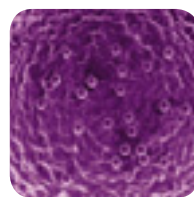
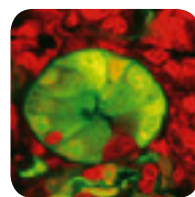
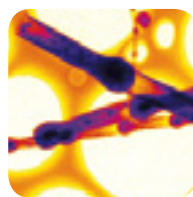
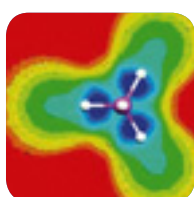
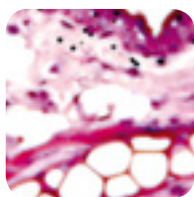
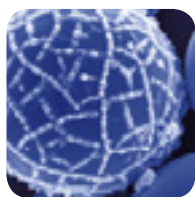
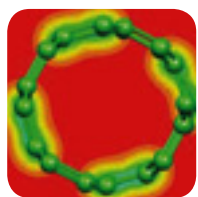


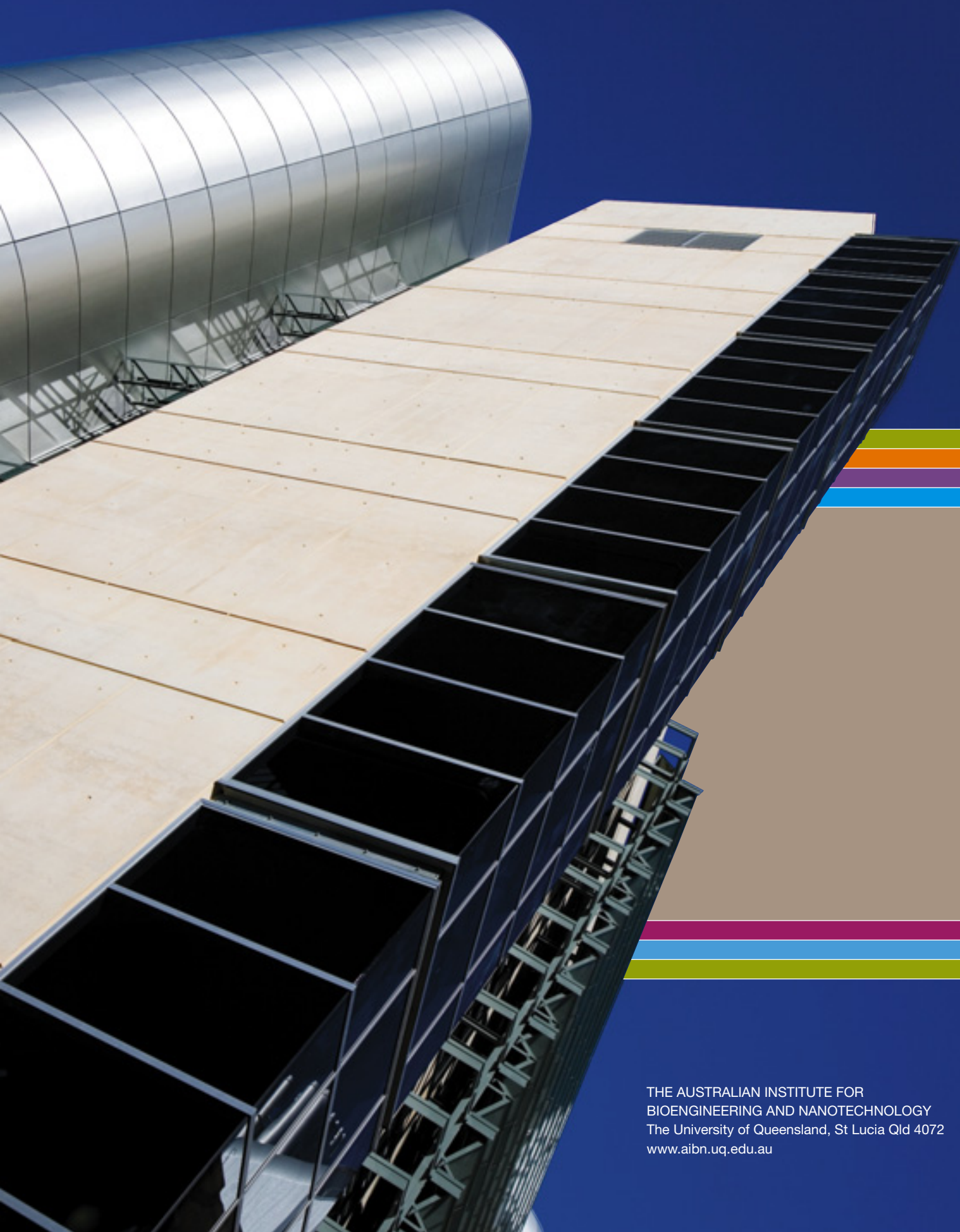
AIBN

annual report 2006

THE AUSTRALIAN INSTITUTE FOR
BIOENGINEERING AND NANOTECHNOLOGY



THE UNIVERSITY
OF QUEENSLAND
AUSTRALIA



THE AUSTRALIAN INSTITUTE FOR
BIOENGINEERING AND NANOTECHNOLOGY
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annual report 2006

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AIBN OVERVIEW

AIBN EPITOMISES SUCCESSFUL SCIENTIFIC RESEARCH IN THE 21ST CENTURY. IT HAS STATE-OF-THE-ART FACILITIES, A DIVERSE RANGE OF SKILL SETS TO DEPLOY ON SCIENTIFIC PROBLEMS, AND SOME OF THE WORLD'S BEST MINDS TO UNDERSTAND AND SOLVE THESE PROBLEMS.

The Institute is also committed to ensuring its research does not remain at the laboratory bench, but is translated into positive outcomes for the whole Australian community.

The Institute's integrated and multidisciplinary approach to research at the interface between the physical, chemical and biological sciences has four main foci:

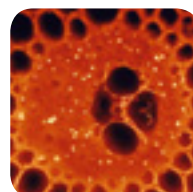
- Nanomaterials
- Cell and Tissue Engineering
- Nanobiotechnology
- Systems Biotechnology.

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

Individually and collectively they are attracting major research funding from national and international sources including strong support from the industry sector, and are being joined by a growing group of highly-credentialed international post-doctoral researchers.

The high quality, globally competitive research being carried out in the AIBN is also attracting some of the brightest young minds in Australia to undertake research higher degree studies which will equip them with the skills to take their place on the world stage.

With its innovative technologies, cutting-edge capabilities and acknowledged research leaders, AIBN can add value through research and development of new processes, technologies, materials and devices.



VICE-CHANCELLOR'S MESSAGE

THE AUSTRALIAN INSTITUTE FOR BIOENGINEERING AND NANOTECHNOLOGY CAME OF AGE IN 2006 WHEN ITS RESEARCHERS AND SUPPORT STAFF MOVED INTO BRILLIANT NEW \$72 MILLION PREMISES AT THE UNIVERSITY OF QUEENSLAND'S ST LUCIA CAMPUS.

The building, made possible by funding from The Atlantic Philanthropies, the Queensland Government and UQ, is highly functional and architecturally stunning.

Its 16 laboratories, and facilities for image processing, microfabrication, tissue culture, electron microscopy and animal cell culture are the ultimate environment for research and commercialisation at the nexus of the biological, chemical and physical sciences. Within four months of the building's completion, the AIBN workforce grew by almost one third, to 260, and it will certainly continue growing as more scientists and engineers are attracted from overseas and around Australia. A series of visits by organisations keen to build similar facilities further attests to the merits of the AIBN complex.

Infrastructure aside, researchers define the AIBN's leadership and attract international and Australian collaborators, clients and income. In 2006 their grant-raising successes included \$14 million (for four years)

from the National Collaborative Research Infrastructure Scheme, \$6.5 million from the Queensland Government's Smart State Innovation Building Fund, and \$3.2 million from the Australian Research Council.

Meanwhile the AIBN's Innovation and Commercial Development team identified 24 discoveries, filed six provisional patent applications and managed a total of 12 patents.

An added advantage for the AIBN comes from its proximity to other new, world-class UQ research institutes and centres. These offer AIBN researchers access to distinguished peers working in complementary fields, and to world-class equipment, including nuclear magnetic resonance spectrometry and microscopy equipment.

As our Institutes climb a trajectory of scientific success and income attraction, so the AIBN will contribute to, and benefit from, the knowledge economy which is flourishing at and around UQ.



A handwritten signature in black ink that reads "John Hay". The signature is fluid and cursive, with a horizontal line underlining the name.

Professor John Hay, AC
Vice-Chancellor
The University of Queensland

DIRECTOR'S REPORT

IN 2006 THE AIBN RELOCATED INTO ITS NEW BUILDING AT THE UNIVERSITY OF QUEENSLAND'S ST LUCIA CAMPUS. THIS WAS THE FIRST TIME ALL MEMBERS OF THE AIBN WERE PRESENT UNDER ONE ROOF AND REPRESENTS A SIGNIFICANT MILESTONE IN THE LIFE OF THE INSTITUTE.



The move brings together the AIBN's groups in the physical, chemical and biological sciences in a research environment that encourages interdisciplinary collaborations and interactions.

The Institute is already benefiting with new collaborations springing into existence as a result of the proximity of such a variety of researchers in the building.

The relocation was a relatively painless experience for most groups and for this I thank the hard work and planning of AIBN's Executive Officer Ms Donna Hannan and our Infrastructure Manager Dr Stephen Love. I also acknowledge the baptism of fire faced by our then newly appointed Floor Managers Ms Christine Fraser and Mr Luke Matthew.

Behind the scenes, the work of AIBN's Finance and Infrastructure Teams enabled a relocation and subsequent expansion with few growing pains. The AIBN has worked quickly to satisfy high Occupational Health and Safety (OHS) standards attributable in large part to the hard work of our newly appointed OHS Manager Dr Elizabeth Miric and the cooperation of all building occupants.

A move of such magnitude could not have been undertaken without the hard work and good humour generously given by these key people. I also thank the staff and

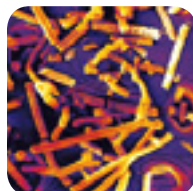
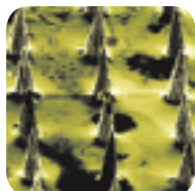
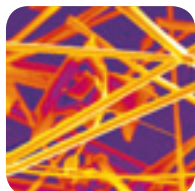
students of the labs involved. Their unstinting support and cooperation has formed a foundation of great fellowship.

The AIBN building was opened by the Premier of Queensland and Minister for Trade, the Honorable Mr Peter Beattie, on 23 October 2006. We were also very fortunate to have present at this ceremony Mr Chuck Feeney who, through Atlantic Philanthropies, donated \$15 million to the construction of the building.

The occupation of the new building not only brought AIBN researchers together for the first time, it also served as the catalyst for the appointment of many new research and infrastructure staff. As a result the AIBN has rapidly expanded from around 200 staff and students to well over 260 people in just four months.

Two new Group Leaders joined the Institute in 2006. Professor Mark Kendall returned to Brisbane after eight years at Oxford University where he was heavily involved in research on the gene gun, a 'biolistic' method of delivering drugs and gene therapies under the skin of patients.

Mark is continuing his research into needle-free vaccinations with projects investigating nano-patch technology to deliver drugs to immunologically important cells just under the surface of the skin. This work involves close collaborations with the University's



Diamantina Institute for Cancer, Immunology and Metabolic Medicine, as well as the Faculty of Health Sciences, both of which make financial contributions in support of this research.

Dr Krassen Dimitrov was the second Group Leader to join us in 2006. His research is developing new technologies such as bar-coded nanoparticles to search for characteristic gene products associated with diseases such as cancer. This work involves detection based on an electric charge tagged onto a molecule of interest and will give a quantitative result rather than the qualitative information currently obtained using fluorescence labelling.

AIBN established an important collaboration with the University of Sheffield, England when Professor David James relocated there in mid-2006. David will maintain his close ties to AIBN through an appointment as a Visiting Professor, ensuring his continued involvement with AIBN researchers, particularly those interested in protein expression in mammalian cells.

Especially pleasing was the success in 2006 of AIBN Group Leaders in attracting \$3.2 million of competitive funding from the Australian Research Council. Much of this funding was awarded to multidisciplinary projects, one of the key goals of the AIBN. This stellar result demonstrates the quality of AIBN research.

In addition AIBN was successful in securing new federal research infrastructure funding via the National

Collaborative Research Infrastructure Scheme (NCRIS). Current plans have over \$14 million of Federal and State funds coming to AIBN to support three NCRIS nodes in metabolomics, microfabrication and biotechnology products. These facilities will be the best equipped in Australia further extending AIBN's unique capabilities.

The AIBN received further support from the Queensland State Government through the award of \$6.5 million from the Smart State Innovation Building Fund. This funding will provide cutting-edge equipment to support a Bio-Nano Products Development Facility, the only facility of its kind in Australia.

Extending AIBN's reach, AIBN Group Leaders Professors Matt Trau and Andrew Whittaker were successful in their application to the Queensland Government Smart State National and International Research Alliance Program to build linkages with leading research and industry groups. These international projects will involve teams from the Fred Hutchinson Cancer Research Institute in Seattle (the largest institute of its kind in the world), the University of Washington, the Seattle Biomedical Research Institute and the Program for Appropriate Technology in Health (PATH).

Thanks need to be extended to the Institute's Scientific and Commercialisation Committee (SACC) which is comprised of leading representatives from Asia, the USA and Europe. These members gave generously of their time in 2006

assisting in planning our research and commercialisation strategies.

I once again acknowledge the contributions of the AIBN Executive Committee, Professors Julie Campbell, Max Lu, Anton Middelberg, Matt Trau and our Postgraduate Coordinator Professor Lars Nielsen, who have continued to further develop the AIBN's activities.

Finally I thank the Institute's many friends in the University. These include Vice-Chancellor Professor John Hay, Senior Deputy Vice-Chancellor Professor Paul Greenfield, Deputy Vice-Chancellor (Research) Professor David Siddle. I acknowledge the support of Professors Mick McManus, Stephen Walker and Peter Brookes; the Executive Deans of the Faculty of Biological and Chemical Sciences; the Faculty of Engineering, Physical Sciences and Architecture; and the Faculty of Health Sciences respectively. I also thank the Head of the School of Engineering Professor Jim Litster and the Head of the School of Molecular and Microbial Sciences Professor Alastair McEwan.

Professor Peter Gray
Director, AIBN

BUILDING AND FACILITIES

THE LEADING-EDGE FACILITIES IN AIBN'S NEW \$72 MILLION BUILDING WILL BE FURTHER ENHANCED IN THE COMING YEARS TO ENSURE THE INSTITUTE REMAINS AT THE FOREFRONT OF BIO-NANO RESEARCH IN AUSTRALIA.

The Institute anticipates receiving \$14 million over four years as part of its successful application to the Federal Government's National Collaborative Research Infrastructure Scheme. This is in addition to \$6.5 million from the Queensland State Government Smart State Innovation Building Fund earmarked to advance the development of bioproducts in Queensland through the Bio-Nano Development Facility (BnDF).

These funds will be used in part to establish new facilities, enabling researchers to study the manipulation of mammalian cells to produce specific proteins that can be used as the basis of new drugs.

According to AIBN Director Professor Peter Gray, bio-nanotechnology will be one of the main drivers of economic growth for the 21st Century.

"The impact will be felt across a wide range of endeavours, from therapeutic and tissue regeneration products, through to bioderived consumer products and environmental applications.

"The BnDF will strengthen and advance the development of bioproducts in Queensland by providing access to an integrated research facility with cutting-edge technology not currently available in Australia."

Professor Gray said the BnDF would also contribute to BioPharmaceuticals Australia, a Queensland Government initiative established to bridge the gap in Australia's ability to produce good manufacturing practice grade biopharmaceuticals for human clinical trials.

"The BnDF focuses on three interrelated research themes – biopharmaceuticals, biomicrodevices and biocommodities," he said.

"Potentially tapping into a market value of more than \$50 billion per year, the biopharmaceutical research theme will focus on developing improved drugs based on large complex proteins produced by mammalian cells.

"Biomicrodevices include the development of lab-on-a-chip devices utilised as diagnostic tools and kits

for animal and human diseases, as well as bioengineered scaffolds and microenvironments to grow cells to replace lost tissue function.

"Finally, biocommodities will focus on the conversion of low cost raw materials such as sugar cane into commodity products, instead of relying on oil as the base material for polymers, solvents, coatings and surfactants."

Professor Gray acknowledged the partner organisations involved in the BnDF, namely the CRC for Sugar Industry Innovation through Biotechnology, the Mater Medical Research Institute and Brisbane based biotech company PanBio Ltd.

The National Collaborative Research Infrastructure funding of \$14 million over four years, will be used to establish research nodes to service the areas of metabolomics, microfabrication and biotechnology products.

Head of the Nano Fabrication Node, Professor Justin Cooper-White, said these facilities would be the best equipped in Australia and would further expand AIBN's capabilities.

"A cornerstone of the Node will be a microfabrication facility which has an environment in which airborne particulate matter is stringently controlled by filtering air through a high efficiency particulate air (HEPA) system, and minimising activities that generate particles. In addition, the facility is temperature and humidity controlled," he said.

"This will enable the production of novel substrates for immunotherapy and drug delivery, and the fabrication of nanoelectronic devices for detection of single biomolecules.

"This facility will meet the needs of the Australian research community in the area of soft materials and nano-biofabrication."

Meanwhile, the new metabolomics facility will usher in the fourth generation of biotechnology.

Professor Lars Nielsen said metabolomics was concerned with understanding and manipulating cellular behaviour at the system level.

"Metabolomics studies the



consequences of proteomic variation by measuring the metabolites that arise from the biological function of proteins," Professor Nielsen said.

"Clinically, metabolites offer opportunities for identification of biomarkers for diagnostics and therapeutic monitoring. It is also currently used to identify new therapeutic targets and is the basis for metabolite-based toxicity screens for drug development, aiming to identify the best drug candidates for the treatment diseases such as diabetes, obesity and cancer.

"The importance of Metabolomics in manipulating cellular behaviour at a system rather than an individual component level has dramatically improved our ability to re-engineer living organisms such as plants and microbes to produce desired products therefore making biotechnology the preferred strategy for many existing and new industrial chemicals.

"NCRIS funds will provide the resources to enable the development of models to analyse and engineer mammalian, plant and microbial fermentation systems to optimise product development," he said.

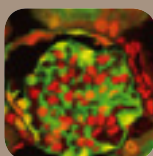
The manufacture of biotechnology products, is currently growing at a rate of around 17 percent per annum and can be attributed in part to significant developments in the post-genomics era.

"These facilities will cement AIBN as Australia's leading institute in the bio-nano research space and will further develop the nation's nanotechnology industry," he said.

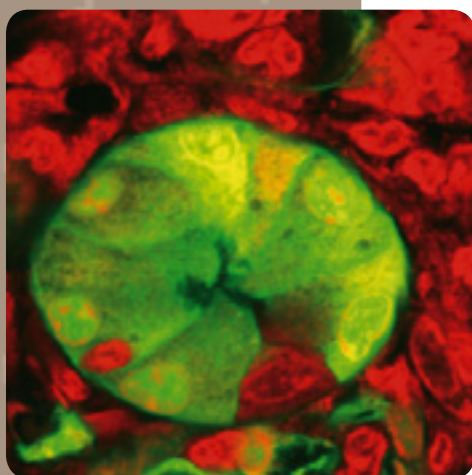


Professor Julie Campbell

VASCULAR RESEARCH



THE GROUP'S CURRENT RESEARCH INTEREST IS IN TISSUE ENGINEERING REPLACEMENT ORGANS FROM THE PATIENT'S OWN CELLS USING THE PERITONEAL (ABDOMINAL) CAVITY AS A BIOREACTOR.



The team, headed by Professor Julie Campbell, grows myofibroblast tissue around appropriately shaped polyethylene moulds of tubes or bulbs in the peritoneal cavity of several animal species.

"This takes two to three weeks," said Professor Campbell, "and when grafted into arteries, bladder, vas deferens or uterus to replace resected segments, the myofibroblast tissue differentiates into structures

identical to the host organ, remaining patent and functional for at least 16 months".

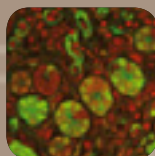
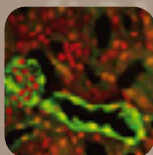
The team's studies are also determining the origin of the cells that constitute the myofibroblast capsule, and the factors influencing their differentiation, using fluorescence-activated cell sorting, microarray technology and bioinformatics.

"This information will be used to maximise tissue growth and optimise its characteristics."

In collaboration with Professor Justin Cooper-White and his team, Professor Campbell's group is also developing an artificial knee meniscus by populating a novel scaffold with mesenchymal stem cells and differentiating them along different cellular pathways according to function.

"The ambitious research program of the group is also aiming to grow functional kidneys through the incorporation of stem cells into embryonic kidneys transplanted to the peritoneal cavity of adult hosts," she said.

Other studies focus on the cell biology of the artery wall in healthy and diseased states such as atherosclerosis and restenosis after angioplasty.



TISSUE ENGINEERING AND MICROFLUIDICS

ENGINEERING TISSUE AND SCAFFOLDS IS JUST ONE OF THE RESEARCH INTERESTS OF AIBN'S PROFESSOR JUSTIN COOPER-WHITE.

The team is also engaged in microfluidics, the multidisciplinary study of the behavior of fluids at the micro and meso scales.

Both research areas are rapidly emerging and exciting fields, with microfluidics central to the development of DNA microarray technology, which is now a crucial tool in many areas of biological and medical research investigating human development disease and treatment.

Tissue engineering can perhaps be best defined as the use of a combination of cells, engineering materials, and suitable biochemical factors to improve or replace biological functions.

Professor Cooper-White said tissue engineering was a revolutionary strategy to treat patients requiring organ or tissue replacement as a result of accidents or disease.

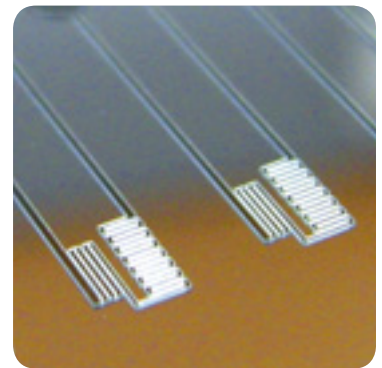
"We are investigating novel methods of manufacturing polymeric scaffolds and methods of surface engineering these scaffolds for drug delivery and tissue engineering applications," he said.

"Our focus extends to enhancing cell-specific adhesion and maximising tissue growth throughout three dimensional scaffolds, which will ultimately find uses in the controlled growth and expansion of stem cells and the generation of vascularised soft tissues within *in-vitro* and *in-vivo* environs."

Professor Cooper-White's interest in microfluidics has led to extensive collaborations with groups at the University of Queensland, the University of Melbourne, ETH Zurich (Switzerland) and Massachusetts Institute of Technology (U.S.A).

He said exciting new avenues for creating and tailoring new biotechnology and nanotechnology products will result from understanding the flow behaviour of non-Newtonian fluids within micrometer to nanometre flow conduits.

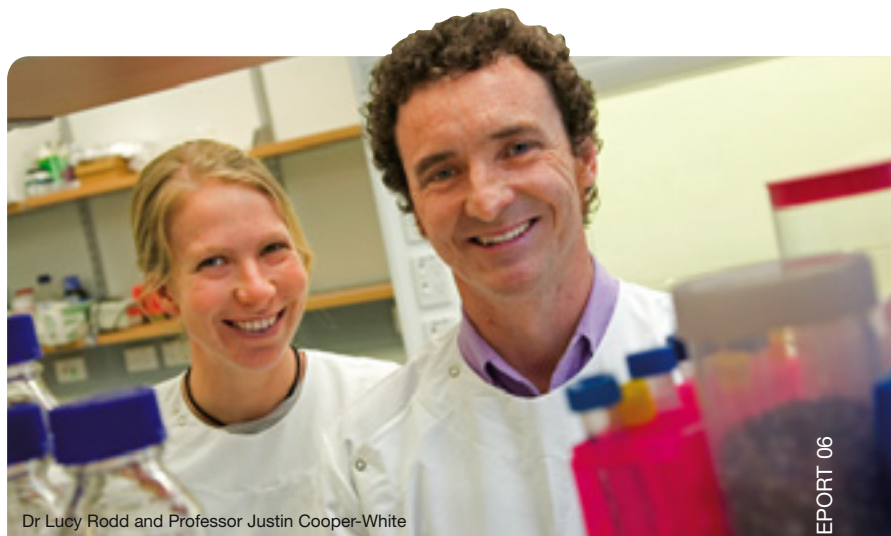
"The most mature application of microfluidics is ink-jet printing and DNA microarray technology; however, other potential applications include



pharmaceutical, biotechnology and public health.

"Because fluids behave differently at the nanoscale, microfluidic devices require different methods of construction and design.

"It is therefore imperative we understand this behaviour so we can maximise the opportunities presented by this enabling technology," he said.



Dr Lucy Rodd and Professor Justin Cooper-White

SINGLE MOLECULE NANOTECHNOLOGY

THE NEXT STEP IN PERSONALISED MEDICINE, A NEW TECHNOLOGY WITH THE ABILITY TO PROVIDE CHEAP AND ACCURATE BIOLOGICAL INFORMATION, IS THE RESEARCH FOCUS OF DR KRASSEN DIMITROV.

Genes, mRNAs and proteins are increasingly being studied by researchers and health professionals to diagnose the onset of diseases such as cancer, which cause profound changes in gene expression long before clinical symptoms appear. New technologies are therefore needed to search for characteristic gene products associated with particular cancers to allow early detection.



Such early detection of cancer greatly improves the effectiveness of any treatment and as a consequence accurate and reliable information is extremely important.

According to Dr Dimitrov, current methods rely on optical fluorescent detection methods which are costly and have a high error rate, problems that could be resolved by using an electronic detection system.

"The electronic information is not subject to the limitations of the diffraction properties of light, but rather it forms a binary code which can be measured quantitatively rather than qualitatively," Dr Dimitrov said.

"This method would detect the absolute number of molecules of interest, rather than an aggregate amount, therefore making it more accurate.

"By comparison, fluorescent technology used in this manner is similar to using a whiteboard marker to write a message in eight point font."

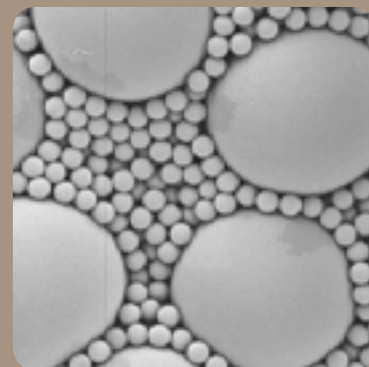
The key to this new technology is developing a nano-electrode to 'read' the information.

He said AIBN's new microfabrication facilities and access to materials characterisation capabilities in the Centre for Microscopy and Microanalysis were critical to this research.

"The technology will be cheaper than current methods because a nano-electrode does not require sophisticated laser technology and fluorescent detection systems.

"Rather, the electrode will read the electrical charge, either positive or negative, and store it in much the same way the information stored on a computer disc is encoded in zeros and ones."

Dr Dimitrov believes that reducing the cost of testing is also likely to make this technology available for other areas such as the agricultural industry, molecular bioscience research and molecular diagnostics.



MICROSCOPIC POWER

TO IMPROVE MATERIALS AND DEVICES

THE ABILITY OF NANOTECHNOLOGY TO DELIVER NEW AND IMPROVED DRUGS, BIOMEDICAL DEVICES AND TO PRODUCE ENERGY MORE EFFICIENTLY DEPENDS LARGELY ON THE ABILITY TO SEE WHAT IS OCCURRING ON THE NANO SCALE.

To do this requires world-class microscopy facilities with leading-edge data storage and visualisation packages.

According to Professor John Drennan, AIBN Group Leader and Director of the Centre for Microscopy and Microanalysis (CMM), the ability to characterise the synthesis efforts of AIBN researchers was critical to their success.

"With research activities in the AIBN ramping up significantly, the range of materials that has been produced is providing a challenge for current microscopy techniques," he said.

"From novel nano-sized tubes and fibres through to virus-like particles, characterisation of these microscopic materials is pushing the boundaries of conventional microscopy, and we are developing new techniques and expertise to provide researchers with high quality images.

"We are seeing cross-disciplinary interactions where techniques, that were once the exclusive domain of biologists, are providing the means to examine a much wider range of novel materials.

"We have successfully moved our facilities into the purpose designed rooms in the AIBN building, with initial reports from AIBN researchers being very positive.

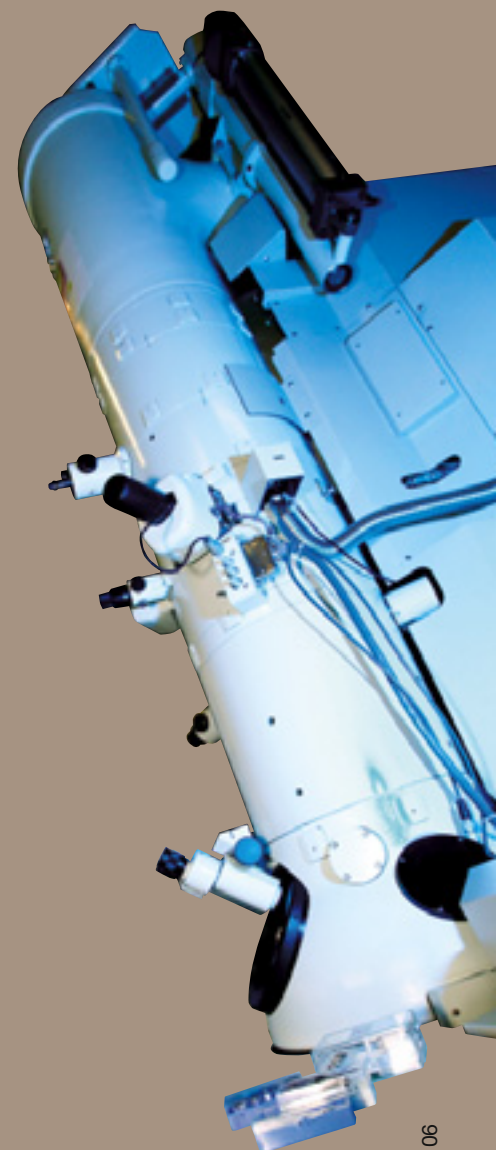
"In 2007 we look forward to upgrading our instrumentation, enhancing our reputation as a world-class characterisation facility for bioengineering and nanotechnology," he said.

In addition to his role with CMM, Professor Drennan said he was developing micro-energy systems in collaboration with Professor Max Lu.

"The facilities for making electrochemical measurements have been installed and we presently have a number of projects focused on developing novel materials for application in battery and fuel cell devices.

"Based on search routines developed by our PhD student Mr Kwok Cheung, we have a number of exciting new material prospects all requiring further characterisation.

"Further work within our group has produced a novel series of electrode designs. These have been developed by Ms Ruth Knibbe, drawing on the solid state chemistry expertise of Dr Anna Lashtabeg, who joined us from Imperial College, London, to develop more efficient electrode design for fuel cells."



MAMMALIAN CELL LINES AND STEM CELL BIOPROCESSES

NEW BIOPHARMACEUTICALS, THE CLASS OF PROTEIN-BASED HUMAN THERAPEUTICS USHERED IN BY THE DNA REVOLUTION, ARE BEING DEVELOPED BY LEADING-EDGE RESEARCH AT AIBN.

The biopharmaceutical sector is experiencing rapid growth of over 20 percent per annum, with products currently accounting for more than US\$40 billion per year in sales.

AIBN Director and Group Leader Professor Peter Gray said that over one-quarter of all new drugs approved by regulatory authorities, such as the US Food and Drug Administration (FDA), were now biopharmaceuticals, with half of these being recombinant DNA-derived monoclonal antibodies.

He said complex proteins such as monoclonal antibodies were not easy to make and must be produced in mammalian cell culture. This process is technically challenging and slow, which in turn means the therapeutics produced are very expensive.

"Consequently there is strong interest in research which can improve the efficiency of mammalian cells as production systems," Professor Gray said.

"A major bottleneck in producing complex proteins in mammalian cell culture is the period of time it takes to develop cell lines which stably express the protein of interest. Our research aims to eliminate this rate-limiting step.

"High throughput techniques, such as fluorescent activated cell sorting (FACS), linked to more detailed understanding of cellular metabolism,

are being used to develop improved transient and stable mammalian cell expression systems.

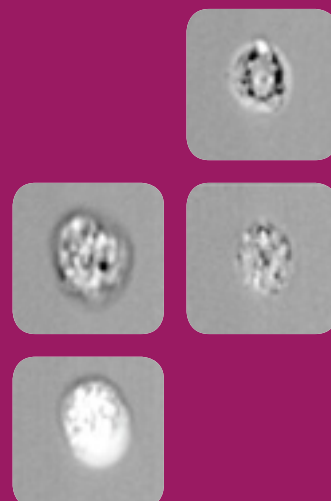
"Transient systems have been developed which allow the rapid production of many proteins over a period of several weeks. However, stable systems are needed to produce larger amounts of the desired protein for pre-clinical and clinical trials," he said.

These approaches, when linked to the understanding at the 'omics' level (genomics, proteomics and metabolomics), of what constitutes the ideal host cell, offer the opportunity to translate research findings into improved expression systems of use to both researchers and the biopharmaceutical industry.

Professor Gray is also interested in applying similar approaches to developing bioprocesses for the controlled expression and differentiation of stem cells.

He said the absence of a reliable technology platform for stem cell production was preventing stem cells being used to treat diseases.

"The challenges include developing platform technologies which are capable of producing the number of stem cells required for clinical applications in reliable and repeatable processes which are acceptable to the regulatory authorities."



RHEOLOGY AND PROCESSING OF BIOPOLYMERS

BIODEGRADABLE PLASTICS AND IMPROVED MEDICAL DEVICES RELY ON A DETAILED UNDERSTANDING OF RHEOLOGY, POLYMER PROCESSING AND PRODUCT DESIGN OF BIOPOLYMERS AND NANOSTRUCTURED POLYMERS.

Associate Professor Peter Halley said his research was aimed at understanding the physical, chemical and processing properties of polymers with a view to developing new plastics.

Rheology, the study of the physical and chemical properties of fluids, plays a vital role in developing industrial processes in the manufacture of many everyday objects, particularly those made of plastic which rely on injection moulding, extrusion, blow moulding and rotational moulding.

Polymers, the building blocks of plastics, are made by reacting monomers into linear chains or a three-dimensional network of polymer chains. This generic term is used to describe the very long molecules that consist of structural and repeating units connected by covalent chemical bonds.

Associate Professor Halley said biopolymers represented the most abundant organic compounds in the biosphere and constituted the largest fraction of cells. They can be generated from renewable natural sources and are often biodegradable

and non-toxic. They can be produced by biological systems or chemically synthesised from biological starting materials such as sugars, starch or oils.

“Polymers, the basic building blocks of plastics, can be manipulated via formulation and processing to build new materials with the features required for new medical, agricultural or food devices,” he said.

“For example, much work was done to develop degradable plastics in the 1980s. However these plastics generally did not degrade or did not survive typical product lifetimes.

“As a result we became interested in controlled lifetime thermoplastic starch-based polymer products and in this study we have obtained both commercial products and a fundamental understanding of the relationships between the structure, properties, processing and biodegradation of starch-based polymers. Our interests extend to the processing and product development of controlled lifetime polymer biomedical devices for a wide range of applications.

“Our work links laboratories from diverse fields such as chemical engineering, chemistry, materials engineering, mechanical engineering, dentistry, anatomy and biomedical sciences,” he said.



NEEDLE-FREE

GENE, DRUG AND VACCINE DELIVERY

PROFESSOR MARK KENDALL JOINED AIBN IN 2006 TO FURTHER HIS RESEARCH INTO NEEDLE-FREE DRUG AND GENE DELIVERY.

According to Professor Kendall, targeting the Langerhans cells of human skin for the delivery of genes and drugs has the potential to reduce the 14 million deaths per year caused by infectious disease.

Unfortunately, delivering biomolecules to this precise skin site cannot be achieved by the needle and syringe because the needle is too blunt and pushed too far into the skin.

With this in mind, Professor Kendall and his team are pursuing a new method of delivery which uses a patch on which there are thousands of micro- and nano-projections invisible to the human eye. These projections are coated with a drug or vaccine and applied to the skin.

"This method of drug delivery does not rely on needles, is painless and also offers significant practical advantages in the developing world because the vaccine will not require refrigeration," Professor Kendall said.

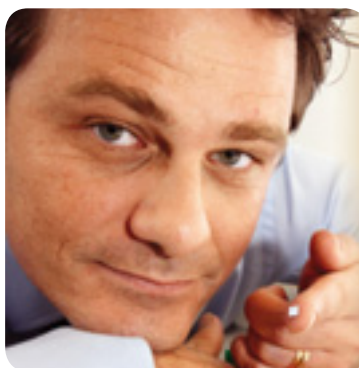
"Needles are very effective in delivering vaccines designed to trigger an antibody response (such as a measles vaccination), however diseases such as malaria, tuberculosis and HIV require a strong

killer T-cell response that is not triggered by standard vaccinations.

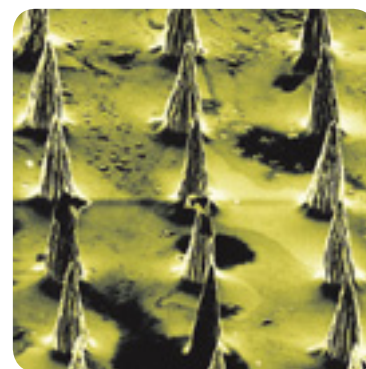
"By targeting the immunologically sensitive cells found less than a hair's breadth under the surface of the skin, we hope to stimulate the appropriate response to fight these diseases."

Before Professor Kendall and his team can start using these nanopatches as a drug delivery method they need to optimise delivery to required sites in the body.

"We need to know the best layer of the skin to deliver the drug to, the cells we are targeting, and the duration of the delivery, in order to stimulate the desired immune response," he said.



Professor Mark Kendall



"It is vital we control the delivery of the vaccines to these skin sites to optimise immune responses."

Professor Kendall added that because nerve endings are found well below the level to which the nano-projections penetrate, applying a patch was painless and it was likely there would only be minimal irritation.

This multi-disciplinary research spans biomedical engineering, diagnostics, dermatology and vaccinology. Professor Kendall has extensive support from and collaborations with the 2006 Australian of the Year Professor Ian Frazer, and other researchers from UQ's Diamantina Institute for Cancer, Immunology and Metabolic Medicine. Professor Kendall is also supported by the University's Faculty of Health Sciences.

FUNCTIONAL NANOMATERIALS

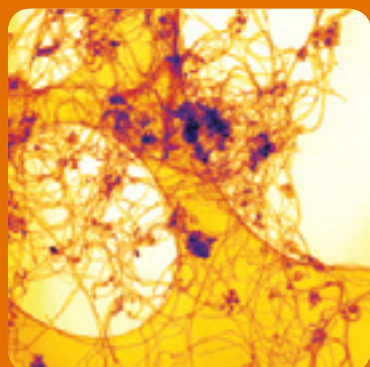
RESEARCH TO IMPROVE ENERGY, ENVIRONMENT AND HEALTH

MICROELECTRONICS, MANUFACTURING, MEDICINE, ENERGY AND THE ENVIRONMENT ALL IMPACT DIRECTLY ON OUR QUALITY OF LIFE.

Nanomaterials and nanotechnology will have a profound impact on industry and AIBN's Professor Max Lu believes that Australian research and development in this field should target those most relevant to our economy in order to reap maximum benefits.

As Director of the Australian Research Council's Centre for Functional Nanomaterials, Professor Lu said clean energy, the environment and health care had been identified as areas in which nanostructured materials would have significant early impact. As a result, the Centre had developed specific research projects in these fields.

"We are applying novel synthesis and characterisation of materials such as nanoparticles, nanotubes, thin films, nanoporous structures and nanocomposites to these areas," Professor Lu said.



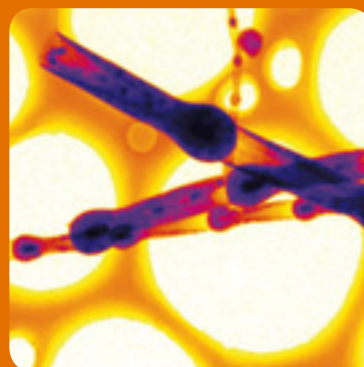
He said these materials were constructed by self-assembly at the nanometer scale and possessed improved properties and unique functionalities, such as high surface areas, nanosize and quantum confinement effects, ordered porosity and high adsorbing and sensing abilities.

This makes them ideal materials for adsorbents, catalysts, sensors, fuel cells, and battery systems. They are also attractive for biotechnology applications due to the controlled effectiveness of protein-material, cell-material, and tissue-material interactions.

"Our research activities are divided into five research programs defined by the dimensionality of the nanostructures. In each case we aim to develop new techniques and methods for the synthesis, characterisation and evaluation of nanomaterials for specific targeted applications.

"We are applying these techniques to three main areas: clean energy production and utilisation, environmental technologies and health care.

"This will lead to viable industries in hydrogen production and storage, improved fuel cells and high energy batteries, photo-catalytic reduction of



Professor Max Lu

pollutants in water and air, economic removal and recovery of inorganic vapours, greenhouse gas reduction and utilisation, as well as biomaterials for orthopaedic and cardiovascular applications and tissue repair," he said.

All research projects seek to enhance nanoscale science and to exploit the knowledge and understanding gained through fundamental studies to establish processing performance relations.



Dr Darren Martin

NANOTOXICOLOGY, BIOMATERIALS AND TISSUE ENGINEERING

DR DARREN MARTIN'S RESEARCH INTERESTS INCLUDE POLYMER NANOCOMPOSITES, NANOTOXICOLOGY, AND EVALUATION OF THE DURABILITY AND MECHANICAL PERFORMANCE OF BIOMATERIALS AND ENGINEERED TISSUES.

In collaboration with many others at UQ including AIBN Group Leaders Max Lu, Matt Trau and Peter Halley, Dr Martin's team is investigating a range of polymer nanocomposite systems including those based on polyurethane, hydroxyapatite-PHBV, polysaccharides, proteins and natural polyesters, and nafion-silica hybrids.

Much of the work has been carried out on thermoplastic polyurethane (TPU) nanocomposites, where novel, patented materials have been developed with the potential to offer extended design freedom, and improve performance in a number of commercial applications such as personal protective items like softer and thinner condoms, and surgical and industrial protective gloves, as well as high-spin, scuff-resistant golf ball covers.

Dr Martin's work has applications in the development of medical devices such as non-silicon finger joint replacements and breast implant shells.

"We have engineered materials with a 130 percent increase in tensile strength and no loss in dynamic performance when compared to TPUs without nano-reinforcement," he said.

"We managed to minimise the increase of Young's Modulus (a measure of stiffness) to less than 10 percent without any increase in permanent set.

"We have recently commenced a toxicological evaluation of nanoparticles and nanostructures to understand the implications of our research.

"This research will advance the field of nanomedicine by providing information about undesirable properties and how to avoid them. It also makes good business sense in terms of sustainability and safety.

"Research of this nature offers early identification of potential safety issues, which will contribute to better, safer products and regulations for the public.

"Establishing robust techniques to provide industry and regulators with scientifically valid data may also help to grant industry a competitive edge for bringing new nanoproducts to market," he said.

Products currently employing nanoparticles include nanocomposites, catalysts, water decontamination absorbents, biomaterials, cosmetics, toothpastes and paint additives.

Dr Martin is particularly interested in studying the release of nanoparticles from nanocomposite materials, as well as the uptake and diffusion of nanoparticles across personal protective equipment such as rubber gloves, in order to assess their efficacy.

One of the real strengths of the nanotoxicology project is the unique assembly of research disciplines, institutes and industry, all well placed to perform toxicology research and development.

This collaborative project incorporates the expertise of Professor Rod Minchin from TetraQ, Dr Suzanne Smith from the Australian Nuclear Science and Technology Organisation (ANSTO), Dr Kathleen Carrado from the Argonne National Labs in the US, and Dr Gordon Xu from AIBN.

Dr Martin's remaining research activity is the in-vitro mechanical stimulation and testing of new biomaterials and engineered tissues.

This area presents considerable challenges in terms of adequately mimicking the physiological environment, and providing suitable conditions for tissue growth. Dr Martin's team is particularly interested in the areas of bone, cartilage and vascular tissue engineering.



BIOMOLECULAR ENGINEERING

DESIGNING, CREATING AND UNDERSTANDING NEW BIO-INSPIRED PRODUCTS IS THE FOCUS OF PROFESSOR ANTON MIDDELBERG AND HIS TEAM.

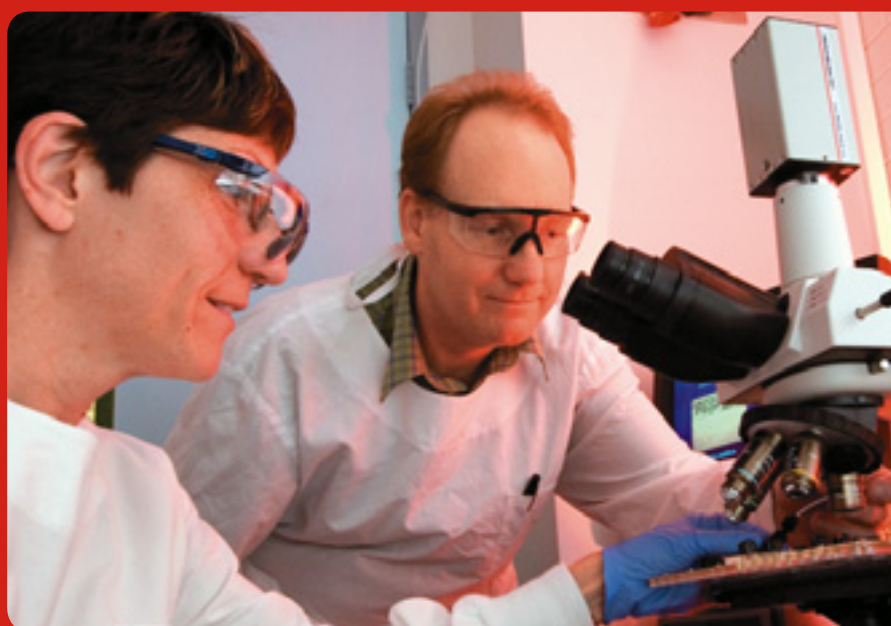
The research team aims to deliver new technologies, and to better understand the fundamentals of how existing products are processed.

Professor Middelberg, an Australian Research Council Federation Fellow and Director of the Centre for Biomolecular Engineering in the AIBN, said his research addressed both existing and new problems in the processing of complex chemical and biological products.

"At one end of the spectrum we are examining the questions behind the design and self-assembly of peptide nanostructures, and how assembly is affected by local physico-chemical factors such as pH and shear stress," he said.

"This has led to a new award-winning technology, and a start-up company which may potentially revolutionise the way emulsions are viewed and processed.

"Emulsions are made by mixing two immiscible liquids, and are important because they are found almost everywhere, in goods ranging from mayonnaise to products for delivering chemotherapy agents and other drugs.



Dr Annette Dexter (left) and Professor Anton Middelberg

"We are looking at the design of nanostructures at interfaces, with a particular focus on exploring how emulsions and foams can be switched on and off at will.

"Our technology allows very quick separation of an emulsion's components, and then reversible re-formation of the emulsion.

"Basically you can have your emulsion, and break it too!"

He said that at the other end of the team's work they were interested in how to self-assemble virus-like particles for use as vaccines, therapeutic and diagnostic use.

By self-assembling these structures Professor Middelberg believes it will be possible to precisely control what is put in the virus-like particles, and to

improve the way these particles are manufactured en masse.

"We will make a cheap and versatile tool that can help us understand how viruses behave, and how they induce an immune response. They can also be tailored to act as a "Trojan horse" to deliver therapeutic payloads to carefully selected cell types" he said.

"Of course, none of this is possible without strong biotechnology skills such as biomolecular cloning, expression and purification.

"My research team has extensive expertise in downstream bioprocessing and in particular protein purification and analysis, and we also work closely with the Protein Expression Facility, headed by Dr Linda Lua.



Associate Professor Michael Monteiro

STRUCTURE AND FUNCTION OF COMPLEX POLYMER ARCHITECTURE

NEW POLYMER STRUCTURES DESIGNED AT THE AIBN, SUITABLE FOR USE IN DRUG AND GENE DELIVERY, AS WELL AS HIGH-STRENGTH COATINGS, WILL PROVIDE AUSTRALIAN PRODUCTS WITH ADVANCED FEATURES AND CAPABILITIES TO SIGNIFICANTLY IMPROVE PERFORMANCE.

This research, conducted by Associate Professor Michael Monteiro, significantly advances the basic knowledge of polymer science and related fields through preparation of previously unavailable, novel and well-defined nanostructures.

Associate Professor Monteiro said his group's research aimed to develop methods to synthesise complex polymer architectures in water with controlled size, molecular weight, morphology and function.

"From this research we will gain an understanding of the structure-property relations of these novel nanomaterials so that targeted properties can be made for specific applications," he said.

Associate Professor Monteiro believes one direct application of his research will be the development of polymer structures on the nanoscale with diverse chemical functionality throughout the structure for the attachment of various important biomolecules.

He said these nanostructures would be designed to protect and deliver

biomolecules to specific cells and could be used in synthetic vaccines or to deliver drugs with controlled release.

"The knowledge obtained through this application will advance the development of synthetic vaccines and drug delivery devices more generally, by providing an understanding of how these structures function in the body," he said.

"We have also developed a new 'living' radical system via the SET-LRP using Cu(O) to make ultrafast and ultra high molecular weight polymer with near uniform chain length. This novel technology allows us to make polymer structures with near quantitative functionality on the chain-ends. To this end we have also synthesised new and highly complex polymer architectures.

"We have synthesised functional nanoparticles that irreversibly sequester heavy metals down to parts per billion, and can have applications in water purification, drug delivery and removal of heavy metals from the blood stream."

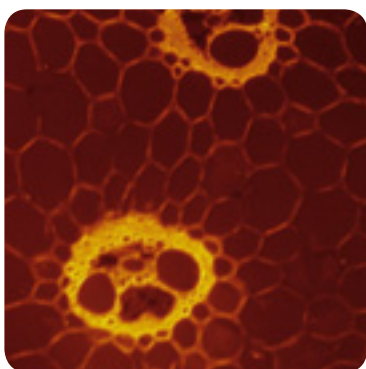
TISSUE AND METABOLIC ENGINEERING

CONTINUING ADVANCES IN THE ABILITY TO ENGINEER BIOLOGICAL SYSTEMS ARE REDEFINING BIOTECHNOLOGY AND MEDICINE AND WILL BROADLY IMPACT ON EXISTING INDUSTRIES AS WELL AS CREATE TOTALLY NEW ONES.

As a result or consequence of these advances new research and development opportunities are constantly emerging in the pharmaceutical, food and biomedical areas.

AIBN's Professor Lars Nielsen is harnessing a combination of chemical engineering, biochemistry and molecular cell biology to develop new and innovative bioprocess applications.

Professor Nielsen and his team are advancing bioengineering and applying it to specific problems ranging from production of blood cells for transfusion to the production of industrial biopolymers.



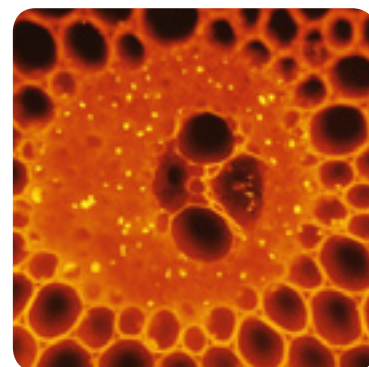
His two broad research areas are tissue and metabolic engineering; specifically haematotherapy and immunotherapy as they can be harnessed to solve problems in the study of disease, as well as polymer production in bacteria and sugar cane engineering.

The group has several projects investigating the normal processes involved in replacing the approximately 300 billion blood cells a human loses each day, and applying this knowledge to blood related disorders.

"The ability to grow blood cells in culture is an enabling technology with many potential applications in bone-marrow transplantation, gene therapy, immunotherapy, and the production of blood products," he said.

Professor Nielsen is also interested in metabolic engineering: that is, the rational redesign of organisms using tissue engineering, to meet commercial objectives.

"I am interested in biopolymer production, in particular new approaches to produce hyaluronic acid in bacteria and polyhydroxyalkanoates (PHAs) in sugar cane.



"PHAs are the most promising form of biopolymer and by using different bacteria and varying their carbon source, it is possible to produce biomaterials with properties ranging from stiff and brittle plastics to rubbery polymers.

"In Australia, production of PHAs and other bulk chemicals in sugar cane offers a potential for product diversification and reduced reliance on the price of sugar for Queensland's cane growing industry.

"To be successful, the new process must offer an economically viable alternative to current sources of PHAs and other bulk chemicals."

BIOPESTICIDES

INCREASED RESISTANCE TO CHEMICAL PESTICIDES AND CONCERN OVER THEIR USE HAS RESULTED IN RENEWED INTEREST IN THE APPLICATION OF BIOLOGICAL MEANS TO CONTROL PESTS OF COMMERCIAL IMPORTANCE.

Dr Steve Reid is advancing the technology necessary to reduce the production costs of biological control agents, initially focusing on effective scale-up of insect viruses.

"There are many wild type Baculoviruses that can specifically infect and kill key agricultural caterpillar pests," he said.

"At 300 times smaller than a human hair, Baculoviruses are the largest viruses known, because they wrap their genomes up in large protein coats known as occlusion bodies.

"This enables the virus to be stable in the open environment and therefore deliverable to crops using conventional land and air based spraying procedures."

According to Dr Reid, his laboratory has a process patent on a procedure for producing Baculoviruses via fermentation.

"Our lead product is a Baculovirus which targets the *Helicoverpa* pest species, which represents a market of US\$1.7 billion per annum.



Helicoverpa

"Baculoviruses are currently produced '*in vivo*' using caterpillar farms, but our intention is to produce such viruses '*in vitro*' using bioreactors.

"Current pilot work is conducted in 30-100 litre bioreactors and the virus product is simply harvested by cross flow filtration, with the concentrated virus then being formulated so that it is ready for spraying onto fields.

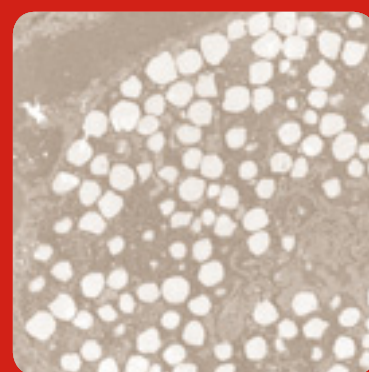
"Final production, to be cost effective, would need to be conducted at the 20,000 litre scale."

At current yields production costs would allow the team to target *Helicoverpa* pest species in areas where this pest is resistant to most low cost chemical options (\$15/ha), and where only more expensive chemicals are in use (\$30-\$50/ha).

Dr Reid believes a two-fold improvement in yield would allow the product to compete on cost alone in all markets, including the extensive markets in India and China.

However, opening up these markets requires large capital investment in bioreactor based infrastructure. To justify such investment requires the technology to apply to a portfolio of virus products.

Currently Dr Reid is looking to raise money to extend the group's production technology to other viruses that target additional key pests such as the Diamondback Moth and a number of other caterpillar pests. Expanding the technology to just five key viruses allows the technology to target a total annual market valued at US\$4-5 billion.



The group is also looking at the potential to produce Baculoviruses that specifically target mosquitoes to help reduce the spread of major human diseases such as West Nile Virus and Dengue.

"Safe alternatives to chemical sprays are critical if we are to combat mosquito numbers in our waterways in a sustainable way during the current period of global warming.

"One of the major technical challenges, limiting the full scale manufacture of Baculoviruses '*in vivo*', is the development of few polyhedra mutant (FPM) viruses during the extended passaging of the virus in cell culture.

"FPMs are caused by the mutation of a key viral gene during scale-up.

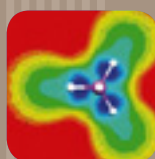
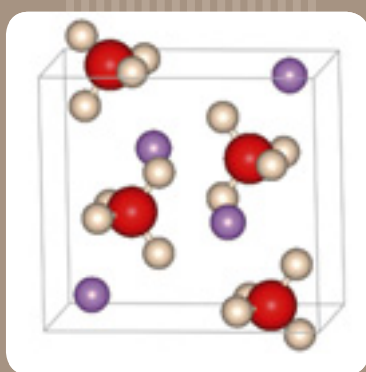
"Currently we are investigating the basic biology of these mutation events which will give us insights into the cause of the yield-limiting mutations occurring during manufacture of this viral pesticide," he said.

Overcoming these problems through the use of modern molecular biology techniques would propel the technology forward and lead to further valuable patent positions.



COMPUTER POWER
TO SIMULATE AND VISUALISE

MOLECULAR SYSTEMS



A WORLD-LEADING PROGRAM IS DEVELOPING NEW MOLECULAR AND COMPUTATIONAL METHODOLOGIES FOR APPLICATION-BASED MODELLING.

This interdisciplinary work focuses on molecular scale modelling in the areas of biological science, materials science, nanotechnology and environmental science.

Core research interests, according to Group Leader Professor Sean Smith, include computational studies of fluorescent proteins with a view to designing new proteins for use in cellular imaging applications, as well as hydrogen storage in carbon nanotubes as an alternative energy source.

"Quantum chemical studies, coupled with quantum and molecular dynamic calculations reveal the key features that control the mechanistic and functional properties we wish to design into new engineered fluorescent proteins," Professor Smith said.

"Such mechanistic information is presently patchy, and substantial developments in this area of theoretical modelling will greatly facilitate attempts to develop new fluorescent proteins for a wide range of biotechnology applications.

"Meanwhile our computational study on hydrogen storage, a research area of enormous economic significance, is performed in close collaboration with experimental studies."

He said hydrogen was both renewable and environmentally friendly with nearly three times the energy content of gasoline; however the lack of practical storage methods had hindered the widespread use of this fuel.

"This research concentrates on the interactions of molecular and atomic hydrogen with a range of novel nanomaterials being specifically designed for hydrogen storage.

"These new materials are based on carbon nanotubes and magnesium, where small amounts of heavy metals have been incorporated to form impurities which will assist in catalysing the adsorption and release of hydrogen.

"Another research project in the area of drug delivery, computationally investigates the action mechanism of a number of new nanoparticles designed to deliver targeted DNA across cell membranes.

"These new technologies have far-reaching consequences for medical applications, and the mechanism by which they operate is presently unknown and speculative."

Professor Smith said these projects were generally computationally intensive and expensive in terms of processing time.

The research is greatly aided by in house computational facilities, incorporating both large distributed memory clusters (Intel, Xeon and AMD Opteron) and shared-memory computers.

"Parallel computing strategies often facilitate the most difficult and extensive calculations, or indeed enable them when they would otherwise be unfeasible," he said.

NANOTECHNOLOGY^{AND} BIOMATERIALS

IMPROVING HUMAN HEALTH BY DEVELOPING NANO-SCALED BIOLOGICALLY RELATED MATERIALS AND DEVICES IS THE OVERALL GOAL OF PROFESSOR MATT TRAU'S GROUP.

The work of Professor Trau focuses on two main areas; nano-scaled molecular diagnostics, and artificial tissue matrices for implantation in the human body.

Both of these research areas require creation of novel materials and devices, usually microscopic or colloidal in nature, which have been fashioned to contain designed nanostructures.

With the recent award of a new \$4 million Queensland Smart State grant in the area of biomarker discovery and diagnostics, the group is significantly increasing its activities in the area of early disease diagnosis using nanotechnology.

According to Professor Trau the word 'biomarker' is a collective term used to describe any biomolecule present in blood or tissue which is indicative of disease (eg, specific DNA sequences, methylated-DNA, specific proteins or small molecule metabolites).

"We know that these are present in blood, however we need new technologies to detect these in an accurate, reliable and inexpensive manner," he said.

"Early identification of a disease using biomarkers will significantly increase the success of treatment, particularly in the case of cancer.

"If cancer is detected early enough the chances of successful treatment using conventional methods can be as high as 95 percent, whereas with late detection the chances of recovery have generally not varied significantly in 40 years," he said.

"Rather than examining a patient for lumps or other obvious signs of disease, we anticipate that our research will eventually enable us to test a drop of blood for specific molecules associated with particular diseases.

"The individual would then report to their doctor to discuss appropriate treatment options.

"Before this becomes a reality however, there are three critical factors that need to be developed: discovery of specific biomarkers for particular diseases; the ability to reliably detect these biomarkers at the required sensitivity; and the development of cheap and robust testing techniques that can be used in the clinical setting," he said.

"These detection methods also have the potential to unlock the vast

amount of information uncovered by the Human Genome Project."

Professor Trau's group has established collaborations with the Fred Hutchinson Cancer Research Centre and the Seattle Biomedical Research Institute, both in the United States, providing access to samples for cancer and infectious diseases as well as outstanding clinical and research expertise.

In addition the team is researching ways to create artificial tissue, a breakthrough that would enable doctors to trigger regrowth in patients, avoiding the problem of rejection by the body.

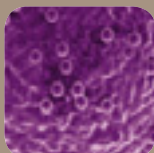
"We are focused on developing novel biological, degradable and living implants for the human body," he said.

"Many human ailments arise as a result of the body's inability to fully regenerate damaged tissue such as in bone, the liver and the pancreas.

"This research area focuses on developing novel biological, degradable and 'living' implants for the human body, he said.

PROFESSOR MATT TRAU

Professor Matt Trau



POLYMER CHEMISTRY

POLYMERS IN THEIR MYRIAD FORMS ARE THE BUILDING BLOCKS OF OUR MODERN LIFESTYLE. THEY ARE THE MAJOR COMPONENTS OF CLOTHING, FURNISHINGS, PACKAGING AND MOTOR VEHICLES, AND INCREASINGLY HAVE IMPORTANCE IN DIVERSE AREAS SUCH AS MEDICINE AND MICROELECTRONICS.

Professor Andrew Whittaker, is making novel polymeric materials and studies how the structure of these materials can be manipulated to provide key properties. His research team has two key areas of application, namely biomaterials and for microelectronics.

Biomaterials are synthetic polymers for use in the human body. They can be used for imaging cell types and tissue function, delivery of drugs and growth factors, and support for tissue regeneration and cell expansion.

Professor Whittaker said his team had research programs in these three areas and collaborated extensively with other groups from AIBN.

"Polymers with Magnetic Resonance Imaging (MRI) or Positron Emission Tomography (PET)-imaging labels are injected into the body to enable the study of blood flow, and if conjugated with a suitable targeting moiety, provide images of specific tissue types, such as tumour cells," he said.

"Polymers are also used as tissue scaffolds; biodegradable polymers

provide mechanical support to allow regeneration of many different tissue types.

"The ability to control polymer chemistry and network structure allows the delivery of biological agents (drugs and growth factors) at a defined extent and rate.

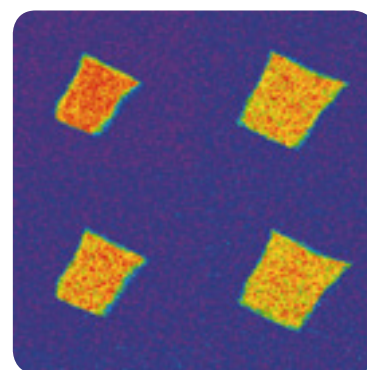
"We are also interested in preparing polymer-gold nanoparticles for application as high sensitivity biosensors."

Polymers are also an essential element of the manufacture of integrated circuits with increased processor speed depending on ever-decreasing feature size on the silicon wafer.

This decrease in feature size is achieved by new chemistry, specifically, polymers with high refractive indices.

The team is developing novel materials to be used in the manufacture of the next generation of computer chips.

"Towards the end of the decade an entirely new polymer technology will



be required if computer technology is to advance any further," Professor Whittaker said.

"We are working to develop new polymers for this technology, known as extreme ultraviolet lithography."

Underpinning these research efforts is a program developing modern methods of analysis by magnetic resonance spectroscopy and imaging.

The team has strong links to the Centre for Magnetic Resonance, and also received funding from the Queensland Government and UQ to establish the International Biomaterials Research Alliance.

The Alliance will develop materials science solutions for dental bone repair, vascular regeneration, vision and medical imaging agents, in conjunction with four leading international groups.

INNOVATION AND COMMERCIAL DEVELOPMENT

AIBN IS A TRANSLATIONAL RESEARCH INSTITUTE WITH A STRONG COMMERCIAL FOCUS. THE INSTITUTE'S OBJECTIVE IS THE NURTURING OF BIO- AND NANO-TECHNOLOGY INNOVATION TO GROW AUSTRALIAN INDUSTRIES AND DEVELOP NEW PRODUCTS, PROCESSES AND TECHNOLOGIES.

The AIBN's Innovation and Commercial Development (I&CD) team manages the intellectual property (IP) and commercialisation activities of the Institute, and fosters industry-led collaborations and contract research.

The Institute's commercialisation strategy has two broad objectives. The first enables the development of AIBN intellectual property via licensing agreements or start-up companies. The second makes AIBN's unparalleled suite of capabilities, facilities and intellectual capital available to industry.

IP Management and Commercialisation

The team's commercial activities include:

- development and implementation of IP-related policies;
- continual IP monitoring and capture;
- commercial assessment of new discoveries;
- filing and maintaining patents;
- protecting AIBN's intellectual property;
- sourcing funding from government granting schemes in partnership with external companies; and
- packaging IP in preparation for licensing and the formation of start-up companies.

In 2006, the I&CD team identified 24 discoveries, filed six provisional patent applications and managed a total of 12 patents, all at various stages of application.

AIBN's capabilities also provide opportunities to work closely for or with industry. By engaging with key figures in the bioengineering and nanotechnology industries, AIBN had commercial discussions resulting in consultancies, contract research and collaborations.

Commercial Affiliates Program

The Commercial Affiliates Program is a network of individuals and commercial organisations invited to join the AIBN to serve as a two-way conduit with industry.

The Program aims to increase industry awareness of the AIBN, its IP, capabilities and expertise, as well as providing a commercial benchmark and industry perspective of its technology and market opportunities.

Befitting its status as a premier institute in the bionano space in Australia, AIBN takes a leading role in advocacy. These activities include:

- participating in the Queensland Nanotechnology Strategy;
- membership in the Australian NanoBusiness Forum; and
- membership of the Queensland Nanotechnology Alliance.

Opportunities for Industry

The AIBN is an environment rich with innovative technologies, cutting edge capabilities, acknowledged research leaders and a culture of collaboration. It adds value through the research and development of new processes, technologies, materials and devices in the following areas:

- nanotechnology-based imaging and drug delivery for therapeutic products;
- regenerative medicine – biology, stem cells, micro-bioreactors and novel scaffolds;
- nanotechnology enabled commodity products for industrial application;
- novel protein expression utilising metabolomics and systems biotechnology; and
- nanotechnology for energy and environmental applications.

AIBN can work for, or with, industry to undertake R&D with flexible arrangements to meet partners' needs, including:

- consulting;
- partnering;
- contract research;
- licensing; or
- investment in the formation of a start-up company.

For speculative, strategic or long-term corporate initiatives, it is possible to explore new areas of research by sponsoring postgraduate research students.

Pepfactants

World leading research conducted in the AIBN has led to a new start-up company to further develop the technology.

Pepfactants® Pty Ltd was formed on the back of research conducted by Professor Anton Middelberg and Dr Annette Dexter and published in the prestigious international science journal *Nature Materials*.

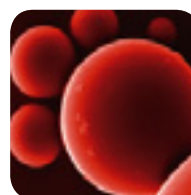
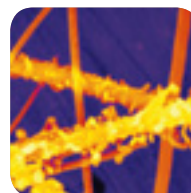
Pepfactants is based on a peptide surfactant that can reversibly make and break emulsions and foams, and is expected to bring new functionality to a range of products and industrial processes, especially where the biodegradability and safety of the product is important.

There are many potential applications for this technology, particularly in the pharmaceutical industry but also in biocatalysis, chemical synthesis, oil and gas production and cosmetics.

It is believed to be the first and only surfactant that can reversibly control the formation, stabilisation and destabilisation of emulsions and foams.

The potential of this technology to impact on multiple large global markets along with its high quality pedigree is illustrated by the Emerging Technology Award at Tech-Connect Summit 2006 in the US, and a successful application for federal funding through the Commercialisation of Emerging Technology (COMET) scheme.

The direction taken with this technology is a great example of the research and commercial focus of the AIBN.



GRADUATE PROGRAM

2006 COMMENCING STUDENTS	NAME	TOPIC	PRINCIPAL ADVISOR
	Yalun Arifun	Metabolic engineering of peptide production in E-coli	Lars Nielsen
	Samantha Bothe	Application for fuel cells to micro power systems for biomedical devices	Max Lu
	Sandy Budihartono	Functionalised Mesoporous Silica for <i>Trichoderma reesei</i> Cellulase Immobilisation	Max Lu
	Jessica Cameron	Bioactive Polymers for Wound Healing Applications	Andrew Whittaker
	Lien Chau	Ex Vivo Tissue Vascularisation	Justin Cooper-White
	Annie Chen	Nanotechnology-based proteomic biosensors	Matt Trau
	Joe Codamo	Process development and characterisation of transient expression technology in CHO cells	Peter Gray
	Michel Hoenig	Angiogenesis: Towards a cure for coronary artery disease and ischaemic heart failure	Julie Campbell
	Chalida Klaysom	Novel inorganic-organic nanocomposite membranes for electrodialysis application in water recovery	Max Lu
	Daria Lonsdale	Synthesis of complex polymer architectures for vaccine delivery services	Michael Monteiro
	Flavia Marturana	Ex vivo production of neutrophils	Lars Nielsen
	Jane Mooney	The peritoneal bioreactor: monocyte/macrophages as smooth muscle progenitors	Barbara Rolfe
	Geety Nabi	Functional testing of bioengineering virus-inspired nanoparticles for gene therapy	Andrew Whittaker
	Warren Pilbrough	Stable Episomal Expression Vectors and Evolutionary Engineering of the Host Cell: Improving the Mammalian Cell Line Development Process for Biopharmaceutical Production	Peter Gray
	Oliver Squires	Self Assembly of Fluorinated Micelles in Supercritical CO ₂ and other Solvents	Andrew Whittaker
	Peter Stickler	Factors affecting the differentiation of biotubes	Julie Campbell
	Yunyi Wong	Layered Double Hydroxide (LDH) Nanoparticle-based Nuclei Acid Delivery Carrier	Max Lu



THE AIBN GRADUATE PROGRAM GREW SIGNIFICANTLY IN 2006, WITH THE NUMBER OF STUDENTS ENROLLED THROUGH THE INSTITUTE DOUBLING.

These AIBN students, in conjunction with approximately 50 students already enrolled through the Schools of Engineering and Molecular and Microbial Sciences, form a vibrant and diverse student community of almost 80 researchers, a quarter of which come from overseas.

AIBN expects that by 2010 all students in the building will be enrolled through the Institute. Additionally we expect the program to expand from 80 to more than 100 research higher degree (RHD) students. This expansion seems well within AIBN's capacity with the commencement of two new Group Leaders, Mark Kendall and Krassen Dimitrov in 2006, and the subsequent growth of their research teams.

The greatest challenge for the Graduate Program is attracting and retaining high-quality domestic students in what is a very competitive market. With large engineering firms recruiting students in April and May each year, AIBN is implementing programs to identify and aggressively pursue high-achieving students for RHD studies.

To this end several Group Leaders, with Institute support, made contact with high-achieving undergraduate students in order to stimulate their interest in research.

In addition, the AIBN is developing a Winter School for talented interstate undergraduate scholars. This program exposes local and interstate students to the breadth and depth of the Institute's research capability, through a week long emersion in AIBN's research programs.

The majority of the 17 new students who commenced their research projects in 2006 were successful in the major highly competitive scholarship funding rounds.

Once again, AIBN attracted applications from high calibre international students. The Institute's two nominations for the extremely competitive Endeavour Foundation International Postgraduate Research Scholarship scheme were both successful.

The Institute also undertook its first round of student confirmations in 2006. Confirmation is a significant milestone in the life of a Research

Higher Degree student, marking the completion of the first 12 months of candidature as well as the transition from a provisional to confirmed candidate. The standard of the work presented was very high and it was pleasing to note the diligence with which all students had applied themselves to their projects.

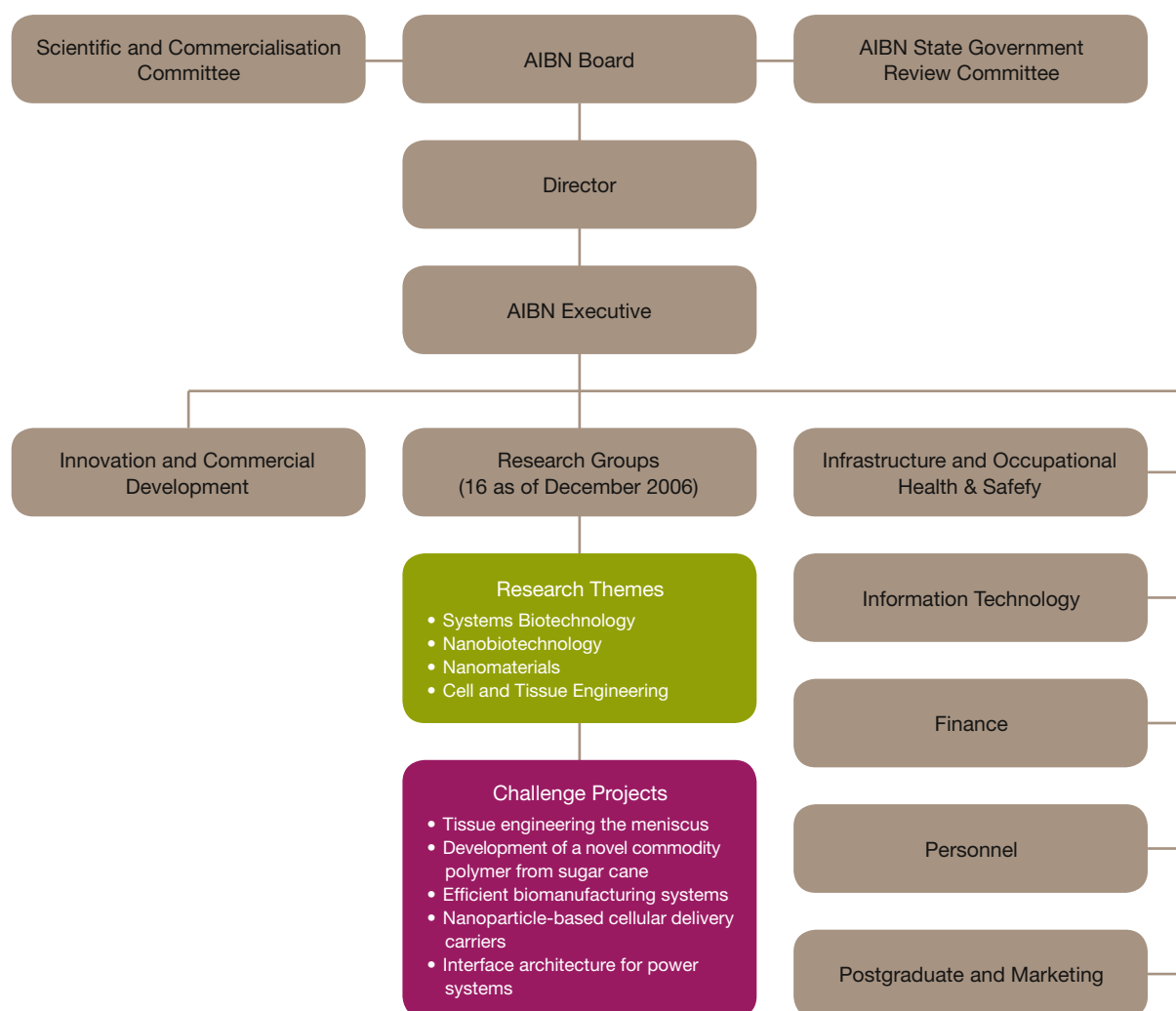
The RHD students of the AIBN are to be commended for starting their own student association with the aims of generating awareness of the skills and expertise existing in the Institute, as well as providing a support network for students and early career researchers. The AIBN Student Association (ASA) will organise various events through the year such as skills workshops for writing a literature review and a thesis, research planning and time management, as well as intellectual property management and career planning. In addition, the Association will organise a number of social events throughout the year.

In summary, 2006 was very successful for the Graduate Program and it augurs well for future success.

Professor Lars Nielsen

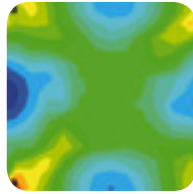
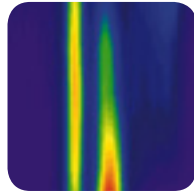
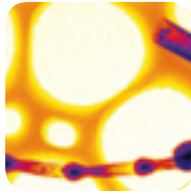
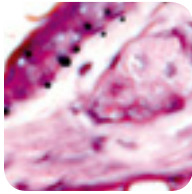
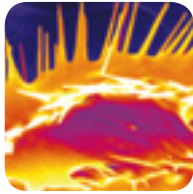
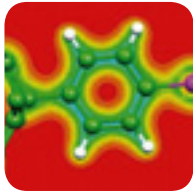
AIBN, Postgraduate Coordinator

AIBN ORGANISATION STRUCTURE



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