

Annual Report

BIO21 MOLECULAR SCIENCE AND BIOTECHNOLOGY INSTITUTE

www.bio21.unimelb.edu.au





Introduction

The University of Melbourne's Bio21 Molecular Science and Biotechnology Institute (Bio21 Institute) is a multidisciplinary research facility specialising in medical, agricultural and environmental biotechnology and nanobiotechnology.

Our vision is to improve health and the environment through innovation in biotechnology and related areas, driven by multidisciplinary research and dynamic interactions with industry.

This vision was built on the premise that multidisciplinary ventures between life sciences, physical sciences and engineering disciplines, including the exploitation of 'omics' technologies, was fundamental to translating biological discoveries into biotechnology innovations.

Located in the heart of the Parkville Biomedical Precinct, the Institute accommodates 560 research scientists, students, professional staff and industry participants, making it one of the largest biotechnology research centres in Australia.

Our Goals

The goals of the Bio21 Institute are to

- Achieve biotechnology innovation through worldclass interdisciplinary research in biomedical, agricultural and environmental biotechnology
- Establish core platform technologies available to a wide cross section of the science and industry communities
- Translate research into educational, economic and community benefits
- Enhance research and training programs
- Provide a forum for community debate

As a flagship facility in the heart of the Parkville Biomedical Precinct, the Bio21 Institute's expertise and state-of-the-art platforms, provide the foundation for collaborative research across the University, Bio21 Cluster organisations and the broader biotechnology community.

Our History

- The Bio21 Institute is built in the grounds of the University of Melbourne's Western Precinct (formerly the Veterinary Precinct) which was established in 1908.
- From the late nineteenth century the site was a livestock market. The heritage-listed remains of the market wall stand by the entrance of the Institute. A horse head sculpture from the market entrance stands at the corner of Story Street and Park Drive.
- In 1930, CSIRO established the Animal Health Research Laboratory on the site.
- In 1996, CSIRO Animal Health moved from Parkville to Geelong. One of the former CSIRO buildings now serves as the Bio21 Institute Business Incubator.
- In 2001, the State Government donated the land in the Western Precinct (previously a Crown Lease to the University of Melbourne) as part of their contribution to the Bio21 Project.
- Building of the Bio21 Institute commenced in May 2002 and the first phase was completed in December 2004.
- The major funding contributors to the construction of the Bio21 Institute building were Atlantic
 Philanthropies, The University of Melbourne, State Government of Victoria and Commonwealth Government.
- The Bio21 Institute was officially opened in June 2005.



institute

The Bio21 Institute logo with its interlocking rings represents the Institute's strategy – to embrace the partnership between the University, industry and the community.

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Director's Message



On behalf of the Bio21 Institute members and partners it is a great pleasure to commend to you the Bio21 Institute's 2011 Annual Report. It has been an enormously exciting time with significant achievements across our four key elements of worldclass interdisciplinary research underpinning biotechnology; cutting-edge platform technologies; education, training and outreach; and industry engagement. Our vision is for the Bio21 Institute to be a world leader in basic and strategic interdisciplinary research and biotechnological innovation that underpins the life sciences sector. This vision is being implemented through the development of a "School to Bench to Workplace" concept which embraces and embeds the effective delivery of science education, training and outreach into our basic and translational research objectives.

Modern research increasingly involves the application of a range of disciplines to achieve big-picture goals focussed on societal challenges. The University has been a leader in the development of research institutes aimed at bringing together multi-disciplinary teams to tackle complex research questions. The Bio21 Institute, established in 2005, was the first Institute developed with the express purpose of fostering interdisciplinary research and innovation in the biotechnology sector and was the forerunner for the "Virtual Institutes" that form a key plank of the University of Melbourne's *Growing Esteem* Research strand of the triple helix. The Bio21 Institute brings together 600 researchers from the University (9 Departments/Schools across 3 Faculties), hospital

researchers and biotechnology industry members (including the CSL Limited Protein Therapeutics Research Group). These are supported by key Platform Technologies that the Institute provides for the University, the Parkville precinct and other government and industry research agencies as a model for providing access to cutting-edge infrastructure, both physical and intellectual, to the research community.

The Institute has developed a new Business Plan to implement a vision of a 'School to Bench to Workplace' continuum for improving and delivering effective science education and training, as well as basic and applied (industry) research; thereby ensuring that the "best and brightest minds" are engaged in addressing the challenges of a sustainable society.

The inspirational leadership provided by the inter-disciplinary research theme leaders (Structural Biology (Malcolm McConville), Chemical Biology (Spencer Williams), and Nanobiotechnology (Paul Mulvaney)) has provided a much needed boost to our research focus and embedding our integrated "whole of Institute" approach. This now informs and drives our recruitment strategy and our investment in infrastructure.

We are delighted to welcome two new outstanding senior appointments, namely Professor Leann Tilley and Professor Jose Villadangos, whose cross-Department and cross-Institutes appointments underpin the united strategy within the University leadership team, and will lead to new collaborations both within the Institute and between the Institute and national and international collaborators. On a sadder note we bid farewell to Associate Professor Matt Perugini who has taken up an appointment at LIMS, LaTrobe University - Matt was an enthusiastic and generous contributor to the Institute's programs as well as generating world-class research and we wish him well in his future activities.

We extend our heartiest congratulations to Institute researchers that have been the beneficiaries of numerous prestigious national and international awards that recognise their individual and group's contributions in their designated research fields and also further bolster the reputation of the Institute.

This Institute's complex operating environment is able to deliver world-class research outcomes due to the

development of world-class platform technologies (research infrastructure) that provide capability for current research while evolving with the fast pace of technology development. This is largely made possible by the quality of the highly skilled platform staff supported by equally talented administrative and management staff. Through the outstanding leadership provided by Dr Veronica Borrett, General Manager Bio21 Institute, who has been responsible for driving the development of strategic/operational/ business plans for each of the platforms through a highly consultative process with academic staff to ensure that the developments reflected the key research themes of the Institute, the Bio21 Institute has developed a "sustainable" operating model for technology platforms ensuring their extensive utilisation by the broad researcher community. The success of these platforms is recognised by publication of the research output in the most prestigious international peer reviewed journals (such as Nature and Science) and the co-authorship of platform staff reflecting their high level of critical intellectual input.

The depth, breadth and impact of our education, training and outreach program is truly amazing and a testament to the incredible skills and unending enthusiasm of our Communications and Public Relations Manager, Ms Helen Varnavas and is a vital element of the Institute's core activities. Informing the public of the impacts of biotechnology, enthusing and mentoring our future generation of scientists and technologists are all critical strands in our local, national and global engagement and outreach programs. Equally important are the "in-house" activities that build "bridges" both within the Institute and between the Institute and the University and the broader biotechnology sector.

Industry engagement remains a key objective and driver for the Institute as we strive to translate

discoveries into practice. The strategy is multifaceted and includes direct engagement with University of Melbourne Commercial and our industry tenants. The Institute has been highly successful in developing industry engagement (as well as research and consultancy contracts) through strategic relationships with R&D biotechnology/biopharmaceutical companies. A unique feature of the Bio21 Institute is the presence of both SMEs and the multinational CSL group with research capabilities "on-site". These partnerships offer enormous opportunities for collaborative research projects/programs, training opportunities for the postgraduate students of the Institute and mutual sharing of new platform technologies. We also value the contributions of industry scientists who are also appointed as Honorary Institute members; their contributions to teaching, training and outreach activities are highly valued and provide "real world" context to the Institute's activities.

We invite you to share in our enthusiasm of the achievements of Institute members during 2011.



Professor Tony Bacic Director Bio21 Molecular Science and Biotechnology Institute

Governance, Structure and Operations

The Bio21 Institute is a multidisciplinary research environment involving a diverse research community, high-end scientific instrumentation and external industry and researcher interactions. To support the operation and management of the Institute, a range of committees representing key stakeholders, areas and functions have been established with membership from across the range of resident groups and affiliated departments.

Committees include:

- Bio21 Institute Governance Group
- Associate Director's / Executive Group
- Bio21 Institute Management Advisory Committee
- Biological Facility Management Committee
- Stores Facility Management Committee
- Environmental, Health and Safety (EHS) Committee
- Information Technology Management Committee
- Microscopy and Nanotechnology Facility Management Committee
- NMR Facility Strategic Committee
- Mass Spectrometry and Proteomics Facility Management Committee

Underpinning the Bio21 Institute's research and technology capabilities is a portfolio of operational, administrative, maintenance and research support activities. These include management of high end laboratory facilities, common areas, communications, event management and conference facilities, meeting spaces, laboratory services, administration and EHS for more than 600 University researchers plus approximately 80 industry members.

Environmental Health and Safety

The Bio21 Institute is committed to creating a safe working environment for all staff, students and visitors. Operating under an innovative 'whole of institute' approach to EHS, this includes developing risk management within its boundaries, safety policy and review compliance with the National Audit Tool, OHS legislation and environmental legislation.

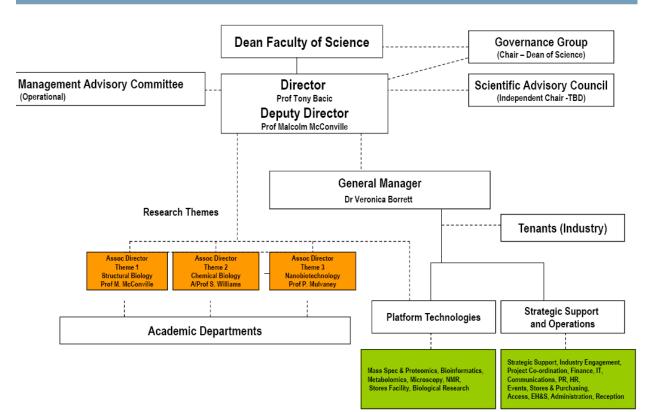
The Bio21 Institute EHS Committee operates as a working group for promulgation of safety standards, ensuring compliance and escalation of issues requiring resolution.

In 2011, the Bio21 Institute was audited by Lloyds against the National Audit Tool.





The Bio21 Institute: Reporting and Organisational Structure



Research Highlights and Achievements

The Bio21 Institute is a world class research and research training Institute built on the performance of our research groups, state of the art research infrastructure and by attracting the best and brightest researchers and research higher degree students.

Anchored by the Institute's key research themes - Structural Biology, Chemical Biology and Nanobiotechnology – the breadth of our multidisciplinarity has continued to grow over the past 12 months.

New programs and research groups play a key role in both establishing major research programs across disciplines and institutes, but also boosting the expertise and application of our platform technologies that enhance our 'in house' expertise and application.

Microbiologist joins Bio21 Institute



Professor Jose Villadangos (pictured above) joined the Department of Biochemistry and Molecular Biology at the Bio21 Institute.

Professor Villadangos comes to us from Walter and Eliza Hall Institute for Medical Research with his team relocating in December.

Professor Villadangos has multidisciplinary research interests in cellular immunology, cell biology, membrane biochemistry, imaging and proteomics. His appointment is across both the Departments of Biochemistry and Molecular Biology department and Microbiology and Immunology (Peter Doherty Institute) which brings exciting developments and opportunities to enhance cross-disciplinary collaboration.

Dengue virus spread blocked by fruitfly bacteria

By infecting mosquitoes with bacteria from flies that commonly live in kitchen fruit bowls, researchers have potentially halted the insects spreading the dengue virus.

The work was conducted by an international team of scientists from the Eliminate Dengue program, and was published in two papers in the journal *Nature*.

Co-authors include researchers from the University of Melbourne, Monash University and James Cook University. The second paper also shows how the fruitfly bacteria was established in wild mosquito populations, offering a practical and inexpensive way to stop transmission of dengue fever which affects 50 million people annually.

The strain of dengue-blocking bacteria, called wMel Wolbachia, was first discovered in Australian fruit flies in 1988 by Professor Ary Hoffmann from the Department of Genetics and Zoology and Bio21 Institute, University of Melbourne.

Essentially the Aussie fruit bacteria can effectively immunise mosquitoes against dengue, thereby preventing its spread to humans.

The finding has the potential to halt the spread of the dengue virus which is vital as there is currently no vaccine and the geographical areas of infection are growing.



Professor Ary Hoffmann

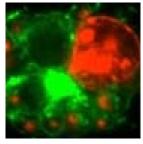
What parasites eat is the key to better drug design

A team led by Professor Malcolm McConville from the Department of Biochemistry and Molecular Biology, developed a new analytical method which can be used for many infectious parasites and bacteria. The technique revealed which metabolic pathways are essential for the parasite's survival, down to the particular atoms it uses as a food source.

A significant breakthrough in this field, the new method allows researchers to learn more about these dangerous pathogens and how they live, therefore allowing them to develop new, effective drugs to help fight them.

Current anti-parasitic drugs have enormous side effects as they don't target specific pathogen metabolic pathways. With a greater understanding of *Leishmania* researchers can now develop specific drugs with minimal side effects.





Professor Malcolm McConville (left) Images of the Leishmania parasite (right)

The team studied the parasite's metabolism by labelling carbon atoms in its food source (the sugar glucose) and using cutting-edge equipment including nuclear magnetic resonance (NMR) to follow how the atoms were used in the parasite's metabolism. The results revealed which of the metabolic pathways are essential to Leishmania's survival, and therefore good drug targets to block and kill the parasite.

The parasite *Leishmania* was used to develop the technique as its complex life cycle and ability to infect many animals makes treatment very difficult and limits the effectiveness of a vaccine. *Leishmania* causes a range of infections in humans, from skin conditions to organ infection which can be fatal. The parasite lives within tiny sandflies which bite an animal or human to get the blood they require to produce eggs, thereby passing on the *Leishmania* parasite.

The study was published in the international Journal of Biological Chemistry.

Hybrid possum gives endangered species a chance

Geneticist, Dr Andrew Weeks working with a team of scientists from the Victorian Government's Department of Sustainability and Environment, Healesville Sanctuary and a wildlife consultant took six male Mountain Pygmypossums, caught in the wild at Mt Hotham and released them at Mt Buller.

By temporarily re-locating the Mt Hotham males into the territory of females at Mt Buller during the breeding season they have succeeded in producing the first wildborn male Pygmy-possum with genetic features from both populations.

The isolated populations of Mountain Pygmy-possums, Australia's only hibernating marsupial and confined to Alpine environments, had lost all genetic diversity and relocation was vital.

The smaller populations meant the species was open to inbreeding which would affect their ability to survive and adapt to change and the hybrid offspring would reinvigorate the species.

Mountain Pygmy-possums have one breeding season per year and can have up to four young at one time. In the wild during winter they hibernate at 2°C for up to six months under the snow.





Dr Andrew Weeks (left); Endangered species the Mountain Pygmypossums (right). Photo of Pygmy-possum, Dean Heinze.

Funding boost for Victorian Organic Solar Cells Project

A \$3.5 million grant from the Victorian and Federal Governments provided researchers from the Victorian Organic Solar Cell Consortium (VICOSC) with funding to further develop their revolutionary plastic solar cells and bringing Victoria one step closer to achieving a sustainable future.

The funding was announced by Minister for Energy and Resources Michael O'Brien and his Commonwealth counterpart Martin Ferguson as part of a new round of funding for the Organic Solar Cells Project from the Victorian Government Department of Primary Industries and the Australian Solar Institute (ASI).

Scientists from the University of Melbourne, CSIRO and Monash University produced the flexible, plastic solar cells, printed with a light sensitive ink to convert sunlight into energy. The new grant allowed for the development of new materials and devices for the printing process, enabling production of inexpensive, mass produced solar panels.

With an aim to produce prototype solar cells printed on plastic and steel substrates within three years, the researchers have teamed up with industry partners including BlueScope Steel, Innovia Films and Robert Bosch South East Asia to expand the activities of VICOSC.

It is expected the new solar cells will drastically increase the use of solar electricity in Australia, making the cost of production of the panels affordable and accessible.



Pictured L to R: At the funding announcement at the Bio21 Institute, Dr Gerry Adams (VICOSC CSIRO), Mr Michael O'Brien, Victorian Minister for Energy and Resources, Mr Martin Ferguson, Federal Minister for Energy and Resources, Dr David Jones (VICOSC, Bio21 Institute) and ASI Chairman Michael Sargent. (Photo: M Silver).

ARC Australian Professorial Fellow joins Bio21 Institute

In 2011, ARC Australian Professorial Fellow, Professor Leann Tilley joined the Bio21 Institute as a new member of the Department of Biochemistry and Molecular Biology. Relocating her group from Latrobe University, her research focuses on the study of the malaria parasite, *Plasmodium falciparum*. One of mankind's major pathogens, *Plasmodium falciparum* kills about 780 thousand children every year.

Using the state-of-the-art platform technologies available at the Bio21 Institute's Microscopy facility, her team aims to image the machinery that the parasite uses to modify the red blood cells it invades, thereby causing disease pathology.

They are also interested in the remarkable transformation that turns parasites banana-shaped that prepares the malaria parasite for transmission from a human to a mosquito.

The team is also investigating the action of and resistance to the antimalarial drug, artemisinin, with a view to designing better drugs.

New microscopy imaging methods are enabling biologists to study molecular machines in a whole cell with views of the insides of malaria parasites which may lead to new strategies to combat this major disease. This revolution in cell biology based on improvements in imaging technologies, coupled with new super resolution microscopy techniques, is helping bridge the gap between cellular and molecular levels.



Professor Leann Tilley (above) is also Deputy Director of the ARC Centre of Excellence for Coherent X-ray Science (CXS)

Not just another brick in the (plant cell) wall

In a new study revealing key steps for controlling plant growth, Professor Tony Bacic along with colleagues from the ARC Centre of Excellence in Plant Cell Walls, School of Botany and the Bio21 Institute, at the University of Melbourne, have shown how the assembly of components of the plant cell wall regulates growth of root hairs.

Root hairs are important structures that allow plants to absorb essential nutrients and water from the soil. The research will assist in contributing to the sustainability of Australia's plant -based industries such as, agriculture, horticulture and forestry.

Plant cell walls (plant biomass) represent the world's largest renewable resource and have become a major new driver of international research due to their central role as renewable sources of transport fuels, as functional foods to improve human health, and as a source of raw materials for industrial processes.

The study was published in the international journal *Science*.

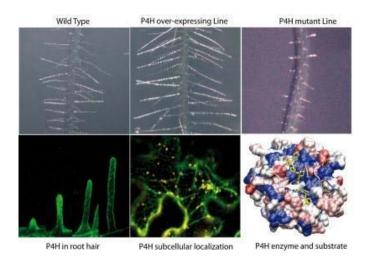


Image by Jose M. Estevez, Ph.D., CONICET jestevez@fbmc.fcen.uba.ar

Multiple awards recognise a career in NMR Spectroscopy



Professor Frances Separovic, elected Fellow of the Biophysical Society USA and recipient of the 2011 ANZMAG Medal.

In 2011, Professor Frances Separovic from the School of Chemistry and Bio21 Institute, was recognised by the scientific community both in Australia and overseas, for her significant contribution to the field of biophysics and Nuclear Magnetic Resonance (NMR) research.

Professor Separovic was elected a Fellow of the Biophysical Society of the USA in recognition of her pioneering research using solid-state NMR techniques to study the structure and dynamics of membrane-associated polypeptides.

Fellows are elected based on their demonstrated excellence in science, contributions to the expansion of the field of biophysics, and support of the Biophysical Society.

A second award followed later in the year at the 2011 Australian and New Zealand Society for Magnetic Resonance (ANZMAG) Conference where Professor Separovic was awarded the ANZMAG Medal.

The ANZMAG Medal is awarded in recognition of outstanding contributions to magnetic resonance which may also include contributions to NMR teaching and service to the discipline.

Melbourne Laureate



Professor Eric Reynolds, CEO of the Oral Health CRC and Head of Melbourne's Dental School was appointed a University of Melbourne Laureate Professor in 2011.

The honour, rarely bestowed, is reserved for the most distinguished members of academic staff at the University of Melbourne.

The appointment recognises the extraordinarily high standing Professor Reynolds enjoys within the University of Melbourne as well as both nationally and internationally.

In 2011, Professor Reynolds was also recognised by the International Association for Dental Research (IADR) for his significant contribution to the field of dental research with an award presented at the San Diego Conference.

2011 Woodward Medal



Professor Ary Hoffmann, an Australian ARC Laureate Fellow with the Departments of Genetics and Zoology at the Bio21 Institute was awarded the University of Melbourne 2011 Woodward Medal in Science and Technology.

Recognised as an international leader for his work in the areas of climate change adaptation and pest control, Professor Hoffmann was awarded the prestigious award for his contributions to the renowned journals *Science* and *Functional Ecology*.

The work in *Science* painted a clear picture about fundamental genetic limits to expected evolutionary responses imposed by genetics. The work in *Functional Ecology* showed that widespread species can lack adaptive potential for some traits, including adaptation to high temperature, critical for dealing with future climate change.

The University of Melbourne's Woodward Medal is awarded to staff recognised for research considered to have made the most significant contribution in their field during the previous three years.

2011 Victoria Fellowship



Dr Brett Paterson features in a Business Victoria YouTube video.

Synthetic Chemist Dr Brett Paterson, was one of six early career researchers to be awarded a prestigious 2011 Victoria Fellowship.

Dr Paterson from the School of Chemistry at the Bio21 Institute was awarded a 2011 Victoria Fellowship in recognition of his research into new diagnostic molecular agents for use in detecting early stage cancer.

During his postgraduate studies Dr Paterson designed a new chemical reaction for molecules that can help to target tumours. The technology allows clinicians to detect cancerous tissues in patients non-invasively, producing high quality images to diagnose tumours and then monitor treatment. The research has led to a patent that has been licensed to Clarity Pharmaceuticals.

The award will allow Dr Paterson to travel to King's College, London, to use the copper-64 radioactive isotope, a technology that is not yet available in Australia, to test out the efficacy of the molecules he has developed.

The Victoria Fellowships, each worth \$18,000, recognise early career researchers with leadership potential and help to enhance their future careers, while developing new ideas and undertaking specialist training overseas which could ultimately offer commercial benefit to Victoria.

NHMRC Science to Art Award for 'Spooning'

Bio21 Institute Electron Microscopy Facility Manager and Research Fellow, Dr Eric Hanssen was awarded the 2011 NHMRC Science to Art Award for his image entitled 'Spooning'.

The image (pictured below) shows a 3D segmentation model of the stack Maurer's cleft from the main malaria agent, *Plasmodium falciparum*.

These structures are responsible for the export of the principal virulence factor of the parasite.

The pictured segmentation model was made with IMOD from an electron tomogram of a whole *Plasmodium* falciparum parasite. The rendering was done with Blender.

Imaging, now a central component for medical research is both scientifically important, and can also be aesthetically powerful.

The NHMRC Science to Art prize recognises outstanding examples of the art that can arise from the research funded by NHMRC. The Council of NHMRC judged the most outstanding electronic image generated by NHMRC funded research.



Tthe award winning image 'Spooning'. Photo: Eric Hanssen.

Interdisciplinary research

In 2010, the Bio21 Institute established three broad research themes with the focus to build on synergies and programs that align our basic and strategic research strengths across medicine, science and engineering and with our key platform technologies.

Under the leadership of three Associate Directors, the themes have developed over the past 12 months, providing an anchor for exploring interdisciplinary opportunities.

Achievements have been in alignment with the strategic vision ranging from increased cross disciplinary collaborations resulting in research publications, development of our platform technology capability and expertise and an injection of new skills and knowledge from new appointments to the Institute.



Picture above: The Bio21 Institute key platform technologies underpin research at the Bio21 Institute. (Photo: J Vittorio.)

Bio21 Institute Interdisciplinary Research Themes

- Structural Biology, which provides an understanding of the organisation of complex biological systems and molecular processes that underpin normal cellular development and disease.
- Chemical Biology uses small molecules and chemical methods and techniques to illuminate and enrich our understanding of biology, human health and disease, and environmental ecosystems.
- Nanobiotechnology that brings together the physical and life sciences with engineering, working at the sub-nano scale, to provide a new level of health, agricultural and environmental research.



Picture above: The Bio21 Institute Business Incubator is linked to the main Bio21 Institute building.

(Photo: M Silver.)

Structural Biology



Theme Leader and Deputy Director, Professor Malcolm McConville

The Structural Biology theme covers research that is directed at understanding cellular processes that underpin normal cellular development and human/animal diseases, as well as the development of new tools for monitoring human impact on the environment. This research is underpinned by major platforms and capabilities in the Bio21 Institute including NexGen DNA sequencing, proteomics, metabolomics, protein expression and protein structural characterization, and high resolution imaging of cellular structures using fluorescence and electron microscopy.

Major research highlights in 2011 included:

- mapping of the genome of the Australian sheep blowfly, the primary cause of flystrike in sheep and an agronomically important pest (*BMC Genomics*, 2011)
- developing new strategies for controlling dengue virus by biological control of mosquito life span (*Nature* 2011, 2011)
- utilising proteomic approaches to identify protein modifications that underlie inflammatory immune responses (*Nature*, 2011)
- developing new mass spectrometry-based metabolomics approaches for identifying drug targets in microbial pathogens (*J Biol Chem*, 2011).

As part of the University of Melbourne's Interdisciplinary Seed Funding Scheme, the Institute also funded or cofunded a number of projects involving Bio21 researchers that further highlighted the diversity and breadth of basic and applied research being undertaken under the Structural Biology Theme.

These projects involve multiple research teams and are directed at:

- developing new peptide sensors for detecting cancerrelated protein in blood samples
- imaging protein aggregates that underlie neurodegenerative diseases in situ
- characterizing protein receptors on blood cells that could be exploited to prolong the life time of novel therapeutic proteins in the bloodstream
- understanding the mode of action of novel anti-diabetic drugs
- studying very small membrane vesicles in milk that could be used to deliver genetic material and other molecules.

In addition to providing researchers with access to stateof-the art facilities, members of the institute's platform technologies continue to play a key role in developing the methodology that underpins these platforms.

The Bio21 Institute Mass Spectrometry and Proteomics Facility houses one of the largest proteomics facilities in Melbourne providing advanced protein/peptide analysis as well as specialized applications such as bacterial biotyping. Drs Nick Williamson and David Perkins (a coappointment with VPAC), have developed new software tools that facilitate the rapid analysis of proteomic workflows. Highlighting both the capability and rapid developments in this area, Dr Williamson and colleagues have expanded the list of peptides recognized by the human immune system by more than two orders of magnitude over the last 2-3 years (>1200 per cell).

The Bio21 Institute houses a second major mass spectrometry facility in the NCRIS Metabolomics Australia (MA) laboratory. The analytical and bioinformatics groups associated with the Bio21 MA facility have also been involved in the development of new hyphenated mass spectrometry methods for analyzing complex biological samples, such as blood, urine, tissues. This group interacts with a wide range of researchers from academia, industry and Government from around Australia. They are leading the way in identifying metabolite biomarkers for a number of important human diseases such as malaria (*Plasmodium falciparum*) and melioidosis (Berkholderia), and have joined a consortium of Australian cancer researchers to study melanoma.

Chemical Biology



Theme Leader Associate Director, Dr Spencer Williams

The Chemical Biology theme seeks to develop a molecular understanding of biological processes and to control and manipulate these processes using small molecules. Translational outcomes include the development of therapeutic agents based on new insights into the causes of disease or for the control of insect pests.

The chemical biology theme requires significant molecular and materials characterization capabilities and is supported by platform technologies including the Bio21 Institute's NMR facility, X-ray diffraction capabilities, and mass spectrometry and separation science capabilities within the mass spectrometry and proteomics facility. NMR upgrades have enhanced the Bio21 Institute capabilities. With the support of an ARC LIEF grant, the capability provides automated sample analysis and enhances the throughput of this heavily utilized facility.

Major research highlights in 2011 around the Chemical Biology theme included:

- developing antioxidant selenosugars and paramagnetic AT(1) receptor antagonists (Chem Commun, 2011)
- identifying mycobacterial glycolipids as selective natural killer T cell activators (Nature Immunol, 2011)
- using cobalt complexes to stimulate neuroprotective proteins for treatment of brain injury (*J Biol Chem*, 2011)
- using Copper(II) complexes that protect against oxidative damage and prolong survival of Amyotrophic Lateral Sclerosis mice (J Biol Chem, 2011).

Commercial achievements related to the theme include:

- University of Melbourne spinout biotechnology companies including Fibrotech Therapeutics (antifibrotic drug development), Clarity Pharmaceuticals (metal-based imaging), NeuProtect (cardioprotective drugs) and Procipra (metal-based therapeutics).
- Strong collaborative interactions with Bio21 Institute members and Prana Biotechnology (neurological drug development) located in the Bio21 Institute business incubator.
- Award of a drug development grant by FastForward and EMD Serono for sodium channel blockers for multiple sclerosis.

University of Melbourne Interdisciplinary Seed Funding and an independent co-investment from the Bio21 Institute supported projects in the area of stem cell drug discovery and kinase drug development.

Nanobiotechnology



Theme Leader
Associate Director,
Professor Paul Mulvaney

At the Bio21 institute, the Nanobiotechnology theme captures the importance of new materials and new instruments for driving progress in biotechnology. Key instrument platforms that underpin this theme include the Bio21 Institute's in-house environmental scanning electron microscopy (ESEM) for direct visualization of cells and biomaterials, as well as a 300kV cryo-TEM for imaging soft matter and hydrated biological specimens. A state of the art focused ion beam instrument is also available for nanofabrication.

In 2011, new instruments supported by ARC LIEF funds included a new Asylum Instruments MFP atomic force microscope for probing cellular mechanics, nanoscale and atomic topography, determination of cell, protein and polymer elasticity and cellular adhesion. This instrument will be coupled with a laser confocal excitation system in 2012 to allow simultaneous fluorescence and AFM topography imaging.

A second LIEF grant in 2011 will fund a new OMX super resolution light microscopy system with 10nm spatial resolution. These new instruments allow Bio21 Institute researchers and scientists from across the broader community with access to the leading edge in sample imaging.

The Nanobiotechnology theme is also focused on the development of new materials with potential biotechnology application. For example, Bio21 Institute scientists are working on dendrimers, quantum dots, plasmonic biosensors, self-assembled nanostructures, magnetic nanocrystals for MRI and PET imaging reagents, for drug delivery, artificial bone and teeth. This work draws together Bio21 Institute scientists and collaborators at the Ludwig Institute, CSIRO, St Vincent's Hospital, Monash and RMIT Universities along with other universities and research institutes.

Nanobiotechnology Theme relates to solar energy conversion and artificial photosynthesis. Current world leading work at the Bio21 Institute focuses on conducting polymers, carbon nanotubes and quantum dots for photovoltaic (PV) devices through the VICOSC consortium. The ultimate goal for this field is sustainable (bio)chemical fuel production from sunlight. The ARC Centre of Excellence in Plant Cell Walls is also studying the feed stocks needed in these applications.

Key new partnerships related to the theme include:

 Defence Science Institute (DSI) to develop platforms for biosecurity applications

Major research highlights in 2011 around the Nanobiotechnology theme included the following projects:

- Developing nanocrystals for biolabelling applications
- Developing organic solar cells to supersede silicon based PV
- New drug delivery vehicles using self-assembly.
- New biosensors for detection of pathogens and biological molecules such as Hendra virus.
- Developing the Quantum Decoherence Microscope
- Observing single molecule binding events in biological systems via plasmonic sensors

Interdisciplinary seed funding

The University of Melbourne's commitment to tackling society's big picture issues is the aim of the Interdisciplinary (ID) Seed Funding Scheme. The scheme continued in 2011 with Bio21 Institute taking the lead in facilitating the overall 'biotechnology' theme.

Seven projects were supported in 2010 by the Bio21 Institute and the University's Melbourne Research Office for commencement in 2011. An additional project was part funded by both the Bio21 Institute and Melbourne Materials Institute. These ranged from development of new therapeutics including novel compounds for treating neurodegenerative diseases, antibacterials and novel therapeutics for preventing brain damage during trauma, the use of NMR to study prebiotics and gut heath and new methods to increase the bioavailability of key nutrients in biofortified cereals.

The 2011 round of projects similarly provided a range in research applications with collaborations from Melbourne's Research Institutes, multiple departments and industry.

Funding for eight projects was awarded in 2011 for commencement in 2012.

2011 projects

Grants funded from the Melbourne Research Office

- Hatters, Hannan, Petrou (\$50K) Building an "Aggreomics" paradigm for neurodegenerative disease
- Mulhern, Williams, Parker (\$50K) Understanding the mechanism of action of a new type II diabetes drug.
- Cheng, Graham, Tuck, Nandurkar (\$50K) Self-Reporting Fluorescent Chemosensor Peptide Substrates as Molecular Sensors of Src Kinase Activity in Platelets – Development of a Sensitive and Reliable Assay of Platelet Function

Funded by Bio21 Institute

- Gleeson, Dower (\$50K) Intracellular trafficking and function of the membrane receptor FcRn which prolongs the serum half-life of novel therapeutic proteins.
- Williams, Pera, Savage (\$30k) New molecular regulators of stem cells in the central nervous system – an interdisciplinary approach
- Morfa, Rijs, Khairallah, da Silva (\$30k) Nanoparticle Films for Catalytic Capture and Reuse of Carbon Dioxide.

 Hill, Gras, Scheerlink (\$50K) Measuring milk quality through miRNA profiling of milk derived exosomes and microvesicles; a role for dietary miRNA?

Grant part-funded by Bio21 Institute with equal contribution from Melbourne Materials Institute

 Tran, Hocking, O'Connor (\$20K from Bio21, \$20K from MMI) Developing Nanocomposites for Soft Tissue Regeneration

2010 ID Project in focus 'Soluble Fibre for Increased Gut Health'

Researchers: Dr Sally Gras, the Department of Chemical and Biomolecular Engineering; Associate Professor Sandra Kentish, Chemical and Biomolecular Engineering; Associate Professor Paul Gooley, Department of Biochemistry and Molecular Biology; Dr Aaron Gosling, Department of Chemical and Biomolecular Engineering; and Dr Filomena Pettolino, School of Botany.

Gut health is critical for the prevention of disease and promotion of community health. Yet our understanding of the complex interactions between food, microbes and the gut is far from complete.

Aim: This project applied innovative NMR techniques to unravel the interactions between important gut microbes and the beneficial prebiotic compounds produced by some bacteria. These prebiotic compounds can increase immune function, increase mineral absorption and decrease the risk of cancer.

The study provides new insight into microbial metabolism that will aid our understanding of gut disease and provide opportunities for preventative health products.

Cross institutional, national and international

High calibre research conducted in the world renowned Parkville Biosciences Precinct provides a major catalyst for researchers to come together and explore opportunities beyond their immediate research interests.

In 2011, researchers at Bio21 Institute were actively collaborating with researcher colleagues from institutes within the University and across the wider Parkville Biosciences Precinct and beyond. They include the Ludwig Institute for Cancer Research, Walter and Eliza Hall Institute of Medical Research, CSIRO, LaTrobe University, Deakin University, Monash University, RMIT University, St Vincent's Institute for Medical Research, Royal Melbourne Hospital, Women's Hospital, Royal Children's Hospital and the Murdoch Children's Research Institute, Peter Mac Institute and Swinburne University.

As one of the University's 'bricks and mortar' research institutes, we are interested in exploring opportunities to develop links and collaborations with other flagship University research Institutes. This includes the University's Materials, Energy and Neurosciences Institutes, and the Defence Science Institute (DSI). These links are being fostered to ensure that potential synergies are maximised.

The emerging field of Bioinformatics and the significant opportunities that are provided by collaborations with the Victorian Life Sciences Computational Initiative (VLSCI) and the IBM Research Collaboratory are also a key area being explored by the Institute with a number of research links and collaborations already underway.

Our premier location in the heart of the Parkville Biosciences Precinct, one of the world's most concentrated areas of biomedical research, and our membership of the Bio21 Cluster is a key to attracting world-class researchers and an ideal location for new 'omics platform technologies.

Across the country and internationally, research collaborations continue to flourish building on the strength of existing relationships. Many new collaborations and strategic research projects have also been developed. These include opportunities fostered from mobility grants offered from organisations including the Australian Academy of Science.

The breadth of our international reach includes research collaborations across a number of organisations and countries.

Austria – Innsbruck University; Graz University **Canada** – McGill University; University of Toronto; University of Calgary;

China - Chinese Academy of Biophysics; Nanjing Agricultural University;

Czech Republic - Czech Academy of Sciences

Denmark – University of Copenhagen; Aarhus University

France – Curie Institute

Germany – University of Munster; Liebniz-Inst of Plant Genetics and Crop Plant Research; Max Planck Institute, Golm; University of Ulm; University of Karlsruhe; IPK Gatersleben

India - University of Kolkata;

Italy - University of Padova; CERM Florence;

Japan - Tohoku University; University of Nagasaki;

Korea - Hallym University; Kyunpook University

New Zealand – Massey University; Canterbury University; **The Netherlands** - University of Groningen and the Netherlands Metabolomics Centre.

UK - York University; Scottish Crop Research Institute; University of Dundee; Cornell University; Cambridge University; Reading University; University of Leicester; USA – Energy Biosciences Institute; Virginia Tech; University of California; University of Pittsburgh; National Institute of Health Bethesda; Scripps Institute; North Carolina University; Ohio State University; Stanford University; Vanderbilt University; University of Arkansas for Medical Sciences;

Sweden – Lund University and KTH.

In 2011, the Bio21 Institute hosted visiting scientists from industry and academia. This included scientists from both Australia and overseas ranging from short visits and collaborative meetings to sabbatical programs with participating research groups and departments.

Industry and Government collaborations

The number of research projects with industry and government collaborators continued to grow in 2011. Many of the current larger research programs are well positioned in their industry and or government interactions. These include the Oral Health CRC, Centre for Aquatic Pollution Investigation and Management, ARC COE for Free Radical Research, Victorian Organic Solar Cell Consortium. ARC COE for Plant Cell Walls and work conducted by the NH&MRC Neurodegenerative research program. In 2011 the ARC COE for Coherent X-ray Science also joined the Bio21 Institute as a major node for the centre with extensive industry linkages.

Research opportunities for investigation with government departments and agencies together with industry collaboration have also continued to develop throughout 2011. The Bio21 Institute is currently working with the Defence Science and Technology Organisation, Australian Nuclear Science and Technology Organisation, Victorian Department of Primary Industries and Department of Sustainability and Environments, Melbourne Water, Environmental Protection Authority, Parks Victoria, CSL Ltd, Novartis, Dairy Innovation Australia, VPAC and IBM.

Events and Training

Bringing together Melbourne's biotech community to explore frontiers in research, technology and commercialisation is an important aspect of our operation. A range of activities include industry focussed events, seminars and conferences, practical training workshops targeting new instrumentation and frontier areas of technology.

In 2011 the Bio21 Institute hosted more than 20 industry focused events and seminars. These included seminars, presentations and demonstrations from companies including: Roche, Sigma, Diagnostic Technology, GE.

The popular Suppliers Morning Tea events continued throughout 2011 at the Bio21 Institute. Ten events provided more than 100 companies the opportunity to engage with researchers and provide visibility and discussion on new products and services.

Test Tube meets Blue Gene

To help foster even deeper collaborations as part of the IBM Research Collaboratory-Melbourne partnership, researchers from the Bio21 Institute hosted four IBM researchers for a mini-sabbatical from May 30 to July 1, 2011.

Associate Professor Matthew Perugini (Department of Biochemistry and Molecular Biology, Bio21 Institute) and his research group hosted IBM research staff, Dr John Wagner, Dr Matthew Downton, Dr Stephen Moore and Dr Matthias Reumann. With backgrounds in high performance computing, mathematics and/or physics the team were looking to develop their expertise in biological wet lab experimentation.

The mini-sabbatical aimed to expose the IBM researchers to basic life science research at the bench that will lead to determination of the crystal structure of the dihydrodipicolinate synthase (DHDPS) enzyme which is of interest to the Perugini team therefore providing sufficient data for a publication and potential for further computational studies on this enzyme on the Blue Gene Supercomputer.

Enabling Platform Technologies

Underpinning contemporary biotechnology research are core platform technologies which help us to understand the composition, structure and interaction of molecules.

The Bio21 Institute has made significant investment in platform technologies and the intellectual capital necessary to maintain such capabilities at the cutting edge. In particular we have created critical mass in the areas of nuclear magnetic resonance (NMR) spectroscopy, mass spectrometry and proteomics, imaging (electron and optical microscopy), metabolomics and peptide synthesis making them accessible to a range of users from across academia, government and industry.

In addition, the opportunity to build critical mass in key areas is of major importance allowing for stronger collaborations, sharing of expertise and benefiting from economies of scale. The Bio21 Institute has strong connections with platform capabilities in University departments and affiliated research institutions including the Walter and Eliza Hall Institute, the Australian Synchrotron, Victorian Life Sciences Computational Initiative and NCRIS platforms.

More broadly, the Bio21 Institute's key platforms are also part of the Victorian Platform Technology Network through the Bio21 Cluster – a Victorian Government initiative which aims to connect Victoria's biomedical and biotechnology capabilities and to capture opportunities and benefits of the concentration of capability across Victoria.



Researcher Jenny Chambers (above) at the 800 MHz NMR Spectrometer. Photo: VPTN Bio21 Cluster

Nuclear Magnetic Resonance

Nuclear Magnetic Resonance (NMR) spectroscopy determines the structures of molecules ranging from small chemicals to macromolecular proteins and nucleic acids. It is particularly useful for the analysis of proteins that cannot be crystallised, and for investigating interactions between proteins, biological membranes and ligands, including potential new drugs.

Incorporating instruments from the University of Melbourne Departments of Biochemistry and Molecular Biology and Chemistry and the Walter and Eliza Hall Institute, the Bio21 Institute facility houses nine NMR spectrometers ranging from 300 to 800 MHz, making it the largest high field facility in Australia.

Instruments include:

- 400 MHz NMR Varian INOVA system equipped with broadband probe
- 500 MHz NMR Varian INOVA system and Bruker Avance II with cryoprobe
- 600 MHz NMR Bruker Avance III with cryoprobe and autosampler, Varian VNMRS system and Bruker DRX
- 800 MHz NMR Bruker Avance II with cryoprobe and autosampler (pictured left)
- 300 and 600 MHz NMR Varian INOVA solid-state spectrometers.

Key applications include:

- Superior ligand screening using cryogenic probes
- Methods development including protein (macromolecular) structure elucidation (solution, solids)
- Screening for novel drug leads
- Range of nuclei including ¹H, ¹³C, ¹⁵N, and ³¹P and low gamma nuclei
- Metabolomics
- Methods for examining peptides in biomembranes

Highlight for 2011

In 2011, the University of Melbourne, Bio21 Institute in collaboration with RMIT University were successful in an ARC LIEF grant totalling \$1.23 million. The project focusing on advanced characterisation of materials by NMR will support a broad range of research possibilities for development of advanced materials for medical, industrial and environmental applications. Funding will allow for upgrades to NMR capability including an upgrade to the Bio21 Institute 500 MHz and 600 MHz spectrometers and purchase of a new 400 system with associated robot.

Electron Microscopy

The Bio21 Institute Electron Microscopy (EM) Facility provides high quality facilities for physical sciences, life sciences and engineering applications.

The Bio21 Institute's Electron Microscopy Facility is a key participant in the broader University of Melbourne Advanced Microscopy Facility - bringing together multiple disciplines ranging from biochemistry to botany, microbiology to anatomy and cell biology, physics, engineering and nanotechnology.

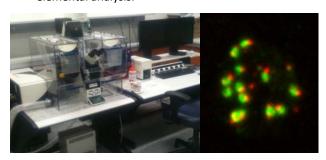
With multiple nodes across University departments, Melbourne's Advanced Microscopy Facility is a well established suite of state of the art electron and optical microscopes located across multiple nodes catering to the spectrum of scientists from academia, industry and government.

The Bio21 Institute node comprises high end electron microscopes available to academic and industry users on a subscription or fee for use basis.

The Electron Microscopes include:

- Tecnai F30 Transmission electron microscope a key Victorian high-resolution cryo-electron microscope for structural investigation of biological molecules. The cryo TEM is equipped with an anti-contaminator and cold stage which allows imaging of quick frozen samples as well as tomography in either room temperature or cryo conditions. The main application of this microscope is in the structural investigation of biological macromolecules, cells and tissue in 3D. It can also be used for material science when 3D data or cryogenic conditions are necessary.
- Tecnai F20 Transmission electron microscope. A high-resolution TEM for materials science applications with HAADF (STEM) detector and EDAX system.
- FEI Quanta scanning electron microscope (ESEM) An Environmental Scanning Electron Microscope fitted with a Peltier cold stage operating from -25 to + 40°C.
- FEI Nova dual beam, focussed ion beam system. The Nova Combined SEM and gallium ion beam instrument is equipped with EDAX, Pt-deposition system and micromanipulator. Suitable for device cross-sectioning, TEM sample preparation, nanofabrication and 3D reconstruction using the Slice and View system.

 Philips XL-30 Scanning Electron Microscope equipped with an X-ray microanalysis system for elemental analysis.



Leica SP5 confocal microscope dedicated to live cell imaging. Photos: Dr Eric Hanssen

Highlights for 2011

BEAM workshop: More than 150 scientists attended the Biological Electron and Advanced Microscopy workshop at the Bio21 Institute. Most of the research institutes in the Greater Melbourne area were represented. Supported by industry partners Leica Microsystems and Nanotechnology Systems, the day's program included presentations ranging from EM of Biological samples, Immuno-labelling, standard and diagnostic EM, EM in biocontainment, correlative and advanced fluorescence microscopy and single particle EM. Similarly presenters across Victoria's EM community were guest speakers.

New Leica UC7 microtome installed: The facility has installed three microtomes, two Reicherts UltraCut E (Bio21 and Botany) and a brand new Leica UltraCut 7 (Bio21).

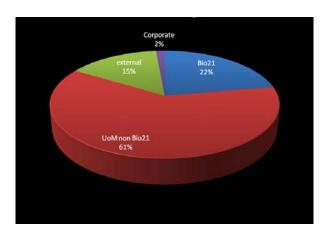


Chart of Microscopy facility users 2011 (above)

Mass spectrometry and proteomics

The Bio21 Institute's Mass Spectrometry and Proteomics Facility (MSPF) is an open access research laboratory providing access to instrumentation that is either unavailable or unaffordable to the general biotechnology community. With five mass spectrometers and three HPLC systems primarily setup for peptide/protein and small molecule research, this forms the basis of the mass spectrometry and proteomics platform at Bio21 Institute.

The facility offers mass analysis of small molecules to large proteins, as well as proteomics for the analysis of individual proteins up to high throughput of complex tissue samples using spot picking and digestion robots, and bioinformatic analysis.

Instruments include:

- HPLC-CHIP LC / Ion Trap XCT Plus Mass spectrometer
- Bruker MALDI-TOF Mass spectrometer
- NanoLC / Q-TOF Mass spectrometer
- NanoLC/QTRAP Mass spectrometer
- LC/ESI-TOF mass spectrometer

An extension of the MSPF is a Peptide Technology facility, which specialises in the design, synthesis and purification of modified and/or unusual peptide-based products. The purification laboratory contains three HPLC systems, offering users both high throughput and a flexible methodology, for isolating a wide range of compounds such as peptides, proteins and organic molecules.

In house specialists operate instruments and provide technical expertise for users of the facility in chemical and biological mass spectrometry, HPLC and bioinformatics. This includes training users to run their own samples resulting in a significant increase in the total number of samples that can be run through the facility.



Dr Nick Williamson MSPF Manager. Photo: VPTN Bio21 Cluster

Highlights for 2011

Launch of the new Mass Spectrometry and Proteomics Facility: A new purpose built facility was launched in 2011. The existing facility was expanded to provide additional capacity in high throughput analysis of peptides and proteins, as well as specialized applications, such as bacterial biotyping. The largest in the Parkville precinct, the facility offers ready access and training opportunities for students and postdoctoral researchers.

Bioinformatics has developed as a key capability at the Bio21 Institute. Dr David Perkins, a Proteomics Bioinformatician joined the Institute's MSPF in 2011. A joint appointment with the Victorian Partnership for Advanced Computing, this co-appointment provides key informatics and software support that is critical for high end analyses and overall builds capability in this emerging field that is helping solve complex biological problems.

New technologies: A new Bruker Biotyper system for identifying and classifying microorganisms was a new addition to the capability and instrumentation available in the Bio21 MSPF. Using protein 'fingerprints' measured by MALDI-TOF mass spectrometry, the benchtop instrument can be used to determine masses on small molecules, oligonucleotides, polymers, peptides and intact proteins. The instrument is fast, efficient and easy to use providing results in minutes as opposed to hours.

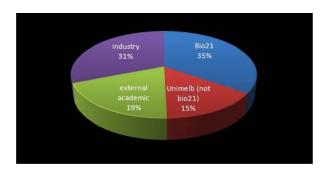


Chart of Mass Spectrometry users 2011(above)

Metabolomics Australia

The Metabolomics Australia (MA) Facility located at the Bio21 Institute and the School of Botany at the University of Melbourne is a key national research service facility. As part of the Australian Government's National Collaborative Research Infrastructure Service Bioplatforms Australia investment into 'omics' technologies, researchers at the University of Melbourne node work with node partner organisations including the University of Western Australia, the Australian Wine Research Institute, Murdoch University and the University of Queensland to provide infrastructure and expertise to the wider Australian research community.

A major focus of the MA facility is small molecule (metabolome) analysis on bio-medical samples looking at fundamental processes in disease and developing new diagnostics for both disease health as well as in environmental and agri-food related research.

Supported by a dedicated team of analytical chemists/biochemists and bioinformaticians, MA provides a comprehensive end to end service. Analysts work closely with clients and collaborators providing advice on the design of projects, experiments, developing methods specific to their biological system and questions, as well as training in sample preparation, instrumentation and data processing.

Specifically, the Metabolomics Facility provides both targeted and untargeted analysis of polar and lipidic small molecules on a variety of different biological systems including microbes, biofluid and tissues using LC-MS, GC-MS and NMR technologies.

To complement the analytical service, a sophisticated Metabolomics Australia Bioinformatics capability is also part of the overall platform. Bioinformaticians work alongside analytical researchers to develop tools enabling more efficient data processing, statistical analysis, data visualisation and information management leading to improved biological interpretation.

Services include:

- Variety of sample types (cells, media, biofluids, tissues)
- Sample preparation & tissue extraction
- Untargeted metabolite analysis
- Targeted metabolite analysis
- Bioinformatics data analysis and visualisation
- Methods development
- Skills training
- Research hotel

Highlight for 2011 (Bio21 Institute node)

- Consultation and /or analytical services to more than 35 different users on about 40 different projects.
- Typical users range from local, national and international researchers from academic, government departments and industry.
- Projects range from biomedical, environmental and nutrition fields.
- Installation of a new LC-QQQ-MS for targeted analysis including lipidomics analysis.

Australasian Metabolomics Conference

The MA team based at the Bio21 Institute and School of Botany organised and hosted the 2010 Australasian Metabolomics Conference. With more than 120 attendees, the conference provided delegates with a diverse program with international speakers including Dr Jules Griffin from Cambridge Systems Biology Institute from UK and Professor Edward Dennis from University of California San Diego USA. To complement the conference, a three day workshop was held with a program showcasing our expertise and facilities with hands on training in a variety of analytical and bioinformatics methods and specialist seminars.



(Pictured: Metabolomics Australia Facility Manager at the Bio21 Institute, Dr Dee Tull. Photo: VPTN Bio21 Cluster)

Education, Training and Development

With a large community of early career researchers and students at the Bio21 Institute, a focus is paramount to facilitate programs that aid in their training and career development.

The opportunity to partner with programs that train and develop senior secondary school students and TAFE students is also part of the Institute's education, training and development objectives.

A range of programs continued in 2011 supporting Honours, Masters, Postgraduate students and Postdoctoral researcher levels. Programs range from the Bio21 Institute Postgraduate Travel Award Scheme through to supporting member driven initiatives such as the annual Bio21 Institute Research Symposium led by the Research Assistant and Postdoctoral Research Fellow Association also known as RAPD.

Ultimately, support, both financial and advisory, help strengthen our internal community by providing our next generation of researchers with valuable experience and skills relevant in today's biotechnology sector.

A range of programs for a range of groups

Bio21 Institute Vacation Studentships

A six to eight week summer vacation program provided students with an opportunity to gain invaluable laboratory and research experience. A limited number of studentships for suitably qualified students with an interest in pursuing future studies in an honours program are offered.

In 2010/11 two Bio21 Institute supported studentships were placed. For the 2011/12 period, a further five students were supported.

Masters in Biotechnology Program

As a flagship institute of the University in the biotechnology sector, the Institute is in a key position to contribute to Masters of Science Programs. Emerging areas of bioinformatics, key platform technology areas and business development and industry linkages, allow members to add valuable elements to courses and training.

Since 2009, microscopy specialists have participated in a microscopy course that forms part of the Masters in Biotechnology program. In 2011, two modules commenced for the Masters in Biotechnology program - Metabolomics and Proteomics and, Genomics and Bioinformatics.

Research and laboratory skills training for secondary school students

Three new students from Coburg Senior High School's commenced their trainee/apprentice program at the Bio21 Institute in 2011.

The program is a partnership between Coburg Senior High School, the Victorian Employer Chamber of Commerce (VECCI) Bio21 Institute and the Department of Biochemistry and Molecular Biology.

Over the years, the program has hosted up to 12 students with the aim of providing them with the laboratory skills and experience as part of the trainee/apprenticeship program and to inspire them to pursue science in Year 12 with the potential to further their studies in undergraduate Engineering and Science degrees.

"Ventures in Residence': To help raise awareness of IP and technology commercialisation issues amongst our members, the Bio21 Institute initiated a pilot program called "Ventures in Residence". Working with the University's commercialization arm, Melbourne Ventures Limited, the program included business development team members located 'in house' one day per fortnight providing researchers with opportunities to discuss their research and gain commercialization advice.

The "Ventures in Residence" pilot program is part of the Bio21 Institute's overall strategic vision to build skills in the development of IP and the opportunities that can evolve from potential commercialization of outcomes.



Bio21 Postgraduate Student Travel Awards

The Bio21 Institute encourages postgraduate students to broaden their experience and education. To support these programs, travel awards are intended to contribute towards students interested in attending a cross-disciplinary conference, visit laboratories to learn techniques or to enhance industry collaborations and outcomes. In 2011, the institute awarded 16 student travel awards.

Award recipients for 2011

Andrew Watt (Pathology) Alzheimer's Association International Conference on Alzheimer's Disease, France.

Chor Tek Tan (Biochemistry and Molecular Biology) HUPO World Congress, Geneva. Visit to A*Star, National University of Singapore laboratories. Visit to ABSciex Mass Spectrometry factory / Demo Labs, Singapore.

Katherine Scull (Biochemistry and Molecular Biology) HUPO World Congress Geneva; Visit to Max Planck Institute, Germany and Medical Inflammation Research, Sweden.

Patrick Shilling (Biochemistry and Molecular Biology) ConformetRX GPCR Workshop, Maui. Laboratory visits to Johnson and Johnson and National Laboratory California.

Matthew Hill (Zoology) 2nd International Conference on Biological Invasions, Argentina. Lab visit to Biodiversity Research Group, IADIZA, CONICET, Argentina.

Alexander Rey (Biochemistry and Molecular Biology) 2012 Gordon Research Conference on Protein Transport. Visit Goethe University Germany and McGill University Canada.

Melina Glasson (Chemistry) Adhesives and Consolidants for Conservation: Research and Applications Conference, Ottawa, Canada. Visit GCI, New Zealand.

David Hayne (Chemistry) 15th International Conference on Biological Inorganic Chemistry, Vancouver Canada. Visit to Bioinorganic laboratories of University of British Columbia.

Ellen Ross (Biochemistry and Molecular Biology) Immunoregulatory Networks Conference, USA. Visits to USA Labs. Sevgi Irtegun (Biochemistry and Molecular Biology) Gordon Research Conference "Mechanisms of Cell signalling" USA.

Elise Furlan (Genetics) American Society of Mammalogist Conference (USA. Visit to Portland State University laboratories.

Charles Reilly (Biochemistry and Molecular Biology)
Visualisation of Biological Data conference and
workshop, Broad Institute of Harvard and MIT, USA. Visit
to labs Center for Molecular and Cellular Dynamics at
Harvard Medical School and Proteomics facility at Broad
Institute of Harvard and MIT, USA.

Eric Tu (Genetics) Keystone Symposia Immunoregulatoy Networks, USA. Visit to labs at National Institues of Health; University of California, USA.

Loredana Spoerri (Pathology) International Conference on Alzheimer's and Parkinson's Diseases, Spain. Visit to Novartis and Roche laboratories.

Jason Somers (Genetics) Nicotinic Acetylcholine Receptors 2011 conference at ellcome Trust Genome Campus, UK. Visit labs in University of Cambridge and University of Manchester, UK.

Mohamed Iqbal Hossain (Biochemistry and Molecular Biology) Gordon Research Conference on Protein Transport. Visit University of Calgary laboratories.

Bio21 RAPD and student associations

The Bio21 Institute's Research Assistant and Postdoctoral Research Fellows (RAPD) and Postgraduate members are a dynamic group driving a significant number of institutewide programs that support learning and development.

Embracing the multidisciplinary approach, a cross section of our member representatives, connect with the aim of fostering networks and potential collaborations.

A range of initiatives led by our RAPD and student groups during 2011 include:

The annual Bio21 Institute RAPD Research Symposium

This full day symposium includes oral and poster presentations by postdoctoral fellows. The 2011 program was tailored around the Bio21 Institute's strategic research themes.

Professional Development Series

A new four part Professional Development Series was launched in 2011 by the RAPD Association. Tailored to the postdoctoral / early career researcher level, but open to all, the sessions covered topics including 'Coping with Workload', 'Managing Contracts, Contacts and Opportunities', 'Building up a track record' and 'From postdoc to group leader'.



Bio21 Institute 2011 RAPD Association members



The RAPD Association hosted special guest speaker, Professor Ross Garnaut (left) pictured with RAPD President, Dr Eleanor Saunders (Photo: Sen Han).

Careers in Biotech Forum

The Bio21 Institute's postgraduate student members were similarly active in facilitating networks and interactions across their member groups and collectively. A key focus for this group is facilitating forums to explore career opportunities within the biotechnology sector. In 2011, a Careers in Biotech Forum was held with participants from industry, government, academia and member organization.



Postgraduate students Martin Peverelli and Melina Glasson (far right) facilitate the panel discussion at the 2011 Careers in Biotech Forum (Photo: H Varnavas Bio21 Institute).

Engagement, Outreach and Events

The Bio21 Institute is engaged with a broad range of audiences and stakeholder groups from the academic, industry and community sectors.

Key areas include hosting events and outreach programs, tours and visits, and engaging within the community.

In 2011 the Bio21 Institute hosted a range of events for a range of visitors, to raise awareness about cutting edge science and showcase the state of the art facility and technologies. Visitors included University of Third Age and Rotary Groups, secondary school students, teachers, local and international graduate and undergraduate students, industry networks and members of the general public.

We are also aligned with initiatives across the University and broader biotechnology sector, including participating and hosting scientific conferences, seminars and key events.

'School to Bench to Workplace' -Bio21 Science sub-school project

Inspiring the next generation of scientists will be the focus of an innovative education initiative – the Bio21 science sub school to be located at the University of Melbourne Western Precinct. The science sub school is a partnership between the Victorian Government, the University of Melbourne, led by the Bio21 Institute and the Melbourne Graduate School of Education, University High School and Debney Park Secondary College. Year 11 and 12 students will have access to state of the art facilities at the new sub school and will gain exposure to an environment that fosters interest in science.

The project will support advancements in the development and delivery of science curricula that is grounded in cutting-edge science and supported by robust pedagogical research to:

- Deliver up-to-date science curricula to students in purpose built science facilities, inspiring students to undertake and continue Science education;
- Provide a 'laboratory' for research into science education, exploring new ways of delivering effective science education;
- Build the capability of in-service and pre-service science teachers, *lifetime learnin*;
- Expand the links between science in schools, research and industry, science in context.

The science sub school will play a key role in helping to keep Victoria competitive in the scientific world, by increasing the number and quality of people in science. Students will gain insight into a wide range of science disciplines. The Bio21 Institute, in association with the Faculties of Science, Veterinary Science, Engineering and Medicine, Dentistry and Health Sciences, as well as the Melbourne School of Land and Environment, will contribute through access to expertise.

The science sub school will also provide outstanding professional development opportunities for science teachers. Scientists from the University will pass on leading edge techniques to the teachers, enabling them to take knowledge of the latest developments back to their classrooms.

A new model of delivering science learning and teaching, the initiative aims to transform the science education experience through a 'school-bench-workplace' concept, which ultimately is an investment in the future growth and sustainability of Australia's science and biotechnology sector.



Outreach activity at Bio21 Institute (Photo: H Varnavas Bio21 Institute).

BIO21 MOLECULAR SCIENCE AND BIOTECHNOLOGY INSTITUTE

Outreach, Visits and Tours

A key objective of the Bio21 Institute is to engage with secondary school students, teachers and the general public to inspire and inform them about scientific discovery, impacts of biotechnological innovation and related matters.

Science Experience at Bio21: In 2011, more than 100 Year 10 and 11 students from schools across Victoria visited Bio21 Institute. Part of a three day Science Experience event at the University of Melbourne, students had the opportunity to meet some of our talented young scientists and to hear about and see some of the exciting and diverse research undertaken at Bio21 ranging from health and medical research to environment and nanotechnology.



Lisa Golding from the Centre of Aquatic Pollution Investigation and Management. (Photo: H Varnavas Bio21 Institute).

'Just add Water': The Bio21 Institute in conjunction with the School of Chemistry and RACI supported public events by international presenter Dr Peter Wothers, Director of Studies in Chemistry, St Catharine's College, Cambridge University.

'Just Add Water' the theme for the public event, explored how much we really know about $\rm H_2O$ and its properties. More than 380 secondary school students, teachers, the general public and scientific community across Victoria took part in this special event.

Community groups visit Bio21: In 2011, the Bio21 Institute in conjunction with the TechNyou Outreach Program was pleased to host a number of members from the 'University of the Third Age' (U3A). Guests visited the Electron Microscopy suite, CAPIM, VICOSC and Neurodegenerative Diseases pathology group.



Pictured: Dr Kevin Barnham (foreground) explains his research interests in neurodegenerative diseases to U3A visitors. (Photo: H Varnavas Bio21 Institute.)

Free Radical Engagement: In 2011, as part of their community engagement programs, the ARC Centre for Excellence for Free Radical Chemistry and Biotechnology's launched Concept Radical – an art competition and workshop for secondary school students. The event held at the Bio21 Institute explained free radicals and their impact on health, the environment and materials such as paint, plastics and artwork and included an interactive lecture and activity stations where students watched demonstrations and took part in hands-on chemistry activities.



Local and International Visitors and Delegations

The Bio21 Institute's international standing has established us as a key destination to visit for many international visitors and delegations. In 2011, the Bio21 Institute continued to host a range of VIPs and delegations from here and abroad including Minister for Technology, The Hon Gordon Rich-Phillips and Mr Adam Bandt, Federal Member for Melbourne who were guests as part of the 2011 Undergraduate Research Opportunities Program conference held at the Bio21 Institute, the Commonwealth and State Ministers for Energy and Resources the Hon Martin Ferguson and the Hon Michael O'Brien as part of the VICOSC Launch; Korean DVC international and the Lt Governor of Georgia.



Pictured L-R: Dr Simon Green, Global Head R&D Product Development, CSL, The Hon Gordon Rich-Phillips Victorian Minister for Technology, Dr Stella Clark CEO Bio21 Cluster and Professor Tony Bacic Director, Bio21 Institute. (Photo: H Varnavas, Bio21 Institute)



Pictured L-R: Dr Stella Clark CEO Bio21 Cluster with Mr Adam Bandt, Federal Member for Melbourne and Professor Tony Bacic Director, Bio21 Institute. (Photo: H Varnavas, Bio21 Institute)

Bio21 welcomes International Laureate delegates: The Institute was pleased to once again participate in the International Scholar Laureate Program (ISLP) Delegation on Medicine to Australia. The program provides high achieving pre-med students an opportunity to find out more about medical research and health care in Australia along with the opportunity to visit some of Australia's leading research institutes, hospitals and universities. This year we welcomed fifteen pre-med students from South Africa, US and Canada, providing them with an overview of Bio21's multidisciplinary research activities, platform technologies and our contribution to the community and wider biotech sector.



The 2011 ISLP delegates. (Photo: H Varnavas, Bio21 Institute)

Engaging within the community

Bio21 Institute researchers are actively engaged within the scientific community and with the general public to promote their research and raise awareness about science via a range of activities.

Key activities undertaken by researchers and students include attending and presenting at local and international conferences and scientific meetings. Many of our research group leaders are also invited speakers at key international conferences and events. (Refer to the Bio21 Institute 2011 Annual Report Appendix for a list of invited presentations and seminars.)

Within the community, researchers and students are also engaged with secondary school students, teachers and parents. This includes media activities and participating in programs such as Scientists in Schools and In2Science.

Bio21 Institute researchers feature in The Age Health Poster. Researchers from the Bio21 Institute were featured in a special liftout produced by The Age newspaper. The poster "Frontiers: Medicine" looked at the human body and profiled some of the researchers and institutes around Melbourne working in medical research. Researchers profiled included the Women's Centre for Infectious Disease team and their research into women's sexual health; Oral Health CRC's work on dental health; and neurodegenerative diseases including Huntington's disease and Prion diseases.

Science engagement via the small screen

In 2011, Bio21 Institute researchers featured in three episodes of the Channel 10 Children's Show 'Scope'. The show provided the opportunity to engage a younger audience. Young researchers explained science and science concepts in a simple and fun way. This also provided a great opportunity for our researchers to practice their science communication skills.

Featured in the episodes were the Institute's 800 MHz NMR Spectrometer as part of the 'Big Machines' episode with Research Assistant, Jenny Chambers explaining the technology and how it helps her research work.

Lisa Golding from CAPIM team featured in an episode on the theme of 'Acids and Bases' and Free Radicals postgraduate student Melina Glasson featured in the episode 'Oxygen'.

Conferences and seminars

In 2011, the Bio21 Institute hosted more than 50 major events and conferences and 70 research and industry seminars including 12 international speakers. These include institute organized events, regular discipline seminar series, PhD completion seminars, key University events and external events.

Some of the key events and conferences held in 2011 included the Australian Gene Therapy Society Meeting, Nossal Institute for Global Health Conference, the Victorian Young Tall Poppy awards, the World Health Organisation Influenza Conference, Ataxia Friedrich Research Association Forum, Melbourne Protein Group Conference and the Australian Society for Medical Research Student Conference.

Three key events for the Institute to showcase our research and capabilities included the VICOSC funding launch, the Biological Electron and Advanced Microscopy Network event and launch of the new Mass Spectrometry and Proteomics Facility.

In 2011, the Bio21 Institute Director's Seminar Series hosted key speakers to present 'big picture' ideas. Professor Peter Taylor, Director of the Victorian Life Sciences and Computation Initiative and Dr Tom Quirk, former Director at Biota, were guest speakers hosted by Institute Director Professor Tony Bacic.



Picture L to R: Professor Peter Taylor, Director VLSCI with Professor Tony Bacic, Director Bio21 Institute (Photo: Bio21 Institute)

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2011 Research & Management Profile Summary

Resident Departments and Research group leaders

Bio21 Institute

Dr Vladimir Likic (joint Metabolomics Aust)

Faculty of Medicine, Dentistry and Health Sciences

Biochemistry and Molecular Biology

Associate Professor Marie Bogoyevitch Associate Professor Heung-Chin Cheng

Professor Paul Gleeson

Associate Professor Paul Gooley

Dr Danny Hatters

Associate Professor Andrew Hill

Associate Professor Geoff Howlett

Professor Malcolm McConville

Dr Terry Mulhern

Associate Professor Matthew Perugini

Associate Professor Anthony Purcell

Dr Stuart Ralph

Professor Leann Tilley

Associate Professor Ian van Driel

Professor Jose Villadangos (joint Microbiology)

Dental Science

Professor Eric Reynolds

Obstetrics and Gynaecology

Professor Suzanne Garland (with Women's Hospital)

Pathology

Professor Roberto Cappai

Associate Professor Kevin Barnham

Faculty of Science

Botany

Professor Tony Bacic

Chemistry

Dr Paul Donnelly

Professor Andrew Holmes (joint Bio21 Institute & CSIRO)

Dr Craig Hutton

Professor Paul Mulvaney

Professor Richard O'Hair

Professor Mark Rizzacasa

Professor Carl Schiesser

Professor Frances Separovic

Professor Tony Wedd

Associate Professor Jonathan White

Dr Spencer Williams

Associate Professor Uta Wille

Genetics

Professor Philip Batterham

Zoology

Professor Ary Hoffmann (joint Genetics)

Dr Charles Robin

Melbourne School of Engineering

Chemical and Biomolecular Engineering

Dr Sally Gras

Profiles of our research group leaders and their research interests, are available in the Bio21 Institute website www.bio21.unimelb.edu.au

Affiliated departments

University of Melbourne departments and centres participate in Bio21 Institute programs and research collaborations. These include:

Anatomy and Cell Biology

Botany

Centre for Animal Biotechnology (Vet Science)

Centre for Nanoscience and Nanotechnology (Chemical

and Biomolecular Engineering)

Chemistry (main campus research groups)

Chemical and Biomolecular Engineering

Genetics (main campus research groups)

Medicine

Microbiology and Immunology

Pathology (main campus research groups)

Physics

Surgery

Veterinary Science

Zoology (main campus research groups)

Key Centres and Programs

The Bio21 Institute accommodates a number of research centres and programs including:

ARC Centre of Excellence in Plant Cell Walls

ARC Centre of Excellence Free Radical Chemistry and

Biotechnology

ARC Centre of Excellence Coherent X-ray Crystallography

NHMRC Program for Neurodegeneration Diseases

Oral Health Co-operative Research Centre

Victorian Organic Solar Cell Consortium

Victorian Centre for Aquatic Pollution Identification and

Management

Women's Centre for Infectious Diseases - Royal

Women's Hospital

Platform Technologies

Electron Microscopy

Dr Eric Hanssen Dr Sergey Rubanov Mr Roger Curtain

Nuclear Magnetic Resonance

Dr David Keizer Dr Hamish Grant

Mass Spectrometry and Proteomics and Peptide Technology

Dr Nick Williamson Mr Paul O'Donnell Mr John Karas

Dr David Perkins (with VPAC)

Biological Research Facility

Mr Max Walker Ms Shiralee Whitehead Mr Carlos Chahine Mr John Borg Ms Shasta Brown Ms Tabatha Lovelace Ms Amy Lambalk

Ms Samantha Zahra

Professor Tony Bacic

Ms Lan Ta

NCRIS Metabolomics Australia (with School of Botany)

Professor Malcolm McConville Dr Uta Roessner (Botany)

Dr Dedreja Tull (Bio21 Institute)

Dr Vladimir Likic (Bioinformatics)

Dr Saravanan Daylan Dr Amsha Nahid

Mr David De Souza

Dr Thusitha Rupasinghe

Mr James Pyke

Ms Sheena Sahani

Mr Jairus Bowne

Mr Sean O'Callaghan

Ms Alysha deLivera

Dr Claudio Silva

Ms Mala Jayamanne

Management, Administration and **Operations**

Professor Tony Bacic

Dr Veronica Borrett

Mr Michael Blake

Mr Chris Bunney

Ms Denea Conlan

Mr Sam Eshtiaghi

Ms Annetta Jensen

Dr David Keizer

Mr Victor Iwanov

Mr Thu Nguyen

Mr Christian Rantzau

Mr Peter Riak

Mr Vladimir Tikhomandritskiy

Mr Zlatan Trifunovic

Ms Helen Varnavas

Mr Manuel Zacharias

Honorary Members

Professorial Fellows

Professor REH (Dick) Wettenhall

Professor Michael Parker (joint Biochemistry)

Professor Steven Dower (CSL)

Principal Fellows

Dr Nick Birbilis (Monash University)

Dr Vic Ilag (Patrys Ltd)

Professor Darren Kelly (St Vincent's / School of Medicine)

Dr Eugene Maraskovsky (CSL)

Associate Professor Peter Meikle (Baker Institute)

Dr Andrew Nash (CSL)

Dr Martin Pearse (CSL)

Honorary Senior Fellows

Dr Henry Butt (Bioscreen)

Dr Suzanne Fiel (St Vincent's Institute)

Dr Mark Hinds (Walter and Eliza Hall Institute)

Honorary Fellows

Dr Luke Miles (St Vincent's Institute)

Dr Jack Parsons (Prana Biotechnology)

Dr Fabio Turatti (Sienna Cancer Diagnostics)

Dr Scott Watkins (CSIRO)

In addition, senior research staff with CSL hold Honorary Appointments.

Industry members

Bioscreen

CSL Limited Research and Development Group

Patrys Limited

Prana Biotechnology Limited

Sienna Cancer Diagnostics

Tecniplast

TechNyou

Major Awards and Prizes

Professor Frances Separovic elected Fellow of the Biophysical Society of the USA, and awarded 2011 ANZMAG Medal

Ramaciotti Medal for Excellence in Biomedical Research awarded to Professor Michael Parker

Professor Eric Reynolds appointed Laureate Professor University of Melbourne, and recognised for his significant contribution to the field of dental researchaward by the International Association for Dental Research (IADR)

University of Melbourne 2011 Woodward Medal in Science and Technology awarded to Professor Ary Hoffmann

Professor Andrew Holmes awarded Newton Abraham Visiting Professorship, University of Oxford

Victoria Fellowship awarded to Dr Brett Paterson

ASBMB Inaugural Bioplatforms Australia access voucher (\$10,000) and Applied Biosystems Edman Award awarded to Dr Dominic Ng

ASBMB 2011 Lemberg Medal awarded to Professor Michael Parker (with St Vincent's Institute)

Beckman Coulter Discovery Science Award awarded to Professor Leann Tilley

2011 Fresh Scientist, Mr Brandon MacDonald

Faculty of Science Grimwade Prize in Industrial Chemistry awarded to Dr Spencer J Williams

Research Facts and Figures

- Total grants income > \$32 million
- Research Higher Degree students in 2011 >220
- Postdoctoral Research Fellows > 170
- More than 350 Publications 12.7% increase from 2010 to 2011
- Research group leaders 37
- Independently funded research fellows 34%
- New Centres of Excellence 2
- More than 60 major conferences and events and 70 research and industry seminars hosted in 2011

New major funding success

- Victorian Organic Solar Cells Consortium \$13.25 million – Victorian Science Agenda Strategic / SERD2 / Australian Solar Institute with involvement from the Energy Institute
- ARC Centre of Excellence in Plant Cell Walls \$6.475 million (2011-2017)

New grants

- ARC Discovery Projects 7
- NH&MRC 8
- ARC Large Infrastructure & Equipment Funding 2
- University of Melbourne Interdisciplinary Grants 2011 – 8 (1 co-funded with Melbourne Materials Institute)

Memberships

The Bio21 Institute is an active member within the broader biotechnology community supporting a number of organisations. This includes Corporate Memberships, sponsoring events and programs and participating at and hosting events and conferences for the broader scientific community.

Our memberships include:

- Ausbiotech
- BioMelbourne Network
- Bio21 Australia Ltd (Bio21 Cluster)
- Victorian Platforms Technology Network
- ANZAAS The Australian & New Zealand Association for the Advancement of Science
- Victorian Microscopy Network
- Melbourne Biomolecular NMR Network
- ANZMAGnet

The Bio21 Institute 2011 Annual Report has been produced by Bio21 Institute Communications and published by the Bio21 Institute Director's Office.

The Bio21 Institute 2011 Annual Report is available as a downloadable PDF document on the Bio21 Institute website. The website also provides further information including: Profiles of Bio21 Institute based Researchers, key Centres and Programs located at the Bio21 Institute, Events including Key Conferences, Research and Industry Seminars, PhD completion seminars and Visiting Scientists.

The Bio21 Institute 2011 Annual Report is available on the Bio21 Institute website at www.bio21.unimelb.edu.au

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