

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 industry engagement.

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 more than 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 innovation in the broad area of biotechnology through multidisciplinary research, genomics and strategic alliances/collaborations with academia and industry
- Attract outstanding scientists and technicians
- Establish core platform facilities accessible to diverse scientific and industry communities
- Engage industry and nurture the commercialization of discoveries
- Contribute employable skills and prepare research students and postdoctoral fellows for leadership in industry
- Translate research into community benefits (economic and educational)
- Provide a forum for community engagement and dissemination of information on emerging bioscience and technology issues.

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 national and international 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.



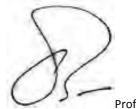
The Bio21 Institute logo with its interlocking rings represents the Institute's strategy – to embrace the partnership between the University, industry and the community.

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Director's Message





Professor Tony Bacic Director Bio21 Molecular Science and Biotechnology Institute

Photo: Casamento Photography

Research Highlights

Dr Greg Moseley joins Bio21 Institute

Dr Greg Moseley (pictured left) joined the Bio21 Institute



d left) joined the Bio21 Institute in early 2013. A group leader within the Biochemistry and Molecular Biology Department , Dr Moseley relocated his research group from Monash University after being awarded the Grimwade Fellowship at the University of Melbourne.

Viral disease progression is critically dependent on the formation of specific interaction networks between viral proteins and host cell factors, which enable viral subversion of important processes such as antiviral immunity and cell survival. Research in Dr Moseley's laboratory seeks to elucidate these interactions at the molecular level and to understand their functions in diseases which caused highly lethal human viruses including rhabdoviruses (e.g. rabies virus, Australian bat lyssavirus), paramyxoviruses (e.g. Nipah, Hendra,

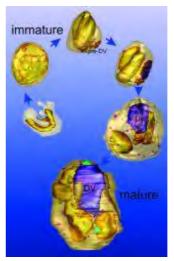


measles) and filoviruses (e.g. Ebola), as well as a number of agriculturally significant and potentially zoonotic animal viruses.

Image: CLSM image of viral protein interacting with microtubules in a mammalian cell.

Dr Moseley graduated with BSc(Hons) from the University of York, UK, and went on to do PhD research at the University of Sheffield in the UK and the Walter and Eliza Hall Institute (Melbourne), looking at the roles of tetraspanin proteins in immunology and infection. He was subsequently awarded a fellowship from the Royal Society which enabled him to undertake postdoctoral research in immunology at the Austin Research Institute (Melbourne). He then moved to Monash University to investigate the mechanisms of subcellular protein trafficking, and established an independent research laboratory there, bringing together his research expertise in virology, protein trafficking and immunology to investigate the molecular mechanisms underlying viral immune evasion and pathogenicity. Moseley also undertook fellowship research in CNRS (France) and Gifu University (Japan).

Young malaria parasites refuse to take their medicine



A study led by **Professor Leann Tilley** and Dr Nectarios (Nick) Klonis from the Department of **Biochemistry and** Molecular Biology and the Bio21 Institute have shown for the first time that malaria parasites (Plasmodium *falciparum*) in the early stages of development are more than 100 times less sensitive to artemisinin-based

drugs, which currently represent a last line of defence against malaria. The findings are collated in "Altered temporal response of malaria parasites determines differential sensitivity to artemisinin" which was copublished with colleagues in the journal Proceedings of the National Academy of Science USA (PNAS) in 2013.

The drug artemisinin (ART) saves millions of lives each year, but it is still not clear exactly how it works. Professor Tilley's team developed a novel approach to examine how the parasite responds to drugs under the conditions it encounters in the body. This is important because the malaria parasite takes two days to reach maturity in each cycle but the drug only remains in the bloodstream for a few hours. They found that juvenile parasites were up to 100 times less sensitive to the drug than mature parasites, and that in some strains they showed a particularly high degree of resistance. This would result in a large number of juvenile parasites surviving against clinical treatment and helps explain how resistance to drugs develops.

The possibility of lower drug sensitivity of juvenile parasites was first suspected when the team studied the parasite's digestive system using a revolutionary 3D imaging technique called electron tomography at the Bio21 Institute. This initial work was supported by the ARC Centre of Excellence for Coherent X-ray Science.

The next steps for the team are to try and establish why certain strains are more resistant to ART drug attack than others. They hope their findings will provide a guide for changing the timing of the drug treatment regime and developing longer lasting drugs, thereby killing more of the parasites and reducing the development of drug resistance.

Fighting disease from within the mosquito: new techniques to help halt the spread of disease



Professor Ary Hoffmann of the Bio21 Institute and the Department of Genetics and Professor Michael Turelli of the University of California have revealed a technique in which releasing diseaseblocking bacteria into mosquitoes may lead to a

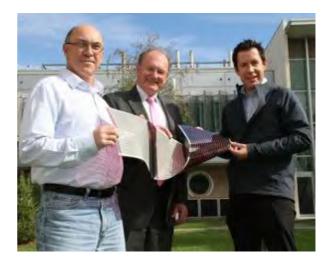
halt in the spread of diseases such as dengue fever, yellow fever, and possibly malaria. Professor Hoffmann first discovered the disease-blocking strain of Wolbachia in Australian fruit flies in 1988, and trials with collaborators at Monash and James Cook Universities in 2011 showed that Wolbachia-infected mosquitoes were unable to spread the dengue virus.

Evidence shows that when mosquitoes are infected with the Wolbachia bacteria, they are less able to spread dangerous viruses to humans. Scientists have found that the bacteria is been difficult to spread within the mosquito population because it reduces their ability to lay viable eggs. Hoffmann and Turelli have shown in their research that introducing an insecticide resistance gene into the mosquito alongside the bacteria causes the insects to pass the disease-blocking Wolbachia bacteria to other mosquitoes faster.

Currently, there are no vaccines or specific treatments for dengue and it kills around 40,000 people per year, with 2,400 dengue infection cases in Northern Australia in recent years. These findings could hold the key to a cheap and sustainable approach to disease control, with a faster rate of prevention, and less infected mosquitoes required to be released in a disease control program.

Hoffmann and Turelli co-published their research findings in the journal, *Proceedings of the Royal Society B*, in April 2013.

CTRL+P: Printing Australia's largest solar cells



Pictured: LtoR: Dr David Jones, Professor Andrew Holmes and Dr Scott Watkins of the VICOSC Consortium.

In May 2013, the Victorian Organic Solar Cell Consortium (VICOSC) – a collaboration between the CSIRO, The University of Melbourne, Monash University and industry partners – announced the installation of a new solar cell printer facility at CSIRO that can produce the largest flexible, plastic solar cells in Australia. The Bio21 Institute researchers integral to the development of the technology are polymer and photovoltaics expert Professor Andrew Holmes and Dr David Jones.

Worth A\$200,000, the printer has been developed using existing printing techniques, similar to those used for screen printing an image on to a T-Shirt. The cells are printed straight onto paper-thin flexible plastic or steel using semiconducting inks and it can print at speeds of up to ten metres per minute, with the ability to produce one cell every two seconds. It is a big step up for the VICOSC team, who have gone from making cells the size of a fingernail to cells 10cm square, and now 30cm wide, in just three years.

There are many possibilities for cells this size including public lighting, outdoor signage and mobile power generation. Eventually, by printing directly to materials like steel, the new technology will be able to embed cells onto roofing materials, and laminated on windows that line skyscrapers. The organic photovoltaic cells, which produce 10–50 watts of power per square metre, might also be used to improve the efficiency of more traditional silicon solar panels. The different types of cells capture light from different parts of the solar spectrum, and are complementary to existing technologies.

New Dairy Innovation Hub announced

In May 2013, the ARC announced funding for the Industrial Transformation Research Hubs, a scheme designed to support higher education and industry collaboration, innovation and strategic outcomes for the Australian manufacturing sector.

Dr Sally Gras (pictured left), of the Department of Chemical and Biomolecular Engineering and the Bio21 Institute at the University of Melbourne, is leading the Dairy Innovation Hub, along with partners at the University of Queensland and Dairy Innovation Australia. The Hub will receive \$5 million over the five year duration of the project.

The dairy manufacturing industry contributes significantly to the Australian economy through strong exports and regional employment, but faces serious economic and environmental pressures that impede future growth. The Dairy Innovation Hub will aim to resolve some of these challenges to industrial economies by developing breakthrough technical solutions.

Tracking dysentery-causing bacteria from Europe to Vietnam

Working in collaboration with researchers from Australia, Korea, Vietnam and the UK, Dr Kat Holt and colleagues have found that a strain of dysentery-causing bacterium, Shingella sonnei, which originated from Europe centuries ago, is spreading rapidly into developing countries such as Vietnam due to the emergence of antibiotic resistance.

Their study "Tracking the establishment of local endemic populations of an emergent enteric pathogen", was published in the journal Proceedings of the National Academy of Science USA (PNAS) in 2013 and follows previous work which showed that this form of dysentery spread out of Europe in the 1970s-1980s, into developing countries including Vietnam.

Dr Holt is using next generation sequencing to study the bacterium strain that causes dysentery in humans and kills more than one million people, mostly young children.

of social signals in malaria parasites changes the way scientists think about the malaria problem

The discovery was made by Professor Alan Cowman, Dr Neta Regev-Rudzki, Dr Danny Wilson and colleagues from the Walter and Eliza Hall Institute (WEHI) Infection and Immunity division, in collaboration with Professor Andrew Hill from the Bio21 Institute and Department of Biochemistry and Molecular Biology at the University of Melbourne.

The data and experiments of the research group were checked and redone many times in many different ways before confirming that the parasites were signalling to each other and communicating. It appears that the malaria parasite uses this mechanism to find out how many other parasites are in the human, and when is the right time to activate into sexual forms, which can live and replicate in the mosquito, ensuring the parasite survives and is transmitted to another human.

The hope is that this fundamental new understanding of the malaria parasite will lead to the identification of molecules involved in the social behaviour of the parasite, and in turn, ways in which these signals could be blocked. The ultimate goal is to develop new antimalarial vaccines and drugs that might eventually help prevent and treat the hundreds of thousands of deaths and illness malaria causes each year.

The findings were published in Cell, <u>Volume 153, Issue 5</u>, p1120–1133, 23 May 2013.

New Australia-US Institute for Advanced Photovoltaics

The University of Melbourne is a key collaboration partner in the Australia-US Institute for Advanced Photovoltaics. The \$33 million, eight year program is led by the University of New South Wales and will develop photovoltaic technologies with a focus on improving solar cell efficiencies and reducing costs.

The initiative is funded through the Australian Solar Institute – which is now part of the Australian Renewable Energy Agency (ARENA) –via the USA-Australia Solar Energy Collaboration. The new consortium brings together the Australian National University, CSIRO, Monash University and the Universities of Melbourne, New South Wales and Queensland, 12 American universities, three American laboratories and four industry partners. This multi-institute, multidisciplinary collaboration plans to leverage past and current funding to significantly accelerate photovoltaic development beyond what each could achieve individually.

The University of Melbourne is involved via groups led by Professor Andrew Holmes and Dr David Jones (Bio21 Institute/Chemistry) and Prof Ken Ghiggino (Chemistry). They are looking at the materials development and characterisation component, interacting with some of the American partners and strengthening the collaboration with the Victorian Organic Solar Cell Consortium and members of the silicon solar cell community

Awards and Recognition

Dr Kat Holt awarded L'Oréal For Women in Science Fellowship



Dr Kathryn Holt, from the Bio21 Institute and Department of Biochemistry and Molecular Biology, The University of Melbourne, is using genetics, mathematics, bioinformatics and supercomputers to study the whole genome of deadly bacteria and work out how they spread.

Looking at a typhoid epidemic in Kathmandu, she found that it didn't spread in the way we thought epidemics did. Her research, published in Nature Genetics, will change how we respond to epidemics.

Dr Holt will use her L'Oréal For Women in Science Fellowship to understand how antibiotic-resistant bacteria spread in Melbourne hospitals, and intends to discover if patients are catching superbugs in hospital, or bringing the bugs into hospital with them.

One of Dr Holt's major current projects funded by the NHMRC is using genomics to study the origin, evolution and spread of antibiotic resistance in hospitals, particularly the role of Klebsiella, a bacterium that is rapidly becoming a problem worldwide because of its capacity for survival in a broad range of environments and its propensity for picking up novel genes.

Dr Holt was chosen from 230 applicants by a panel of eminent scientists. The Fellowship funds are intended to further the Fellows' research and may be used for any expenses they incur, including childcare. The program is part of L'Oréal's global support for women in science.

Photo courtesy L'Oreal Australia/sdpmedia.com

Professor Tony Bacic awarded LaTrobe University Distinguished Alumni

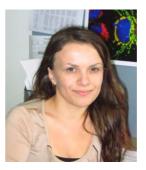


Bio21 Institute Director, Professor Tony Bacic, was honoured as a LaTrobe University Distinguished Alumni in October 2013. He completed his PhD in BioChemistry at LaTrobe in 1980. A

fellow of the Australian Academy of Science, he is an internationally-renowned expert and leader in plant biology, with a focus on the structure, function and biosynthesis of plant cell walls (biomass) and their biotechnological applications as well as the application of functional genomics tools to biological systems.

Photo: Professor Tony Bacic receives his award from Professor Adrienne E Clarke AC, Chancellor La Trobe University. Image courtesy Tess Flynn, La Trobe University.

Dr Diana Stojanovski awarded the ASBMB Edman Award for 2013



In recognition for outstanding research work, the Australian Society for Biochemistry and Molecular Biology presents the ASBMB Edman Award each year to a biochemist or molecular biologist with no more than 7 years postdoctoral experience. It provides funds to assist the recipient to

attend an overseas conference or briefly visit a research laboratory to access specialist equipment or learn new research techniques.

Dr Stojanovski, a new member at the Bio21 Institute, joined the Department of Biochemistry and Molecular Biology in January 2013 as the Biochemistry Fund Fellow. Her research interests are in the area of mitochondrial biogenesis and disease. Some of the diseases associated with mitochondrial dysfunction include cancer, Alzheimer's and Parkinson's diseases.

Professor Andrew Holmes President-elect of the Australian Academy of Science



Professor Andrew Holmes was elected as President of the Australian Academy of Science in late 2013, and assumes the role after the Academy's Annual General Meeting in May 2014.

A pioneer of research in organic electronics, Professor Holmes is a Laureate Professor of Chemistry at theBio21

Institute, a CSIRO Fellow and Distinguished Research Fellow in the Department of Chemistry at the Imperial College London. He first achieved international recognition when, in collaboration with Cambridge physicists, he was part of a team who developed a new class of light-emitting polymers that transformed technology for televisions and computers with lightweight, super-thin, flexible video screens bright enough to be viewed even in direct sunlight.

Professor Holmes returned to Melbourne in 2004 as ARC Federation Fellow and inaugural veski Fellow establishing his laboratory at the Bio21 Institute. He was instrumental in forming the Victorian Organic Solar Cell Consortium.

Professor Holmes is a Fellow of the Australian Academy of Science and was appointed a Member of the Order of Australia in the 2004 Australia Day Honours list. In 2012 he was awarded a prestigious Royal Medal from the Royal Society London.

Professor Philip Batterham elected President of the International Genetics Federation



Geneticist Professor Philip Batterham was elected to the Presidency of the International Genetics Federation for a five-year term from 2013. His role will be to engage and promote the science of genetics globally, with a particular focus on collaboration, sharing knowledge and

advancing fledgling groups of geneticists in developing nations. Professor Batterham's research examines innovative ways to control insects that plague global agriculture, which provides the global perspective required for the challenges of his new role. He will preside over the 2018 International Congress of Genetics to be held in Vancouver.

ARC Future Fellowships awarded

The Australian Research Council's Future Fellowships scheme supports research in areas of critical national importance by giving outstanding researchers incentives to conduct their research in Australia.

The following Bio21 researchers were awarded Future Fellowships for the period 2013 – 2017:

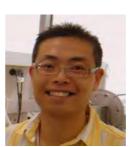


Dr Paul Donnelly (Inorganic Chemistry): \$872,240. This project will focus on fundamental chemistry that underpins innovations in the synthesis of metal-based imaging and therapeutic agents.

Associate Professor Spencer Williams (Organic Chemistry): \$872,240.

This work will inform strategies to engineer new enzymes for future biotechnology and industrial applications including sustainable chemical

manufacturing, and underpin the development of innovative drugs for treating fungal infections and cancer.



Dr Wallace Wong (Macromolecular and Materials Chemistry): \$755,320.

This project will look at designing smart materials that can self-organise and enhance the properties required for specific applications. New insights will be acquired in

structure-property-function relations and successful concepts will be used to assemble well-defined macroscopic materials in organic electronic applications.

Chemist awarded William Evans Visiting Fellowship



Photo: Rick Danheiser

Professor Mark Rizzacasa was awarded a prestigious William Evans Visiting Fellowship at the University of Otago, New Zealand. The fellowship included a series of research presentations and 4th year course lectures.

Enabling Platform Technologies

The Bio21 Institute continues to make significant investment in platform technologies and the intellectual capital necessary to maintan such capabilities at the cutting edge

Specifically we have critical mass in the key areas of nuclear magnetic resonance, mass spectrometry and proteomics, advanced microscopy and metabolomics.

Accessible to a range of users from across the sector including academia, industry and government, the opportunity to build critical mass is a driver enabling stronger collaborations, sharing of exerptise and benefiting from economics of scale.

The Bio21 Institute's platforms are associated with the Victorian Platform Technology Network – 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.

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.

Melbourne Magnetic Resonance has ten NMR spectrometers ranging from 300 to 800 MHz and one EPR spectrometer, making it the largest high field facility in Australia.

NMR Instruments include:

- 300 MHz NMR Varian system for solid-state spectroscopy
- 400 MHZ NMR Two Agilent 400MR NMRs with a one probe
- 500 MHz NMR Agilent DD2 system equipped with autosampler and a broadband probe
- 500 MHz NMR Bruker Avance System equipped with TXI cryoprobe
- 600 MHz NMR Bruker Avance III with TCI cryoprobe
- 600 MHZ NMR Varian VNMRS system for solidstate spectroscopy
- 600 MHz NMR Varian INOVA equipped with a broadband probe
- 700 MHz NMR Bruker AVANCE IIIHD with TCI cryoprobe and SampleJet
- 800 MHz NMR Bruker Avance II with TCI cryoprobe and autosampler

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 2013

 The Institute's NMR capability was further enhanced with installation of a 700 MHz NMR spectrometer as a result of a successful ARC LIEF grant totalling \$1.84 million between The University of Melbourne, Bio21 Institute in collaboration with WEHI.

Electron Microscopy

The Bio21 Institute Electron Microscopy (EM) Facility provides high quality facilities for physical sciences, life sciences and engineering applications. The Institute's EM 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 located across University departments, Melbourne's Advanced Microscopy Facility is a well-established suite of state of the art electron and optical microscopes catering to the spectrum of scientists from academia, industry and government. For example around 80% of the usage of the Bio21-based EM Facility is by researchers outside the Institute.

The Electron Microscopes:

- Tecnai F30 Transmission electron microscope a key Australian 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.
- Tecnai F20 Transmission electron microscope. Highresolution 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 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. It is equipped with a Kleindiek NanoWorkstation with for micromanipulation, electrical measurements, tension measurements and nanoforging.

The optical microscopes:

- Confocal Leica SP5 with resonance scanner for fast live imaging
- OMX Blaze structured illumination microscope for super resolution microscopy with resolution up to 115 nm. Equipped with 4 cameras, 6 lasers and temperature controlled stage.

The sample preparation equipment:

• A manual and an automated plunge freezers for macromolecule solutions

- A Leica EMPACT2 High Pressure freezer for rapid freezing of specimen under vitreous conditions
- A Leica AFS1 for manual freeze substitution of frozen samples
- A Leica AFS2 with robot loading for fully automated freeze substitution and embedding of frozen samples
- A Reichert-Jung UCE and Leica UC7 ultramicrotomes for room temperature section of ultra-thin sections
- A Leica UC7/FC7 cryo ultra microtome for sectioning of frozen samples.

Highlights for 2013

New instrumentation installed:

• EDAX solid state detectors on the Nova and the TF20.

Grant for new instrumentation:

• Successful LIEF13 that will fund an energy filter for the TF30, commissioning June 2014.



Mass Spectrometry and Proteomics Facility

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

Instruments include:

- ABSciex 5600 Mass Spectrometer
- ABSciex 5500 Mass Spectrometer
- Thermo OrbiTRAP ELITE ETD Mass Spectrometer
- Bruker MALDI-TOF Mass Spectrometer
- 2 x Agilent LC-esi-TOF Mass Spectrometers

Highlights for 2013

- The facility has continued grow with more than 300 users that have booked time and been taught how to run their own experiments using the mass spectrometers in the MSPF.
- The user base includes users from not only The University of Melbourne but also every other Victorian university, WEHI, Peter MacCallum, St Vincent's Institute, MHRI, MCRI, and multiple industry groups.
- Dr David Perkins joined the Mass Spectrometry and Proteomics Facility full-time in 2013 as an in-house proteomic bioinformatics specialist.



Photo: Agilent 6220 LC/esiTOFAccurate mass of chemicals and proteins.

Metabolomics

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

Highlights for 2013 (Bio21 Institute node)

- The Inaugural Australian Lipidomics User Meeting organised and held at Bio21 Institute on 1 February.
- Konstantinos Kouremenos joined the analytical team in 2013, and comes to the Bio21-MA team with expertise in both GCMS- and LCMS-based metabolomics.
- In 2013, the Facility ran 40 projects: 13 were internal projects from UoM departments and 27 were external projects from other universities (Victorian and interstate), Research Institutes/Centres, Government Departments and Industry. The projects were across biomedical research and included investigations in the area of cancer, microbial pathogens (e.g. malaria,) diabetes and drug action research. The team also worked on environmental research projects, including biomonitoring of waterways and soil water.
- The MA Bioinformaticians took a leading role in organising and presenting at the ANZMN Hands-on Metabolomics Data Analysis Workshop in October 2013. The workshop, held over 2 days, was attended by 25 clients from 11 different groups / organisations.

Education, Training and Development

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

A range of programs continued in 2013, 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 Bio21 Institute Research Symposium led by the Research Assistant and Postdoctoral Research Fellow Association also known as RAPD.

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.

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 crossdisciplinary conference, visit laboratories to learn techniques or to enhance industry collaborations and outcomes. In 2013, the institute awarded 24 student travel awards.

Bio21 Institute Postdoctoral Fellowship Scheme - Two new initiatives supporting early career researchers

In 2012, the Bio21 Institute launched two new initiatives in support of early career researchers commencing in 2013.

The Wettenhall Establishment Award is a postdoctoral researcher award established in recognition of the outstanding vision of the inaugural Director of the Bio21 Institute, Professor Richard (Dick) EH Wettenhall and his commitment to the career development of young researchers.

The Bio21 Institute / CSL Ltd Early Career Researcher Award is a new two year initiative aimed at supporting outstanding early career researchers who are undertaking fundamental research in the life sciences / biomedical field that has potential biotechnology applications.

In 2012, the 2013 fellowships were awarded to Dr Justine Mintern and Dr Darren Creek.

Dr Justine Mintern (pictured below) is the recipient of the Bio21 Institute / CSL ECR Award for 2013.

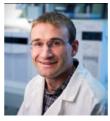
Dr Mintern is a NHMRC Career Development Fellow with



the Department of Biochemistry and Molecular Biology at the University of Melbourne. Her research focuses on autophagy – a critical cellular pathway that participates in generating robust immunity.

Dr Darren Creek (pictured below) is the recipient of the Inaugural REH Wettenhall ECR Establishment Award 2013.

Dr Creek is a NHMRC Postdoctoral Training Fellow



(Overseas based biomedical CJ Martin), with the Department of Biochemistry and Molecular Biology at the University of Melbourne. His research focuses on drug discovery for tropical diseases caused by the parasitic protozoa *Plasmodium falciparum*

and Trypanosoma brucei. (Photo: Gavin Blues).



Left to Right: Dr Andrew Nash, Dr Justine Mintern and Professor Tony Bacic (Photo: H Varnavas Bio21 Institute)



Left to Right: Professor Tony Bacic, Dr Darren Creek and Professor Dick Wettenhall (Photo: H Varnavas Bio21 Institute)

In 2013, the fellowships commencing in 2014 were awarded to Dr Matthew Dixon (recipient of the Wettenhall Establishment Award) and Dr Linda Wakim (recipient of the Bio21 Institute/CSL Ltd Early Career Researcher Award).

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 institute-wide 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 supported by the Institute were led by our RAPD and student groups during 2013, including a new series of Multidisciplinary Research Symposiums and a Professional Development Series tailored to the RA and postdoctoral/early career researcher level. The program comprised of relevant themes and expert key speakers, with the chance for students to present on their own research. The following are highlights from the program:

Multidisciplinary mini research symposium series

Drug Design and Delivery in Focus. Key note speaker: Professor Michael Parker, Deputy Director SVIMR and Professorial Fellow, Bio21 Institute.

Imaging in Focus @ Bio21. Key note speaker Dr Eric Hanssen, Manager, Bio21 Institute Electron Microscopy Unit. Parasitology in Focus. Key note speaker Professor Marshall Lightowlers (Vet Science UoM).

Professional Development series

Creating Cross-Sector Collaborations. Presented by Professor Andrew Hill (Bio21). Dos and Don'ts with Data! Accurate research data representation. Speaker Professor David Vaux, Head of cell signalling and cell death division WEHI. Creativity in Science. Presented by Professor Leon Mann, Director of the Research Leadership Unit, MRO. Sell Your Science. Presented by Shane Huntington (MRO/Physics/MDHS).



Left to Right: Dr Jet Phey Lim, Professor David Vaux and Dr Eleanor Saunders (Photo: H Varnavas Bio21 Institute)

Imaging in Biology Symposium

The successful Imaging in Biology Symposium in September 2013 was conceptualised by the student group Biochemists and Molecular Biologists at Bio21 (BAMBII) and organised with support from Paul McMillan (BOMP) and Helen Varnavas (Bio21 Institute).

The theme of the symposium was "Microscopic Strategies: Providing Solutions for Macroscopic Health Issues", with a program featuring leading researchers, graduate students and technology specialists. There were technical lectures conducted by imaging specialists and facility managers, graduate presentations, and researchers showcasing how cutting-edge imaging technologies have provided key leads in unravelling the molecular and cellular mechanisms of disease.

The symposium was targeted at graduate students and early career researchers, and drew more than 150 participants from across the University of Melbourne and the broader research community and industry around Melbourne.



Imaging Biology Symposium audience (Photo: H Varnavas Bio21 Institute)

Engagement, Outreach and Events

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. This involves a range of events, activities and programs using a range of channels.

We also contribute within the community, providing support for student conferences and public forums which are aligned with the Institute's objectives. Some of the activities Bio21 supported in 2013 included:

- ICT for Life Sciences Graeme Clark Oration
- Australian Academy of Sciences Science Shine at the Dome for ECRs and Teachers
- Victorian Young Tall Poppy Awards
- EMBL Systems Biology Initiative





The Bio21 Institute proudly supported two key events on the Australia's science calendar in 2013.

Top: 2013 Graeme Clark Oration. The 2013 Orator Mr Geoff Lamb from the Bill and Melinda Gates Foundation. Photo courtesy The ICT life sciences.

Bottom: AAS Science at the Shine Dome ECR/Teacher event .Professor Tony Bacic (left) being introduced by AAS Professor Bob Williamson. Photo courtesy AAS

TechNyou Outreach Program

Since 2010, the Bio21 Institute managed the Australian Government's TechNyou Outreach Program until it ended in June 2013. An initiative of the Australian Government's Department of Innovation, Industry, Science, Research and Tertiary Education (DIISRTE) the program aimed to inform and engage the Australian public on emerging technologies such as bio- and nanotechnologies. TechNyou aligned with the Bio21 Institute's ongoing commitment to engagement and provided excellent opportunities for community groups, students, teachers and the general public to engage in a range of activities including visits, tours, presentations, field days and teacher conferences.

In 2013, the program expanded its national focus with three dedicated part-time outreach officers delivering outreach activities to schools, community groups and at events across QLD, NSW and WA which complemented the programs delivered in Victoria and South Australia.

Careers Counsellors PD

In July 2013, the Bio21 Institute hosted a group of 30 tertiary career counsellors to provide a tour, presentation and networking opportunities. The visit was part of a national PD event organised by the National Association of Graduate Careers Advisory Services (NAGCAS).

The theme for 2013 was "Careers for a Sustainable Future". With biotechnology playing a major part in improving health in the present and into the future, the Bio21 Institute was a key draw card for the group.

Speakers included CEO of the Bio21 Cluster, Associate Professor Jan Tennent; University of Melbourne Master of Biotechnology Course Coordinator Associate Professor Matthew Digby, Dental Science lead researcher, Associate Professor Stuart Dashper and Bioinformatician Dr Sean O'Callaghan.



Careers Counsellors hosted at Bio21 (Photo: H Varnavas)

BioMelbourne Network breakfast

As part of the University of Melbourne's Festival of Ideas program, the Bio21 Institute partnered with BioMelbourne Network to organise a BioBreakfast on 1st October. Held at the Bio21 Institute the forum entitled "Jobs and Industries of the Future: Innovation Driving Tomorrow's Employment" included a distinguished panel of representatives from education and research, agriculture, health and medical sectors who explored the industries and job roles of the future and how we are preparing our next generation and current working populations to maximise these opportunities.



Pictured above: Panellists at the BioMelbourne Network &Bio21 Institute Jobs of the Future BioBreakfast. Photo by Helen Varnavas.

Bio21 Science sub-school project

In 2012, construction commenced for the new Science Sub-school and the project was well underway in 2013, with an expected completion in early 2014.

With the focus of inspiring the next generation of scientists, this innovative education initiative is a partnership between the Victorian Government, the University of Melbourne, led by the Bio21 Institute and the Melbourne Graduate School of Education and, University High School. Two hundred 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 which ultimately helps keep Victoria competitive in the scientific world by increasing the number and quality of people in science.

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. 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.

Seeing is Believing: National Science Week @ Bio21

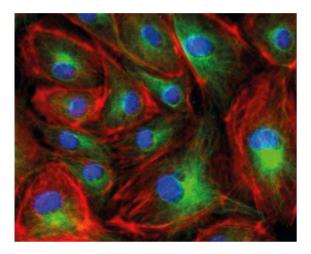


Image above: Using fluorescent microscopes, students were able to take images of scientific samples and print them off to take away. This image shows cells stained for the Nucleus (blue), Tubulin (green) and Actin (red).

In August 2013, as part of National Science Week, Year 9 and 10 Secondary school students with an interest in science visited the Bio21 Institute to learn more about the use of light microscopy. 'Seeing is Believing: Investigating biology and disease using light microscopy' attracted approximately 60 students and teachers from high schools across Melbourne and Geelong.

For more than two hours, the Bio21 Institute's atrium transformed as students moved through a series of 15 minute activities designed to demonstrate how scientists use light microscopy to investigate the biology of the body and how disease is caused. There was a general introduction into cell biology and light microscopy followed by hands-on and interactive activities. Students were shown through an experiment, including applying methods, investigating a question and identifying techniques, and were able to learn more about the biology of diseases such as cancer, malaria and Alzheimer's.

Graduate students from the Department of Biochemistry and Molecular Biology at the Bio21 Institute (BAMBII) acted as student hosts and activity presenters, providing students with insights into the range of research projects undertaken, and the opportunities scientists have to engage with the broader community.

Conferences, events and seminars

In 2013, the Bio21 Institute hosted a range of major events, seminars and conferences for research and industry and the general public.

Key events and conferences hosted in 2013 included the annual Nossal Institute for Global Health Conference; the Victorian Young Tall Poppy awards, the inaugural international Sonochemistry Conference, Interact 2013, Systems Biology forums and the Victorian Immunity and Infection Network Conference.

In conjunction with the Swiss Australian Academic Network 'Fostering Swiss Australian Scientific Collaboration'. A special seminar by Nobel Laureates Professor Peter Doherty and Professor Rolf Zinkernagel showcased the ultimate example of Swiss Australian scientific collaboration. The event welcomed HE Ambassador of Switzerland to Australia, Mr Marcel Stutz, and a capacity audience of 200 guests.



Pictured L-R: HE Marcel Stutz, Prof Peter Doherty, Prof Rolf Zinkernagel, Prof Tony Bacic, Prof Jim McCluskey, Prof Jim Angus, Associate Prof and President SAAN Matthias Ernst. Photo: H Varnavas, Bio21 Institute.

The Institute organised a series of major programs throughout 2013 profiling key strategic research areas and drawing a range of researchers from academia and industry. These included the Advancing Systems Biology program that incorporated the Cell Signalling Symposium and the Metagenomics symposium and attracted more than 250 registrants. The Metabolomics Australia led Lipidomics User Workshop and a Postgraduate led Careers events.

The Institute also hosted a series of Big Picture Seminars with international and local speakers including Professor Margaret MacKinnon, Professor Thomas Maschmeyer and Professor Gerhard Wagner.



Pictured L-R: Professor Gerhard Wagner was awarded the Aust-Harvard Fellowship during his visit to Melbourne. Professor Wagner with Prof Frances Separovic and Mr John Turner, Chair of the Harvard Club of Australia. Photo: H Varnavas Bio21 Institute

International Student Visits

The Bio21 Institute hosted a number of student visits and programs during 2013. These included the annual visit by Nanjing Agricultural University (NAU) PhD students. NAU and the University have a long standing relationship with a formal Memorandum of Agreement in place linking the Melbourne School of Land and Environments and the Bio21 Institute. Over two days students were engaged with a program of presentations, tours and site visits.

As part of the Institute's international engagement and outreach activities, Institute based researchers and technology managers participated in the University of Melbourne's Conservational Biology Summer Camp Program hosting fifteen 3rd year Undergraduate biology / life sciences students from Tsinghua University. Institute based experts presented lectures on key areas including conservation genetics and climate change with Professor Ary Hoffmann and systems biology in insecticide action with Professor Phil Batterham. Students also visited key platforms at Bio21 including the Mass Spectrometry and Proteomics Facility.



Pictured: A visit to the Bio21 Mass Spectrometry and Proteomics Facility, Dr Chin-Seng Ang, farleft, with visiting student.s Photo: H Varnavas, Bio21 Institute.

The Bio21 Institute 2013 Annual Report has been produced by Bio21 Institute Communications and published by the Bio21 Institute Director's Office.

The Bio21 Institute 2013 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 and key Centres and Programs located at the Bio21 Institute.

The Bio21 Institute 2013 Annual Report is available on the Bio21 Institute website at www.bio21.unimelb.edu.au

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