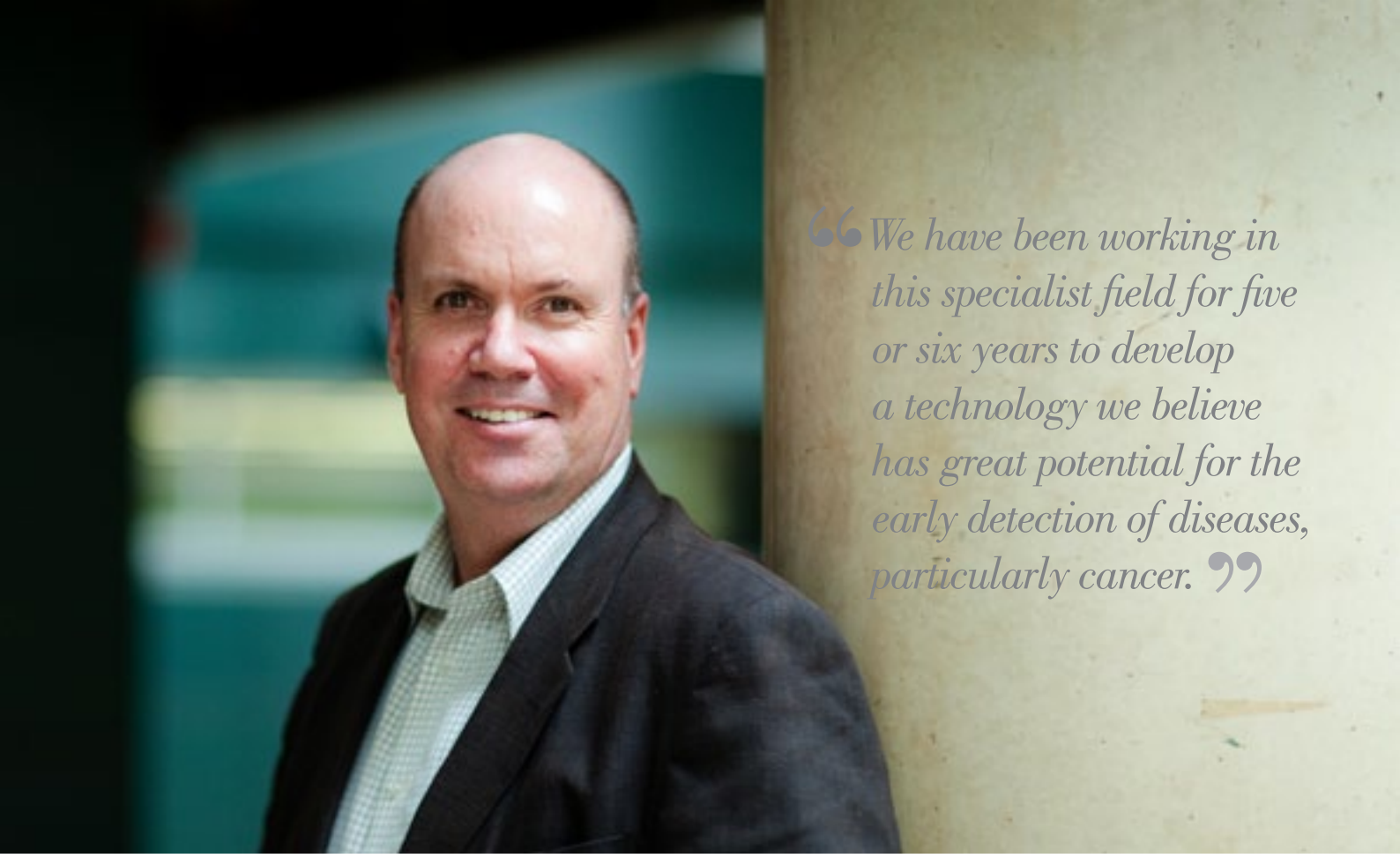
"The MRI contrast agents being developed at The University of Queensland are being designed to have increased sensitivity to allow for early detection. The smart nature of the agents has the added advantage that they are only visible by MRI when they enter cancer cells, so should reduce the number of false positives."

AIBN early-career researcher Dr Chunxia Zhao was awarded an Australian Postdoctoral Research Fellowship to research better ways to deliver life-saving drugs. It was a major accomplishment, given Dr Zhao was only three years out from her PhD at the time and was the sole investigator on the research project.

Dr Zhao will work to develop nanoporous materials to assist with targeted drug delivery. She is working to turn soft emulsion materials into nano-porous solids that will help ensure cancer drugs are carried to an affected area, such as a tumour. Such targeted drug delivery aims to reduce the seriousness of side effects inherent in broad-spectrum cancer treatments. The nanoporous materials may do more than just help with targeted drug delivery, with potential application in photocatalysis for sustainable clean energy.

AIBN's Dr Jian Liu received an Australian Postdoctoral Fellowship for work on a new-generation cancer drug delivery vehicle. He is part of a larger team that secured an ARC Discovery Project grant. The team includes AIBN Professors Max Lu and Chengzhong (Michael) Yu; and Professor Xinguo Jiang from Fudan University in Shanghai, China.

Dr Liu is combining elements of material chemistry, nanotechnology and bioengineering to engineer a nano-carrier made of nanoporous silica, designed to have a high surface area. Dr Liu's work focuses on preparing nano-carriers, making surface modifications, ensuring the pH-sensitive nano-carrier's site-specific delivery and studying the kinetics of drug release.



ARC ACHIEVEMENT

Professor Andrew Whittaker’s research group came a step closer in 2010 to creating a new generation of imaging agents for MRI examinations, used to detect cancer and Alzheimer’s disease. Professor Whittaker was awarded an Australian Research Council Australian Professorial Fellowship and a Discovery-Project grant to support this work.

The funds will help with research on how the design of molecules injected into the blood stream during MRI examinations can impact on the quality of the images received and improve accurate diagnosis. Professor Whittaker will work with Centre for Advanced Imaging Principal Research Fellow and Associate Professor Stephen Rose, AIBN Associate Professor Idriss Blakey, and Doctors Hui Peng and Kris Thurecht, to design new polymer structures for the imaging agents used to detect prostate cancer, malignant glioma and Alzheimer’s disease.

Professor Whittaker’s research group is affiliated with the Centre for Advanced Imaging, created in 2009 to bring together the skills of a critical mass of researchers and state-of-the-art research imaging instruments. It is the only facility of its type in Australia and one of only a handful in the world.

The AIBN research group aims to design new classes of high-performance imaging agents which offer the prospect of faster, more accurate diagnosis. This will involve a broad range of expertise in the polymer chemistry field, including radical polymerisation, advanced characterisation methods and magnetic resonance spectroscopy.

This will be an important step for the estimated 60 million MRI procedures performed annually worldwide, with about 30 percent using MRI imaging agents. Imaging agents allow doctors to study blood flow and identify particular tissue types and diseases.

Professor Whittaker said the ARC funds would accelerate the development of imaging agents and gave the research group the impetus to keep up their hard work. “It is an acknowledgement the work our team has been performing is of the highest quality and of great importance.

“It is very important. We have been working in this specialist field for five or six years to develop a technology we believe has great potential for the early detection of diseases, particularly cancer. Discussions with clinical oncologists have identified the enormous potential of the technology under development. They are excited by it.

“We have initiated several small projects to demonstrate this potential. In addition, discussions are under way with potential commercial partners.”

AWARDS

Awards are one measure of the value of researchers and their work at AIBN. The AIBN research community received several awards during 2010, acknowledging the cutting-edge nature of work conducted at the institute. Below are a few of the honours bestowed during the year.

University of Queensland Deputy Vice-Chancellor (Research) and AIBN group leader Professor Max Lu was named International Alumnus of the Year (Research) at the 2010 Queensland Education and Training International Awards. The State Government awards recognised Professor Lu for his leadership in research, with a citation from the judges saying he had "become a role model, a benchmark, an inspiration for other researchers".

Professor Mark Kendall's research team won a major award in 2010 for its work on needle-free vaccination delivery device Nanopatch. Winning the 2010 Translational Research Excellence Commercialisation Award gave Professor Kendall a chance to meet senior executives from global pharmaceutical company Merck Sharp & Dohme in the US. Merck Sharp & Dohme initiated the award together with the Queensland Clinical Trials Network to boost the capability of the state's burgeoning biotechnology industry and gain increased health and economic benefits for Queensland. The award aims to expand global connections for Queensland science and facilitate more global collaborations for domestic biotechnology companies.

AIBN researcher Dr Akshat Tanksale was selected in 2010 for the Australia Japan Emerging Research Leaders' Exchange Program. The Australian Academy of Technological Sciences and Engineering selected Dr Tanksale on behalf of the Department of Innovation, Industry, Science and Research, the Japanese Society for the promotion of Science, and the Engineering Academy of Japan. He was one of eight mid-career Australian researchers under the age of 45 years selected to visit prominent research institutes and universities in Japan in November.

Professor Mark Kendall's research group was listed as one of three finalists in the prestigious Australian Research Council Eureka Prize in 2010. The group was a finalist in the Australian Museum's category Excellence in Research by an Interdisciplinary Team. The group made the finals for their work on the Nanopatch.

AIBN students were recognised with a host of prestigious awards and scholarships during 2010. These are detailed in the Student Experience section of this report.

STUDENT EXPERIENCE

FAST FACTS

- Cohort of enrolled Research Higher Degree students reached 100 in late 2010.
- Most recent Federal Government figures show growth in PhD commencements at AIBN outpaced all Australian Group of Eight institutions.
- Diverse cohort includes students originating from every continent, except Antarctica.

RHD REPORT

AIBN's goal to develop and expand its high-quality student research program has achieved a significant milestone. Student numbers in the research higher degree program reached a new high. The student cohort reached a very healthy 100 in late 2010, with diverse international representation. Females just outnumbered their male counterparts in the PhD cohort by a single student, while numbers were level among MPhil students.

Graduating PhD students set a new record for AIBN, with eight awarded in 2010 – up from four in 2009. The graduates were Wendy Chen, Yunyi Wong, Kwok Wai Steny Cheung, Esteban Marcellin, Wadcharawadee Noohom, Annie Chen, Lien Chau and Anthony Musumeci.

Dr Marcellin was awarded a Dean's Commendation for Outstanding Research Higher Degree Thesis from The University of Queensland. It recognised his work in the field of understanding molecular weight control of hyaluronic acid production, for use in pharmacy, implants, injections for osteoarthritis and eye surgery.

The Dean's Commendation gives formal recognition to outstanding PhD graduates who receive unanimous commendations from their examiners for genuine and substantial contributions to their field of research. No more than 10 percent of research higher degree graduates are recognised in this way each year.

Graduations are expected to continue to grow, with Joe Codamo, Drew Titmarsh, Vinh Truong, Guak-Kim Tan and Chalida Klaysom expected to have PhDs awarded in 2011.

AIBN is conscious of the important contributions research students make to the success of a research organisation and, as a result, is committed to providing students with a comprehensive scientific skill set, to form the foundation of a successful scientific career.

The institute encourages and financially supports students to engage with research groups outside AIBN, allowing both personal development and skilling and opening the institute's door to potential collaboration and networking with the best minds from around the world.

It was this culture that enabled PhD chemistry student Oliver Squires to meet leaders such as former United Nations Secretary-General Kofi Annan and anti-apartheid activist Archbishop Desmond Tutu at a One Young World summit in London in 2010.

Awards and scholarships have assisted students to travel and hone their scientific skill sets. The breadth of student successes in 2010, as exemplified below, recognises the AIBN cohort's high-quality research, innovation, commercial potential and enthusiasm. Students used those skills to give winning presentations and claim prizes at leading conferences and awards nights.

Alexandra Depelsenaire won the NSW PhD Student Researcher Award for Excellence in Nanomedicine Research at the International Nanomedicine Conference in Sydney in only her first year of PhD studies at AIBN. The award recognised her work in localised skin cell death in generating improved immune responses during Nanopatch targeted vaccine delivery.

PhD student Jakov Kulis was awarded the Treloar Prize for best oral presentation at the 11th Pacific Polymer Conference. The award is given to a member of the Royal Australian Chemistry Institute or the New Zealand Institute of Chemistry. The recognition is particularly impressive as Mr Kulis is only in the first year of his PhD.

Nani Wibowo won a prize for the best presentation in the biopharmaceuticals stream of the Asia Pacific Biochemical Engineering Conference in Kobe, Japan. Ms Wibowo is working on virus-like particles and capsomeres as a vaccine platform.

Nilay Thakar was awarded the prestigious International Postgraduate Research Scholarship in UQ's first scholarship round for 2010. The scholarship will cover Mr Thakar's tuition fees for the duration of his PhD candidature.

Michael Crichton won the student category of the Trailblazer Award, organised by Australia's leading research commercialisation group, UniQuest. His idea of a micro-needle applicator won because it was judged innovative and commercially attractive. Mr Crichton was a finalist in the competition, alongside fellow AIBN researcher Meihua Yu.

Guak-Kim Tan won the International Bone-Tissue-Engineering Congress Award for the best young scientist. The annual award recognises an outstanding young scientist who authored and presented at the Bonetec conference with creativity, novelty and clarity. It allowed Ms Tan to complete an internship in Professor Yasuhiko Tabata's Department of Biomaterials lab at the Institute for Frontier Medical Sciences at Kyoto University in Japan. Professor Tabata is an expert in the fields of biomaterials, drug delivery system, tissue engineering and stem cell technology.

Andrew Cameron won the Best Student Presentation at the 2010 Annual CRC-Polymers Meeting held at CSIRO in Melbourne.

Student Sooa Lim completed a successful year, winning the 2010 Poster Prize Award for a distinguished presentation at the Korean Peptide and Protein Symposium in Seoul on December 3.

MIRJANA DIMITRIJEV DWYER

PHD STUDENT PROFILE

Mirjana Dimitrijev Dwyer spends her days in an AIBN biochemistry lab while nearing the end of her PhD studies. But she will leave with much more than a highly regarded PhD and skills in her research field.

Sharing knowledge with leaders at the forefront of research in engineering, chemistry, biology and computational sciences has broadened Mrs Dimitrijev Dwyer's outlook.

"I haven't just learned to grow cells in a shake flask. I listened to what was going on all around me at AIBN. The researchers connect the different fields of science and research projects going on around the building. It definitely opened up things I did not know existed."

Mrs Dimitrijev Dwyer began her PhD in 2007, testing designed peptides as foaming agents used in cleaning products in a bid to produce products not reliant on environmentally unfriendly petrochemicals.

She secured a place in Professor Anton Middelberg's research team, which has projects in protein and nanoparticle technology for new vaccines; vaccine nano-emulsions; recovery and modification of biopharmaceuticals; design and bioprocessing of sustainable biosurfactants, including pepfactants; and nanomaterial manufacture through biomolecular templating.

Professor Middelberg is an excellent example of the high-quality research supervisors available at AIBN. He is highly regarded, was awarded a 2010 Queensland Smart Futures Premier's Fellowship and named one of Australia's 100 most influential engineers in *Engineers Australia* magazine.

Mrs Dimitrijev Dwyer has set her sights high, but believes her time at AIBN has given her a good grounding to tackle the challenge.

"I would like to be involved in the growth of biotechnology in Queensland. I think I have things to offer. I have skills across the board that you need as a scientist, that you can take to other fields. I have learned to plan, write, work with scientists in other disciplines and work in the research environment. I have learned to critically analyse difficult situations. I can now effectively manage myself, my time and other people – and communicate complex scientific ideas to others."

Mrs Dimitrijev Dwyer was a chemical engineering student at The University of Queensland when she made contact with Professor Middelberg. She worked with Professor Middelberg's group while writing an undergraduate thesis as part of her Bachelor of Engineering.

"I was hearing lots about the projects at AIBN. It sounded exciting because it had real world connections. I talked to Anton and he told me about the surfactants."

Mrs Dimitrijev Dwyer chose surfactants as the topic for her PhD. "Surfactants are a problem for the environment. It is important to know the issue and the ways it can be solved.

"I have been involved in developing an alternative technology to surfactants – the active ingredients of most cleaning products, such as shampoos, dishwashing liquid, and many creams and cosmetics. Just like plastics, surfactants are produced from petrochemical sources. They aren't renewable and do not break down once released to the environment.

"We design peptide or protein sequences which we think will be good surfactants and have low production costs, make the surfactants in bacterial culture, separate them, then test them. By learning which elements of the peptide design work or don't work, we can re-iterate the design until we get it right. Specifically, I was studying the ability of peptide surfactants to form viscoelastic skins on the bubble surface, and whether this improves their performance."

The research has instilled in Mrs Dimitrijev Dwyer an appreciation for the importance of commercialisation, in line with AIBN's specific aim of combining research excellence with an industry focus. The institute's commercial objectives are to produce innovations assisting in the growth of industries; develop new products, processes and technologies; and play a major role in developing the Australian nanotechnology and biotechnology industries, through establishing new opportunities, obtaining the support of the industry sector and interfacing with industrial collaborators.

Mrs Dimitrijev Dwyer quickly realised being at AIBN opened many doors, given the broad scope of the research conducted and the network of contacts already in place.

She travelled to Daejeon in South Korea; Oxford in the UK; and Knoxville in the US as part of her studies. She also spent time in the Australian Nuclear Science and Technology Organisation laboratories in Sydney, was involved in lodging a provisional patent application and published in scientific journals.

ANTHONY MUSUMECI

PHD GRADUATE PROFILE

Research skills and problem-solving abilities are only a few of the skills graduate Dr Anthony Musumeci has gained during his time at AIBN.

Access to a network of world leaders in research and cutting-edge facilities attracted Dr Musumeci to AIBN in 2007. Once he arrived to start his PhD, he also found a spirit of collaboration, plenty of support and a chance to travel around the world.

Now that he has started a new phase of his life, with his graduation in late 2010 and a new role at leading research commercialisation group UniQuest, Dr Musumeci appreciates how much he gained during his time at AIBN.

"AIBN has set me up for a successful career by allowing me to complete a PhD at a respected institution, under the guidance of world-class researchers. The wealth of contacts made within AIBN and the research community more broadly will greatly benefit me in my future career endeavours.

"The research skills and problem-solving abilities developed during my PhD greatly help me in my current role. In addition, in-depth knowledge of the nanomaterials field has been highly beneficial in my current role as a physical science, technology commercialisation analyst at UniQuest."

Dr Musumeci had completed an Applied Science Degree when he came across AIBN. "I was searching around for a good place to undertake PhD studies. I came across the AIBN website and was quite impressed by the multidisciplinary nature of the institute."

During a meeting with group leader and subsequent PhD supervisor Associate Professor Darren Martin, Dr Musumeci had his first look at the AIBN building and facilities.

"I was impressed by the quality of research, facilities, opportunities and collaborative culture present within AIBN."

Dr Musumeci also was impressed with the facilities and dedicated technicians on all advanced instrumentation, ensuring researchers got the most out of their experiments.

While at AIBN, Dr Musumeci was involved in the synthesis and characterisation of a range of different nanoparticles (clay and TiO_2). "My laboratory experiments were not carried out within a single lab in AIBN, but rather within multiple labs in AIBN, Chemistry and Pharmacology to ensure the best outcomes could be achieved."

He published five articles in international peer-reviewed journals and had the chance to travel extensively. "In fact, I would have spent more than a year (out of the three-year candidature) working in different laboratories nationally or internationally and attending conferences.

"I had the chance to travel to the USA twice – to attend a conference in Boston and then to spend four months working at the Center for Nanoscale Materials at Argonne National Labs Chicago. I also had the opportunity to attend international conferences in Switzerland and Amsterdam and visited work colleagues at Cambridge University.

"At a national level, I spent six months working at the Australian Nuclear Science and Technology Organisation during eight separate visits. I attended six national conferences in Brisbane, an international conference in Sydney, two international conferences in Melbourne and a national conference in Adelaide."

The collaboration, travel and skilling not only made Dr Musumeci's time at AIBN memorable, it has instilled a life-long interest in research.

"I have learned so much and enjoyed it all. It has given me such a buzz. I hope to stay close to cutting-edge research and make a positive impact for the greater community."

2010/11 SUMMER INTERNSHIP

Undergraduate students from The University of Queensland experienced life in an AIBN lab in late 2010. They gained skills for careers in engineering, chemistry and biology as part of AIBN's Summer Internship Program.

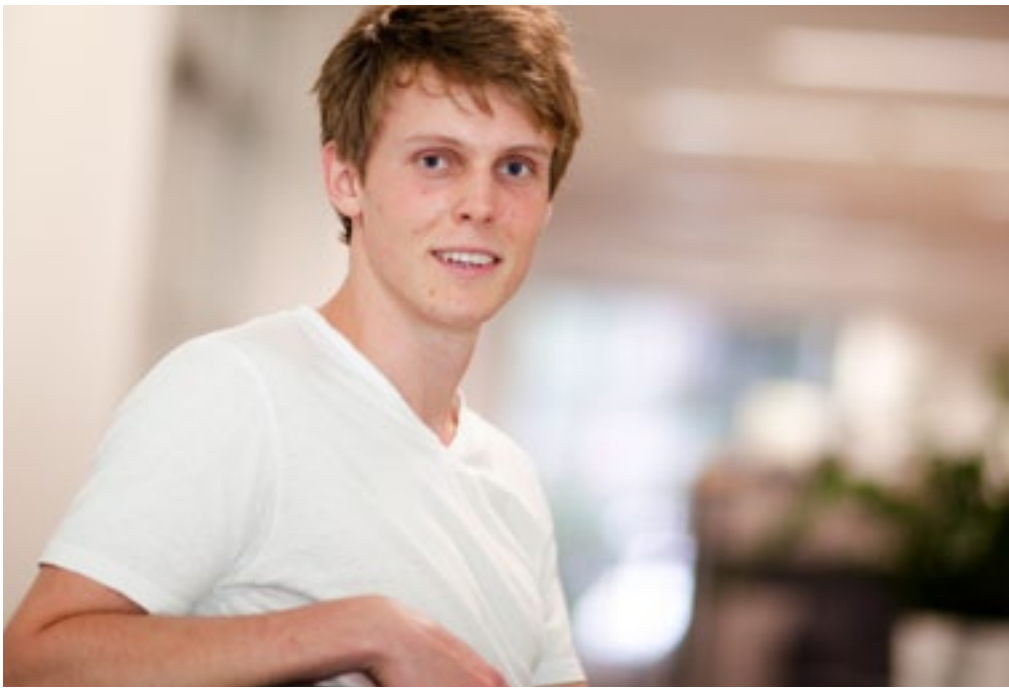
A group of 12 students started their internships in November, with a chance to complete tasks such as sequencing DNA, testing saliva to determine the risks of heart disease and computer modelling exercises. The internship gave students exposure to the research environment; allowed them to explore the possibility of research careers; and displayed the breadth of AIBN's various research fields.

The annual summer internship provides undergraduate students with valuable laboratory experience and exposure to AIBN's cutting-edge research. It is an opportunity for highly motivated undergraduate students to spend eight to 12 weeks undertaking a focused research project.

Students assisted in crystallisation studies; a nanoparticle study involving styrene polymerisation; cloning plant genes; synthesising particles for the enrichment of peptides; and developing a polymerase chain reaction-based method for detecting breast cancer biomarkers.

They gained valuable research skills; had access to cutting-edge research facilities; received career mentoring; and some received credit towards an undergraduate degree. Some students qualified for scholarships, with The University of Queensland and AIBN sharing the costs.

AIBN has run a Summer Internship Program for several years, with students returning in subsequent years. One such student is James Briggs, who first joined the program as part of Associate Professor Ernst Wolvetang's research group in 2008-09.



James Briggs

Mr Briggs took part in his second internship in 2009-10 and was still with Associate Professor Wolvetang's research group in early 2011 as a casual research assistant, while nearing completion in his studies for a Bachelor of Science.

"I have an appreciation of the freedom you can have doing research," Mr Briggs said. "It exposes you to something of interest to you personally. It links back to my undergraduate studies. Undergraduate studies have a lot of lecture content but being at AIBN makes it seem more practical and useful for my career."

Another major benefit for Mr Briggs was working with leaders in the research field, such as Associate Professor Wolvetang. Mr Briggs said he was exposed to research at the cutting edge, a network of renowned researchers from around the world and equipment found only in the top research facilities.

AIBN also benefited from hosting interns such as Mr Briggs, with exposure to the most promising young researchers at UQ.

"I have been exposed to what happens at AIBN and I am feeding that back to other undergraduates," he said. "That gives them some sense of what happens at the institutes. They may then want to test the waters."

Mr Briggs hopes to complete his undergraduate degree mid-2011 and will then consider eventually taking on PhD studies, possibly at AIBN.

OCCUPATIONAL TRAINEES

AIBN's occupational trainee program provided a valuable exchange of knowledge and ideas in 2010, with students from a host of countries working in the institute's labs for up to six months.

As many as 28 students from countries including China, Germany, France and Italy undertook occupational traineeships at AIBN during 2010. They completed research in fields such as vaccine engineering, fluid mechanics, flow simulation, polymer characterisation and metabolic engineering.

While the students were at AIBN, they gained important experience, training and research skills to use in their post-graduate studies in their own countries.

The experience gained at AIBN was relevant to the students' research fields of interest and counted towards the completion of their undergraduate degrees.

AIBN's occupational trainee program helps extend collaborative relationships between AIBN and renowned institutions around the world and opens opportunities for future funding and further staff and student exchanges.

The program is part of AIBN's wider engagement with the global research community, which includes training people from universities, research institutes and industry in other countries. As part of its development and engagement program, AIBN also encourages its own students and early career researchers to engage with outside groups to develop networks, skills and provide strong foundation networks and skills for a successful scientific career.

RESEARCH HIGHER DEGREE STUDENTS

Ian Aird
Samah Alharbi
Eid Alosime
AbdulKarim AlSultan
Yosephine Andriani
Melisa Anggraeni
Colin Archer
Yalun Arifin
Timothy Brennan
Marion Brunck
Michele Bruschi
Maria Buchsteiner
Sandy Budi Hartono
Andrew Cameron
Jessica Cameron
Lien Chau
Annie Chen
Xiaojing Chen
Panagiotis Chrysanthopoulos
Ya-Mi Chuang
Giuseppe Codamo
Jacob Coffey
Natalie Connors
Holly Corbett
Jorja Cork
Michael Crichton
Licona Cuauhtemoc
Alexandra Depelsenaire
Stefanie Dietmair
Mirjana Dimitrijev Dwyer
Tao Ding
Yong Ding
Tania Falzun
Liam Fearnley
Erika Fiset
Nicholas Fletcher
Marianne Gillard
Zi Gu
Md Haque
Ryan Harrison
Belinda Hartmann
Alejandro Hidalgo-Gonzalez
Michael Hines
Md Daloar Hossain
Jia Hou
James Hudson
Hoai Huynh
Sani Saite Jahnke
Siddharth Jambhrunkar
Pamela Jaramillo Ferrada
Yi Jia
Yan Jiao
Atikah Kadri
Li Pin Kao
Chalida Klaysom
Jakov Kulis
Kirsten Lawrie
Kebaneilwe Lebani
Pearl Lee
Hui Hui Lee-Wang
Peng Li
Ji Liang
Wing On Liew
Soo Lim
Shui Liu
Chunli Liu
Daria Lonsdale
Paul Luckman
Veronica Martinez Salazar
Leila Matindoost
Stefano Meliga
Richard Mills
Mohd Hezmee Mohd Noor
Marek Mrozkiewicz
Sean Muir
Dennis Murray
Geety Nabi
Hoang Quan Nguyen
Tuan Anh Huu Nguyen
Andrew Nolan
Huey Wen Ooi
Ajay Orpe
Azlin Fazlina Osman
Gillian Osmond
Defang Ouyang
Ramkumar Palanisamy
Warren Pilbrough
Amirali Popat
Clementine Pradal
Kun Qian
Lake-Ee Quek
Anthony Raphael
Tania Rivera Hernandez
Suriana Sabri
Anne Sandstrom
Miriem Santander Borrego
Khaled Sebakhy
Abhijit Shrotri
Oliver Squires
Frances Stahr
Guak-Kim Tan
Nilay Thakar
David Thomson
Kimberley Tilbrook
Drew Titmarsh
Thi-Bich-Trinh Tran
Xuan Truong
Nghia Truong Phuoc
Jennifer Turner
Srinivas Varanasi
Sainimili Vaubula Mateyawa
Jenny Vo
David Wang
Tianyu Wang
Joshua Watts
Nani Wibowo
John Wright
Xiao Xia Yan
Jie Yang
Meihua Yu
Hidayatul Zakaria
Bi Yun Zeng
Jun Zhang
Yao Zheng
Yian Zhu

* List includes graduating students and those in a UQ RHD program undertaken at the AIBN during 2010

FAST FACTS

- At the end of 2010, AIBN had 19 Group Leaders.
- Three AIBN Group Leaders were cited among Australia's 100 most influential engineers.
- Citations for AIBN Group Leaders reached a milestone of 25,000 in 2010.

SENIOR RESEARCHERS

PROFESSOR PETER GRAY

AIBN DIRECTOR AND GROUP LEADER

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

Large complex proteins that make up the majority of biologics approved for human therapy can only be produced in mammalian cell expression systems. Such systems can conduct complex assembly and post-translational modification for a molecule's biological activity.

Mammalian cell expression systems use Chinese hamster ovary (CHO) cells as the production host. Although CHO cells have been widely used to produce human therapeutics, there are still opportunities to improve them as production hosts. Those opportunities include improving properties of the host CHO cell line's ability to grow at high rates and to high cell densities in bioreactor systems, and the ability to rapidly select clones producing the protein of interest at high rates.

Professor Peter Gray's research is aimed at reducing bottlenecks present when CHO cells are used to produce biologics and includes:

- developing a CHO cell transient protein expression system that will allow researchers to produce, within a few days of obtaining DNA coding for the protein of interest, the desired protein for characterisation and testing of a new potential biologic. The transient CHO system developed, Epi-CHO, makes use of episomal plasmid replication and plasmid segregation on cell division to allow the protein to be produced over several weeks, and has resulted in the highest productivity reported for a CHO transient system;
- high-throughput approaches that allow rapid selection of clones that stably express high levels of the desired biologic;
- developing and patenting a FACS-based system capable of rapidly scanning pools of cells at up to 70,000 cells per second, and selecting those few cells from the population that are expressing high levels of the desired biologic; and
- using modern 'omics' approaches to gain better understanding of cellular metabolism to allow development of host cell lines with improved bioreactor performance and improved specific productivity of the desired protein.

The research approaches, which have been used to gain a greater understanding of mammalian cell processes, are now being applied to developing bioprocesses based on embryonic stem cells.

The challenge with stem cells is to accurately define the physical and chemical environment that allows the controlled proliferation and subsequent differentiation of the cells, then translate those conditions into processes that can be scaled up to produce the number of cells required for clinical testing.

Key publications for 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.

Dietmair S, Timmins NE, Gray PP, Nielsen LK, Kromer JO. (2010) Towards quantitative metabolomics of mammalian cells: Development of a metabolite extraction protocol. *Analytical Biochemistry* 404(2), 155-164.

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.

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 the rapid, ligation-independent reformatting of recombinant monoclonal antibodies. *Journal of Immunological 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. doi: 10.1371/journal.pone.0008432.

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.

Prowse AE, Wolvetang E, Gray PP. (2009) A rapid, cost-effective method for counting human embryonic stem cell numbers as clumps. *Biotechniques* 47(1), 599-606.

Vari F, Munster DJ, Hsu JL, Rossetti TR, Mahler SM, Gray PP, Turtle CJ, Prue RL, Hart DNJ. (2008) Practical blood dendritic cell vaccination for immunotherapy of multiple myeloma. *British Journal of Haematology* 143(3), 374-377.

Gray PP, Pilbrough W, Codamo G, Munro TP. (2008) Speeding up the production of recombinant proteins by CHO cells. *J Biotechnol* 136(S1), S8.

Xu ZP, Niebert M, Porazik K, Walker TL, Cooper HM, Middelberg APJ, Gray PP, Bartlett PF, Lu GQM. (2008) Subcellular compartment targeting of layered double hydroxide nanoparticles. *J Control Release* 130(1), 86-94.

PROFESSOR KIRILL ALEXANDROV

ARC FUTURE FELLOW AND GROUP LEADER

Research: Next generation technologies for protein research

Professor Kirill Alexandrov's research group is developing new methods for rapid in vitro synthesis of proteins and analysis of their structure and function.

Advances in life sciences and biotechnology are driven by an ability to replicate the building blocks of life in vitro, modify them and use them in academic and industrial applications. Much biotechnological progress in the past 40 years stemmed from advances in analysis and synthesis technologies for DNA and proteins. However, while orders of magnitude cost reduction was achieved in DNA sequencing and synthesis, the protein technologies have changed comparatively little.

Professor Alexandrov's group is focusing on filling this technological gap with new methods for rapid in vitro synthesis of proteins and analysis of their structure and function. The group has developed a novel, cell-free protein expression system based on protozoan *Leishmania tarentolae*. It has demonstrated that, using this technology, large sets of genes can be converted into proteins within hours. Group researchers apply the technology to study cellular processes controlled by Rab GTPases and the role of protein prenylation in the process. Due to their importance in many signalling and trafficking pathways, a deregulation of the GTPases (expression defects, mutations, or defects in their prenylation status) is associated with numerous human pathologies.

Professor Alexandrov has research projects in:

- developing high-yield, cell-free protein expression system based on *Leishmania tarentolae*;
- quantitative analysis of protein-protein protein-small molecule interactions using in vitro protein expression systems;
- proteome-wide analysis of protein prenylation and its variation in human diseases;
- understanding mechanisms regulating protein prenylation machinery; and
- identifying small molecules modulating prenylation and localisation of RabGTPases.

Key publications for 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(12), 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. *Nature Chemical Biology* 4, 227-235.

Wu Y, Tan KT, Waldmann H, Goody SR, Alexandrov K. (2007). Quantitative analysis of the interaction of prenylated Rab proteins with REP and GDI explains the requirement for both regulators in Rab function. *Proceedings of the National Academy of Sciences USA* 104, 12294-12299.

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

DR BRONWYN BATTERSBY

ASSOCIATE GROUP LEADER

Research: Developing and commercialising biosensor technology for disease biomarker detection

Dr Bronwyn Battersby is working with biomarkers, which are biological indicators for disease found in blood, tissue, urine and cerebrospinal fluid. Blood components, such as circulating tumour cells, RNA, DNA, proteins, peptides and metabolites, are potential biomarkers that indicate disease status. Often, more than one biomarker can be associated with a given disease.

There is a strong need to develop biomarkers and associated molecular diagnostic tests to enable clinicians to assess for disease risk, personalise therapy, monitor response therapy and screen for disease recurrence.

Dr Battersby's research focuses on developing and commercialising biosensor technologies for molecular detection of cancer and infectious disease biomarkers.

The biosensors are platform technologies that have been tailored for several applications, including:

- reading epigenetic signatures in breast and cervical cancer, and leukaemia;
- profiling the specificity of proteolytic enzymes associated with West Nile virus and dengue fever;
- detecting ovarian cancer protein biomarkers in blood;
- detecting DNA mutations in cancer; and
- diagnosing plant and animal-based viruses for biosecurity applications.

The research has been conducted in collaboration with the Fred Hutchinson Cancer Research Center and the University of Washington in Seattle; the Peter MacCallum Cancer Centre; the Garvan Institute; Queensland Primary Industries and Fisheries; the Cooperative Research Centre for National Plant Biosecurity; and the Australian Biosecurity Cooperative Research Centre for Emerging Infectious Disease.

The University of Queensland's spin-off company Nanomics BioSystems Pty Ltd is commercialising the biosensors. The company is incubated at AIBN. Dr Battersby was recently appointed General Manager. Commercialising Emerging Technologies (COMET) funding was awarded to Nanomics during 2010 for completion of pre-commercialisation activities.

Nanomics recently developed its Promenade software with Melbourne-based Bioscience Applications Pty Ltd. Touchscreen-enabled for user-friendliness, Promenade has been designed for rapid analysis of data collected through the use of the biosensor technology in the laboratory.

Key publications for the past five years:

Marcon L, Spriet C, Meehan TD, Battersby BJ, Lawrie GA, Héliot L, Trau M. (2009) Synthesis and Application of FRET Nanoparticles in the Profiling of a Protease. *Small* 5(18), 2053-2056.

Chen A, Kozak D, Battersby BJ, Forrest RM, Scholler N, Urban N, Trau M. (2009) Antifouling Surface Layers for Improved Signal-to-Noise of Particle-Based Immunoassays. *Langmuir* 25(23), 13510-13515.

Corrie S, Sova P, Lawrie G, Battersby B, Kiviat N, Trau M. (2009) Development of a multiplexed bead-based assay for detection of DNA methylation in cancer-related genes. *Mol Biosyst* 5, 262-268.

Corrie SR, Vogel R, Keen IJ, Jack K, Kozak D, Lawrie GA, Battersby BJ, Fredericks P, Trau M. (2008) A Morphological Study of Hybrid Organosilica Materials for Colloid-Based DNA Biosensors. *J Mater Chem* 18, 523-529.

Johnston APR, Battersby BJ, Lawrie GA, Lambert LK, Trau M. (2006) A Mechanism for Forming Large Fluorescent Organo-Silica Particles: Potential Supports for Combinatorial Synthesis. *Chem Mater* 18, 6163-6169.

Patents:

Battersby, Bryant, Trau. Carriers for combinatorial compound libraries (CA2352082-C). Granted September 21, 2010.

ASSOCIATE PROFESSOR IDRISS BLAKEY

ARC FUTURE FELLOW AND ASSOCIATE GROUP LEADER

Research: Functional polymers for value-added applications

Associate Professor Idriss Blakey's research interests span synthesis of functional polymeric materials and nanomaterials; and advanced characterisation of materials and surfaces.

Associate Professor Blakey and his team have key strengths in bringing together these two areas by developing a fundamental understanding of the structure-property relationships for polymers and polymer-based nanomaterials. That understanding enables the design and synthesis of improved materials for a range of different applications, including biomedical imaging, sensors, photolithography and drug delivery.

The team and key collaborators cover a range of disciplines, including polymer physical chemistry, synthetic chemistry, pharmacy, biomaterials, photolithography, spectroscopy, biomedical imaging and oncology.

Some achievements for 2010 include:

- initiating an ARC funded program on development of multimodal biomedical imaging agents;
- publishing research findings in high impact/high ranking journals;
- maintaining strong links with the semiconductor industry, such as with Intel Corp and Sematech (an international consortium of semiconductor companies), and developing links with Dow Chemical Company; and
- being awarded an ARC Future Fellowship.

Active research projects include:

- smart contrast agents for enhancing performance of Magnetic Resonance Imaging (MRI);
- high-performance polymers for computer chip manufacture;
- self-assembly of hybrid nanoparticles for biosensors;
- biodegradable polymers for drug delivery; and
- modification of polymer surfaces.

Key publications for the past five years:

Yu A, Liu H, Blinco JP, Jack K S, Leeson M, Younkin TR, Whittaker AK, Blakey I. (2010) Patterning of Tailored Polycarbonate Based Non-Chemically-Amplified Resists using Extreme Ultraviolet Lithography. *Macromolecular Rapid Communications* 31(16), 1449–1455.

Thurecht KJ, Blakey I, Peng H, Squires O, Hsu S, Alexander C, Whittaker AK. (2010) Functional Hyperbranched Polymers: Towards Targeted in vivo 19F Magnetic Resonance Imaging using Designed Macromolecules. *Journal of the American Chemical Society* 132(15), 5336-5337.

Blakey I, Thurecht KJ, Whittaker AK. (2010) High-Pressure Real-Time 129Xe NMR: Monitoring of Surfactant Conformation During the Self-Assembly of Reverse Micelles in Supercritical Carbon Dioxide. *Chemical Communications* 46(16), 2850-2852.

Merican Z, Schiller TL, Hawker CJ, Fredericks PM, Blakey I. (2007) Self-assembly and encoding of polymer-stabilized gold nanoparticles with surface-enhanced Raman reporter molecules. *Langmuir* 23(21), 10539-10545.

Blakey I, George GA, Hill DJT, Liu H, Rasoul F, Rintoul L, Zimmerman P, Whittaker AK. (2007) Mechanism of 157 nm Photodegradation of Poly[4,5-difluoro-2,2- bis(trifluoromethyl)-1,3-dioxole-co-tetrafluoroethylene] (Teflon AF). *Macromolecules* 40(25), 8954-8961.

PROFESSOR JULIE CAMPBELL

NHMRC SENIOR PRINCIPAL RESEARCH FELLOW AND GROUP LEADER

Research: Cell biology and tissue engineering

Professor Julie Campbell's research group discovered that peritoneal macrophages can transdifferentiate into smooth muscle-like cells and that grafts of hollow, smooth-muscle organs (arteries, bladder, vas deferens and uterus) can be grown from those cells in the peritoneal cavity for autologous transplantation.

The group's research is concentrating on the pathways through which the transdifferentiation occurs and their regulatory factors. The group continues to investigate the mechanisms of vascular disease and potential therapeutic strategies.

Professor Campbell has research projects in:

- gene array analysis of the foreign body response;
- macrophages as progenitors of myofibroblasts and their potential as a therapeutic target for fibrotic disease;
- regulation of myofibroblast differentiation using lentiviral delivery of shRNA to knockdown genes for candidate growth factors;
- antibody-directed delivery of anti-restenotic agents using inorganic nanoparticles (collaboration with Professor Max Lu, Dr Gordon Xu and Dr Anita Thomas);
- the mechanism by which oestrogen mediates its atheroprotective effects on the vasculature;
- the complement system in vascular disease and tumour growth (collaboration with Professor Steve Taylor and Dr Trent Woodruff, SBMS); and
- tissue engineering the kidney.

Professor Campbell and Dr Barbara Rolfe gained a new National Health and Medical Research Council grant in 2010 to study the mechanisms of peritoneal fibrosis. Professor Campbell retired in the same year as a Senior Principal Research Fellow of the NHMRC after 30 years of continuous funding. She also became President of the Association of Australian Medical Research Institutes for two years.

Key publications for the past five years:

Golledge J, Campbell JH. (2010) Peroxisome proliferator-activated receptor ligands reduce aortic dilatation in a mouse model of aortic aneurysm. *Atherosclerosis* 210, 51-56.

Mooney JE, Rolfe BE, Osborne GW, Sester DP, van Rooijen N, Campbell GR, Hume DA, Campbell JH. (2010) Cellular plasticity of inflammatory myeloid cells in the peritoneal foreign body response. *Am J Pathol* 176, 369-80.

Stickler P, De Visscher G, Mesure L, Famaey N, Martin D, Campbell JH, Van Oosterwyck H, Meuris B, Flameng W. (2010) Cyclically stretching developing tissue in vivo enhances mechanical strength and organisation of vascular grafts. *Acta Biomater* 6, 2448-2456.

Le SJ, Gongora M, Zhang B, Grimmond S, Campbell GR, Campbell JH, Rolfe BE. (2010) Gene expression profile of the fibrotic response in the peritoneal cavity. *Differentiation* 79, 232-43.

Gu Z, Rolfe BE, Xu Z, Thomas AC, Campbell JH, Lu G. (2010) Enhanced effects of low molecular weight heparin intercalated with layered double hydroxide nanoparticles on rat vascular smooth muscle cells. *Biomaterials* 20, 5455-5462.

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 and his research group are focused on designing and developing complex, polymer-based structures and device systems that are tailored for investigation of biological systems and, in particular, to invoke control over stem cell behaviours.

Projects underway include investigations into:

- engineering surfaces for stem cell attachment and phenotype control;
- tailored polymeric scaffolds for drug delivery and stem cell-based tissue engineering;
- cell-based diagnostic microdevices for mapping cellular microenvironments, in particular cell-surface, cell-cell and cell-scaffold interactions;
- microfluidic devices for manufacturing functional microparticles/nanoparticles and probing complex fluid behaviour in those microdevices; and
- microfluidic device platforms for biofluid (for example, saliva) characterisation and early disease detection (in particular for cardiovascular disease and cancer).

Key publications for the past five years:

Croll T, O'Connor AJ, Stevens GW, Cooper-White JJ. (2006) A blank slate? Layer-by-layer deposition of hyaluronic acid and chitosan onto various surfaces. *Biomacromolecules* 7(5), 1610-1622.

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.

George PA, Doran MR, Croll TI, Munro TP, Cooper-White JJ. (2009) Nanoscale presentation of cell adhesive molecules via block copolymer self-assembly. *Biomaterials* 30(27), 4732-4737.

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

Tan GK, Dinnes DLM, Butler LN, Cooper-White JJ. (2010) Interactions between meniscal cells and a self-assembled biomimetic surface composed of hyaluronic acid, chitosan and meniscal extracellular matrix molecules. *Biomaterials* 31(23), 6104-6118.

Research: Peptide surfactants and peptide hydrogels

DR ANNETTE DEXTER

ARC FUTURE FELLOW AND ASSOCIATE GROUP LEADER

Dr Annette Dexter research interests span areas of control of oil-water mixtures and peptide hydrogels.

Controlling stability in oil-water mixtures (emulsions) principally involves designing and testing peptide surfactants that can stabilise emulsions in high salt, including sea water and blood serum, with applications in:

- drug delivery;
- crop protection; and
- enhanced oil recovery.

Separately, Dr Dexter has demonstrated that specific ion effects can be used to control the stability of emulsions formed with conventional, non-peptide surfactants, with potential benefits in waste water treatment and disposal of industrial emulsions.

Dr Dexter interacts closely with AIBN start-up company Pepfactants Pty Ltd, of which she is a founding co-inventor, in developing applications for designed peptides as green surfactants. In 2010, that involved sponsored research for a multinational household and personal care company on using designed peptides as cleaning agents. A separate sponsored project is addressing the incorporation of peptides as green surfactants in industrial lubricants.

Work on peptide hydrogels similarly involves the design of new peptides, with the aim of forming soft supports for living cells, potentially leading to non-toxic injectable implants for new tissue generation, for example, in repair of the eye or spinal cord.

Dr Dexter has successfully:

- filed two Australian provisional patents on emulsion stability control and formation of salt-resistant peptide emulsions;
- demonstrated pH-controlled assembly of an elastic hydrogel using a single designed helical peptide; and
- demonstrated the successful design of heat-resistant, digestion-resistant mini-proteins for low-cost bioproduction of peptide surfactants.

Dr Dexter has research projects in:

- peptide surfactants for reversible control of foams and emulsions;
- biological production of peptide concatemers;
- specific ion effects in self-assembly and colloid stability; and
- peptide hydrogels for tissue repair and drug delivery.

Key publications for the past five years:

Dexter AF. (2010) Interfacial and emulsifying properties of designed -strand peptides. *Langmuir* 26(23), 17997-18007.

Malcolm AS, Dexter AF, Katakdhond JA, Karakashev SI, Nguyen AV, Middelberg APJ. (2009) Tuneable control of interfacial rheology and emulsion coalescence. *ChemPhysChem* 10(5), 778-781.

Middelberg APJ, He L, Dexter AF, Shen HH, Thomas RK. (2008) The interfacial structure and Young's modulus of peptide films having switchable mechanical properties. *Journal of the Royal Society Interface* 5(18), 47-54.

Dexter AF, Middelberg APJ. (2007) Switchable peptide surfactants with designed metal binding capacity. *Journal of Physical Chemistry C* 111(28), 10484-10492.

Dexter AF, Malcolm AS, Middelberg APJ. (2006) Reversible active switching of the mechanical properties of a peptide film at a fluid-fluid interface. *Nature Materials* 5(6), 502-506.

DR KRASSEN DIMITROV

GROUP LEADER

Reseach: Single-molecule technologies for diagnostics

Dr Krassen Dimitrov's research group is working to develop new diagnostic technologies involving single-molecule nanolabels that can be used for accurate and sensitive determination of marker molecules associated with disease and found in small amounts of biological samples.

The nanolabels are translocated with magnetic forces through a nanometer-sized electronic sensor, for digital readout. The group is developing the technology with a specific focus on diagnostics for tropical infectious diseases such as malaria and dengue fever.

Future applications include such varied fields as biomedical research, forensics, agribusiness, and biosurveillance.

Key publications for the past five years:

Thomson DAC, Dimitrov K, Cooper MA. (2011) Amplification free detection of Herpes Simplex Virus DNA. *Analyst* 136, 1599-1607.

Qin G, Darain F, Hui W, Dimitrov K. (2011) Surface modification of permalloy (Ni80Fe20) nanoparticles for biomedical applications. *J Nanoparticle Res* 13(1), 45-51.

Rahaie M, Ghai R, Babi´c B, Dimitrov, K. (2010) Synthesis and characterisation of DNA-based micro and nanodumbbell structures. *J Bionanosci* 3(2) 73-79.

Babic B, Ghai R, Dimitrov K. (2007) Induced movement of the magnetic beads and DNA-based dumbbell in a micro fluidic channel in *Proceedings of SPIE: BioMEMS and Nanotechnology III* (Nicolau D V, Abbott D, Kalantar-Zadeh K, Matteo TD, Bezrukov SM, Eds).

Babic B, Ghai R, Dimitrov K. (2008) Magnetophoresis of flexible DNA-based dumbbell structures. *Applied Physics Letters* 92(5). Article number 053910.

Geiss GK, Bumgarner RE, Birditt B, Dahl T, Dowidar N, Dunaway DL, Fell HP, Ferree S, George RD, Grogan T, James JJ, Maysuria M, Mitton JD, Oliveri P, Osborn JL, Peng T, Ratcliffe AL, Webster P J, Davidson EH, Hood L, Dimitrov K. (2008) Direct multiplexed measurement of gene expression with colour-coded probe pairs. *Nature Biotechnology* 26(3), 317-325.

Halvorsen OJ, Oyan AM, Bo TH, Olsen S, Rostad K, Haukaas SA, Bakke AM, Marzolf B, Dimitrov K, Stordrange L, et al. (2005) Gene expression profiles in prostate cancer: Association with patient subgroups and tumour differentiation. *International Journal of Oncology* 26, 329-336.

Wang H, Padmanabhan H, Dimitrov K. (2010) Controlled assembling of biomolecule-functionalised magnetic nanoparticles. *ICBB 2010: International Conference on Biotechnology and Bioengineering.* Tokyo, Japan, May 26-28, 2010.

Awards and prizes:

Nominated in 2009 for the 2010 ENI Award for Energy Research

PROFESSOR JOHN DRENNAN

GROUP LEADER

Research: Materials development and characterisation

The main body of Professor John Drennan's research relates to understanding the relationship between microstructural characterisation and the physical property of materials. A central focus of the work is developing improvements in the conduction of oxygen ions in materials, which has application in solid oxide fuel cells.

Tight microstructural control at the atomic level is proving to be a key factor in developing a new range of materials that have longer operating life and better properties.

The expertise of Professor Drennan and his research group in this area has led to projects involving other refractory systems.

The group is turning its attention to materials for extreme environments and developing a novel system for protecting critical components in hypersonic scram jets – a serious challenge for materials science.

In addition, the group is examining the development of "zinc oxide (ZnO) soaps" in artists' paints. This phenomenon can be devastating to an artwork, resulting in the formation of large, unsightly protrusions, which can crack and severely damage the painting. Researchers are examining, through very detailed microstructutral analysis, the mechanism responsible for the phenomenon.

Funded through an Australian Research Council Industry Linkage project with major galleries across Australia and several in the US and Asia, the project is looking at the first stages of deterioration of ZnO particles at the atomic level with a view to developing curatorial protocols to minimise damage.

Key publications for the past five years:

Ou DR, Mori T, Ye F, Kobayashi T, Zou J, Auchterlonie GJ, Drennan J. (2006) Oxygen vacancy ordering in heavily rare-earth doped ceria. *Applied Physics Letters* 89, 171911.

Ye F, Mori T, Ou DR, Zou J, Auchterlonie GJ, Drennan J. (2007) Compositional and Valent State Inhomogeneities and Ordering of Oxygen Vacancies in Terbium- doped Ceria. *Journal of Applied Physics* 101(11) Art. No. 113528.

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.

ASSOCIATE PROFESSOR AIJUN DU

ARC QEII FELLOW AND ASSOCIATE GROUP LEADER

Research: theoretical modelling for smarter nanoelectronic devices and energy storage

Associate Professor Aijun Du's research interests span the areas of clean energy, environmental science and nanoelectronics.

His research focus is on tackling band-gap problems, charge/spin transport issues, hydrogen storage and carbon-dioxide capture in nanoscale materials. The aim is to develop improved devices for nano-electronics, spintronics, energy storage and conversion. As well as aiming to develop truly smaller, faster and smarter electronics materials, there is the potential for the research to open a new knowledge-based electronics industry and create emerging energy technologies in Australia.

Associate Professor Du has strong interactions with disciplines of chemical engineering, environmental science, computational chemistry and condensed matter physics.

Associate Professor Du has, for the first time, predicted that lithium-decorated porous graphene is a superb candidate for hydrogen storage. The enhanced adsorption energy and high storage capacity (7 wt %) meets the standard set for 2010 by the Department of Energy in the US. A new mechanism involving electrostatic interaction has been proposed.

Huge magnetism may be associated with triangular nanodots or triangular holes carved from boron nitride hexagonal monolayers and a lattice of such nanoholes demonstrates half metallicity. A collaborator is attempting to synthesise such structures and measure their properties.

Porous graphene will open a direct gap in contrast to currently extensively studied graphene. This will provide a novel pathway to solve the formidable hurdle of graphene's lack of "obvious band gap" for building field effect transistor.

The group has research projects in:

- nanomaterials for hydrogen storage;
- nanomaterials for CO_2 capture and activation;
- materials for nanoelectronics and spintronics;
- materials for catalysis applications; and
- advanced theoretical modeling methods.

Key publications for the past five years:

Du A, Zhu ZH, Smith SC. (2010) Multifunctional Porous Graphene for Nanoelectronics and Hydrogen Storage: New Properties Revealed by First Principle Calculations. *J Amer Chem Soc* 132, 2876.

Du A, Chen Y, Zhu Z, Lu M, Smith SC. (2009) C-BN Single Walled Nanotubes from Hybrid Connection of BN/C Nanoribbons: Prediction by ab initio density functional calculations. *J Amer Chem Soc* 131, 1682.

Du A, Chen Y, Zhu ZH, Amal R, Lu M, Smith SC. (2009) Dots versus Antidots: Computational Exploration of Structure, Magnetism and Half-metallicity in Boron-Nitride Nanostructures. *J Amer Chem Soc* 131, 17354.

Du A, Smith SC, Lu M. (2007) Formation of Single Walled Carbon Nanotube via the Interaction of Graphene Nanoribbons: ab initio Density Functional Calculations. *Nano Letters* 7, 3349.

Du A, Smith SC, Yao XD, Lu M. (2007) Hydrogen Spill-over mechanism on a Pd doped Mg surface as revealed by ab initio Density Functional Theory Method. *J Amer Chem Soc* 129, 10201.

Awards and prizes:

ARC Future and QEII Fellowship in 2010

Research: Biofluids characterisation and biopolymer processing

The research interests of Professor Peter Halley's group span two major research areas:

- biofluids characterisation; and
- biopolymer processing.

Biofluids characterisation incorporates novel material and flow characterisation (rheology) for a variety of projects, including:

- design of texture-modified foods for aged care;
- cystic Fibrosis sputum diagnostics; and
- novel techniques for predicting swallowing of foods and tablets.

The group has strong intereactions with the disciplines of chemical engineering, pharmacy, biochemistry, food science and speech pathology, and links with various hospitals.

The biopolymer processing area of research focuses on understanding and optimising the processibility of a wide range of biopolymers such as starch; lignin; polyhydroxyalkanoates (PHA); polylactic acid (PLA); and biopolymer nanocomposites, which include starch, polyurethane and polyester nanocomposites. The work aims to develop smart, functional biopolymer systems for biomedical, drug delivery and high-value industrial applications.

The group has successfully:

- initiated three new projects investigating water resistant starch, texture-modified foods and PHA polymers from waste;
- published a book discussing reactive processing;
- published and patented work on biopolymers and degradable polymers; and
- maintained strong links with relevant industries in the areas of biofluids and biopolymers.

The group has research projects in:

- novel texture-modified foods for aged care for increased nutrition;
- water resistant starch polymers for smart food packaging applications;
- PHA polymers from waste streams;
- PHA/lignin composites from sugar cane;
- rheology of TPU nanocomposites; and
- supercritical CO_2 processing of starch nanocomposites.

Key publications for the past five years:

Liu WC, 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; from fundamentals to reactive processing*, Cambridge University Press, Cambridge, UK.

Zhao RX, Torley P, Halley PJ. (2008) Emerging biodegradable materials: starch- and protein-based bio-nanocomposites. *Journal of Materials Science* 43(9), 3058-3071.

Chaléat CM, Halley PJ, Truss RW. (2008) Properties of a plasticised starch blend. Part 1: Influence of moisture content on fracture properties. *Carbohydrate Polymers* 71(4), 535-543.

Russo M, Strounina E, Waret M, Nicholson T, Truss R, Halley PJ. (2007) A study of water diffusion into a high amylose starch blend: The effect of moisture content and temperature. *Biomacromolecules* 8(1), 296-301.

Awards and prizes:

2009 UQ Award for Programs that Enhance Learning

PROFESSOR PETER HALLEY

GROUP LEADER

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's research group focuses on physical methods for delivering biomolecules and stimuli to key immune response-inducing cells located in the skin; and extracting important biomolecules for diagnostics purposes.

The ultimate goal of the research is to dramatically improve the cost and efficiency of vaccination and treatment of major diseases, such as malaria and influenza. To achieve this goal, the group is:

- developing needle-free gene and drug delivery and extraction technologies to and from the skin;
- onvestigating micro-nanoprojection array patch (Nanopatch) technology;
- measuring the key biological and mechanical properties of skin; and
- assessing clinical application.

This multidisciplinary research spans biomedical engineering (fluid mechanics; micro-nanofabrication; solid mechanics), diagnostics (multi-photon microscopy) and dermatology and vaccinology.

Professor Kendall's group has research projects covering:

- micro-nanoprojection patches for minimally-invasive and targeted delivery of genes and drugs to skin cells;
- micro-nanoprojection patches for targeted gene and drug delivery to the skin and improved DNA vaccines;
- micro-nanoprojection patches for improved sampling in diagnosis of disease;
- multi-photon microscopy for in vivo imaging following delivery of drugs and vaccines to skin;
- MPM non-invasive imaging of biological interactions following drug delivery with micro-nanoprojection patches;
- measurement of mechanical properties in skin at the cellular and subcellular scale; and
- developing medical devices for clinical use.

The group has started a joint partnership research and development project with an international large vaccine company.

Key publications for the past five years:

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.

Chen X, Corbett H, Yukiko SR, Raphael A, Fernando GJP, Fairmaid, EJ, Prow TW, Brown LE, Kendall MAF. (2010) Site-selectively coated, densely-packed microprojection array patches for targeted delivery of vaccines to skin. *Advanced Functional Materials* 21(3), 464-473.

Prow TP, Chen X, Prow NA, Fernando GJP, Tan CSE, Raphael AP, Chang D, Ruutu MP, Jenkins DWK, Pyke A, Crichton ML, Raphaelli K, Goh LYH, Frazer IH, Roberts MS, Gardner J, Khromykh AA, Suhrbier A, Hall RA, Kendall MAF. (2010) Nanopatch-Targeted Skin Vaccination against West Nile Virus and Chikungunya Virus in Mice. *Small* 6(16), 1776-84. (front cover).

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.

Crichton ML, Ansaldo A, Chen X, Prow TW, Fernando GJP, Kendall MAF. (2010) The effect of strain rate on the precision of penetration of short densely-packed microprojection array patches coated with vaccine. *Biomaterials* 31(16), 4562-4572.

Awards and prizes:

2009 Future Summit Australian Leadership Award

Inaugural ARC Future Fellow, Professorial level

2010 Translational Research Excellence Commercialisation Award from MERCK, in conjunction with the Queensland Clinical Trials Network

2010 finalist for Australian Museum Eureka prize. Category: Research by an Interdisciplinary Team Nanopatch Influenza Vaccination Team

Enterprize Business Plan Competition's People's Choice Award 2010

2010 UniQuest Trailblazer Award in Student category for original, innovative early-stage research and entrepreneurial ideas competition

PROFESSOR MAX LU

UQ DEPUTY VICE-CHANCELLOR (RESEARCH) AND AIBN GROUP LEADER

Research: Functional nanomaterials

Professor Max Lu is the Foundation Director and current Research Director of the Australian Research Council Centre of Excellence for Functional Nanomaterials. He is also Deputy Vice-Chancellor (Research) at The University of Queensland.

The research interests of Professor Lu and his group lie in the synthesis and molecular engineering of nanomaterials, such as inorganic nanoparticles, carbons, nanoporous materials and membranes.

The team is developing many innovative applications of these materials in the areas of clean energy and environmental technologies, and in biomedical fields.

Specifically, Professor Lu's group has research projects in the areas of:

- visible light photocatalysts for solar and hydrogen energy generation and storage;
- nanoparticles and mesoporous carriers for drug and vaccine delivery;
- nanostructured materials for high-density supercapacitors and batteries; and
- efficient catalysts and processes for renewable energy.

Key publications for the past five years:

Li Z, Cheng LN, Sun Q, Zhu ZH, Riley MJ, Aljada M, Cheng ZX, Wang XL, Hanson GR, Qiao SZ, Smith SC, Lu GQ. (2010) Diluted Magnetic Semiconductor Nanowires Prepared by the Solution-Liquid-Solid Method. *Angewandte Chemie-International Edition* 49(15), 2777-2781.

Li ZY, Zhu GS, Lu GQ, Qiu SL, Yao XD. (2010) Ammonia Borane Confined by a Metal-Organic Framework for Chemical Hydrogen Storage: Enhancing Kinetics and Eliminating Ammonia. *Journal of the American Chemical Society* 132(5), 1490-1491.

Liu G, Niu P, Sun CH, Smith SC, Chen ZG, Lu GQ, Cheng HM. (2010) Unique Electronic Structure Induced High Photoreactivity of Sulfur-Doped Graphitic C3N4. *Journal of the American Chemical Society* 132(33), 11642-11648.

Liu J, Qiao SZ, Hartono SB, Lu GQ. (2010) Monodisperse Yolk-Shell Nanoparticles with a Hierarchical Porous Structure for Delivery Vehicles and Nanoreactors. *Angewandte Chemie-International Edition* 49(29), 4981-4985.

Chen ZG, Cheng LN, Xu HY, Liu JZ, Zou J, Sekiguchi T, Lu GQ, Cheng HM. (2010) ZnS Branched Architectures as Optoelectronic Devices and Field Emitters. *Advanced Materials* 22(21), 2376-2380.

Yang HG, Liu G, Qiao SZ, Sun CH, Jin YG, Smith SC, Zou J, Cheng HM, Lu GQ. (2009) Solvothermal Synthesis and Photoreactivity of Anatase TiO_2 Nanosheets with Dominant {001} Facets. *Journal of the American Chemical Society* 131(11), 4078-4083.

Wang LZ, Tang FQ, Ozawa K, Chen ZG, Mukherj A, Zhu YC, Zou J, Cheng HM, Lu GQ. (2009) A General Single-Source Route for the Preparation of Hollow Nanoporous Metal Oxide Structures. *Angewandte Chemie-International Edition* 48(38), 7048-7051.

Liu G, Yang HG, Wang XW, Cheng LN, Pan J, Lu GQ, Cheng HM. (2009) Visible Light Responsive Nitrogen Doped Anatase TiO_2 Sheets with Dominant {001} Facets Derived from TiN. *Journal of the American Chemical Society* 131(36), 12868-12869.

Hulicova-Jurcakova D, Puziy AM, Poddubnaya OI, Suarez-Garcia F, Tascon JMD, Lu G Q. (2009) Highly Stable Performance of Supercapacitors from Phosphorus-Enriched Carbons. *Journal of the American Chemical Society* 131(14), 5026-5027.

Zhang L, Qiao SZ, Jin YG, Chen ZG, Gu HC, Lu GQ. (2008) Magnetic hollow spheres of periodic mesoporous organosilica and Fe3O4 nanocrystals: Fabrication and structure control. *Advanced Materials* 20(4), 805-809.

Yang HG, Sun CH, Qiao SZ, Zou J, Liu G, Smith SC, Cheng HM, Lu GQ. (2008) Anatase TiO_2 single crystals with a large percentage of reactive facets. *Nature* 453(7195), 638-641.

Wang DW, Li F, Liu M, Lu GQ, Cheng HM. (2008) 3D aperiodic hierarchical porous graphitic carbon material for high-rate electrochemical capacitive energy storage. *Angewandte Chemie-International Edition* 47(2), 373-376.

Awards and prizes:

Aluminus of Year (Research), Queensland Education International Award 2010

Australia's Top 100 Most Influential Engineers, 2010, Engineers Australia

ISI Highly Cited Researcher in Materials Science, Thomson Reuters

ASSOCIATE PROFESSOR STEPHEN MAHLER

Research: Developing biological medicines

The principal theme of Associate Professor Stephen Mahler's research is discovering and developing biologic medicines.

His research activities include a balanced mix of basic and applied research. As a biotechnologist, Associate Professor Mahler has specialised in applied immunology, proteomics and bioengineering.

A highlight of his present research includes isolating monoclonal antibodies from large immunoglobulin gene libraries using high throughput selection techniques against selected targets. The targets are associated with cancer, infectious disease and graft versus host disease.

Another highlight is isolating antibody lead that binds to dendritic cells. The research is part of a collaboration with the Mater Medical Research Institute, and is associated with a novel approach for preventing graft versus host disease, through antibody-mediated depletion of dendritic cells. The lead antibody has shown to be effective in in vitro and in vivo bioassays, and is undergoing further development for potential future clinical trial.

Key publications for the past five years:

Falconer RJ, Jackson-Matthews D, Mahler SM. (2011) Analytical strategies for assessing comparability of biosimilars. *J Chem Technol and Biotechnol.* (Accepted for publication March 2011).

Mahler SM. (2011) Biologics and biosimilars: emerging technologies driving global opportunity. *J Chem Technol and Biotechnol*. (Accepted for publication March 2011).

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. *Journal of Immunological Methods* 354, 85-90.

Matigian N, Abrahamsen G, Sutharsan R, Cook A, Nouwens A, Bellette B, Vitale A, An J, Anderson M, Beckhouse B, Cecil R, Chalk A. Cochrane J, Fan Y, Féron F, McCurdy R, McGrath J, Perry C, Raju J, Ravishankar S, Silburn P, Sutherland G, Mahler SM, Mellick G, Wood S, Sue C, Wells C, Mackay-Sim A. (2010) Disease-specific, neurosphere-derived cells as models for brain disorders. *Disease Models and Mechanisms* 3, 785-798.

De Leon EJ, Yuan FF, Pearson H, Marquis C, Mahler SM. (2009) Evidence of heterogeneity in the antibody response against the platelet antigen 3a; recognition of an 11-mer peptide carrying the HPA-3a polymorphic determinant. *Vox Sanguinis* 96, 252-255,

Wang XS, Shao B, Heinecke J, Mahler SM, Stocker R. (2009) Detection of methionine sulfoxide-containing, oxidized apolipoprotein AI in HDL and plasma by ELISA. *J Lipid Research* 50, 586-594.

Marcal H, Wanandy NS, Sanguanchaipaiwong V, Woolnough CE, Lauto A, Mahler SM, Foster LJR. (2008) BioPEGylation of polyhydroxyalkanoates: Influence on properties and satellite stem cell cycle. *Biomacromolecules* 9, 2719–2726.

Vari F, Munster DJ, Hsu JL, Rossetti TR, Mahler SM, Gray PP, Turtle, CJ, Prue RL, Hart DNJ. (2008) Practical blood dendritic cell vaccination for immunotherapy of multiple myeloma. *British J Haematology* 143, 374-377.

Dinnes DM, Marcal H, Raftery M, Labow RS, Mahler SM. (2008) The macrophage-biomaterial interface: A proteomic analysis of the conditioned medium. *J Chem Technol and Biotechnol.* 83, 482-495.

Dinnes DM, Marcal H, Santerre JP, Mahler SM, Labow RS. (2007) Material surfacesaffect the protein expression patterns of human macrophages: a proteomic approach. *Journal of Biomedical Materials Research* 80, 895-908.

ASSOCIATE PROFESSOR DARREN MARTIN

GROUP LEADER

Research: Polymer nanocomposites and nanotoxicology

Associate Professor Darren Martin's primary research themes are the processing and structure-property performance of novel polymeric biomaterials; renewable-based polymers and nanocomposites; and the toxicology of engineered nanoparticles. These interests overlap significantly, with mature initiatives now well under way, investigating the physical and biological performance of polyurethane nanocomposites for biomedical and industrial applications.

There is also parallel research that links a better understanding of the molecular and cellular mechanisms associated with nanoparticle toxicology with measurements of industrial exposure and bio-distribution. One of Associate Professor Martin's key research aims is to shift the strong underlying science and engineering taking place in these projects towards consumer products, or medical device component applications. For example, his research group is working on new flexible nanocomposite insulation materials for Cochlear implants and high-pressure tubing and hoses.

Associate Professor Martin is the chief scientific officer of start-up company TenasiTech, which is commercialising the polyurethane nanocomposites.

The Martin research group has projects in:

- thermoplastic polyurethane nanocomposites, through TenasiTech Pty Ltd, Cochlear Ltd and Aortech Pty Ltd;
- the toxicology of engineered nanoparticles, through ARC and NHMRC funded projects; and
- renewable polymers and composites based on resin from spinifex native grasses – an ARC funded project.

Key publications for the past five years:

Rowlands AS, Lim SA, Martin D, Cooper-White JJ. (2007) Polyurethane/poly(lactic-co-glycolic acid composite scaffolds fabricated by thermally induced phase separation. *Biomaterials* 28, 2109-2121.

Ladewig BP, Knott RB, Hill AJ, Riches JD, White JW, Martin DJ, da Costa JCD, Lu GQ. (2007) Physical and electrochemical characterisation of nanocomposite membranes of Nafion and functionalised silicon oxide. *Chem Mater* 19(9), 2372-2381.

Cao Y, Zhang B, Croll TI, Rolfe BE, Campbell JH, Campbell GR, Martin DJ, Cooper-White JJ. (2006) Engineering tissue tubes using novel multilayered scaffolds in the rabbit and rat peritoneal cavity. *Tissue Engineering* 12(4), 1020-1021.

Musumeci AW, Schiller TL, Xu ZP, Minchin RF, Martin DJ, Smith SV. (2010) Synthesis and characterization of dual radiolabeled layered double hydroxide nanoparticles for use in in vitro and in vivo nanotoxicology studies. *Journal of Physical Chemistry C,* 114(2), 734-740.

McNally T, Pötschke P, Halley P, Murphy M, Martin DJ, Bell SEJ, Brennan GP, Bein D, Lemoine P, Quinn JP. (2005) Polyethylene multiwalled carbon nanotube composites. *Polymer* 46(19), 8222-8232.

Musumeci AW, Gosztola D, Schiller TL, Dimitrijevic NM, Mujica V, Martin DJ. (2009) SERS of semiconducting nanoparticles (TiO2 hybrid composites). *JACS Communication* 131(17), 6040-6041.

Smart S, Cassady A, Lu GQ, Martin DJ. (2006) The Biocompatibility of Carbon Nanotubes: A Review. *Carbon* 44, 1034-1047.

Finnigan B, Jack K, Campbell K, Halley P, Truss R, Casey P, Cookson D, King S, Martin DJ. (2005) Segmented Polyurethane Nanocomposites: Impact of Controlled Size Nanofillers on the Morphological Response to Uniaxial Deformation. *Macromolecules* 38(17), 7386-7396.

PROFESSOR ANTON MIDDELBERG

SMART FUTURES PREMIER'S FELLOW AND GROUP LEADER

Research: Biomolecular engineering

Professor Anton Middelberg and his research team focuses on designing and processing engineered proteins and peptides to develop new functional products and new manufacturing methods. The work brings together bioengineering and nanotechnology, with application in vaccines and biopharmaceuticals, and bio-renewable sustainable materials.

Professor Middelberg and his group address global opportunities such as:

- developing new vaccine technologies that change the way we combat infectious and chronic diseases, including influenza and arthritis;
- understanding how biopharmaceuticals behave in solution and manufacturing processes, to devise new processes to recover products from complex suspensions; and
- using bio-inspired approaches to deliver new manufactured materials, such as customised surfactants, self-assembling peptides and nanostructured materials, from sustainable resources.

Professor Middelberg's research brings together knowledge from engineering and the physical and life sciences.

The group has research projects in:

- protein and nanoparticle technology for new vaccines;
- the aggregation of virus-like particle vaccines;
- vaccine nano-emulsions;
- recovery and modification of biopharmaceuticals;
- design and bioprocessing of sustainable biosurfactants including pepfactants; and
- nanomaterial manufacture through biomolecular templating.

Key publications for the past five years:

Liew MWO, Rajendran A, Middelberg APJ. (2010) Microbial production of virus-like particle vaccine protein at gram-per-litre levels. *J Biotechnol* 150(2), 224-231.

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

Chuan YP, Fan YY, Lua LHL, Middelberg APJ. (2010) Virus assembly occurs following a pH- or Ca^{2+}- triggered switch in the thermodynamic attraction between structural protein capsomeres. *J R Soc Interface* 7, 409-421.

He LZ, Wang H, Garamus VM, Hanley T, Lensch M, Gabius HJ, Fee CJ, Middelberg APJ. (2010) Analysis of MonoPEGylated Human Galectin-2 by Small-Angle X-ray and Neutron Scattering: Concentration Dependence of PEG Conformation in the Conjugate. *Biomacromolecules* 11(12), 3504-3510.

Ding T, Li RY, Zeitler JA, Huber TL, Gladden LF, Middelberg APJ, Falconer RJ. (2010) Terahertz and far infrared spectroscopy of alanine-rich peptides having variable ellipticity. *Optics Express* 18(26), 27431-27444.

Awards and prizes:

2010 Queensland Smart Futures Premier's Fellow

PROFESSOR MICHAEL MONTEIRO

ARC FUTURE FELLOW
AND GROUP LEADER

Research: Designer polymer nanoreactors for use in biomedical applications and environmentally friendly organic reactions

Professor Michael Monteiro's research focuses on synthesising complex polymer architectures. The tailor-made architectures have the capacity to self-assemble into nanostructures, such as rods, vesicles, spheres or donuts. The nanostructure confers important characteristics that can be applied in drug delivery and tissue regeneration.

In one example, a new, self-adjuvanting vaccine was created through the self-assembly of a dendrimer consisting of epitopes covalently bound to a polymeric core. Incorporating certain polymers into these structures is proving useful for siRNA delivery. Other work by Professor Monteiro and his research group has demonstrated that highly dense nanoparticles can denature specific serum proteins, which induces the activation of certain biochemical pathways.

Custom-made polymer architectures designed by Professor Monteiro's group have also been used as nanoreactors. The group has developed a completely new way of conducting polymerisations in water by creating the desired nanoenvironment using custom-made nanoreactors.

This new water-based methodology has been driven by increased demand for environmentally-friendly and economically-competitive polymeric materials for use in the coatings, biomedical and electronic industries.

It is envisaged that this methodology will expand the range of structures available to materials scientists.

The group has projects in the areas of:

- nanoreactors for polymer and organic reactions in water;
- customised nanostructures for drug and vaccine delivery; and
- nanotoxicology of these designer nanostructures.

Key publications for the past five years:

Sebakhy KO, Kessel S, Monteiro MJ. (2010) Nanoreactors to Synthesize Well-defined Polymer Nanoparticles: Decoupling Particle Size from Molecular Weight. *Macromolecules* 43(23), 9598-9600.

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.

Monteiro MJ. (2010) Nanoreactors for Polymerizations and Organic Reactions. *Macromolecules* 43(3), 1159-1168.

Liang M, Lin IC, Whittaker MR, Minchin RF, Monteiro MJ, Toth I. (2010) Cellular Uptake of Densely Packed Polymer Coatings on Gold Nanoparticles. *ACS Nano* 4(1), 403-413.

Kulis J, Bell CA, Micallef AS, Jia ZF, Monteiro MJ. (2010) Rapid, Selective, and Reversible Nitroxide Radical Coupling (NRC) Reactions at Ambient Temperature. *Macromolecules* 42(21), 8218-8227.

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 Engl* 49(33), 5742-5745.

Percec V, Guliashvili T, Ladislaw JS, Wistrand A, Stjerndahl A, Sienkowska MJ, Monteiro MJ, Sahoo S. (2006) Ultrafast Synthesis of Ultrahigh Molar Mass Polymers by Metal-Catalyzed Living Radical Polymerization of Acrylates, Methacrylates, and Vinyl Chloride Mediated by SET at 25°C. *J Am Chem Soc* 128(43), 14156-14165.

Whittaker MR, Urbani CN, Monteiro MJ. (2006) Synthesis of 3-Miktoarm Stars and 1st Generation Mikto Dendritic Copolymers by "Living" Radical Polymerization and "Click" Chemistry. *J Am Chem Soc* 128(35), 11360-11361.

Lonsdale DE, Monteiro MJ. (2010) Various polystyrene topologies built from tailored cyclic polystyrene via CuAAC reactions. *Chem Commun (Cambridge, UK)* 46(42), 7945-7947.

PROFESSOR LARS NIELSEN

GROUP LEADER

Research: Systems and synthetic biology

Systems biology provides the means of answering intricate questions about complex biological systems. The questions considered by Professor Lars Nielsen's research group are very diverse, but generally inspired by some practical applications. For example:

How do we efficiently convert stem cells into white and red blood cells for use in anti-bacterial treatment?

Why does transgenic sugarcane produce plastic efficiently in one type of leaf cells, but not the other?

How do we efficiently engineer *E. coli* and yeast to produce fuels and chemicals from sucrose?

Given the number and diversity of mutations in any given tumour type, what are the common signalling phenotypes responsible for malignancy?

The common challenge for all these problems lies in formulating the question in such a way that it will yield a meaningful answer when using the appropriate mathematical, statistical and analytical tools. A key focus of Professor Nielsen's group is to develop the engineering frameworks and tools required to meet this challenge.

With an applied focus, the proof is ultimately that the understanding gained can be used to synthesise better systems and processes. In addition to various in-house model systems, Professor Nielsen's group works closely with Australian and international companies and academic groups exploring the potential of the novel strategies developed.

The group has research projects in the areas of:

- developing biological replacements for materials currently produced from petrochemical feedstocks;
- producing plastics in sugar cane;
- expanding neutrophils from stem cells for therapeutic purposes;
- modelling and analysis of mammalian cell metabolism using genome-scale models and metabolomics; and
- modelling signalling and transcription regulation networks in animal cells.

Key publications for the past five years:

Petrasovits LA, Purnell MP, Nielsen LK, Brumbley SM. (2007) Production of polyhydroxybutyrate in sugarcane. *Plant Biotechnology Journal* 5, 162-172.

Quek L-E, Nielsen LK. (2008) On the reconstruction of the *Mus musculus* genome-scale metabolic network model. *Genome Informatics* 21, 89-100.

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.

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.

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.

DR STEVEN REID

GROUP LEADER

Research: Systems biology approach to the production of baculovirus biopesticides

Dr Steven Reid's research group has a process patent on a procedure for producing baculoviruses using fermentation. The lead product is a baculovirus targeting the *Helicoverpa* pest species, the subjugation of which is responsible for a $US3.2 billion annual market in traditional chemical pesticides.

A baculovirus product manufactured by Dr Reid's group and formulated by Bioflexus has been registered for use on Australian crops to combat heliothis caterpillars (more widely known as the cotton bollworm), under the trade name of Heliocide. Dr Reid's group is undertaking further research to increase current fermentation yields, which will enable the product's manufacture and evaluation in the niche Australian market.

The group is collaborating with AIBN's Professor Lars Nielsen to use a systems biology approach using transcriptomic and metabolomic techniques in an effort to understand how the virus interacts with host cells in culture. The group anticipates further increases in yield, making it cost effective in broader markets, both nationally and internationally.

Specific research projects include:

- development of a Heliothis bacmid system for manipulation of the H.arm virus genome (gene knockouts). This system will be used to generate altered viruses for further transciptomic and metabolomic studies;
- using real time PCR to quantify virus-binding kinetics to enable optimisation of early process steps for manufacturing the virus in vitro; and
- developing sample extraction procedures and appropriate HPLC/GC-MS techniques for quantifying intracellular metabolite levels for infected and non-infected cells in culture, which will enable the metabolomic studies.

Key publications in the past five years:

Chan L, Reid S, Nielsen LK. (2010) The kinetics of virus production from cell culture. In *Wiley Encyclopedia of Industrial Biotechnology* (Flickinger MC, Ed.), pp. 1-24, Hoboken, NJ, US.

Pedrini MRS, Chan LCL, Nielsen LK, Reid S. (2006) In vitro production of *Helicoverpa armigera* single-nucleocapsid nucleopolyhedrovirus. *Brazilian Archives of Biology and Technology* 49 (special issue), 35-41.

Pedrini MRS, Christian P, Nielsen LK, Reid S, Chan LCL. (2006) Importance of virus-medium interactions on the biological activity of wild-type Heliothine nucleopolyhedroviruses propagated via suspension insect cell cultures. *J Virol Methods* 136, 267-272.

Pedrini MRS, Nielsen LK, Reid S, Chan LCL. (2005) Properties of a Unique Mutant of *Helicoverpa armigera* Single – Nucleocapsid Nucleopolyhedrovirus that Exhibits a Partial Many Polyhedra and Few Polyhedra Phenotype on Extended Serial Passaging in Suspension Cell Cultures. *In Vitro Cell Dev Biol – Animal* 41, 289-297.

Research: Computational molecular science

The research of Professor Sean Smith and his group applies theoretical and computational studies at the molecular scale to gain enabling insights that will facilitate progress towards new technologies in electronics, sustainable energy and biomolecular/biomedical applications. His research group conducts computational explorations of:

- chemical kinetics;
- catalysis; and
- complexation/association phenomena and transport within:
  - nanostructured materials;
  - proteins;
  - hybrid nano-bio systems; and
  - gaseous environments.

The research is performed at the atomistic level, including advanced applications of solid state and molecular electronic structure theory, molecular dynamics, quantum dynamics and kinetics theories.

The studies are conducted in an interdisciplinary context, in close collaboration with experimental and other theoretical groups. They require state-of-the-art high-performance computing facilities for their implementation.

Professor Smith's group has research projects in:

- computational studies of light metal hydride nanocomposite materials for hydrogen storage;
- fluorescent proteins: photophysics, mechanism and dynamics;
- simulation of layered-double-hydroxide nanoparticle-DNA interactions for gene delivery applications;
- simulation of biological dendrimer-DNA interactions for gene delivery applications;
- computational studies of C and BN nanotube and nanoribbon reactivity and functionalisation;
- quantum dynamical studies of H transport in confined systems; and
- computational kinetics and quantum dynamical studies of elementary reactions for combustion and atmospheric chemistry.

Key publications for the past five years:

Du AJ, Zhu ZH, Smith SC. (2010) Multifunctional Porous Graphene for Nanoelectronics and Hydrogen Storage: New Properties Revealed by First Principle Calculations. *J Amer Chem Soc* 132(9), 2876-2877.

Li Z, Cheng L, Sun Q, Zhu Z, Riley MJ, Aljada M, Cheng Z, Wang X, Qiao S, Smith SC, Lu GQ. (2010) Diluted Magnetic Semiconductor Nanowires Prepared by Solution-Liquid-Solid Method. *Angew Chem Int Ed* 49(15), 2777-2781.

Du AJ, Chen Y, Zhu ZH, Amal R, Lu GQ, Smith SC. (2009) Dots versus Antidots: Computational Exploration of Structure, Magnetism and Half-metallicity in Boron-Nitride Nanostructures. *J Amer Chem Soc* 131, 17354-17359.

Yang HG, Liu G, Qiao SZ, Sun CH, Jin YG, Smith SC, Zou J, Cheng HM, Lu GQ. (2009) Solvothermal Synthesis and Photoreactivity of Anatase TiO_2 Nanosheets with Dominant {001} Facets. *J Amer Chem Soc* 131, 4078-4083.

Du AJ, Chen Y, Zhu ZH, Lu GQ, Smith SC. (2009) C-BN Single Walled Nanotubes from Hybrid Connection of BN/C Nanoribbons: Prediction by Ab Initio Density Functional Calculations. *J Amer Chem Soc* 131, 1682-1683.

Yao XD, Lu GQ, Li L, Sun CH, Du AJ, Smith SC, Zhu ZH. (2009) Lithium-Catalyzed Dehydrogenation of Ammonia Borane within Mesoporous Carbon Framework for Chemical Hydrogen Storage. *Advanced Functional Materials* 19, 265-271.

Yang HG, Sun CH, Qiao SZ, Zhou J, Smith SC, Cheng HM, Lu GQ. (2008) Anatase TiO_2 single crystals with a large percentage of {001} facets. *Nature* 453, 638-641.

Du AJ, Smith SC, Lu GQ. (2007) Formation of Single Walled Carbon Nanotube Via the Interaction of Graphene Nanoribbons: *ab initio* Density Functional Calculations. *Nano Lett* 7, 3349-3354.

Yao X, Wu CZ, Du AJ, Zou J, He Y, Zhu ZH, Wang P, Cheng HM, Smith SC, Lu GQ. (2007) Metallic and Carbon Nanotube-Catalyzed Coupling of Hydrogenation in Magnesium. *J Amer Chem Soc* 129, 15650-15654.

Du AJ, Smith SC, Yao XD, Lu G. (2007) Hydrogen Spillover Mechanism on a Pd-doped Mg Surface as Revealed by ab initio Density Functional Calculations. *J Amer Chem Soc* 129, 10201-10204.

PROFESSOR SEAN SMITH

GROUP LEADER

PROFESSOR MATT TRAU

GROUP LEADER

Research: Nanotechnology, biomarkers and molecular diagnostics

The use of biomarkers (molecules that indicate the onset and status of disease) is emerging as one of the most promising strategies for disease management. In nearly all forms of cancer, early diagnosis can lead to a cure at a fraction of the cost of currently ineffective treatments for late-stage disease. It is predicted the development of new biomarker diagnostic technologies will simultaneously improve survival rates and quality of life, while significantly reducing health care costs.

At AIBN's Centre for Biomarker Research and Development, Professor Matt Trau and his research group are currently focused on several projects:

- nano-scaled biosensors for epigenetic readouts in breast cancer;
- novel nano-devices for protein capture in diagnostics;
- single molecule readouts within elastic nanopores; and
- nanotechnology devices for capturing circulating tumour cells.

The development of nanoscaled biosensors is highly multidisciplinary, bringing together scientists from many areas, such as nanotechnology, molecular biology, biochemistry, pathology, medicine and bioinformatics. The research involves strong interactions with the Peter MacCallum Cancer Centre; the Garvan Institute; the University of Newcastle; the Fred Hutchinson Cancer Research Center; the Seattle Biomedical Research Institute; the Benaroya Research Institute, the University of Washington; and Nanomics BioSystems Pty Ltd.

The single molecule readout area of research focuses on understanding tunable elastic nanopore sensors that are being developed with New Zealand's Izon Science Ltd. The sensors are used for monitoring particle-particle and particle-biomolecule interactions, and quantitative sizing of colloidal dispersions.

Key publications in the past 12 months:

Connolly AR, Trau M. (2011) Rapid DNA detection by Beacon Assisted Detection Amplification. *Nature Protocols*. (Accepted Feb 2011) In print.

Palanisamy R, Connolly AR, Trau M. (2011) Epiallele quantification using molecular inversion probes. *Analytical Chemistry* 83(7), 2631-2637.

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/feature article).

Connolly A, Trau M. (2010) Isothermal Detection of DNA by Beacon Assisted Detection Amplification (BAD AMP). *Angewandte Chemie* (International Ed.) 122, 2780-2782.

Roberts GS, Kozak D, Anderson W, Broom MF, Vogel R, Trau M. (2010) Tunable Nano/Micropores for Particle Detection and Discrimination: Scanning Ion Occlusion Spectroscopy. *Small* 6(23), 2653-2658.

Patents:

Trau, Johnston. Synthesis and use of organosilica particles (US7754646-B2). Granted July 13, 2010.

Battersby, Bryant, Trau. Carriers for combinatorial compound libraries (CA2352082-C). Granted September 21, 2010.

Awards and prizes:

The National Breast Cancer Foundation awarded Professor Trau the 2010 Pink Circle Breast Cancer Research Award.

ASSOCIATE PROFESSOR CHRISTINE WELLS

NHMRC CAREER DEVELOPMENT AWARD AND GROUP LEADER

Research: Cellular differentiation and activation

Associate Professor Christine Wells was appointed to AIBN in 2010 and took up her position in January 2011. She heads a research group that uses genomic technologies to understand genetic and environmental factors that lead to disease susceptibility. The group is interested in:

- innate immune function and susceptibility to infectious disease; and
- stem cell differentiation.

The innate immune system provides the first line of defence against infection. Infectious diseases remain the leading cause of death world-wide. Many infectious agents have been implicated in the onset of cancers, tissue death and organ failure; and in some cases are responsible for exacerbating chronic diseases. To mount effective preventative programs, such as vaccinations, or provide appropriate diagnosis and point of care, researchers need to understand why some people are susceptible to infection, whereas others can resolve infection without medical intervention.

The Wells group's research is aimed at:

- identifying the networks of genes marshalled to fight an infection;
- modelling the interactions of the immune system with our environment; and
- developing markers for improved diagnosis and treatment of susceptible individuals.

The group's most recent success has been identifying the C-type Lectin Mincle, which has a critical role in immune responses to fungal diseases, including thrush, and has been implicated in mycobacterial infections, such as TB. The group is characterising the regulation and function of Mincle in human health.

Stem cell biology promises new strategies for regenerative medicine. The Wells group recognises there is a wealth of stem cell data that is effectively hidden in public databases, but could bring important information on stem cell behaviours if collated and interrogated in a systematic manner. The Stemformatics web portal is aimed at collating the data and enabling stem cell researchers to investigate the gene signatures that correlate with stem cell function. The project is funded through the Australian Stem Cell Centre as a collaboration between the Wells group at AIBN; the Hilton group at the Walter and Eliza Hall Institute; and the Grimmond group at The University of Queensland's Institute for Molecular Bioscience.

Stemformatics.org currently:

- hosts expertly curated public gene expression data from exemplar stem cell datasets;
- facilitates simple gene searches across mouse and human stem cell datasets;
- presents data in high-quality images; and
- provides transparent links to the original source and facilitates access to the primary data.

The Wells group is multidisciplinary, with expertise in cell biology and signalling, genomics, transcriptomics and bioinformatics. It has collaborations with microbiology labs, clinicians and immunology groups through the Australian Infectious Disease Research Centre at UQ; and is a participant in the international FANTOM (Functional Annotation of the Mammalian Genome) and the Functional Glycomics consortia. The group works closely with John Quackenbush and his group at the Dana-Farber Cancer Institute; and the biostatistics group at the Harvard School of Public Health, Boston.

The group has research projects in:

- genome biology to identify key genes determining macrophage differentiation and activation;
- genomics, bioinformatics and cell biology to investigate the transcriptional analysis of monocytes infected with an exemplar pathogen series;
- genomic and cell biology to understand the epigenetic events that modify immune cell differentiation; and
- developing new computational approaches for predictive models of cell fate.

Key publications for the past five years:

Mar J, Wells CA, Quackenbush J. (2011) Defining an Informativeness Metric for Clustering Gene Expression Data. *Bioinformatics.* Feb 16 [Epub ahead of print].

FANTOM4 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.

FANTOM3 consortium including Wells CA. (2006) Genome-wide analysis of mammalian promoter architecture and evolution. *Nature Genetics* 38(6), 626-635.

Wells CA, Chalk AM, Forrest A, Taylor D, Waddell N, Schroder K, Himes SR, Faulkner G, Lo S, Kasukawa T *et al.* (2006) Alternate transcription of the Toll-like receptor signalling cascade. *Genome Biology* 7(2), R10.

Awards and prizes:

2010 Women in Technology Research Excellence Award

PROFESSOR ANDREW WHITTAKER

ARC PROFESSORIAL FELLOW
AND GROUP LEADER

Research: Polymer chemistry

Professor Andrew Whittaker and his team are working to develop novel polymeric materials for application in:

- biomaterials for diagnosis and treatment of disease;
- photolithography for manufacturing integrated circuits; and
- molecular imaging agents for disease identification using nuclear magnetic resonance imaging.

This research is underpinned by extensive expertise in polymer synthetic chemistry, polymer physical chemistry, interactions with biological systems and magnetic resonance technology.

The group's biomaterials research is targeting various applications including:

- polymers for use as tissue implants;
- improving drug delivery; and
- aiding medical diagnosis.

This is in addition to projects shedding light on drug delivery, the fundamentals of hydrogel polymer networks, surface modification and biosensors.

Using immersion and ultra-violet immersion lithography, the group is also investigating the challenges facing the microelectronics industry as it struggles to incorporate nanometre-sized features on integrated circuits.

Research projects include:

- polymers for 193 nm immersion lithography;
- polymers for EUV lithography;
- block copolymers for healing of line edge roughness;
- polymers for artificial vitreous;
- artificial blood vessels;
- dental bone repair;
- molecular imaging agents;
- hybrid imaging agents;
- ultrasound contrast agents;
- diffusion in hydrogels;
- novel hydrogel networks; and
- spinal cord repair.

Key publications for the past five years:

Whittaker AK. (2006) The Structure of Polymer Networks. *Handbook of Modern Magnetic Resonance* 1, 579-585. G. Webb (Ed.), Springer, Dordrecht, Neth.

Zainuddin, Hill DJT, Traian CV, Whittaker AK, Kemp A. (2006) Experimental Calcification of hydroxyethyl methacrylate-Based Hydrogels in the Presence of Albumin and a Comparison to the in Vivo Calcification. *Biomacromolecules* 7(6), 1758-1765.

Thurecht KJ, Hill DJT, Whittaker A K. (2006) NMR microscopy: a tool for measuring monomer diffusion in supercritical CO_2. *Macromolecular Chemistry and Physics* 207(17), 1539-1545.

Plummer R, Hill DJT, Whittaker AK. (2006) Solution Properties of Star and Linear Poly(N-isopropylacrylamide). *Macromolecules* 39(24), 8379-8388.

Tan I, Flanagan BM, Halley PJ, Whittaker AK, Gidley MJ. (2007) A Method for Estimating the Nature and Relative Proportions of Amorphous, Single, and Double-Helical Components in Starch Granules by 13C CP/MAS NMR. *Biomacromolecules* 8(3), 885-891.

Blakey I, George GA, Hill DJT, Liu H, Rasoul F, Rintoul L, Zimmerman P, Whittaker AK. (2007) Mechanism of 157 nm Photodegradation of Poly[4,5-difluoro-2,2- bis(trifluoromethyl)-1,3-dioxole-co-tetrafluoroethylene] (Teflon AF). *Macromolecules* 40(25), 8954-8961.

Zainuddin, Le TT, Park Y, Chirila TV, Halley PJ, Whittaker AK. (2008) The behaviour of aged regenerated Bombyx mori silk fibroin solutions studied by ^{1}H NMR and rheology. *Biomaterials* 29(32), 4268-4274.

Kealley CS, Rout MK, Dezfouli MR, Strounina E, Whittaker AK, Appelqvist IAM, Lillford PJ, Gilbert EP, Gidley MJ. (2008) Structure and Molecular Mobility of Soy Glycinin in the Solid State. *Biomacromolecules* 9(10), 2937-2946.

Peng H, Xiao Y, Mao X, Chen L, Crawford R, Whittaker AK. (2008) Amphiphilic Triblock Copolymers of Methoxy-poly(ethylene glycol)-b-poly(L-lactide)-b-poly(L-lysine) for Enhancement of Osteoblast Attachment and Growth. *Biomacromolecules* 10(1), 95-104.

Peng H, Blakey I, Dargaville B, Rasoul F, Rose S, Whittaker AK. (2009) Synthesis and Evaluation of Partly Fluorinated Block Copolymers as MRI Imaging Agents. *Biomacromolecules* 10(2), 374-381.

Mao X, Peng H, Ling J, Friis T, Whittaker AK, Crawford R, Xiao Y. (2009) Enhanced human bone marrow stromal cell affinity for modified poly(-lactide) surfaces by the upregulation of adhesion molecular genes. *Biomaterials* 30(36), 6903-6911.

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(15), 5336-5337.

Blakey I, Thurecht KJ, Whittaker AK. (2010) High-pressure real-time 129Xe NMR: monitoring of surfactant conformation during the self-assembly of reverse micelles in supercritical carbon dioxide. *Chemical Communications* (Cambridge, UK) 46(16), 2850-2852.

Ngo TTV, Duchet-Rumeau J, Whittaker AK, Gerard, JF. (2010) Processing of nanocomposite foams in supercritical carbon dioxide. Part I: Effect of surfactant. *Polymer* 51(15), 3436-3444.

Paterson SM, Brown DH, Chirila TV, Keen I, Whittaker AK, Baker MV. (2010) The synthesis of water-soluble PHEMA via ARGET ATRP in protic media. *Journal of Polymer Science, Part A: Polymer Chemistry* 48(18), 4084-4092.

ASSOCIATE PROFESSOR ERNST WOLVETANG

GROUP LEADER

Research: Human pluripotent stem cells for regenerative medicine

Associate Professor Ernst Wolvetang's research is focused on developing human pluripotent stem cell-based therapies and disease models.

Because human pluripotent stem cells can be cultured indefinitely and can generate every cell type of the human body, they are the cell type of choice for stem cell based regenerative medicine, and discovery platform for understanding the molecular basis of human disease and development.

The ability to reprogram adult cells into pluripotent cells (called induced pluripotent stem cells (iPS cells)) that are essentially equivalent to embryonic stem cells has removed the ethical concerns attached to this brand of stem cell research. It also allows the generation of patient specific stem cells that will not suffer from rejection. Generating iPS cells allows the creation of unique disease models previously not available to researchers.

Associate Professor Wolvetang joined AIBN in 2008. Current research activities in the Wolvetang group concentrate on:

- elucidating the role of specific signalling pathways and the microenvironment in controlling the behaviour of human pluripotent cells to enable safer, more efficient stem cell expansion and differentiation; and
- generating species and patient-specific iPS cells to understand the molecular basis of disease and enable cellular therapy.

Specific projects in these areas include:

- developing novel cell reprogramming technologies;
- generating Down Syndrome iPS cells to understand Alzheimer's disease;
- understanding the epigenetic effects of culture conditions;
- elucidating BMP-SMAD signalling in human stem cells;
- metabolomic analysis of human embryonic stem cells; and
- Developing smart surfaces for stem cell expansion and differentiation.

By combining cutting-edge molecular analysis and cell biology tools, the group will gain an in-depth understanding of the molecular machinery controlling human pluripotent stem cells and consequently be able to unlock the potential of these cells for application in regenerative medicine and drug development.

Key publications in the past five years:

Wolvetang EJ, 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. *Nature Biotech* 24(3), 351-357.

Chung TL, 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.

Chung TL, Turner J, Thakar N, Kolle G, Cooper-White JJ, Grimmond SM, Pera MF, Wolvetang EJ. (2010) Ascorbate Promotes Epigenetic activation of CD30 in Human Embryonic Stem Cells. *Stem Cells* 28(10), 1782-1793.

Prowse A, Doran M, Cooper-White JJ, Chong F, Munro T, 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.

Grandela C, Pera MF, Wolvetang EJ. (2007) p53 is required for etoposide-induced apoptosis of human embryonic stem cells. *Stem Cell Research* 1(2), 116-128.

Hannan NRF, Wolvetang EJ. (2008) Adipocyte differentiation in human embryonic stem cells transduced with Oct4 shRNA lentivirus. *Stem Cells and Development* 18(4), 653-660.

Hannan N, Jamshidi P, Pera MF, Wolvetang EJ. (2009) BMP -11 and Myostatin Maintain Human Embryonic Stem Cells in Feeder Free Cultures. *Cloning and Stem Cells* 11(3), 427-435.

Doran MR, Frith JE, Prowse ABJ, Fitzpatrick J, Wolvetang EJ, Munro T, Gray PP, Cooper-White JJ. (2010) Defined high protein content surfaces for stem cell culture. *Biomaterials* 31(19), 5137-5142.

Hudson JE, Mills RJ, Frith JE, Brooke G, Jaramillo-Ferrada P, Wolvetang EJ, Cooper-White JJ. (2010) A Defined Media and Substrate for Expansion of Human Mesenchymal Stromal Cell Progenitors that Enriches for Osteo-genic and Chondro-genic Precursors. *Stem Cells Dev* 20(1), 77-87.

Prowse ABJ, Wilson J, Osborne GW, Gray PP, Wolvetang EJ. (2009) Multiplexed staining of live human embryonic stem cells for flow cytometric analysis of pluripotency markers. *Stem Cells and Development* 18(8), 1135-1140.

Chung TL, Thaker N, Wolvetang EJ. (2010) Genetic and epigenetic instability of human pluripotent stem cells. *The Open Stem Cell Journal* (in press).

Vitale AM, Wolvetang EJ, Mackay-Sim A. (2011) Induced pluripotent cells: a new technology to study human diseases. *The International Journal of Biochemistry and Cell Biology* (accepted for publication).

PROFESSOR CHENGZHONG (MICHAEL) YU

ARC FUTURE FELLOW AND GROUP LEADER

Research: Nanomaterials for biotechnology, energy and environmental protection

Professor Chengzhong (Michael) Yu and his research group have an excellent track record of research and innovation in nanoporous and nano-materials with various compositions, adjustable structures and tailored functions for biotechnology, clean energy and environment protection. His group also focuses on investigating cancer carcinogenesis to identify potential therapeutic targets and using nanotechnology to develop novel cancer diagnosis and therapies.

Research projects in the group include:

- a robust nanomaterial platform for advanced delivery;
- nanoporous materials for bio-catalysis, bio-separation and bio-analysis;
- biomaterials for bone repair and dental applications;
- skin cancer carcingenesis (EMT model), development and therapy; and
- advanced nanomaterials for sustainable environment and energy applications.

Key publications for the past five years:

Yang J, Zhou L, Zhao LZ, Zhang HW, Yin JN, Wei GF, Qian K, Wang YH, Yu CZ. (2011) A Designed Nanoporous Material for Phosphate Removal with High Efficiency. *J Mater Chem* 21(8), 2489 - 2494.

Zhu J, Tang JW, Zhao LZ, Zhou XF, Wang YH, Yu CZ. (2010) Ultrasmall, Well-Dispersed, Hollow Siliceous Spheres with Enhanced Endocytosis Properties. *Small* 6(2), 276-282.

Zhou L, Yang LC, Yuan P, Zou J, Wu YP, Yu CZ. (2010) Alpha-MoO_3 Nanobelts: A High Performance Cathode Material for Lithium Ion Batteries. *J Phys Chem C* 114, 21868-21872.

Qian K, Wan JJ, Huang XD, Yang PY, Liu BH, Yu CZ. (2010) A Smart Glycol-Directed Nanodevice by Rationally Designed Macroporous Materials. *Chem Eur J* 16, 822-828.

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 Using Electron Tomography. *Angew Chem-Int Edit* 47(35), 6670.

GRANTS

TYPE	SCHEME	LEAD AIBN INVESTIGATOR	OTHER CHIEF INVESTIGATORS	PROJECT TITLE	DURATION	2010 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	$270,000
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	$90,000
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	$130,000
Australian Competitive Grant Income	ARC Discovery Projects	Dr Shizhang Qiao	Dr Yonggang Jin, Prof Mietek Jaroniec	Multifunctional porous panospheres engineered composite membranes for hydrogen and methanol fuel cells	2010-2012	$85,000
Australian Competitive Grant Income	ARC Discovery Projects	Prof Sean Smith	Dr Hong Zhang, Prof Walter Thiel	Function, mechanism and dynamics in fluorescent proteins: a computational investigation	2010-2012	$120,000
Australian Competitive Grant Income	ARC Discovery Projects	Prof Chengzhong Yu	Dr Xiangdong Yao	Practical hydrogen storage for fuel cells electrical vehicles by confined ammonia borane system	2010-2012	$130,000
Australian Competitive Grant Income	ARC Discovery Projects	Prof Michael Monteiro	A/Prof Nigel McMillan	Engineered polymer nanoparticles: a potent weapon against cancer	2009-2011	$130,000
Australian Competitive Grant Income	ARC Discovery Projects	Dr Simon Corrie	Prof Mark Kendall	Non-invasive diagnosis using micropatches that sample biomarkers from skin	2009-2011	$120,000
Australian Competitive Grant Income	ARC Discovery Projects	Prof Kirill Alexandrov		Novel approaches for structural and functional analysis of the protein complex cog, a tether that controls intra-golgi trafficking	2009-2011	$180,000
Australian Competitive Grant Income	ARC Discovery Projects	Prof Michael Monteiro	Prof Virgil Percec	Designer nanoreactors: an environmentally friendly solution for polymer synthesis	2009-2011	$150,000
Australian Competitive Grant Income	ARC Discovery Projects	Prof Andrew Whittaker	Dr Kevin Jack, Dr Hui Peng	Designed delivery novel hydrogels for drug delivery from precisely-structured networks	2009-2011	$130,000
Australian Competitive Grant Income	ARC Discovery Projects	Dr Shizhang Qiao	Prof Duong Do, Dr Greg Birkett	Synthesis of unique mesoporous graphitic carbons and their application to fundamental problems in adsorption science	2009-2013	$40,715
Australian Competitive Grant Income	ARC Discovery Projects	Dr Hong Zhang	Prof Suresh Bhatia, A/Prof Xiu Song Zhao	Quantum induced kinetic molecular sieving of hydrogen isotopes in nanoporous materials	2008-2010	$140,000
Australian Competitive Grant Income	ARC Discovery Projects	A/Prof Idriss Blakey	Prof Traian Chirila, Dr David Hill, Dr Craig Hawker	Generation of peptidomimetic surfaces for biomaterials applications	2008-2010	$180,000
Australian Competitive Grant Income	ARC Discovery Projects	Prof Andrew Whittaker	Professor Maree Smith, Dr Bruce Wyse, Dr Kristofer Thurecht	Novel polymeric microparticles for slow-release intrathecal delivery of analgesics	2010-2013	$32,000

TYPE	SCHEME	LEAD AIBN INVESTIGATOR	OTHER CHIEF INVESTIGATORS	PROJECT TITLE	DURATION	2010 INCOME
Australian Competitive Grant Income	ARC Future Fellowships	Prof Michael Monteiro		Transformer 3D nanostructures: stimuli responsive polymers	2010-2013	$222,800
Australian Competitive Grant Income	ARC Future Fellowships	Prof Chengzhong Yu		Novel synthesis and bio-applications of functional macroporous ordered siliceous foams	2009-2014	$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 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	$635,000
Australian Competitive Grant Income	ARC Linkage Projects	Dr Zhi Ping (Gordon) Xu	Prof Anh Nguyen, Dr Longbin Huang	Tailoring nano-crystal suspensions for extended ion supply to hydrophobic and hydrophilic leaf surfaces	2009-2012	$120,535
Australian Competitive Grant Income	ARC Linkage Projects	Prof Andrew Whittaker	Dr Idriss Blakey, Dr Kevin Jack, Prof John Drennan, Dr Todd Ross Younkin	Advanced lithographic solutions using block copolymers: integrating self assembly and lithography	2009-2012	$484,000
Australian Competitive Grant Income	ARC Linkage Projects	Dr Steve Reid	Prof Lars Nielsen	In vitro production of baculovirus biopesticides – a systems biology approach	2009-2012	$250,000
Australian Competitive Grant Income	ARC Linkage Projects	Prof Max Lu	Prof Victor Rudolph, Dr Ronggang Ding, Dr Guo Xiong Wang	Nano and micro-scale engineering of mos2-based catalyst for conversion of syngas to ethanol	2010-2013	$395,000
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	$180,000
Australian Competitive Grant Income	ARC Linkage Projects	Prof Justin Cooper-White	Dr Tanja Eindorf, Prof Gail Anderson	Intelligent scaffolds and methods for repair of osteochondral defects	2009-2012	$444,389
Australian Competitive Grant Income	ARC Linkage Projects	Prof Max Lu	Dr Shizhang Qiao, Dr Brenton Peters, Dr Michael Kennedy	Porous silica-based nanocapsules for targeted and controlled release of biocides	2008-2011	$222,416
Australian Competitive Grant Income	ARC Linkage Projects	A/Prof Stephen Mahler	Prof Maree Smith, Dr Bruce Wyse, Dr Trent Woodruff, Prof Paul Marie Gerard Curmi, Dr Dean Naylor, Dr Richard Brown	Development of chaperonin 10-based second generation biopharmaceuticals for treatment of inflammatory diseases	2010-2013	$150,000
Australian Competitive Grant Income	ARC Linkage Projects	Prof Peter Halley	Prof Bhesh Bhandari	A novel rheological and chewing and swallowing model for the smart design of texture-modified foods for increased aged health	2009-2012	$152,500
Australian Competitive Grant Income	Australian Institute of Nuclear Science and Engineering	Dr Lizhong He		The physical states of pharmaceutical proteins and self-assembled peptides (AINSE Research Fellowship)	2008-2011	$165,982
Australian Competitive Grant Income	NHMRC Program Grant	Prof Kirill Alexandrov	Prof Robert Parton	Molecular and functional characterisation of cell surface microdomains	2008-2012	$935,766
Australian Competitive Grant Income	NHMRC Project Grant	Prof Justin Cooper-White	Prof Dietmar Hutmacher, Dr Michael Doran, Dr Garry Brooke, Prof Julie Campbell	Taking the limp out of cartilage repair	2010-2012	$144,375
Australian Competitive Grant Income	NHMRC Project Grant	Prof Julie Campbell	Dr Anita Thomas, Dr Zhiping Xu, Prof Max Lu	Antibody-directed delivery of anti-restenotic agents using inorganic nanoparticles	2009-2011	$78,563
Australian Competitive Grant Income	NHMRC Project Grant	Prof Kirill Alexandrov	Dr Daniel Abankwa	Understanding changes in the mammalian prenylome induced by statins and prenyltransferase inhibitors	2009-2011	$181,250
Australian Competitive Grant Income	NHMRC Project Grant	Prof Mark Kendall	Dr Germain Fernando, Prof Lorena Brown, Prof Ian Frazer, Dr Dexiang Chen	Nanopatch immunisation against pandemic influenza: improved immune responses at a reduced dose	2009-2011	$98,250

TYPE	SCHEME	LEAD AIBN INVESTIGATOR	OTHER CHIEF INVESTIGATORS	PROJECT TITLE	DURATION	2010 INCOME
Australian Competitive Grant Income	NHMRC Project Grant	Prof Julie Campbell	Dr Sharon Ricardo	Transplanted metanephroi as functional kidneys	2008-2010	$98,500
Australian Competitive Grant Income	NHMRC Research Fellowship	Prof Julie Campbell		Senior principal research fellowship	2006-2010	$158,675
Australian Competitive Grant Income	NHMRC Training (Postdoctoral) Fellowship	Dr Bei Cheng		NHMRC Australia-China exchange: how does oestrogen affect blood vessels?	2009-2011	$188,190
Australian Competitive Grant Income	ARC Centres of Excellence	Prof Sean Smith		ARC Centre for Functional Nanomaterials – Computational nanomaterials sciences	2003-2010	$238,667
Australian Competitive Grant Income	ARC Centres of Excellence	Prof Matt Trau		ARC Centre for Functional Nanomaterials – Healthcare	2003-2010	$92,066
Australian Competitive Grant Income	ARC Centres of Excellence	Prof Max Lu		ARC Centre for Functional Nanomaterials – Healthcare and environmental technologies	2003-2010	$100,000
National and International Grant Income	Australian Academy of Science	Dr Zhen Li		Preparation and bioapplication of multifunctional magnetic nanoparticles – AAS scientific visits to China	2010	$4,100
National and International Grant Income	Australian Academy of Science	Dr Dawei Wang		Australian Academy of Science scientific visits to North America program	2010	$5,000
National and International Grant Income	Australian Stem Cell Centre	Dr Nick Timmins	Prof Michael Atkinson, Dr Garry Brooke	Development of a scalable, automated, closed system device for manufacturing clinical grade mesenchymal stem cells	2009-2011	$165,000
National and International Grant Income	Australian Stem Cell Centre	A/ Prof Ernst Wolvetang		Novel methods of reprogramming (ASCC collaborative stream 2, module 1)	2009-2011	$310,228
National and International Grant Income	Australian Stem Cell Centre	A/ Prof Ernst Wolvetang	Prof Nicholas Fisk, Dr Liza-Jane Raggatt	Primitive ips-derived MSC for bone repair (ASCC collaborative stream 2 module 7)	2010-2011	$145,767
National and International Grant Income	Australian Stem Cell Centre	A/ Prof Ernst Wolvetang		Safe and efficient expansion of genetically stable hesc (ASCC collaborative stream 1-module 6)	2009-2011	$375,018
National and International Grant Income	Australian Stem Cell Centre	Prof Lars Nielsen		Production of neutrophils (ASCC collaborative stream 1-module 4)	2009-2011	$518,532
National and International Grant Income	Australian Stem Cell Centre	Prof Peter Gray	A/ Prof Ernst Wolvetang, Prof Justin Cooper-White	AIBN bioreactor program (ASCC collaborative stream 1-module 2)	2009-2011	$808,212
National and International Grant Income	Australian Stem Cell Centre	A/ Prof Ernst Wolvetang		Safe and efficient expansion of genetically stable hesc under defined conditions (ASCC project p090)	2008-2010	$89,179
National and International Grant Income	Australian Stem Cell Centre	Prof Lars Nielsen	Dr Nicholas Timmins, Dr Sia Athanasas-Platsis, Flavia Marturana, Penny Buntine	Ex vivo generated allogeneic neutrophils for anti-infective supportive care in acute leukaemia	2008-2010	$234,262
National and International Grant Income	Bill & Melinda Gates Foundation	Dr Krassen Dimitrov		Nano-dumbbells for single-molecule diagnostics from saliva	2010-2011	$108,175
National and International Grant Income	Cancer Australia	Prof Matt Trau	A/Professor Melissa Brown, Dr Glenn Francis, Dr Kymberley Vickery, Dr Bronwyn Battersby	Nanoscaled biosensors: reading epigenetic signatures to improve breast cancer detection and treatment	2008-2011	$88,000
National and International Grant Income	CRC for Polymers	Prof Peter Halley	A/Prof Rowan Truss, Prof Mike Gidley, A/Prof Darren Martin, Dr Fengwei Xie, Luke Matthew, Grant Edwards, Stephen Coombs, Robert Shanks	Degradable packaging materials derived from renewable resources	2005-2012	$161,975
National and International Grant Income	CRC for Sugar Industry Innovation through Biotechnology	Prof Lars Nielsen	Dr Stevens Brumbley	The production of PHB/PHAs in plants	2006-2010	$750,740

TYPE	SCHEME	LEAD AIBN INVESTIGATOR	OTHER CHIEF INVESTIGATORS	PROJECT TITLE	DURATION	2010 INCOME
National and International Grant Income	Defence Materials Technology Centre	Prof Peter Halley	Matthew Dargusch, Prof Graeme George, A/Prof Martin Veidt	Aircraft prognostic tools to reduce corrosion impacts (DMTC)	2008-2015	$213,997
National and International Grant Income	Department of Innovation, Industry, Science and Research – ISL Australia-China Special Fund	Prof John Drennan	Prof Jin Zou	Synthesis, characterisation, and applications of novel porous materials with complicated structures	2010-2011	$54,780
National and International Grant Income	Go8 Australia-Germany Joint Research Co-operation Scheme	Prof Sean Smith	Dr Harendra Parekh	Complexation and cellular uptake of genes with novel peptide-based dendrimers: a fundamental joint study involving synthesis, optical single-molecule spectroscopy and simulations	2010-2011	$10,518
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	$825,000
National and International Grant Income	Qld Department of Primary Industries & Fisheries	Prof Max Lu	Dr Shizhang Qiao	Platform technology for nanoparticle based non-injectible delivery of veterinary vaccines	2008-2011	$38,500
National and International Grant Income	Queensland Government	Prof Peter Gray		National Collaborative Research Infrastructure Strategy (NCRIS)-capability area 5.5 biotechnology products	2007-2011	$417,450
National and International Grant Income	Queensland Government	Prof Lars Nielsen		National Collaborative Research Infrastructure Strategy (NCRIS)-capability area 5.1 evolving bio-molecular platforms and informatics (sub-capability-metabolomics)	2007-2011	$137,500
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	2010-2013	$55,000
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	$110,000
National and International Grant Income	Queensland Government Smart Futures Fellowships	Dr Simon Corrie		Smart Futures Fellowship: micropatches for non-invasive disease diagnostics	2009-2012	$55,000
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	$110,000
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	$110,000
National and International Grant Income	Queensland Government Smart Futures Premiers Fellowships	Professor Anton Middelberg		Delivering smarter vaccines faster thorugh nanotechnology	2010-2015	$250,000
National and International Grant Income	Queensland Government Smart Futures Partnerships-Alliances Facilitation Program	Prof Lars Nielsen	Prof Peter Gray, Jason Fletcher	Queensland bio jet fuel initiative	2009-2011	$110,000
National and International Grant Income	Queensland Government Smart Futures Partnerships-Alliances Facilitation Program	Prof Peter Gray	Prof Lars Nielsen, Jason Fletcher	Process modelling applicable to biofuels	2009-2011	$55,000
National and International Grant Income	Queensland Government Smart State National and International Research Alliances Program	Prof Andrew Whittaker	Dr Firas Rasoul, Prof Ian Brereton, Dr Bronwin Dargaville, Assoc Prof John Forsythe, Dr David Nisbet, Dr Eve Tsai	Spinal cord repair	2010-2013	$181,063

TYPE	SCHEME	LEAD AIBN INVESTIGATOR	OTHER CHIEF INVESTIGATORS	PROJECT TITLE	DURATION	2010 INCOME
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	$132,000
National and International Grant Income	Queensland Government Smart State National and International Research Alliances Program	Prof Lars Nielsen	Prof Peter P Gray, 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	$495,000
National and International Grant Income	Queensland Government Smart State National and International Research Alliances Program	Prof Max Lu	Professor Sean Smith, Professor John Zhu, A/Prof Lianzhou Wiang, A/Prof Joe Diniz Da Costa	Queensland-China Alliance in Nanomaterials for Clean Energy Technologies (QCANCET)	2008-2012	$804,375
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	$454,861
National and International Grant Income	Queensland Government Smart State National and International Research Alliances Program	Dr Krassen Dimitrov	Prof Karl Bohringer, Dr Daniel Schwartz	Molecular diagnostics for tropical disease	2009-2011	$536,250
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	$855,671
National and International Grant Income	Queensland Government Smart State National and International Research Alliances Program	Prof Matt Trau	Prof Leland (Lee) Hartwell, Prof Kenneth D Stuart, Prof Nancy B Kiviat	Novel nanotechnology platforms for disease biomarker diagnostics	2007-2010	$467,500
National and International Grant Income	Queensland Government Smart State National and International Research Alliances Program	Prof Andrew Whittaker	Dr Firas Rasoul, Dr Anne Symons, Dr Craig Hawker, Prof Karen Wooley, Prof Julie Campbell, Prof Traian Chirila, Prof David Haddleton, A/Prof Stephen Rose, Prof Steven Howdle	International Biomaterials Research Alliance	2007-2011	$457,526
National and International Grant Income	Queensland Government Smart State Research Facilities Fund	Prof Peter Gray	Prof Lars Nielsen, Prof Justin Cooper-White, Prof Peter Halley, Prof Max Lu, Prof Anton Middelberg, Prof Andrew Whittaker, Prof Michael Monteiro, Prof Matt Trau, Dr Steve Reid, Prof Jonathan Golledge, Dr Stuart Hazell	Bionano-products development facility	2007-2011	$2,721,057
National and International Grant Income	Rural Industries Research & Development Corporation	Dr Akshat Tanksale	Dr Jorge Beltramini	Conversion of lignocellulosic biomass to dimethyl ether (BioDMR)	2010-2013	$82,500
National and International Grant Income	Rural Industries Research & Development Corporation	Prof Justin Cooper-White	A/Prof Paul Mills	Modulation of gap junction expression in healing equine tendon	2007-2011	$11,000
National and International Grant Income	Seattle Biomedical Research Institute	Prof Matt Trau	Prof Gerard Cangelosi	Accelerated molecular probe pipeline	2009-2011	$81,774
National and International Grant Income	University of Sydney	A/Prof Darren Martin		Linked centre and services (source of funds: NCRIS)	2009-2012	$55,550

TYPE	SCHEME	LEAD AIBN INVESTIGATOR	OTHER CHIEF INVESTIGATORS	PROJECT TITLE	DURATION	2010 INCOME
National and International Grant Income	Department of Innovation, Industry, Science and Research (DIISR)	Prof Justin Cooper White		NCRIS fabrication	2007-2011	$1,400,000
National and International Grant Income	Department of Innovation, Industry, Science and Research (DIISR)	Prof Peter Gray		NCRIS biotech products	2007-2011	$700,000
National and International Grant Income	Department of Innovation, Industry, Science and Research (DIISR)	Prof Lars Nielsen		NCRIS-metabolomics	2007-2011	$121,500
National and International Grant Income	Department of Innovation, Industry, Science and Research (DIISR) Equipment Infrastructure Funding (EIF)	Prof Justin Cooper White		EIF ANFF equipment	2010	$1,000,000
Contract Research and other Industry Income	Queensland Government	Prof Peter Gray		Hendra virus	2010	$300,000
Contract Research and other Industry Income	Aortech	A/Prof Darren Martin		Next generation nanocomposite insulation materials for cochlear electrode arrays	2008-2010	$10,000
Contract Research and other Industry Income	Cochlear	A/Prof Darren Martin		Next generation nanocomposite insulation materials for cochlear electrode arrays	2008-2010	$44,500
Contract Research and other Industry Income	Uniquest Pty Ltd	A/Prof Darren Martin		Next generation nanocomposite insulation materials for cochlear electrode arrays	2008-2010	$3,071
Contract Research and other Industry Income	Uniquest Pty Ltd	Dr Zhi Ping (Gordon) Xu	Prof Justin Cooper-White, A/Prof Nigel McMillan	Coated IDH for RNAI delivery	2010	$32,550
Contract Research and other Industry Income	Uniquest Pty Ltd	Prof Matt Trau		Pathfinder forward osmosis	2010	$20,200
Contract Research and other Industry Income	Uniquest Pty Ltd	Dr Annette Dexter		Pepfactants	2010	$85,242
Contract Research and other Industry Income	Uniquest Pty Ltd	A/Prof Stephen Mahler		Bioproton phytase enzymes	2010-2011	$181,500
Contract Research and other Industry Income	Incitec Pivot Ltd, Southern Cross Operations	Dr Zhi Ping (Gordon) Xu	Dr Longbin Huang, A/Prof Rowan W Truss	Preparation of cross-linking starch-based nanocomposite films and characterisation of water adsorption and mechanical strength	2010-2011	$36,667

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AIBN SEMINARS 2010

8 February: **Professor Matthias Lutolf**, Ecole Polytechnique Fédérale de Lausanne, France
Title: Designing materials to direct stem cell fate

19 February: AIBN Special Seminar: **Dr Jin Kawakita**, Advanced Photovoltaics Center, the National Institute for Materials Science, Tsukuba, Japan.
Title: Introduction to photovoltaics research in NIMS

25 February: **Professor Toshiro Ohashi**, Graduate School of Engineering, Hokkaido University, Sapporo, Japan
Title: Mechanical characterisation of vascular endothelial cells focusing on intracellular structures

1 March: AIBN Special Seminar: **Professor Mietek Jaroniec**, Kent State University, Ohio, US
Title: Major advances in chemistry of ordered nanoporous materials

11 March: **Professor Martin Schwartz**, Professor of Microbiology and Biomedical Engineering, University of Virginia, US
Title: Mechanotransduction and force transmission by integrins

18 March: **Professor Karl F Böhringer**, Professor of Electrical Engineering; Adjunct Professor of Computer Science & Engineering and Mechanical Engineering; Director, MEMS Laboratory Department of Electrical Engineering, University of Washington, US
Title: Interfacial Engineering in microelectromechanical systems: handling and assembly of solids and liquids at the microscale

25 March: **Dr Albert S Mellick**, Head, Host Response to Cancer Lab, School of Medical Science, Griffith University, Brisbane, Australia
Title: Endothelial progenitor cells and cancer

15 April: **Dr Kathryn Morris**, Partner, Davies Collison Cave, Brisbane, Australia
Title: You may have an invention but is it commercially valuable – the untold perspective of a patent attorney

22 April: **Professor Mark Walker**, School of Chemistry & Molecular Bioscience, The University of Queensland, Australia
Title: Identification of safe and efficacious vaccines to prevent group A streptococcal infections

27 April: **Professor Zhiguo Su**, Director, National Key Laboratory of Biochemical Engineering, Institute of Process Engineering, Chinese Academy of Science, China
Title: A novel process for making polymer microspheres and microcapsules

29 April: **Associate Professor Nigel McMillan**, Deputy Director and Principal Research Fellow, Diamantina Institute for Cancer, Immunology and Metabolic Medicine, The University of Queensland, Australia
Title: RNA interference: How do we deliver the goods?

4 May: AIBN Special Seminar: **Professor David Edwards**, Harvard University, US
Title: Inhaled vaccines for infectious diseases in low-income settings

13 May: AIBN Seminar: **Dr Amanda S Barnard**, Virtual Nanoscience Laboratory, CSIRO Materials Science and Engineering, Melbourne, Australia
Title: Predicting the properties of multi–functional nanoparticles for bio-applications

19 May: AIBN Special Seminar: **Professor O Savadogo**, Laboratory of New Materials for Electrochemistry and Energy, École Polytechnique the Montréal, Canada
Title: Search for new families of electro catalysts for the ORR cathodes

20 May: **Professor Yi-Bing Cheng**, Department of Materials Engineering, Monash University, Melbourne, Australia
Title: Novel structures of dye-sensitised solar cell devices

27 May: **Dr Suzanne V Smith**, Senior Research Fellow, Node Director, Centre of Excellence in Antimatter Matter Studies, ANSTO, Sydney NSW
Title: Deploying nanotechnologies for the integration of PET and MRI in molecular imaging

3 June: Joint AIBN/QBI Seminar: **Dr Muhammad Zaman**, Department of Biomedical Engineering, Boston University, US
Title: Quantifying cell-matrix interactions through materials and multi-scale modelling

10 June: **Associate Professor Peter Fredericks**, Chemistry, Faculty of Science & Technology, Queensland University of Technology, Australia
Title: Vibrational spectroscopy in materials science: applications in surface characterisation and processing

17 June: **Professor John Prins**, Mater Medical Research Institute, Brisbane, Australia
Title: Obese Australia – understanding the biology of adipose tissue growth and implications for treatment

24 June: **Professor Richard A Jefferson**, Professor of Science, Technology & Law, Queensland University of Technology, Australia
Title: Biological open source (BiOS): Innovation and evolution in complex systems

28 June: AIBN Special Seminar: **Professor Patrick S Stayton**, Department of Bioengineering, University of Washington, US
Title: Smart biohybrid materials that talk and listen in nanospace

8 July: **Professor Rolf Müller**, Helmholtz Centre for Infectious Research; Helmholtz-Institute for Pharmaceutical Research Saarland; Department Microbial Natural Products, Saarland University, Germany
Title: Myxobacteria: cool bugs for novel drugs

15 July: Special Seminar: **Professor Min Wang**, Department of Chemistry, Zhenjiang University, China
Title: Fabrication of highly ordered nanotopography and its applications for bioanalysis

26 July: Special Seminar: **Dr Elsa Sanchez Garcia**, Max-Planck-Institut für Kohlenforschung, Mülheim an der Ruhr, Germany
Title: QM/MM study of monomeric red fluorescent proteins

29 July: Special Seminar: **Dr Paul Dalton**, Institute of Health and Biomedical Innovation, Queensland University of Technology; Med-X Research Institute, Shanghai Jiao Tong University, Shanghai, China
Title: Materials and the neurosciences: New directions with old challenges

6 August: AIBN Special Seminar: **Professor Lei Jiang**, Centre of Molecular Sciences, Institute of Chemistry, Chinese Academy of Sciences, Beijing, China
Title: Bio-Inspired, smart, multiscale interfacial materials

12 August: **Dr Mike O'Shea**, Principal Research Scientist, CSIRO Molecular and Health Technologies, Melbourne, Australia
Title: Drug-polymer conjugates and polymer scaffolds for biomedical applications and renewable opportunities for monomers, polymers and chemicals

19 August: **Associate Professor Alessandro Martucci**, Materials Science Engineering, Dipartimento Ingegneria Meccanica Set. Materiali, Universita' di Padova, Italy
Title: Sol-gel nanocomposite films as gas sensing and active optical materials

26 August: **Dr James R McMillan**, Centre for Children's Burns Research, The University of Queensland, Australia
Title: Comparison of polymer and collagen-based skin tissue engineering scaffolds

26 August: **Professor Pamela Silver**, Department of Systems Biology, Harvard Medical School, Wyss Institute of Biologically Inspired Engineering, Harvard University, US
Title: Designing biological systems

2 September: **Associate Professor John Albert Violet**, Wellington Hospital, New Zealand
Title: Antibody directed radiotherapy; CD25 CD20 and other targets

9 September: **Associate Professor Michael Raghunath**, Division of Bioengineering; Department of Biochemistry, National University of Singapore, Singapore
Title: Reconstructing the stem cell microenvironment by delegation – the liquid and the solid way

9 September: AIBN Special Seminar: **Professor P. Somasundaran**, Columbia University, New York, US
Title: Exploration of nanobiointerface for understanding and mitigating nanotoxicity

16 September: **Professor Melissa Little**, Group Leader, Institute for Molecular Bioscience, The University of Queensland, Australia
Title: Kidney regeneration: What are the options and how far have we come?

23 September: **Professor Chengzhong (Michael) Yu,** ARC Future Fellow, Group Leader, AIBN, The University of Queensland, Australia
Title: Understand the structure-property correlation and design nanostructures with advanced applications

24 September: AIBN Special Seminar: **Professor Noboru Mizushima**, Department of Physiology and Cell Biology Tokyo Medical and Dental University, Tokyo
Title: Physiological role of autophagy and its regulation mechanism

30 September: **Professor Robert Henry**, Director of Queensland Alliance for Agriculture and Food Innovation, The University of Queensland, Australia
Title: Innovation in agriculture and food

30 September: AIBN Special Seminar: **Dr Lisbeth Grondahl**, School of Chemistry and Molecular Biosciences, The University of Queensland, Australia
Title: Use of polysaccharides in biomaterials applications

7 October: AIBN Special Seminar: **Professor Hien Ngo**, School of Dentistry, The University of Queensland, Australia
Title: Adhesive in dentistry: past, present and future

8 October: AIBN Special Seminar: **Professor David Koelle**, University of Washington, US
Title: Human T-cell responses to large-genome viruses: use of unbiased genomic tools to capture

14 October: **Dr. Ming S Liu**, Research Scientist, Molecular Simulation, CSIRO, Mathematics, Informatics & Statistics, Melbourne, Australia
Title: Operating mechanism and dynamics of multimeric proteins – Intrinsic fluctuation, dynamic correlations and allosteric cooperativity

19 October: AIBN Special Seminar: **Darin Zehrung**, Technical Officer, Project Manager, PATH, Seattle, US
Title: Innovative technology solutions for global health: PATH's product development approach and experience

28 October: **Professor Michael Monteiro**, AIBN Group Leader, AIBN, The University of Queensland, Australia
Title: Synthesis and self-assembly of complex polymer architectures into nanostructures

4 November: AIBN Special Seminar: **Associate Professor Yin Xiao**, Institute of Health and Biomedical Innovation, Queensland University of Technology, Australia
Title: The identity of mesenchymal stem cells and their tissue forming capacity in hard tissue regeneration

5 November: AIBN Special Seminar: **Professor Tao Yi**, Department of Chemistry, Fudan University, China
Title: Stimulus responsive soft materials based on supramolecular assembly

5 November: AIBN Special Seminar: **Dr Richard Law**, Principal Engineer, Product Development, Organovo, Inc, US
Title: Product development, Organovo, Inc

8 November: AIBN Special Seminar: **Professor Dennis E Discher**, School of Engineering and Applied Science; Graduate Groups in Cell & Molecular Biology and Physics, University of Pennsylvania, US
Title: Matrix and myosin in cell fate decisions

11 November: **Dr Lars M Blank**, Chemical Biotechnology, Faculty of Biochemical and Chemical Engineering, TU Dortmund University, Germany
Title: A new bioreactor concept – the envirostat

18 November: **Professor Raffaele Mezzenga**, ETH Zurich, Switzerland
Title: A journey into the physics of protein fibrils from their bulk properties to single molecule

25 November: **Barry Thomas**, Vice President, Cook Medical Inc, Director Asia/Pacific, Brisbane, Australia
Title: Commercialisation in perspective: A medical devices experience

9 December: **Dr Michael Johnston**, University of Oxford, UK
Title: Ultrafast terahertz conductivity studies of semiconductor nanowires

15 December: AIBN Special Seminar: **Professor Yateman Arryanto**, Inorganic Material Research Group, Faculty of Mathematic and Natural Sciences, University of Gadjah Mada, Yogyakarta, Indonesia
Title: Synthesis and applications of photocatalyst and adsorbent material from natural bentonite and zeolite

16 December: AIBN Special Seminar: **Dr Kiyoshi Ozawa**, National Institute for Materials Science, Ibaraki, Japan
Title: Superior electrochemical charge and discharge performance of the manganese-based layered cathode materials of $Li[Li_{x/3}M_{1-x}Mn_{2x/3}]O_2$(M=Ni or Co)

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.

THE UNIVERSITY OF QUEENSLAND
AUSTRALIA

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