THE UNIVERSITY OF MELBOURNE

bio21 institute

Annual Report 2018

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Our Mission

The Bio21 Institute seeks to improve human health and the environment through innovation in molecular life sciences and biotechnology, driven by collaborative research and dynamic interactions with industry.

Our Vision

Research Excellence
To be leaders in world-class multidisciplinary molecular science research and research training

Shared Resources
To provide Core Platform Technology Facilities to academic and industry researchers

Industry Engagement and Innovation
To nurture Australia's biotechnology sector

Science Education
To assist secondary schools through the partnership with the Elizabeth Blackburn Sciences

About the Institute

The University of Melbourne's Bio21 Molecular Science and Biotechnology Institute (Bio21 Institute), is a multidisciplinary research centre specialising in medical, agricultural and environmental biotechnology. Accommodating more than 600 research scientists, students and industry participants, the Bio21 Institute is one of the largest biotechnology research centres in Australia.

The Bio21 Institute seeks to improve human health and the environment through innovation in molecular life sciences and biotechnology, driven by collaborative research and dynamic interactions with industry.

The commitment to establish the Bio21 Institute was the University of Melbourne's original contribution to the Bio21 Cluster project, now known as Biomedical Research Victoria.

Established in 2002, the Bio21 Institute was officially launched on 8 June 2005 by Victorian Premier Mr Steve Bracks, joined by University of Melbourne Vice-Chancellor Professor Glyn Davis, Innovation Minister Mr John Brumby and Health Minister Ms Bronwyn Pike.

In 2018 the Bio21 Institute was expanded with the opening of a new building named in honour of Nancy Millis to house the University of Melbourne's Margaret Sheil laboratories and the CSL Global Hub for Translational Research.

A home of research and discovery

The Bio21 Institute was built on the premise that multidisciplinary ventures between life sciences, physical sciences and engineering disciplines, including harnessing genomics knowledge in medical and other biomedical areas of biotechnology, are fundamental to translating biological discoveries into biotechnology outcomes. The Institute also embraces commercialisation as a facilitator for scientific advancement, skills development and economic outcomes. The Institute's commitment to intellectual property protection, technology transfer and business incubation are key drivers of this innovation.

The Bio21 Institute now attracts outstanding scientists and technicians looking to use the purpose-built laboratories and state-of-the-art core platform technology facilities which are accessible to these diverse scientific and industry communities investigating various research themes. Included in this community are the start-up companies supported through business incubation and entrepreneurship skills development, as well as students and early-career researchers.

Director's Message

Professor Michael Parker, Director of the Bio21 Institute

2018, a year of building research capacity and infrastructure and bringing industry groups into our community.

'Bio-21': is a creative and synthetic combination of the Greek word 'bios' meaning life and '21' as in the 21st century. 'Bios' occurs in words such as biology, biotechnology and biomedical, but also biography; life story. We are 18 years into what will be defined as the 'biological' century: 18 years old; practically an adult!

Since the elucidation of the structure of DNA (1953), we have been growing an increasingly versatile biological toolkit with which to discover, visualise, understand and create the molecules of life, such as genomic sequencing, molecular biology, mass spectrometry, proteomics, metabolomics, magnetic resonance spectroscopy, X-ray crystallography and cryo-electron microscopy.

When the words 'Bio' & '21', were creatively combined to name the Institute, a new story began: a story dedicated to the study of life, harnessing molecular science, to solve some of the biggest problems of our time: the loss of biodiversity and food security as a result of climate change; making pesticides safer; combatting infectious diseases and developing therapies and cures against cancer and neurodegenerative diseases.

This Annual Report is an opportunity to reflect on the year that was 2018 at the Bio21 Institute.

Building Research Infrastructure and Capacity

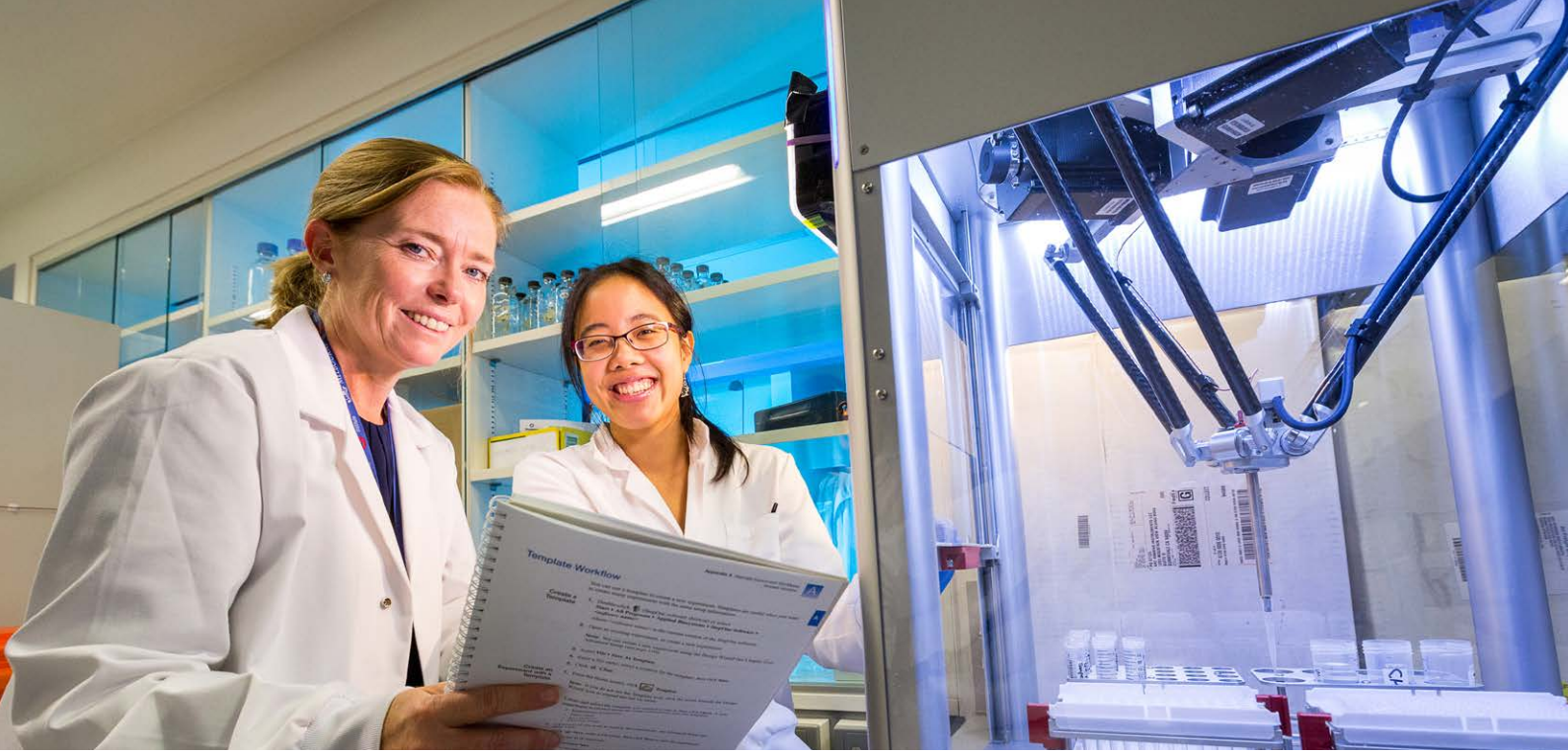
2018 ended with a celebration: Friday, 14 December, Bio21 formally opened the Nancy Millis building and the Margaret Sheil laboratories. Two plaques were unveiled by the Honourable John Brumby, Chairman and Director of Biocurate and former Premier of Victoria. In 2005 the then Premier Steve Bracks with John Brumby, Treasurer and Innovation Minister and Bronwyn Pike, the Health Minister, officially opened the Bio21 Institute David Penington building, so it was wonderful to have him continue to play a role in the Bio21 story.

It was also a great opportunity to honour two trail-blazing women: Professors Nancy Millis and Margaret Sheil through the naming of the building and the Mass Spectrometry facilities.

The building has been made possible through a collaboration and joint funding between CSL and the University of Melbourne. The Nancy Millis building has provided much needed space for people – with CSL growing its scientific workforce to 130 researchers – as well as space for Metabolomics Australia and Mass Spectrometry and Proteomics Facilities' instruments. The new laboratories of the Nancy Millis building are already a hive of activity and it is wonderful to see everyone enjoying the light-filled, common areas for their meetings and lunch breaks.

Supported Research and Researchers

Despite the tight funding environment, it was encouraging to see that Bio21 Institute researchers continued to have their research supported through government grants. Australian Research Council (ARC) grants were announced on the 27 November 2018. Sally Gras, Ary Hoffmann, Craig Hutton, Justine Mintern, Gavin Reid, Frances Separovic, David Stroud and Jose Villadangos received funds to pursue important work in the areas of protein synthesis, mass spectrometry lipidomics, immune host defence, Wolbachia in Drosophila, nuclear magnetic resonance, cell trafficking, improving species ability to adapt to environmental change and synthetic biology.



Institute members Danny Hatters, Jose Villadangos, Malcolm McConville, Justine Mintern, Stuart Ralph, Kat Holt and Paul Gleeson received NHMRC Research Fellowships and Project Grants, announced on 12 December 2018, funding their research into antigen presentation and inflammation; neurodegenerative diseases; pathogen genomics; parasitic protozoa and malaria.

Australian Cancer Research Foundation support

Philanthropic funding from individuals and foundations also played an important role in supporting research at Bio21 into particular areas of need in our society.

On the 28 November 2018, Bio21 received $2M funding from the Australian Cancer Research Foundation (ACRF) to fund a Facility for Innovative Cancer Drug Discovery. I was honoured to officially receive this grant from the Governor General, Sir Peter Cosgrove, at Admiralty House in Sydney.

David Ascher and I were the chief investigators on the grant from Bio21, together with Rick Pearson, Peter MacCallum Cancer Centre and John Silke of the Walter and Eliza Hall Institute, representing some of Victoria's major cancer research institutions; an example of the importance of working collaboratively.

In addition to this, Monday, 3rd December 2018, the Ovarian Cancer Research Foundation officially announced that it would provide funding for operators over three years to help run the new facility and particularly help drive outcomes in ovarian cancer research. We really appreciate this generous support.

The ACRF funding will make it possible to create a facility that houses some of the most cutting-edge structural biology instruments and technologies for the identification and development of drugs for cancers. The Facility will be hosted by the Melbourne Protein Characterisation platform facility that is being established in the basement of the Bio21 Penington building.

With the new Facility, we will be a key go-to service for the cancer research community in the Melbourne Biomedical Precinct and beyond for structural biology-guided drug

discovery. Structural biology holds a key to developing innovative cancer drugs by providing detailed information about the shape of molecules that are involved in cancer-causing biological signalling pathways within cells of our bodies. Structural biology has played a key role in targeted molecular medicines including imatinib (Gleevec) to treat myeloid leukaemia, venetoclax for leukaemia and gefitinib for lung cancer.

The grants awarded by the ACRF are made possible through the generosity of many donors who contribute to the foundation, often people who have personally been affected by a cancer diagnosis.

Australian Wool Innovation

Also a $2.5 million grant from Australian Wool Innovation (AWI) was awarded to Bio21's Trent Perry, Batterham lab, along with Clare Anstead and Vern Bowles (Faculty of Veterinary and Agricultural Sciences) and a research group in CSIRO for a vaccine project to tackle fly strike.

As we receive these grants we recognise with gratitude the generosity of those who make our work possible through their contributions.

Industry supported and embedded in the Institute

Bio21 is co-located with industry tenants. In 2018, we welcomed Rhythm Biosciences (diagnostics), and SYNthesis med chem and Research (medical chemistry), two biotechnology companies, that moved into the Bio21 Business Incubator building (building 404). They joined CSL (biological

therapeutics), Circa Group (chemistry of bio-derived products) and Alterity, formerly Prana Biotech (medicinal chemistry applied to neurodegenerative diseases) as industry research groups who are part of the Bio21 community.

From the beginning, it has been one of Bio21's goals to support translation and commercialisation of research and to provide a supportive 'incubator' space for industry research, whether they be start-ups or more well established companies.

Bio21 is an attractive location for industry groups for many reasons: access to our platform technology facilities, being embedded in a thriving academic research institute and in close proximity to other University of Melbourne institutes and faculties, medical research institutes and hospitals in the Melbourne Biomedical Precinct in Parkville.

A great place to 'do science'

But, it is often the intangible factors such as a collegial, collaborative and welcoming research culture that then leads to the flourishing of industry and academic research groups in the Institute, as well as the growth of opportunities for all.

The Bio21 Institute, reflecting the international nature of science, is a diverse community of academic and industry researchers and professional staff members at various stages of our careers, from diverse cultural, ethnic backgrounds and genders. It is one of the reasons that science institutions are such enriching places to work in, but it also means that as power structures exist, through academic hierarchy, funding access and visa restrictions, some members are more vulnerable than others. The Women of Bio21 committee, chaired by Diana Stojanovski, and our regular internal morning teas, are some of the ways in which we are attempting to create an inclusive, equitable, fair working environment, underpinned by a strong sense of respect for each other.

Bio21 is growing

As the 'Stage 2B'/'Nancy Millis building' project was completed in 2018, the 'Stage 2C' development to house CryoEM microscopes in the former Veterinary Research Institute was commencing. Also, a new Melbourne Protein Characterisation platform was being established. In this way, Bio21 continued to grow our already significant molecular science instrumentation capacity.

The Bio21 Institute is a wonderful environment to undertake molecular science research, equipped with a suite of platform technology facilities. It is however, the combination of these complementary technologies: for example, metabolomics using magnetic resonance and mass spectrometry; X-ray crystallography in combination with cryoEM and computational biology that often give us that extra insight, resolution, detail and data that allow us to solve the missing pieces in our respective puzzles.

Complementing each other, the instruments housed in Bio21's platform facilities provide an incredible resource to the biomedical scientific community within the Melbourne Biomedical Precinct.

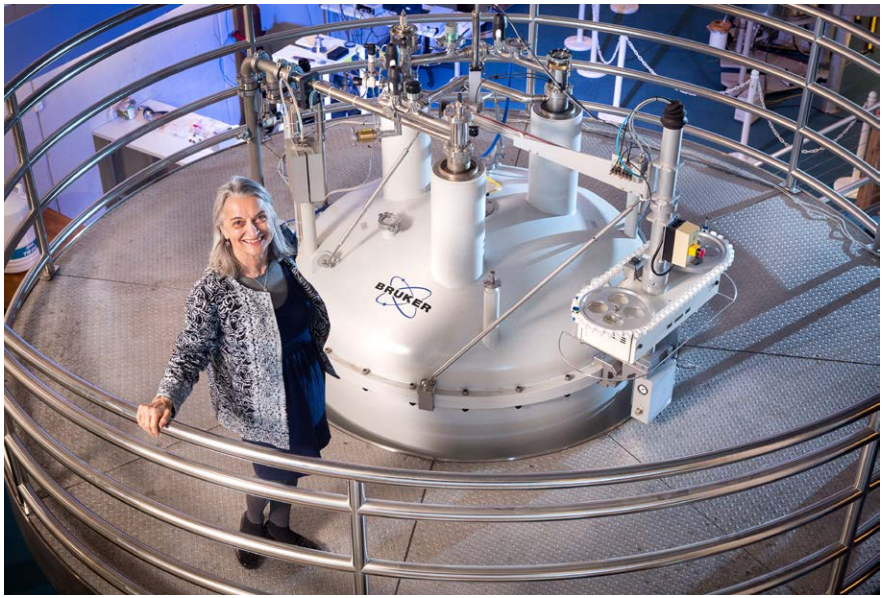
Future directions

As a director, it would sometimes be nice if it were possible to peer into a crystal ball; to know what the future holds and what direction we should steer the Bio21 'ship'. Not only for the next year or two; but to set a path for the next decade and beyond. Identifying the health and environmental needs of our society into the future, whilst continuing to provide the capacity and infrastructure to support cutting edge research for scientists to address these problems remains an ongoing challenge.

Within the pages of this annual report, we provide you with a snapshot and a taste of the academic and industry research taking place at the Bio21 Institute, as well as the exciting infrastructure projects taking place. We hope to infect you with the excitement for discovery, curiosity and learning that is the life-blood of research, as well as the importance and respect for evidence, that underpins our pursuit of knowledge and wisdom.

Michael W. Parker DPhil (Oxon) FAA FAHMS
Director
Bio21 Molecular Science and Biotechnology Institute (Bio21 Institute)

Bio21 Leadership



Deputy Director's Message

Professor Emeritus Frances Separovic AO

In the spirit of diversity and inclusion, a personal highlight in 2018 was the announcement that I had been inducted alongside twenty other women into the Victorian Honour Roll of Women. I felt very proud to be considered amongst these women, who had achieved remarkable things against formidable odds and had come from very diverse backgrounds (e.g. Jess Gallagher, summer and winter paralympic medallist).

Based on my beginnings as a Croatian migrant kid growing up in Broken Hill, this award somehow made me feel that now I really belonged: that I too was a true blue, dyed-in-the-wool Victorian!

In late 2017, the Me Too hashtag (#MeToo) went viral on social media with the stories of thousands of women bringing to light the extent of harassment and abuse women have experienced across society and in their workplaces. Unfortunately, science has not been exempt from this type of behaviour. I tend to use humour when I tell my own story and, although I feel myself fortunate to have had the support of men in the course of my career, the humour often veils the hurt and discrimination that I also have faced in the course of my career, e.g. the shock and disappointment I felt as a 20 year old when I realised that I had been hired at a public research institution primarily due to my looks rather than (obvious) aptitude. Discrimination has often taken the form of not being taken seriously because I was (am) a woman and my talent and commitment being doubted and undermined due to my gender.

As my academic career draws to an end, I have been fortunate to have been recognised by several academic awards but the Victorian Honour Roll is a more public recognition, which has launched me into a series of speaking engagements, where I have been asked to reflect on my career in science, in a male-dominated profession, and that has allowed me to grow into an advocate for women in science. I tell my story not as a deterrent, but to encourage young, passionate women to embark and persevere in scientific careers. It's worth it! Despite the obstacles, I've had a wonderful career and science has enriched my life in so many ways.

During 2018 I have spoken to the Women in Science Network at the Faculty of Science (WiSN), Balmain Public School, Girls in Physics Breakfast – Bendigo, Royal Australian Chemical Institute Annual Dinner, Australian and New Zealand Association for the Advancement of Science, Institute for Molecular Bioscience – Brisbane, Faculty of Veterinary and Agricultural Sciences – Melbourne and

Adelaide Protein Group on 'my brilliant career'. I find this very rewarding and am inspired by the enthusiasm of school children, particularly primary school students.

Exploring my next steps beyond retirement, I applied to 'Homeward Bound' and was fortunate to be accepted to journey to Antarctica and receive intensive training in public engagement towards promoting women in science. In the past year, as a Victorian Honour Roll of Women Ambassador, I've discovered social media and you can follow me on Twitter, LinkedIn and Facebook too!

As Deputy Director, Bio21 Institute, I am committed to supporting cultural change within the Institute. We can be proud of our female Institute leaders, including Professor Sally Gras, Associate Director Engagement, and group leaders Professor Karen Day, Dr Laura Edgington-Mitchell, Dr Elizabeth Hinde, Dr Justine Mintern, Associate Professor Isabelle Rouiller, Dr Diana Stojanovski, Professor Leann Tilley (ARC Laureate Fellow) and Professor Uta Wille. They are each forging ahead in their own disciplines, whilst fostering a diverse group of young scientists and future leaders.

Bio21 Associate Directors

There are three Associate Directors of the Bio21 Institute:

- **Engagement** – Professor Sally Gras
- **Commercialisation** – Professor Spencer Williams
- **Platform Infrastructure** – Professor Malcolm McConville

Associate Director Engagement – Professor Sally Gras

Engagement with the public, industry, government and other stakeholder groups is an important part of what we do as a scientific research community at the Bio21 Institute; informing policy and debate, educating the public, inspiring the next generation and increasing the ways in which our work can have an impact on society. In an age of 'fake news' communicating science in an engaging way is more important than ever.

Science communication and engagement integrates science and society, fulfilling our social contract and maintaining trust in the scientific endeavour. In contrast, scientific jargon and a hesitancy to engage can present significant barriers to communication, particularly when coupled with a lack of public understanding of the scientific method and the complexity of scientific findings. Many highly skilled communicators have found creative and innovative ways of engaging with the public in scientific organisations and museums, as well as through new initiatives such as 'Science Gallery', part of the Global Science Gallery Network hosted at The University of Melbourne that aims to engage 15–25 year olds in science.

For part of 2018, I had the privilege of taking a sabbatical at The Danish Technical University (DTU) in Denmark. As part of my time in Denmark and whilst visiting collaborators and attending conferences, I also took the opportunity to explore public engagement and best practice within Europe. I was particularly impressed by the DTU High Tech Summit, an annual event that in 2018 hosted 1,266 companies and 266 startups in a program of 211 technical talks that aimed to encourage discussion, networking and further development of high tech industries in Europe. Many of Denmark's museums also offer outstanding examples of storytelling and engagement in scientific research, such as the Moesgaard Museum in Aarhus.

I have since been fortunate to connect with Professor Kirsten Drotner from The University of Southern Denmark, an expert on communications and international best practice for museums and interactive displays, with whom we hope to collaborate to develop Bio21's engagement strategy. My laboratory is also establishing scientific collaborations with international firms based in Denmark who are world leaders in technology, to further our international engagement.

Much of the research taking place at the Bio21 Institute on molecules and cells is not visible to the eye. There is a great deal of potential, however, to develop displays to visualise the unseen molecular world for visitors to the Institute, inspiring them with the beauty, complexity and potential value of the knowledge we gain through the study of these molecules.

My own engagement through The ARC Dairy Hub includes diverse stakeholder groups of dairy manufacturers and the dairy industry. We also work with a number

of pharmaceutical companies on Australian Research Council Linkage grants and other contracts. Many of our projects involve the molecular scale but have an impact on the industrial scale and broader societal impact through consumers and patients. Through this research I have learnt the importance of engaging with different groups in targeted ways, both through conversation, presentations and various media.

The Bio21 Institute celebrated many events in 2018 and the year was significant for communication, engagement and events, culminating in the opening of the Nancy Millis Building on 14 December.

As in previous years, we ran a one-week work experience program for 14 Year 10 students from schools across Victoria; opened our doors for the Open House Melbourne Weekend (>500 visitors) and ran the 'Life Magnified' activity during National Science Week organised by Paul McMillan, Biological Optical Microscopy Platform.

We hosted Bio21 'Big Picture' Seminars, hearing from, among others, Professors Paul Sanberg, Prof Koram, Ghana and from the team at Biocurate. We brought our community together and introduced new members, including new industry groups Rhythm Biosciences and SYNthesis Research and med chem at our regular Bio21 morning teas.

Several large conferences and symposia were hosted at Bio21, including AussieMit, the Australian Functional Genomics Conference, the Georgina Sweet Awards and the Victorian Mass Spectrometry Symposium. Our platform groups hosted a series of '101 workshops'.

We were visited by international academic and government delegations from The University of Birmingham and Padua, as well as Savitribai Phule Pune University's affiliated Modern College of Arts, Science and Commerce. A number of high school groups visited Bio21, including Geelong College, Loreto Mandeville Hall and University High School, Elizabeth Blackburn Sciences.

Also, many of our members have appeared in the media, communicating their research or providing expert comment, on radio, in print media and within online platforms, like The Conversation.

Supporting our Communications and Engagement Advisor, Florienne Loder, much of the engagement at the Institute is only possible through the efforts of volunteers who have run tours and activities, or shared their research with tour groups visiting the Institute and we thank them for the important role they play towards our current and future engagement at Bio21.

Associate Director Commercialisation – Professor Spencer Williams

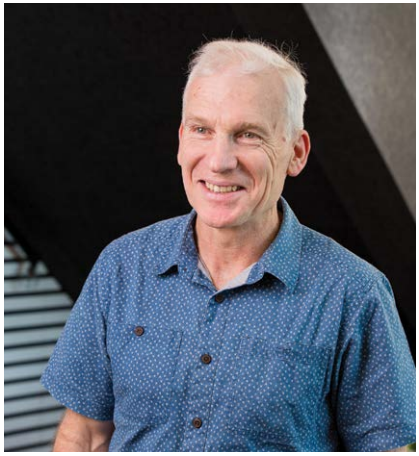
The Bio21 Institute has a mission to drive innovation in the Biotechnology sector through dynamic engagement with industry. Such engagement takes many forms and is assisted by commercial entities that are located within the Bio21 Institute Incubator. In this regard, two significant tenants joined the Bio21 Institute Incubator in 2018: **Rhythm Biosciences**, an ASX-listed cancer diagnostics company, and **SYNthesis med chem**, a privately-owned Australian contract research organisation with extensive laboratories in China that provide services in small molecule drug development. These companies joined the Bio21 Institute community because of tangible and intangible benefits from colocation in the Institute and the broader Melbourne Biomedical Precinct.

2018 marked a major achievement for the Institute with the commissioning of the Nancy Millis building, which has supported an expansion of the **CSL Global Research and Translational Medicine Hub**, including the recruitment of new researchers. The long-term commitment of CSL to increase its presence at the Bio21 Institute will help drive collaboration within the Biomedical Precinct and cements the status of the Bio21 Institute as a significant player within the national biomedical innovation landscape. The increase in floor space available through commissioning the Nancy Millis Building should allow new tenants to join the Bio21 Institute community in the future.

Also within the Nancy Millis building is office space shared by business development staff from the University of Melbourne Research Industry Commercialisation (RIC) unit, and from BioCurate, a joint University of Melbourne / Monash University 'venture catalyst' and technology accelerator. BioCurate's head office is adjacent to Monash Institute of Pharmaceutical Sciences (MIPS) on Royal Parade and the establishment of a footprint on the University of Melbourne campus will help drive engagement with University of Melbourne researchers and boost the development of new medicines and related technologies. During 2018, Glenn Begley and Cathy Drinkwater from BioCurate and Paul Barrett from RIC ran a forum as part of the Bio21 Institute's 'Big Picture' lecture series in which they discussed the barriers to research commercialisation, the support provided by RIC, and the opportunities within BioCurate.

Several drugs developed by University of Melbourne researchers, including those at the Bio21 Institute continue to progress through human clinical trials with commercial partners. One notable milestone has been achieved with Cu(-ATSM), a promising new treatment for Motor Neurone Disease (MND), first discovered by University of Melbourne and Bio21 Institute researchers Paul Donnelly and Kevin Barnham, along with Anthony White. A Phase I clinical trial sponsored by **Collaborative Medicinal Development**, who has licensed the technology, reported that 32 patients treated with the drug showed significantly less decline in lung capacity. A larger, randomised, placebo-controlled double-blind Phase 2 trial is planned to commence in 2019.

Finally, we welcome the appointment of the new University of Melbourne Vice Chancellor, Duncan Maskell who has a strong entrepreneurial background and has made distinguished contributions to research commercialisation in the biotechnology sector in his career in the UK. In his new role Duncan seeks to further advance commercialisation and applications of research discoveries at the University of Melbourne, a place where the Bio21 Institute can and will continue to make significant contributions.



Associate Director Platform Infrastructure – Professor Malcolm McConville

The Bio21 technology platform facilities underpin much of the research that occurs within the institute and are also widely used by academic and industry researchers from around the Melbourne Biomedical Precinct and beyond. The major Bio21 technology platform facilities provide critical mass and national leadership in magnetic resonance spectroscopy, proteomics and metabolomics, and advanced electron and fluorescence microscopy. There is increasing overlap in the capabilities of these platforms, which is leading to synergies, particularly around the characterisation of protein function using techniques such as single particle cryo-EM, mass spectrometry, X-ray crystallography and magnetic resonance spectroscopy. Colocation also brings together critical mass in informatics, data storage and facility management governance.

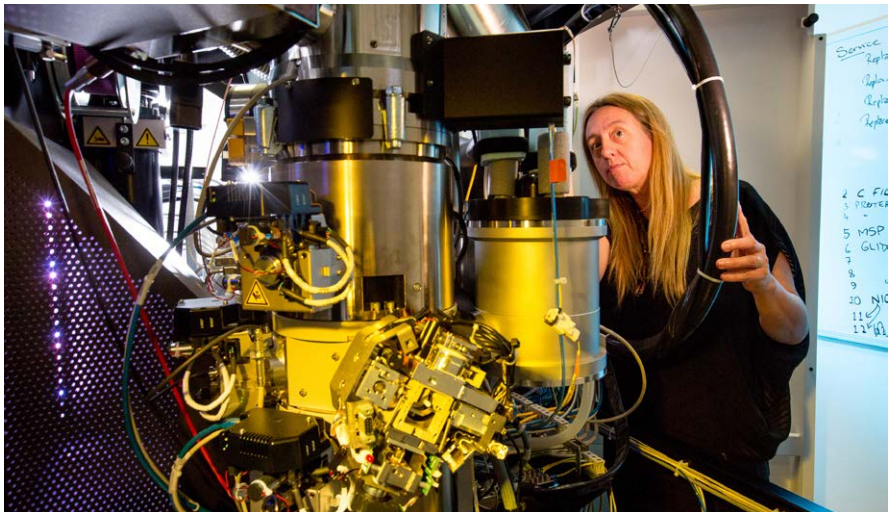
Some key developments that occurred in 2018 include the following.

The combined Mass Spectrometry-Proteomics Facility (MSPF) and Metabolomics Australia (MA)

The combined Mass Spectrometry-Proteomics Facility (MSPF) and Metabolomics Australia (MA) facilities moved to the new purpose built office and lab space (1000sqm) in the Nancy Millis Building (formally opened in Feb 2019). The new labs, named after our previous Provost Professor Margaret Shiel, accommodate over 30 advanced mass spectrometry instruments, supported by 15 research staff. This capability provides complementary expertise in proteomics and metabolomics, and new opportunities for undertaking integrated multi-omic analyses of complex biological systems. The further expansion of these facilities in 2019 is guaranteed with major Federal Government investment through the NCRIS scheme and Philanthropic investments, although keeping abreast of increased user base and raising funds for new instruments represents a significant challenge.

Advanced Microscopy Facility

Similar expansion also occurred in the Advanced Microscopy Facility with the installation of the new 200keV Arctica Talos cryo-EM for structural biology in April 2018, with support from CSL. Single particle cryo-EM has revolutionised the field of protein structural biology, and this new instrument was one of the first of its kind



in the country. This investment as been linked to the recruitment of new structural biology research groups to the institute (Rouiller, Parker labs), the recent purchase of two more advanced cryo-EM systems (a 300keV Titan Krios), and advanced plans for a new 1000sqm building on the north-west corner of the Bio21 precinct.

Melbourne Magnetic Resonance

The Melbourne Magnetic Resonance facility continues to be heavily used by researchers from around the Parkville precinct with interests in protein structure, drug design and metabolomics. The facility saw the retirement of Dr Hamish Grant, who has been a senior research officer in the facility for more than 10 years.

Protein Characterisation

A new Institute platform around Melbourne Protein Characterisation was also established in 2018. This platform brings together substantial investments made by Biochemistry and Chemistry Departments over the years into the newly renovated lab and office space in the Bio21 Basement (previously occupied by the proteomics and metabolomics facilities). Capabilities include high-end analytical ultracentrifuges (including a Beckman Optima AUC with multiple optical detection modes), the new X-ray diffractometer, circular dichroism spectroscopy, and calorimetry. This new facility has been established by Yan Hong Tan and will also provide a one-stop-facility for researchers wanting access to high capacity protein expression (insect, mammalian), purification and characterisation. This facility brings together capability in various steps in the drug development pipelines.

'Goodbye' and 'Welcome'

New arrivals	Departures
Rhythm Biosciences	Mulvaney group
SYNthesis Research	Women's Hospital Infectious Disease research group
SYNthesis med chem	Holt Group
Biocurate	CAPIM group
	Kronzucker Group

Impacts of Research

It is the goal of the Bio21 Institute to improve health and the environment through innovation in molecular science and biotechnology, driven by multi-disciplinary research and dynamic interactions with industry.

From improving the resilience of plants and animals, to the effects of global climate change and controlling mosquito populations that transmit dengue in Australia and abroad, to gaining an understanding of the impact of severe viral infection on our immune systems and developing compounds against Motor Neurone Disease – the impact of the research conducted at the Institute in the Schools of Biosciences, Chemistry and the Department of Biochemistry and Molecular Biology and Melbourne Dental School, Faculty of Medicine, Dentistry and Health Sciences in improving health and the environment is far-reaching.

Human Health

Alzheimer's Disease
Antimicrobial therapies
Cancer
Dengue
Dental Health (Periodontitis)
Huntington's Disease
Inflammation
Leishmaniasis
Legionella
Malaria
Mitochondrial Disease
Motor Neurone Disease
Parkinson's Disease
Sepsis
Toxoplasmosis

The Environment

Species rescue (Eastern Barred Bandicoot; Mountain Pygmy Possum)

Sustainable pesticides (sheep blow fly; cotton bollworm)

Sustainable energy (organic solar cells)

Impacts of Research: Human Health

Researchers have discovered that cancer treatments can help overcome growing resistance to a frontline antimalarial drug

By Kathryn Powley, University of Melbourne

The battle to conquer the deadly malaria parasite could soon take an unexpected turn as University of Melbourne researchers bring chemotherapy drugs into the armoury.

Leading malaria researcher Professor Leann Tilley and her team have uncovered the mechanism of how frontline antimalarial drug, artemisinin, works and are now working on a promising chemotherapy-based compound to treat patients.

Artemisinin is derived from wormwood and was developed in China during Mao Zedong's rule. It has saved millions of lives, but scientists are engaged in a constant game of cat-and-mouse with malaria, searching for ways to beat the parasite's growing resistance.

Malaria claims the lives of about 440,000 people worldwide every year, the majority of whom are children under five years of age, and artemisinin resistance has developed in South-East Asia, with fears it will soon reach Africa.

"If you're going into a coma suffering very serious complications from malaria, you need immediate relief from the symptoms and this drug works very quickly," Professor Tilley says.

But there are at least two catches. First, artemisinin doesn't work very well by itself. It effectively reduces the parasite's impact, but doesn't kill off every parasite infecting an individual. Hence artemisinin is always used in combination with other antimalarial drugs.

But here comes the second catch; resistance is rising to both artemisinin and the partner drugs.

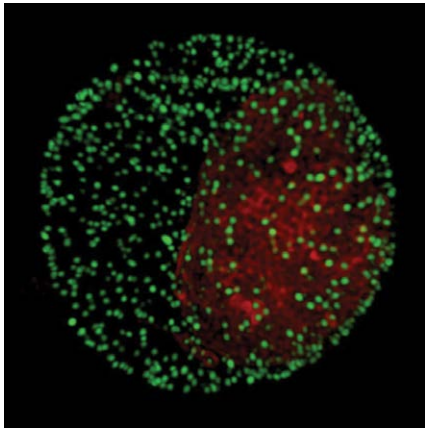
"The combination of artemisinin and various partner drugs reduces the patient's symptoms and stops them from dying, but no longer cures them. A few weeks later malaria comes back and the patient has to return for more treatment; but doctors are running out of treatment options."

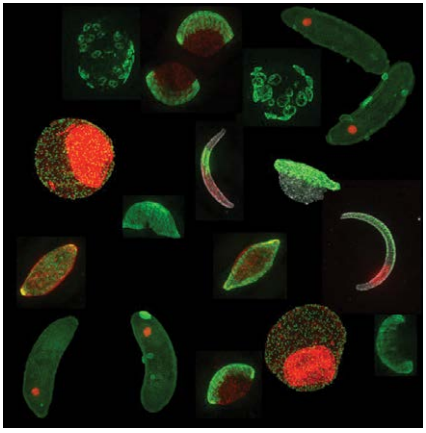
Clearly there's a degree of urgency.

"Although we have very good scientists working on malaria, and we are making progress, there's a risk that we could go backwards very quickly if resistance spreads to Africa," she says.

Understanding Artemisinin

It's surprisingly common not to know exactly how and why a drug works.





For example, the modes of action of paracetamol, which is used to treat pain, and lithium compounds, which are used to treat bipolar disorder, are not clear.

But not knowing how artemisinin works has been a block to understanding the growing resistance and to developing better treatments. Understanding the mechanism underpinning the drug's action has become mission critical for malaria researchers.

"What we have discovered is that artemisinin packs a double whammy," says Professor Tilley.

"When it gets inside the malaria parasite it goes off like a cluster bomb, damaging proteins. After the 'explosion', the parasite is desperately reliant on shredder enzymes, called proteasomes, to dispose of the excess waste. Artemisinin also targets this waste disposal system, further weakening the parasite."

Blockage of the proteasome causes an accumulation of proteins that are marked with a 'kiss of death' modification. When these damaged proteins build up, they stress the parasite and soon lead to cell death.

Enter chemotherapy

Here's where chemotherapy comes in, because some cancer drugs are designed to attack proteasomes. They are called proteasome inhibitors. Professor Tilley explains that cancer cells grow at a gangbusters' rate, creating so much waste they are more reliant on their proteasomes than regular cells.

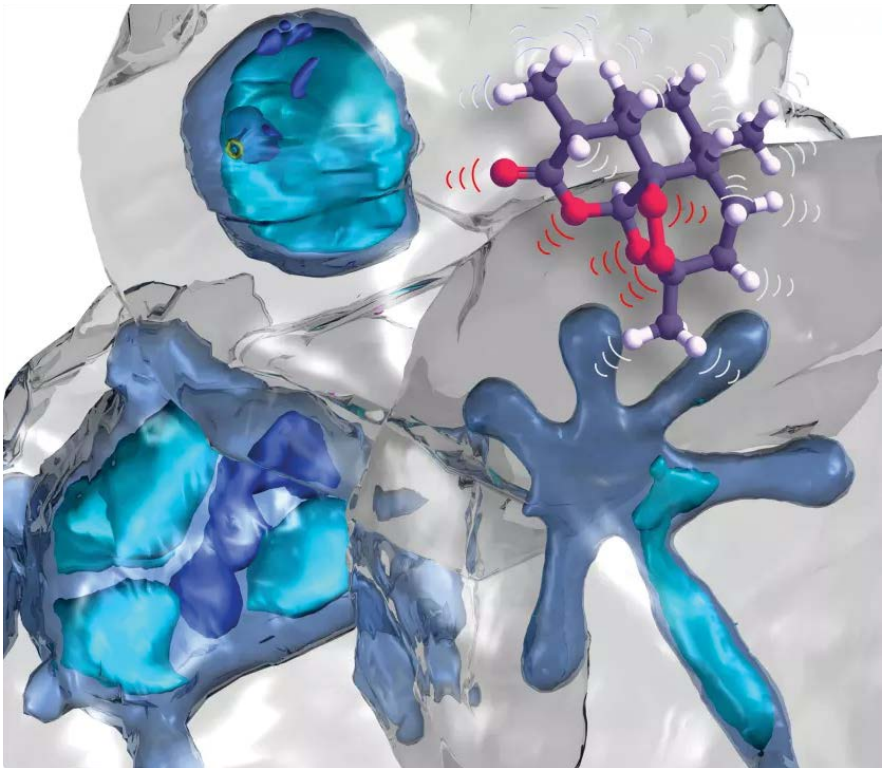
Working on a hunch, Professor Tilley tried hitting malaria parasites with proteasome inhibitors.

The team discovered that artemisinin and the anti-cancer drugs can work together to knock out the proteasome and prevent the parasite's 'shielding' response.

The results are promising, and have led to Professor Tilley teaming up with Takeda of Japan and Swiss-based non-profit research foundation Medicines for Malaria Venture to discover a new parasite-specific proteasome inhibitor that works in tandem with artemisinin, and advance it to clinical trials.

The Medicines for Malaria Venture can shepherd promising antimalarial compounds through the pipeline from discovery to trial via a fast-tracked approvals process.

This is a shortened excerpt, first published in Pursuit.



The genes that turn malaria into a killer

A small group of proteins are associated with the most severe strains of malarial infection and their discovery is a step towards a vaccine against the deadliest forms of the disease.

By Dr Daryl Holland, University of Melbourne

Not all cases of malaria are the same. There are thousands of different strains – some parasites cause only mild symptoms, while other more severe forms can cause disease and death.

And not all people are the same. Some people infected with malaria show no obvious symptoms, while others succumb to a severe and, ultimately, fatal disease. All too often this second group includes young children who have not yet had a chance to develop a strong immune response to the malaria parasite.

"The great burden of mortality for malaria is in children under five," says Dr Michael Duffy, a malaria researcher with the School of BioSciences and Bio21 Institute at the University of Melbourne.

The World Health Organization reported 429,000 malaria deaths in 2015, of which 70 per cent were children under the age of 5.

Why are children at such high risk of death by malaria? And why do some die while others survive?

The human/parasite interaction

"We asked ourselves – is it something about the humans or the parasites that results in this difference?" says Dr Duffy.

"We think it's an interplay of both.

"What we think is that the immunologically naïve – that is, people who have never previously been exposed – get infected with these parasites and those parasites that cause severe disease dominate in these early infections. Either you become immune or you die."

Dr Duffy believes the key to combating the public health challenge of malaria is to focus on those people who are most susceptible to severe malaria – young children – and focus on those malaria strains that are most likely to cause death.

But how can you tell a deadly malaria strain from a more benign strain?

An international research collaboration led by Professor Karen Day, Dean of Science at the University of Melbourne, has developed a 'fingerprinting' technique to uniquely identify different strains of malaria in a population based on the genes (called var genes) that code for the surface protein PfEMP1. This protein plays a key role in the parasite's ability to evade our immune systems.

Each malaria parasite contains around 60 versions of the var gene and when in the bloodstream of a host, these genes will be expressed one at a time, each time building a new surface protein.

"So you develop immunity to one protein and you start to kill off the parasites expressing it," says Dr Duffy.

"And then it spontaneously switches to another protein to which you have no immunity."

A few years ago, Dr Duffy and his collaborators, as well as other malaria researchers, concluded that there is probably a particular set of PfEMP1 proteins that are causing severe disease.

"Once you are immune to them, you are immune to severe disease, but you can still be infected with uncomplicated malaria, or be asymptomatic," says Dr Duffy.

To test this, Dr Duffy and his colleagues used new sequencing and fingerprinting technologies to sample parasites isolated from the blood of 44 adults in a location where malaria is endemic in the state of Papua in Indonesia. Twenty three of these people had severe malaria.

The researchers then assembled 4662 pieces of var genes that were being expressed in these parasites and compared the genes expressed in severe cases against those expressed in mild cases.

They used advanced statistical processing to show that a tiny subset of the thousands of var genes that were present were being expressed at a higher rate in patients with severe malaria than in those with uncomplicated malaria.

Other groups have tested patients in India and Africa for known var genes and have similarly found an association between the expression of certain genes and severe malaria.

"This is the first time anyone has taken the genes that are expressed, sequenced everything that's there and tried to assemble them, to work out what's present and what's different between severe and uncomplicated cases," says Dr Duffy.

Incredibly, all the proteins associated with severe malaria in India and Africa were also upregulated (had a heightened response) in the severe cases in Papua, suggesting that this small group of deadly proteins is highly conserved around the world. With their comprehensive screening technology, the research team also found many severe-malaria associated proteins that hadn't been identified elsewhere.

The researchers are now looking to test children in malaria-endemic regions of Africa – the group by far the most at risk from malaria death – to see if the novel deadly proteins they found in Papua are also present there.

This research was published in *PLoS Biology,* and was conducted by an international team of researchers from the Universities of Melbourne and Oxford, the Walter and Eliza Hall Institute of Medical Research, the Eijkman Institute for Molecular Biology in Jakarta, Indonesia, the Timika Malaria Research Program, Papuan Health and Community Development Foundation, Indonesia, the Peter McCallum Cancer Centre and Charles Darwin University.

This article was first published on Pursuit.

From decades to days: 3D modelling of tuberculosis

3D modelling of the mutations in TB means doctors around the world could soon tailor individual treatments for the disease in a matter of days, rather than years.

By Dr Justin Denholm, University of Melbourne

While many of us may think of tuberculosis (TB) as a historical disease, it actually remains one of the top ten causes of death worldwide. While it's relatively uncommon in Australia, in 2016, around 10.4 million people fell ill with TB globally and 1.7 million lost their lives as a result of the disease.

The 3D mutation modelling aims to support global programs starting to use new therapies for TB.

Part of the reason that TB remains such a difficult disease to manage is the long time it can take to establish what treatment is best for each patient. Traditional approaches to demonstrating that a specific medication will be effective against a strain of TB involve laboratories culturing the organism and checking whether the drug stops its growth.

And because TB is very slow growing, this process can take weeks or even months; and that is long enough for resistance to develop. The end result is that those suffering may die before the right treatment can be started.

In recent years, genomics has brought advances to TB diagnosis, including the ability to rapidly identify when strains have mutations likely to cause drug resistance.

Even so, when a new mutation is found, understanding whether it can lead to drug resistance means seeing evidence both in laboratory testing and in clinical settings.

Clinicians and TB programs, then, may need to treat people while there's still uncertainty about the meaning of these mutations.

But now innovative technology is providing us with a game changer for treatment – modelling mutating tuberculosis genes in a matter of hours.

Dr David Ascher, headed the 3D modelling project of mutations in TB

Modelling mutations

Our team has developed a computer-generated model that allows clinicians to tailor effective therapies for individual patients with multidrug-resistant tuberculosis (MDR-TB).

Researchers from The Peter Doherty Institute for Infection and Immunity and University of Melbourne's Bio21 Molecular Science & Biotechnology Institute, led by University of Melbourne PhD student Malancha Karmakar, have devised a 3D-computational approach to predicting the impact of mutations in TB.

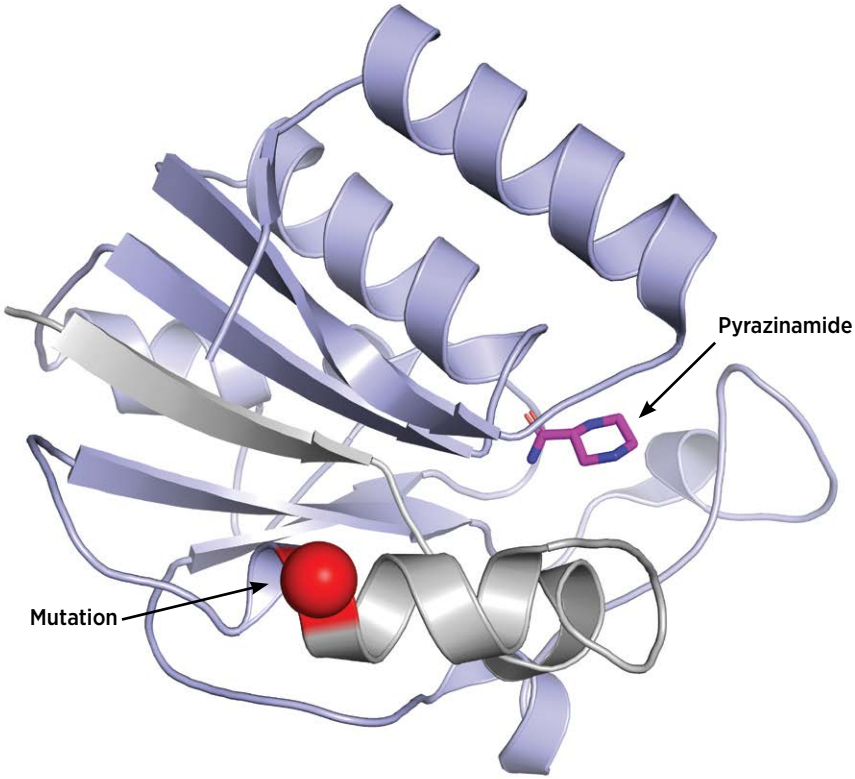
This work is aimed at supporting global programs that are starting to use new TB therapies, allowing them to be tailored to an individual as early as possible while also avoiding the use of ineffective and harmful treatments.

While our research was underway, doctors in Melbourne were treating a patient with multidrug-resistant (MDR) TB who was experiencing significant side effects from the cocktail of medications they required. These problems with side effects are sadly common, as MDR-TB needs treatment for up to two years with medications that can themselves cause deafness, liver and thyroid damage, joint pain and other issues that add to the difficulty of completing therapy.

Scientists at the Victorian Infectious Diseases Reference Laboratory used this cutting-edge genome sequencing technology to look for drug-resistance mutations to help tailor the patient's therapy and identified a mutation that had never been reported before.

Suspecting that the mutation might be causing resistance, Ms Karmakar was quickly able to build a new 3D model to investigate. What she found was that the mutation made one of the drugs being used completely ineffective. As a result, doctors swapped it for another, more effective drug.

This article was first published on Pursuit.



Impacts of Research: Environment

Tracking Climate Threat to Australia's Unique Ecosystems

Evidence of the impact of climate change on our country's distinct flora and fauna is beginning to emerge, and we're running out of time to record and preserve our extraordinary biodiversity.

By Professor Ary Hoffmann, Nicholas Bell and Dr James Camac, University of Melbourne

How do we monitor the impacts of climate change on Australia's terrestrial ecosystems?

It's a complex issue. This is mainly because of how variable the climate can be on land, as well as the unpredictability of extreme events like drought, fire and flooding, which typically reoccur at decade scales. These extreme events are expected to have the largest impacts on our terrestrial biodiversity.

As a result, detecting any climate-driven changes in the frequency and intensity of these extreme events needs sets of data that only come from decades of long-term monitoring.

While this long-term monitoring is critical for ensuring the endurance of species and communities into the future, there are challenges.

For one, it is difficult to fund long-running research like this from research grants, which are typically short – usually three years or so. But then there's also the need for highly specific expertise for accurate monitoring of animal and plant communities.

It's an issue that has attracted global attention – Sir David Attenborough has joined the call warning that time is running out to record and preserve Australia's unique biodiversity.

Nevertheless, the evidence is beginning to emerge. Our team, alongside other scientific colleagues, has collated eight case studies of climate change impacts on Australian terrestrial ecosystems, published in the journal *Austral Ecology*.

Several of these case studies highlight the clear link between recent climate change and its effect on terrestrial biodiversity, while others highlight the uncertainty in climate change impacts and the need to collect more data to better understand the current and future impacts of our changing climate.

A once healthy cushion plant suffering from dieback. Photo: Dana Bergstrom. www.antarctica.gov.au/agazine/2011-2015/issue-28-june-2015

Plants and a changing climate

One of the simpler case studies involves cushion plants on Antarctic islands.

These plants are 'ecosystem engineers', serving a keystone role in their ecosystem. As their habitat becomes drier, these plants, which were once common in the landscape, have become threatened in an extremely short period of time.

They are dying as a consequence of the drier and more variable conditions, as well as other environmental stresses including pathogens.

Animals and the heat

Meanwhile, animal populations are also being severely affected by recent changes in climate.

For example, the Mountain Pygmy-possum is dependent on the annual migration of Bogong Moths – its main food source – which emerge hundreds of kilometres north of the possum's alpine range. But changing climate conditions and modern farming practices are leading to a sharp decline in moth numbers, which has dire consequences for the survival of the possums over winter.

Time is of the essence

Monitoring and understanding the effects of climate change on biodiversity is only the first step in forecasting and adapting natural environments to global change. There are many important questions that need to be considered by both land managers and communities to help minimise the damage of climate change.

For example, if a species is expected to become locally extinct due to changes in climate, at what stage should we consider translocating it to areas of higher suitability?

Should more tolerant species be translocated to areas where a species is expected to become locally extinct in order to maintain critical ecological and economic functions of the environment, like timber production, pollination, carbon capture, microclimate effects, and soil erosion control?

Should we focus our attention on improving a species' resilience to climate change?

Should we focus efforts on identifying climate refuges and prioritise these areas for land acquisition?

These are big questions. And there're a lot of them. But if we don't act now, it may be too late. Some trees and large animals have very slow generation times lasting several decades and, for them, the timing is critical.

There are no simple answers, but if we take early action and commit to detailed monitoring of areas where these changes are happening, we will no doubt make mistakes, but we could also learn important lessons for the future of our unique ecosystems.

This is a shortened excerpt, first published in Pursuit.

Enabling Platform Technologies

Platform Technology Facilities supporting molecular science

The Bio21 research environment consists of well-resourced platform technology facilities that house powerful research instruments.

Some of our facilities represent the largest of their kind in Australia, with cutting edge instruments and led by highly regarded national experts in their respective technologies. Much of the instrumentation has been supported through government grants, such as the ARC LIEF grants.

The Margaret Sheil laboratories in the Nancy Millis building house the Melbourne Mass Spectrometry and Proteomics platform and Metabolomics Australia platform, with a total of over 30 mass spectrometers.

Melbourne Mass Spectrometry and Proteomics

Melbourne Mass Spectrometry and Proteomics, with its fleet of eight mass spectrometers and seven HPLC instruments, as well as sample preparation instruments makes it possible to conduct proteomic, lipidomic and metabolomics analyses of samples, as a powerful way to identify biomarkers of diseases, as well as measure the impact of potential therapeutic candidates. A recent addition to the laboratories, through a collaboration with the Doherty Institute, is an ICP-mass spectrometer that can identify metal ions at very low concentrations in biological samples.

Metabolomics Australia

The Metabolomics Australia facility, also housed in the Margaret Sheil laboratories at Bio21, comprises the combination of high-throughput analytical technologies for the detection and quantification of metabolites in biological systems with the application of sophisticated bioinformatic tools for data mining and analysis. The most commonly used platforms for the detection and measurement of metabolites involves the use of gas chromatography, liquid chromatography, or capillary electrophoresis coupled with mass spectrometry. These analyses can be very powerful for biomedical and environmental research.

Melbourne Magnetic Resonance

The Melbourne Magnetic Resonance platform is home to nine magnetic resonance spectrometers, with a tenth one on the way for fragment-screening purposes. This suite of instruments includes 400, 500, 600, 700 and 800 MHz magnetic resonance spectrometers

and a DNP solid-state dynamic nuclear polarization-enhanced NMR system to make increasingly sensitive measurements of samples from small molecules through to large proteins, in solution, but also as solids in more physiological conditions.

Melbourne Advanced Microscopy

The Melbourne Advanced Microscopy platform is bursting at the seams with high end electron microscopes. It is housing four Transmission Electron Microscopes (TEM), of which three are cryo TEMs. It is also equipped with two Scanning Electron Microscopes (SEM) and a dual beam microscope.. The ThermoFisher FEI Talos Artica cryo EM has already led to a number of atomic resolution protein structures despite only being commissioned a year ago. The Bio21 Institute also has several high end optical microscopes with confocal microscopes and super resolution systems as well as sample preparation equipment as part of the University of Melbourne's Biological Optical Microscopy Platform (BOMP).

With the 'Stage 2C' development to house CryoEM microscopes in the former Veterinary Research Institute and the newly established Melbourne Protein Characterisation platform facility, Bio21 is growing our already significant molecular science instrumentation capacity.

Melbourne Protein Characterisation

Bio21's Melbourne Protein Characterisation Facility (MPC), which is currently being established, will be a key resource within Bio21 for studying protein function and

interactions as well as supporting the other platforms through the production of well characterised proteins for further analysis. The platform will be comprised of three facilities, to support protein discovery research: 1. Protein Production, 2. Protein Characterisation and Interaction and 3. X-ray diffraction. Protein Production will focus on insect and mammalian cell protein expression and is so far equipped with a Biostat twin control tower with rocker and crossflow system. The Protein Characterisation and Interaction facility contains analytical ultracentrifuges, fluorescence spectrophotometers, UV-Vis absorbance spectrophotometers, isothermal titration calorimeters, circular dichroism spectrometers, dynamic light scattering zetasizer, biolayer interferometer, microscale thermophoresis, and differential scanning calorimeter. The facility will soon be complemented by a Biacore surface plasmon resonance with funds from the recent successful ACRF grant. The X-ray Diffraction lab has been fitted out with a Rigaku Synergy-S X-ray diffractometer for both protein and small molecule studies and a PX Scanner. A suite of protein crystallisation robots will be added over the next year.

Systems and Computational Biology Platform

The major Bio21 platforms are supported by the Bio21 Systems and Computational Biology Platform which has recently set up "Bio21 cluster 1", a high performance cpu cluster with a total of 340 cpu core to support our platforms and researchers at Bio21.

ACRF Translational Proteomics Facility opened across VCCC partners

The Australian Cancer Research Foundation (ACRF) Translational Proteomics Facility, funded by a $2,000,000 grant to the Victorian Comprehensive Cancer Centre (VCCC), was officially opened on Monday, 19 November 2018.

The Facility consists of a suite of instruments distributed across two of the VCCC partner organisations, the University of Melbourne (Bio21 Institute) and the Peter McCallum Cancer Centre. Professor Gavin Reid toured with the official delegation from the ACRF and supporters through the Bio21 Institute's Mass Spectrometry and Proteomics Facility, to showcase the mass spectrometer that was purchased with the support of the ACRF grant, before heading with the group to the VCCC for the official opening ceremony. The instrumentation purchased with the support of the ACRF is being used to conduct protein-based assays that will inform the treatment of cancer patients with targeted cancer therapies.

AUSTRALIAN CANCER RESEARCH FOUNDATION

Women of Bio21 Committee Report

At the Bio21 Institute, I chair the "Women of Bio21" Committee, with the aim of identifying ways in which we can improve gender equity at the Institute.

Dr Diana Stojanovski

One of our initiatives in 2018 has been to profile our women from across the Institute, at various stages of their career and representing diverse roles and backgrounds. It has been a wonderful initiative that has highlighted some of the challenges our women face, but also how with support, encouragement and determination they continue to pursue the career they love. Some of the barriers and challenges that have been highlighted through the profiles include:

"Having my children while establishing my independent laboratory."

"Being a first time mum with no family around, in particular since my post-doc contract was coming to an end and I had to start looking for a new position."

"It has been challenging at times to maintain a sense of value and achievement during my working life as I have worked part-time for most of my career and continued to work 'at the bench', which I enjoy."

"The transition into motherhood from fulltime work was very challenging, but the birth of my second child coincided with the dramatic decline of my frail elderly parents."

"Early in my PhD, I spent five months working in a large fly lab in Houston, Texas. I felt totally out of depth in such a fast-paced research environment."

The Bio21 Institute brings together research groups working with molecular science technologies from from three STEMM faculties, including the Faculty of Science (School of Chemistry, School of BioSciences), Faculty of Medicine, Dentistry and Health Sciences (Department of Biochemistry and Molecular Biology, Melbourne School of Dentistry) and the Melbourne School of Engineering (Department of Chemical and Biomolecular Engineering). We also have a number of industry groups within the building, including CSL Ltd, Alterity, formerly Prana Biotech (2018), Circa Group, SYNthesis med chem and Research and Rhythm Biosciences, as well as our Platform Technology groups.

This diversity of research groups, departments, schools and faculties, platform technology facilities and industries is a both a challenge and an opportunity for tackling barriers to gender inequality at the Institute.

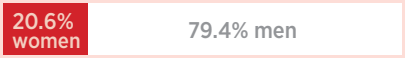
The challenge is that some barriers can only be addressed at a departmental level, so Bio21 can make recommendations, e.g. relating to structural barriers relating to promotions and recruitment, but cannot implement these changes.

However, harnessing our diversity provides women at Bio21 with opportunities, such as mentoring initiatives for career paths, creating a supportive work environment and developing institute-specific funding.

STEMM stats (2016):

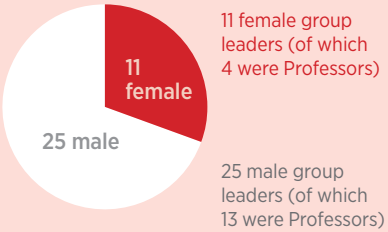
Level A, total of 6,038 junior academics:

Level E, total of 4,007 senior professors:



Source: Department of Education and Training, SAGE website (August 2016)

Bio21 group leaders in 2018:



A starting point for addressing inequalities is to collect data on the numbers of women at each level of our organisation and also to ask people what barriers they face at their respective stage of their career, be it a graduate student, through to a Professor. This is one of the initiatives that the Committee is pursuing.

From data collected by the Department of Education and Training published on the SAGE website (last updated 16 August 2016), we know that women continue to be underrepresented across STEMM fields, particularly at senior levels.

The difference becomes quite marked as women progress in their academic careers, between junior academics (Level A) and senior academics (Level E): there is a total of 6,038 junior academics in STEMM: 3,029 are women (50.2%); 3,009 are men (49.8%); Level E: there is a total of 4,007 senior professors in STEMM: 825 are women (20.6%); and 3,182 are men (79.4%).

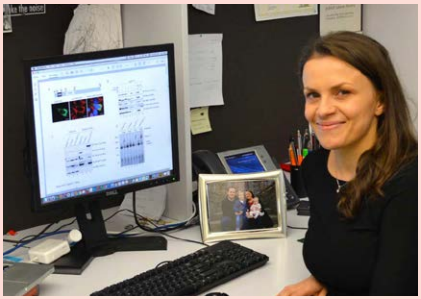
In 2018, Bio21 reflects the STEMM landscape in Australia with 11 female group leaders (of which 4 were Professors); 25 male group leaders (of which 13 were Professors).

Some of the hopes that our women have named for women in STEMM are:

"... attitudinal change in leaders across the academic community to provide generous and positive advocacy for women in STEMM, as well as practical assistance to women navigating career progression through childbearing years – such a short period of time in the context of an entire career."

"... more female lecturers and academics than I had, and to be surrounded by more females in leadership and management positions."

"The workforce and career imbalance in general is not sustainable and I hope over time we achieve equality on a level where gender isn't even a factor. Also, I hope to see an improvement in a way that ensures family versus career is no longer a dilemma."

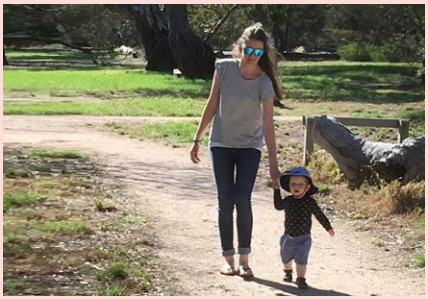


***Diana Stojanovski** chairs the 'Women of Bio21' Committee and heads the Mitochondrial Biology group. Diana seeks to understand how mitochondrial proteins are trafficked within cells and spends every spare minute with the most interesting little creatures of all, her children!*

***Louise Formby-Miller** is passionate about her kids and Bikram yoga. At Rhythm Biosciences she develops immunoassays that form the basis of a blood-based test for colorectal cancer.*

Danielle Christesen *is a PhD student in the Batterham group, School of Biosciences. She enjoys dancing to the rhythm of life and seeks to understand insecticide resistance and how neurons control fruit fly development.*

Xu Li *is a Research Fellow in the Gras Group, Department of Chemical and Biomolecular Engineering. She is developing new semi-synthetic routes for the manufacture of medicinal alkaloids. She's also a gourmet food fiend!*



Susann Wudkte *is a research scientist in the Molecular Biology team at CSL that is responsible for the design, generation and optimisation of protein-based medicines. Susann loves being outdoors, exploring the beauty of Australia with her little family.*

Jacqueline Heath *is a Research Fellow in the Reynolds group, School of Dental Science, interested in the immune responses of the mouth's mucosal epithelia to 'friendly' and disease-causing bacteria. Jacqueline is passionate about perfecting her skills in Punjabi cuisine.*

Kirsty Turner *is Bio21's Research Support Services Manager and a devoted mummy. Kirsty craves to throw on the scuba gear to get close to sharks, loves Formula 1 racing and discovering the world.*

Dedreia Tull *is the Manager of the Metabolomics Australia facility at Bio21. Dee loves Latin dancing and applying her experimental knowledge to the challenge of designing yummy, healthy recipes with limited ingredients to manage her son's allergies.*

Industry Engagement and Commercialisation

From the beginning, it has been one of Bio21's goals to support translation and commercialisation of research and to provide a supportive 'incubator' space for industry research, whether they be start-ups or more well established.

Bio21 is an attractive location for industry groups for many reasons: access to our platform technology facilities, being embedded in a thriving academic research institute and in close proximity to other University of Melbourne institutes and faculties, medical research institutes and hospitals in the precinct. But it is often the intangible factors such as a collegial, collaborative and welcoming research culture that then leads to the flourishing of these groups in our Institute, as well as the growth of opportunities for all.

In the course of 2018, Rhythm Biosciences and SYNthesis med chem moved into the Bio21 Business Incubator building (building 404). They join CSL, Circa Group and Alterity, formerly Prana Biotech as industry research groups who are part of the Bio21 community.

The SYNthesis med chem Group is a privately held group of companies that was founded in Melbourne in July 2007 by Professor Andrew Wilks and Dr Xianyong Bu. The Group employs over 180 staff and currently consists of two companies: (1) SYNthesis med chem which operates as a medicinal chemistry contract research organisation with subsidiaries in Australia, China, USA and UK and (2) SYNthesis Research which is a drug discovery and research organisation with global research interests.

Following the tradition set by CSL at Bio21, SYNthesis sees location within the Bio21 Incubator as a strategic move and are keen to interact and support academic researchers in areas of the company's interest, particular in medicinal chemistry.

Rhythm Biosciences Team

In addition, they are eager to play an active part in university life such as giving occasional lectures, collaborations, partnership in grant applications, mentoring in commercialisation, student placements and employment of graduates. A longer-term goal is to develop a portfolio of home-grown drug discovery companies.

Professor Andrew Wilks said of the Bio21 opportunity:

"By locating our team in Bio21, the very epicentre of Melbourne's world class Parkville Precinct, we seek to take advantage of the opportunities to translate the best research in Australia, while at the same time, alongside our academic colleagues, we are keen to help catalyse a renaissance of the lost art of commercial medicinal chemistry."

In addition to the industry groups, we also have members from Research Innovation and Commercialisation (RIC), such as Martin Elhay, as well as BioCurate (Cathy Drinkwater) located in the Nancy Millis building. They are there to offer support to researchers seeking to translate and commercialise their discoveries and can provide introductions to our industry tenants.

Glenn Begley, CEO of BioCurate introduced BioCurate and its objectives at the 'Big Picture' Seminar, 8 November 2018, that was followed by a moderated Q&A discussion with other BioCurate team members on a panel.

The vision of the Bio21 Institute's business incubator is to provide opportunities for strategic alliances with established companies and to foster the growth of promising biotech start-ups.

RIC and BioCurate at Bio21

Members from Research Innovation & Commercialisation (RIC), such as Martin Elhay, as well as BioCurate's Cathy Drinkwater are located in the Nancy Millis building, neighbouring the Mass Spectrometry and Proteomics Facility and Metabolomics Australia offices.

Martin Elhay is a Senior Business Development Manager, RIC responsible for Life Sciences, in particular FVAS and Medicine, Dentistry and Health Sciences (MDHS) including Bio21. Martin has a PhD from The Walter and Eliza Hall Institute of Medical Research in Immuno-parasitology after which he worked for 7 years as an academic in the Faculty of Veterinary Science and the Statens Serum Institut Denmark, on host responses to parasites and vaccine development. More recently he has worked in Industry (CSL/Pfizer Animal Health from 1998 – 2013) concentrating on novel adjuvant and delivery systems and is responsible for several vaccines now on the market.

BioCurate is a joint venture of the University of Melbourne and Monash University whose focus is on research translation and commercialisation. With our extensive industry experience and a background in successful drug development, we are able to make a critical assessment of a project's status, potential and trajectory that is meaningful to potential industry partners. We work closely with scientists before, during and after project selection, and our scientific partners maintain a strong intellectual and strategic connection with their projects. Our engagement process ensures that high quality applications are put forward for funding, but also ensures that the same advice, mentoring and support delivered to successful projects is available for those that are ultimately unsuccessful. By focusing on the science and the scientist with an industry lens we aim to foster a deeper understanding of what it takes to make a life-changing medication from an academic discovery.

The team from SYNthesis (Research and med chem) and Bio21 management team

Martin Elhay, RIC, Cathy Drinkwater, BioCurate and Bio21 Director, Michael Parker

New BioMedical Research Facility Secures Victoria's Place as World Class Research Destination

The Honourable John Brumby AO formally opened the new 'Nancy Millis' building, an expansion of the Bio21 Institute of Molecular Science and Biotechnology, University of Melbourne, incorporating CSL's Global Hub for Research and Translational Medicine on 14 December 2018.

"This is an important industry-university partnership that will enable greater knowledge and technology transfer, drive innovation and ensure Australian research is translated into positive health outcomes around the world," said Mr Brumby.

The state-of-the-art, $46million research facility expands the footprint of the Bio21 Institute by 5000 square metres and will house the University of Melbourne's Margaret Sheil Mass Spectrometry laboratories, CSL's Global Hub for Research and Translational Medicine and shared meeting spaces.

The Bio21 Institute is one of the University's flagship research institutes, and for more than a decade has played an important role in positioning Victoria and Australia as a leading destination for life sciences and biotechnology research.

CSL is the largest investor in biomedical Research and Development in Australia. In FY2017-18, the company invested more than US$702 million (~A$900 million) globally in R&D, backed by an R&D workforce of approximately 1700 people worldwide. With the opening of the new facility, CSL expects to more than double the presence of its research scientists at Bio21, from 75 to around 150.

"Universities, government and industry are crucial partners in building and enhancing

Australia's innovation ecosystems. This collaboration within a shared facility is a great example of the kind of partnerships we want to encourage," said Mr Brumby.

The building will enable the expansion of major technology platforms that underpin personalised medicine and the development of new diagnostics.

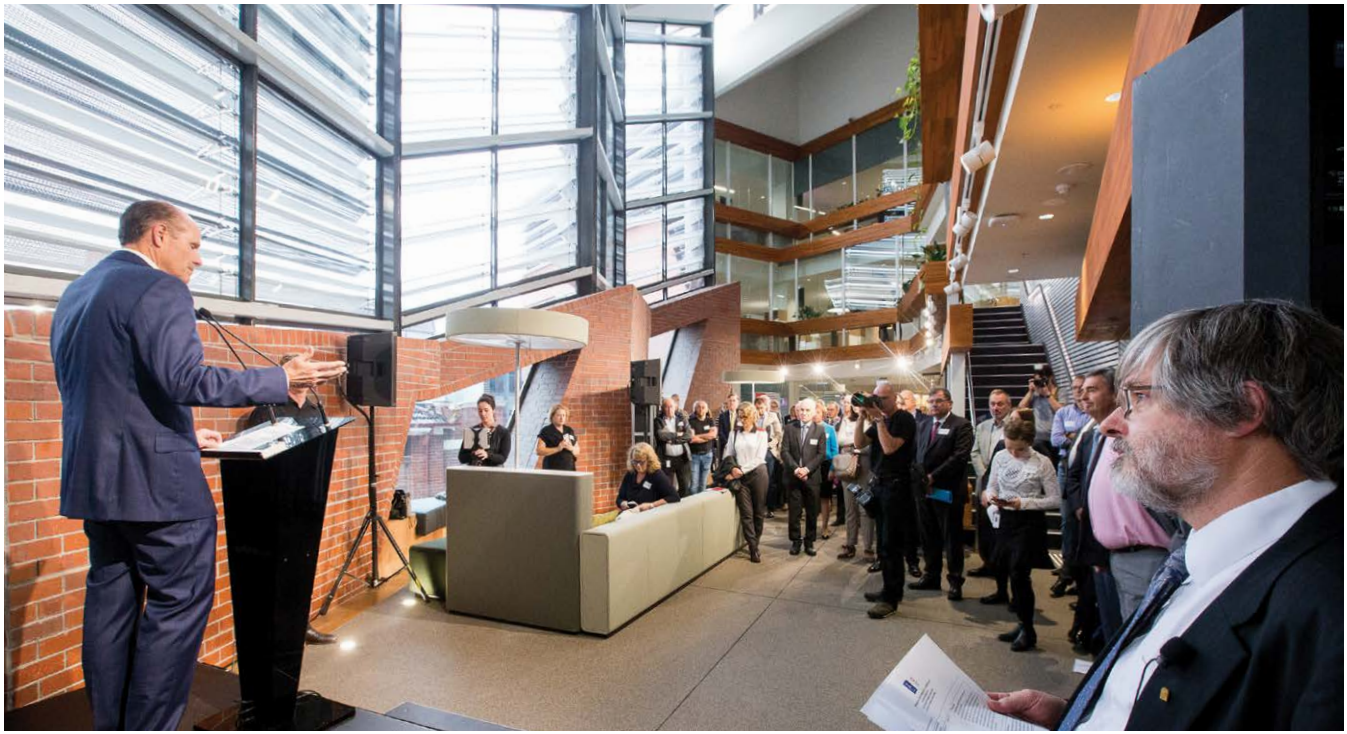
"Bio21 is delivering a world-class research facility for Australia that will play an important part in advancing biomedical research knowledge and the development of new therapies," said University of Melbourne Vice Chancellor, Duncan Maskell.

"It provides a concentration of key infrastructure for researchers from the University and from neighbouring organisations, including medical research institutes and hospitals within the Melbourne Biomedical Precinct.

"The new facility will help researchers to develop diagnostics and treatments for cancer, infectious, metabolic, autoimmune, neurodegenerative and other diseases.

"The co-location of a large multi-national company with the University is a fundamental aspect to the facility's success and will generate an environment in which other start-ups and small businesses can thrive," said Professor Duncan Maskell.

Mr Paul Perreault, CEO and Managing Director, CSL Limited said, "Our investment in an expanded research presence is informed by our commitment to deliver



on our promise to patients. We know from experience that the cross-cultivation of ideas from academia to industry helps translate science into life-saving medicines that improve the quality of life for people with rare and serious diseases."

"CSL is working to maintain a strong pipeline of prospective products in various stages of development. Our collaborations with the medical research community in Australia are critical to this success. We envisage an increased presence at Bio21 will facilitate collaborations with research institutes and hospitals and provide an expanded base for new national and international partnerships," said Mr Perreault.

The building is named in honour of Professor Emeritus Nancy Millis AC, who was one of the first women to be appointed a professor at the University of Melbourne. Prof. Millis introduced fermentation technologies to Australia and created the first applied microbiology course taught in an Australian university. The Bio21 Institute has dedicated its laboratories to Professor Margaret Sheil AO – an Australian academic and Vice Chancellor of Queensland University of Technology.

New Bio21 building recognises pioneering women

The University of Melbourne has honoured two if its most revered scientists at the opening of the expanded Bio21 Institute of Molecular Science and Biotechnology on Friday, 14 December.

The state-of-the-art, $46million research facility expands the footprint of the Bio21 Institute by 5000 square metres.

The new building has been named after Nancy Millis, one of the University's first female professors, while the Margaret Sheil Mass Spectrometry laboratories recognise Australia's first female chemistry professor. CSL's Global Hub for Research and Translational Medicine is also located in the new building.

Nancy Millis graduated from the University with an undergraduate degree in Agricultural Science and a Master of Science. She completed a Doctorate in Fermentation Technology at Bristol University.

Nancy joined the University of Melbourne in 1952 when she was appointed as a Senior Demonstrator in the then Department of Microbiology. In 1953 she was appointed as lecturer.

Early in her career, Nancy set up the first Applied Microbiology course in Australia and in 1982 was appointed as a Professor in the Department of Microbiology and Immunology.

Nancy was awarded Emeritus Professor status in 1987 and continued to work at the University until her death in 2012. Nancy was also Chancellor of La Trobe University from 1992 until 2006.

Nancy co-wrote a text book in 1965 for biochemical engineers called 'Biochemical Engineering'. The book pioneered the application of Biochemical Engineering principles in the fields of pharmaceuticals, chemicals, food processing and microbiology. The book was used as a reference for students and industry alike for decades afterwards.

Nancy was the Chair of the Recombinant DNA Monitoring Committee (RDMC, 1980-1987) and the Genetic Manipulation Advisory Committee (GMAC, 1988-2001). She led and developed the scheme of voluntary oversight of Australian gene technology research until the commencement of the Gene Technology Act 2000.

Nancy also served as a member of the Gene Technology Technical Advisory Committee (GTTAC) 2001-2003. These roles had significant interface with industry, science and government.

Margaret Sheil, University of Melbourne Provost from 2012 to 2017, commenced as Vice-Chancellor of Queensland University of Technology in February 2018. Margaret is a Fellow of the Royal Australian Chemical Institute and the Academy of Technological Sciences and Engineering. She is a Fellow and Morrison Medallist of the Australian and New Zealand Society for Mass Spectrometry and was made an Office of the Order of Australia in 2017.

University of Melbourne Vice-Chancellor Duncan Maskell, said it was fitting to recognise both women at the expanded Bio21 institute.

> ***"Nancy Millis and Margaret Sheil have made enormous contributions to the global scientific community over many decades," Professor Maskell said.***

"Not just in terms of research, but also as role models who paved the way for many women to pursue a career in academia. I am delighted that Nancy and Margaret's names are commemorated at the Bio21 Institute. I have no doubt they will continue to inspire generations of researchers to come."

Nancy's nephew, Ken Millis, said Nancy would be honoured to have her name associated with such an important research facility.

"Nancy dedicated her life to microbiology and finding ways to prevent disease and improve people's health," Mr Millis said.

"Nancy understood that to be successful, then academia and industry had to work closer together. Nancy would be thrilled to know a brand new, world-class facility that can be used by academics and industry has been named in her honour."

Margaret Sheil said the new laboratories at the Bio21 Institute are a significant addition to the University.

"Boosting research outcomes and building a high performing research culture is important to the reputation of any university," Professor Sheil said.

"To be able to do that, you need the best facilities to work in, which is exactly what the expanded Bio21 institute will provide. I am honoured that my name will be associated with these world-class laboratories."

External Relations, Communications and Engagement

Engagement with the public and various stakeholder groups is an important part of what we do as a scientific research community at Bio21: informing policy and debate, educating the public; inspiring the next generation and opening up ways in which our work can have an impact on our society.

The year 2018 has been a big year for the Bio21 Institute overall and also for communication, engagement and events, culminating in the opening of the Nancy Millis Building, 14 December.

As in previous years, we ran a one week work experience program for Year 10 students from schools across Victoria; opened our doors for the Open House Melbourne Weekend and ran the 'Life Magnified' activity during National Science Week organised by Paul McMillan.

We hosted Bio21 'Big Picture' Seminars, hearing from among others Professor Paul Sanberg, Professor Koram and from the team at Biocurate. We brought our community together and introduced new members, including new industry groups Rhythm Biosciences and SYNthesis Research and med chem at our regular Bio21 morning teas.

Several large conferences and symposia were hosted at Bio21, including AussieMit, Australian Functional Genomics Conference, the Georgina Sweet Awards and the Victorian Mass Spectrometry Symposium, and our platform technology groups hosted a series of '101 workshops'.

We were visited by international academic and government delegations from the University of Birmingham and Padua, as well as Savitribai Phule Pune University's affiliated Modern College of Arts, Science and Commerce. A number of high school groups visited Bio21, including Geelong College, Loreto Mandeville Hall and University High School, Elizabeth Blackburn Sciences.

Also, many of our members have appeared in the media, communicating their research, or providing expert comment, on radio, print media and online platforms, like The Conversation.

Much of the engagement at the Institute is only possible through the efforts of volunteers who have run tours and activities, or shared their research with tour groups visiting the Institute.

Bio21 Visiting Delegations

Every now and again, Bio21 receives visits from high level international delegations. We are a popular destination to showcase the research taking place at the University of Melbourne, but also because the Institute brings together state-of-the-art platform technology facilities, and university and industry research groups. Many are impressed by this and wish to learn from our experiences of creating an institute that fosters collaboration and the sharing of resources, but also to connect with research groups in the institute.

University Birmingham aspiring leaders visit Bio21

On the 13 March, Professor Robin Mason, Pro Vice Chancellor International at University of Birmingham visited the University along with a group of academics participating in University of Birmingham's **2018 Research Leadership Programme (RLP)**. As part of the group's visit, they toured through the Bio21 platform technology facilities. Bio21 has a number of connections to the University of Birmingham. Frances Separovic, Sara Long and Malcolm McConville spoke with the group at various points of the tour. An international experience is a core component of the Research Leadership Programme, and the University of Melbourne is a high-profile partner and destination.

BSc (Blended) students and teachers from India visit Bio21

Twenty students and two teachers from India visited Bio21 Tuesday, 20 November to participate in lab tours as well as a practical malaria workshop. The students and teachers were from University of Melbourne partner Savitribai Phule Pune University's affiliated Modern College of Arts, Science and Commerce where they respectively undertook and taught the Bachelor of Science Blended degree.

The BSc Blended degree is one of University of Melbourne's premier undergraduate teaching and learning activities in India enabling top Indian students to obtain a degree in India with quality assured curriculum co-developed by University of Melbourne and Indian partners. The University plans to expand the BSc Blended Program across India, and as we work to enhance international student diversity, contribute to teacher capability building in India, and foster teaching, learning and research collaboration with the prestigious IIT and IISER network.

The group visited the University's campus for a special cell biology research camp hosted by the Faculty of Science and designed to give them the opportunity to experience first-hand a wide range of projects that are currently being undertaken by researchers in the School of BioSciences with an emphasis on cell and molecular biology techniques for addressing a range of challenges facing Australian ecosystems (such as the Great Barrier Reef), human health and agriculture.

Charles Narh, Samantha Deed, Evelyn Chou, Dionne Argyropoulos, Sunnia Rajput and Dave De Souza ran the malaria activity and engaged with the students during the Bio21 Institute tour.

University of Padua delegation tours Bio21

Rizzuto Rosario, Rector of the University of Padua and a biomedical scientist, and his delegation from the University of Padua that included Alessandro Paccagnella, Mara Thiene, Alessandro Martucci and Elena Autizzi, visited the Bio21 Institute on the 6 September 2018. As part of their visit, they heard from Fabienne Mackay, Head of the School of Biomedical Sciences and from the Director Michael Parker. Associate Director, Commercialisation, Spencer Williams led a tour through the new building to the Margaret Sheil laboratories. Ian van Driel, Paul Gleeson, David Stroud and David Ascher also attended the morning meeting and Dave De Souza introduced the new Margaret Sheil laboratories to the guests. The delegation from the University of Padua went on to sign a Memorandum Of Understanding Renewal and Signing Ceremony with the University of Melbourne, to continue to foster ties with the University and opportunities for student exchange.

Public and School Engagement

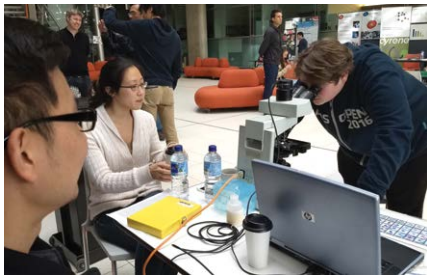
The Bio21 Institute has for the past three years opened our doors over a weekend to the general public in the Open House Melbourne Weekend. We engage with school children through the work experience program, school tours and through the 'Life Magnified' event as part of National Science Week, just to name a few.

Conoco Philips 'Science Experience' at Bio21

On Wednesday 17 January, thirty year 9 and 10 students were introduced into the world of malaria research with Kathryn Tiedje, Samantha Deed and Charles Narh. Given a card with a patient description, students gathered clues by peering down a microscope and interpreting a Polymerase Chain Reaction (PCR) and Rapid Diagnostic Test result to diagnose whether their patient had malaria or not and whether to proceed with treatment. In this way, they received some insight into the malaria research being conducted by the Day group with malaria affected populations in Ghana.

Open House Melbourne Weekend

On Saturday 28 and Sunday 29 July 2018, the Bio21 Institute opened its doors for the Open House Melbourne Weekend.



Visitors took part in tours through the Institute's facilities and laboratories and could engage with researchers at displays in the atrium. Over 500 members of the public visited the Institute.

'Girls in Science' breakfast, Bendigo and Bio21

Bio21's Frances Separovic was a guest speaker at the 'Girls in Science' breakfast event in Bendigo on 27 April 2018. Here she is seen with senior students from Seymour College at the event.

Year 10 Work Experience at the Bio21 Institute

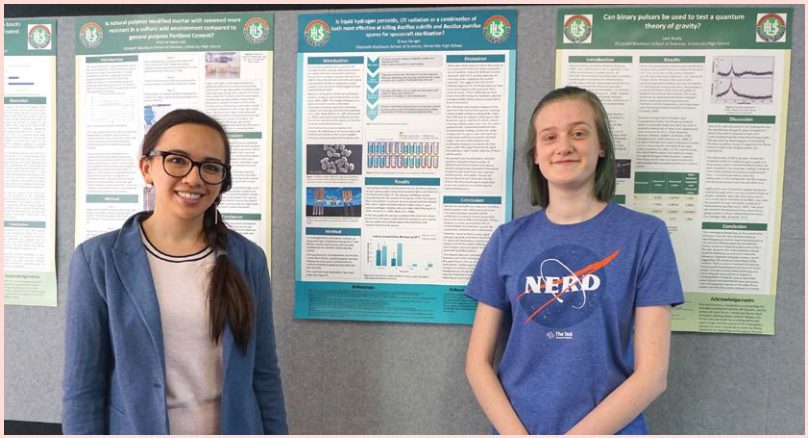
The Bio21 Institute, as part of the Faculty of Science's Work Experience program, hosted 14 year 10 students from schools across Melbourne and Victoria from 25–29 June.

Students participated in a diverse program of experiments, activities and projects, that gave them insight into the research taking place at the Bio21 Institute in order to help them make important career decisions as they embark on their VCE.

National Science Week: 'Life Magnified' presented by BOMP at Bio21

"Life, Magnified", was an event run by the Biological Optical Microscopy Platform at the Bio21 Institute during National Science Week. The event for year 9 and 10 high school students educated them about the microscopic world of our bodies and what can happen when things go wrong. From *The Geelong College in the west to Koo Wee Rup Secondary College in the east, almost 120 students from 8 schools attended the Bio21 Institute on 16 and 17 August. The students were led through an imaging experiment, got to see inside labs, inside cells, play with microscopes and talk to researchers about their work. Mount Alexander College were winners of this year's prize and received 10 foldscope microscopes.

**Schools involved: Geelong College, Templestowe College, Glen Eira College, Copperfield College, Suzanne Cory HS, Mount Alexander College, Strathmore College, Koo Wee Rup SC.*



Alex Louie, Head of Enquiry Learning and VCE student Grace, University High School

Elizabeth Blackburn Sciences' students impress with Scientific Poster Presentations

From the most effective treatment for acne, to the effect of global warming on gene expression in green algae and testing a quantum theory of gravity, the 'Extended Investigations' research projects completed by Year 11 VCE students at the Elizabeth Blackburn Sciences were on display and the quality of the work was impressive.

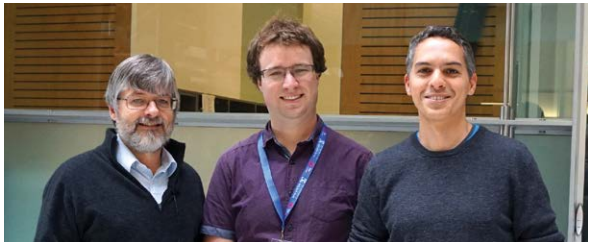
"You are the expert. You are the one teaching the teacher," a proud Alex Louie, Head of Enquiry Learning, Elizabeth Blackburn Sciences, University High School, told her VCE students, after an afternoon of poster presentations. "It's wonderful to see your ability to apply your knowledge to an area of interest," she said.

Bio21 Institute Community Events and Engagement

The Bio21 Institute, reflecting the international nature of science, is a diverse community of academic and industry researchers and professional staff members at various stages of their careers, from diverse cultural, ethnic backgrounds and genders. It is one of the reasons that science institutions are such enriching places to work in.

For a scientific culture such as ours to flourish, it needs to be inclusive, equitable, fair and underpinned by a strong sense of respect for each other.

One of the ways in which Bio21 nurtures its culture is through regular internal morning teas throughout the year often linked with fundraising for various causes, where Bio21 members come together over a cup coffee and some sweet treats to hear from the Director about goings-on, to welcome new members into our community, recognise the achievements of our members and to enjoy a chat with colleagues and peers.



Bio21 Blazers walking to support mitochondrial research

Bio21's team was buoyed by the beautiful weather during the 'Bloody Long Walk' for Mitochondrial Disease Research on Sunday, 26 August. The Bio21 "Blazers", which included Diana Stojanovski, David Stroud, Catherine Palmer, Joanna Sacharz, Yilin Kang, Laura Fielden, Thomas Jackson, Daniella Hock, Emily Selig, Alex Tokolyi and Alex Anderson, followed the iconic route of the Yarra River from Melbourne's northern parklands to the vibrant atmosphere of Southbank before reaching the beaches of St Kilda; a total of 35km.

The team raised a total $5,068 that goes to the Mito Foundation to fund its patient support, research grants and fellowships, as well as education and awareness programmes.

Bio21 Hosted Events

Bio21 is a popular venue for conferences, symposia and other scientific events.

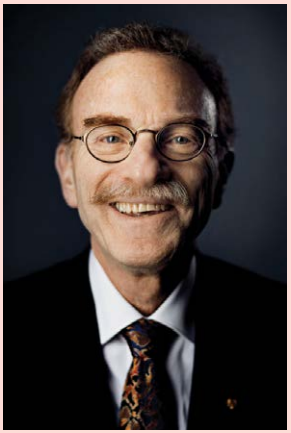
Pest Control Symposium @ Bio21

On Monday, April 23 a special Symposium was held at Bio21 to honour the seminal contributions of Professors Max Whitten and John McKenzie in establishing a research group focused on the genetics of pest control. The Symposium showed how a vibrant contemporary program of pest control research focused on insects and nematodes, running across many research groups, including Bio21's Batterham, Hoffmann and O'Hair groups and utilizing an extremely broad range of advanced technologies has developed on the foundation laid by Whitten and McKenzie.

The Symposium engaged an audience of 100 people from the University community, past and present laboratory group members and a strong contingent of industry representatives.

Nobel Laureate, Randy Schekman delivers Grimwade Medal Oration at Bio21

The Department of Biochemistry and Molecular Biology at the Bio21 Institute was honoured to host 2013 Nobel Laureate Professor Randy Schekman on the 20 September 2018. Randy Schekman was awarded the 2018 Grimwade Medal and presented a wonderful oration titled: "From Pond Scum, to Stockholm." As a cell biologist, whose ground-breaking research has uncovered how membrane proteins are transported in cells, Professor Schekman described his journey from studying basic biological processes in yeast (pond scum) to the award of the Nobel Prize, 2013. The oration was followed by a dinner in the Bio21 Institute atrium.



ARC Training Centre – Chemical Industries (ATCI) launched at Bio21

Senator for Victoria, James Paterson, launched the ARC Training Centre–Chemical Industries (ATCI), led by Tash Polyzos, at the Bio21 Institute on Friday, 21 September 2018.

The ATCI will deliver the innovative Masters of Industrial Research degree, making chemical education more commercially relevant. Students will spend a minimum of 12 months embedded with an industry partner, conducting an R&D project led by the industry partner. The ARC Training Centre – Chemical Industries will be led by The University of Melbourne, in collaboration with The University of New South Wales, Swinburne University of Technology, Chemistry Australia; CSIRO, Duluxgroup (Australia), Qenos, PPG Industries and the Trustee for DCS Technical Trust.

Graduate Research Students and Early Career Researchers

One of the questions that many PhD students have is: what happens after their PhD? In the course of a PhD, students become experts on their topic and can come to know more than anyone else, about their chosen protein, molecule or other object of study. But many fear that this may not prepare them for a research career, or for any other career path.

The competitive nature of the science endeavour can leave many students feeling that if they cannot, or do not wish to pursue the academic research path, that they have failed in some way.

Furthermore, some people would argue that it is a waste of our society's resources to invest in training such specialists, who then may not pursue a research path after completion.

Nothing could be further from the truth.

PhD students have gone on to pursue very disparate and fulfilling career paths, some in academia, but many in other professions.

A PhD is a challenging endeavour, where a student takes responsibility for their own project. They need to work independently and in teams to solve problems that no one else has ever encountered. To do this they need endurance, perseverance and grit. Problem-solving becomes a way of approaching the world.

A PhD trains your critical thinking skills like no other work. Students are constantly asked to question what they see, what they read and to be critical of their own work and that of their peers. The ability to think critically and clearly is highly sought after in many high level professions.

PhD students are constantly challenged to communicate their work to the outside world – from small groups of colleagues to an auditorium of international peers; from school children to journalists – honing their public speaking, oral and written communication skills.

From patent law, journalism, entrepreneurialism, politics, education, or even as a committee member at your local school, these skills are required in all walks of life.

Most importantly, there is an urgent need for scientists to take up careers in science journalism, politics and school teaching, in particular, if we are serious about Australia being a "clever" country.

By delving into the depths of problems in the course of a PhD, a world of opportunity opens up to students.

Jasmina Markulic (Parker lab) and Emily Crisafulli (Ralph lab), winners of the Biochemistry & Molecular Biology 3MT @ Bio21, 4 May

Bio21 is host to over 200 Honours, Masters and PhD students and we are very supportive of the postgraduate student societies BAMBII (Biochemistry and Molecular Biology) and CPS (Chemistry Postgraduate Society), who often host social events at the Bio21 Institute.

Riley Metcalfe awarded poster prize at the Melbourne Protein Group meeting

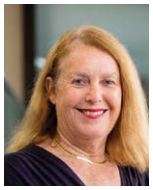
Riley Metcalfe from the Griffin lab was awarded a poster prize at the Melbourne Protein Group meeting for his work on the structure of the inflammatory cytokine interleukin 11.

Institute Members Honoured

Despite the fierce competition for grants, Bio21 remains a success story. Situated in the Parkville Precinct, the Bio21 Institute is located amongst a unique concentration of hospitals and medical research institutes within walking distance of one another. It is a powerhouse of scientific research. This provides researchers at Bio21 with fabulous opportunities to collaborate with researchers in neighbouring institutes. It is the mentors and supervisors, our team members, our colleagues and collaborators that contribute to our success through their support, advice and sharing of ideas.

For Bio21 Institute members it has been an exciting year for awards and prizes:

Professor Frances Separovic was one of twenty outstanding Victorian women who were inducted into the 2018 Victorian Honour Roll of Women.



Professor Suzanne Garland, who directed the Royal Women's Hospital Centre for Women's Infectious Diseases at Bio21, received the prestigious title of an Officer of the Order of Australia (AO).

Bio21's **Dr Michael Duffy**, School of BioSciences, partnering with University of Erlangen, was one of four awardees from the Faculty of Science, for the Australia-Germany Joint Research Co-operation Scheme. The scheme supports exchanges for researchers to spend time at partner institutions in Germany and for collaborating German researchers to spend time here.

Ismail Hacioglou receives ISS 'Apple Award'

Ismail Hacioglou cares for the Bio21 building and its community and takes pride in his work and it shows. On Thursday, 30 August, 2018 Tony Gould, the CEO of ISS, that provides cleaning services to Bio21, and University of Melbourne Manager, Dannielle Rostan, came down to the Bio21 Institute to present Ismail with the 'ISS Apple Award', the highest award presented to an employee of ISS, for the wonderful service that he offers.

Grant Successes

Government research grants as well as major philanthropic grants will ensure Bio21 research and researchers continue to be funded in the years to come.

Bio21 researchers receive ARC and NHMRC Research Fellowships

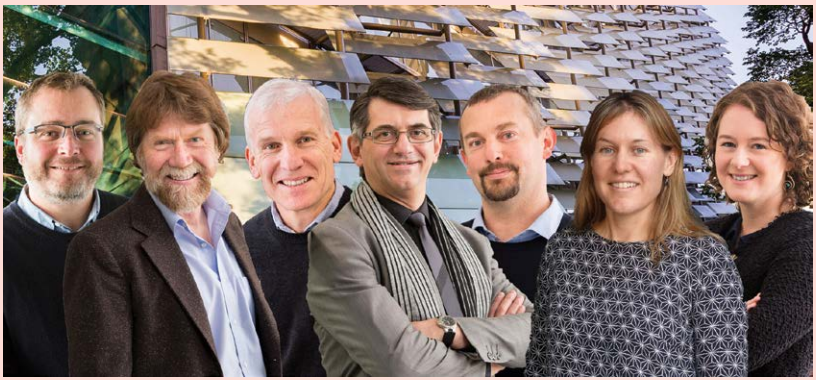
It is wonderful to see the quality of the work of Bio21 researchers being recognised and supported through the NHMRC and ARC funding schemes.

Australian Research Council (ARC):

ARC grants were announced on the 27 November. Sally Gras, Ary Hoffmann, Craig Hutton, Justine Mintern, Gavin Reid, Frances Separovic, David Stroud, Sebastian Duchene and Jose Villadangos received funding to pursue important work in the areas of protein synthesis, mass spectrometry lipidomics, immune host defence, Wolbachia in Drosophila, nuclear magnetic resonance, cell trafficking, species rescue, pathogen evolution and synthetic biology.

National Health and Medical Research Council (NHMRC):

Institute members Danny Hatters, Jose Villadangos, Malcolm McConville, Justine Mintern, Stuart Ralph, Gavin Reid, David Stroud, and Paul Gleeson, received NHMRC Research Fellowships and Project Grants in the last funding round announced 12 December. These grants fund research into antigen presentation and inflammation; neurodegenerative diseases; pathogen genomics; lipidomics in colon cancer; proteomics; parasitic protozoa and malaria.



Philanthropic Support

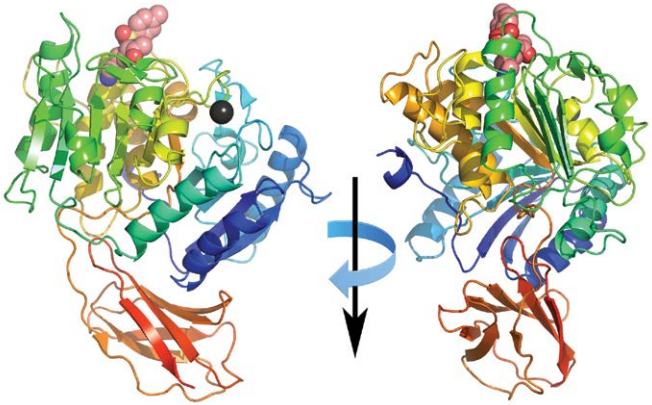
Australian Cancer Research Foundation (ACRF) and Ovarian Cancer Research Foundation Support

On the 28th November, Bio21 received substantial funding from another source: the grant submitted to the Australian Cancer Research Foundation (ACRF) earlier in the year to fund a Facility for Innovative Cancer Drug Discovery was successful and so Bio21 Institute's Director, Michael Parker, was presented with a framed certificate and cheque for $2M from the Governor General, Sir Peter Cosgrove, at Admiralty House in Sydney.

David Ascher and Michael Parker were the chief investigators on the grant from the Bio21 Institute, together with Rick Pearson, Peter MacCallum Cancer Centre and John Silke of the Walter and Eliza Hall Institute, representing some of Victoria's major cancer research institutions.

On Monday, 3rd December, it was announced at the annual ACRF Chairman's dinner, attended by David and Rick, that the Ovarian Cancer Research Foundation would provide funding for operators over three years to help run the new facility and particularly help drive outcomes in ovarian cancer research.

The ACRF funding will make it possible to create a facility that houses some of the most cutting-edge structural biology instruments and technologies for the identification and development of drugs for cancers. The Facility will be hosted by the Melbourne Protein Characterisation platform that is being established in the basement of the David Penington building.



With the new facility, the Bio21 Institute will be a key go-to service for the cancer research community in the Melbourne Biomedical Precinct and beyond for structural biology work in drug discovery.

Structural biology holds the key to developing innovative cancer drugs by providing detailed information about the shape of molecules that are involved in cancer-causing biological signalling pathways within cells of our bodies. Structural biology has played a key role in targeted molecular medicines including imatinib (Gleevec) to treat myeloid leukaemia, venetoclax for leukaemia and gefitinib for lung cancer.

On their website, the ACRF state that 'Our mission is to outsmart cancer by providing world-class scientists with the equipment they need to improve prevention, diagnosis and treatment of all types of cancer.'

The grants awarded by the ACRF are made possible through the generosity of many donors who contribute to the foundation, often people who have personally been affected by a cancer diagnosis. The ACRF states:

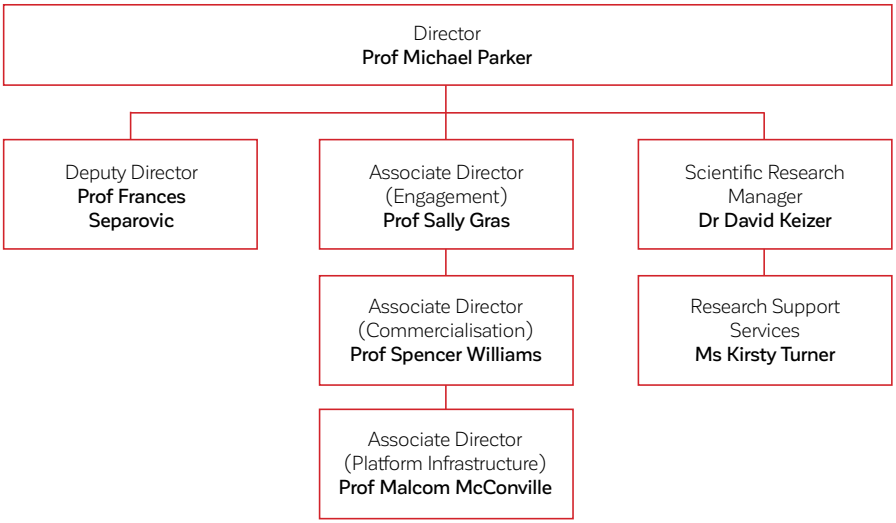
'Thanks to our generous supporters, we have awarded 73 grants totalling $153.2 million to world-class Australian research initiatives.'

AUSTRALIAN CANCER RESEARCH FOUNDATION

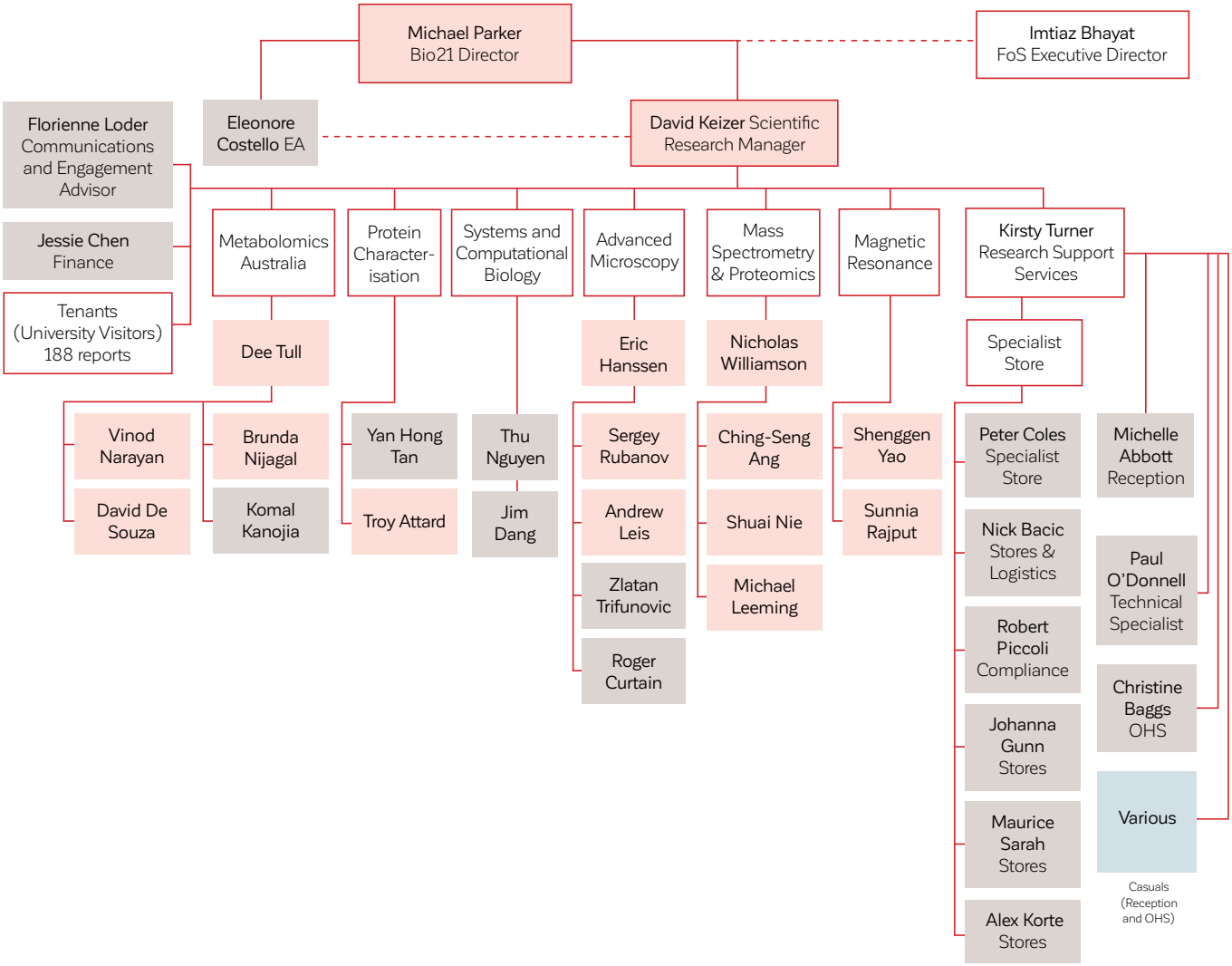
Australian Wool Innovation Grant

A $2.5M grant from Australian Wool Innovation (AWI) was awarded to Trent Perry, Batterham group, along with Clare Anstead and Vern Bowles Faculty of Veterinary and Agricultural Sciences (FVAS) and a research group in CSIRO for a vaccine project to tackle fly strike.

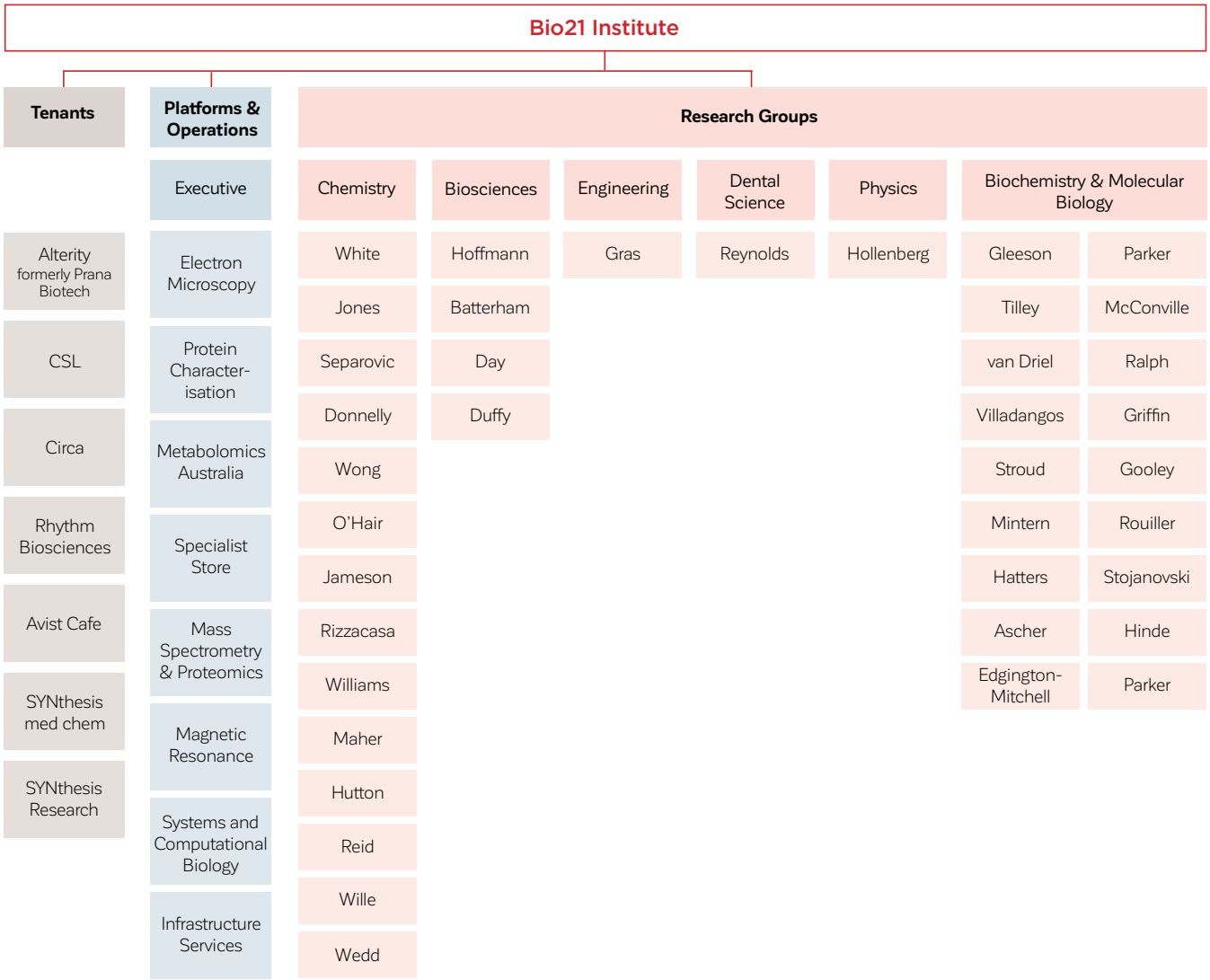
Governance


Director
Prof Michael Parker
Deputy Director
Prof Frances Separovic
Associate Director (Engagement)
Prof Sally Gras
Scientific Research Manager
Dr David Keizer
Associate Director (Commercialisation)
Prof Spencer Williams
Research Support Services
Ms Kirsty Turner
Associate Director (Platform Infrastructure)
Prof Malcom McConville

Bio21 Institute – Scientific Research Team



Bio21 Institute – Research groups



OHS Report

Bio21 Institute is committed to the health, safety and wellbeing of its members and visitors and has the support of senior management to achieve safety targets. Objectives and targets for 2018 were predominantly focused on training and internal audits to ensure compliance was met when conducting high risk activities. It is pleasing to see high levels of occupational health and safety (OHS) related training across all Institute members.

October 2018 saw the completion of a major reconstruction project, the Nancy Millis building. There was a united effort to move our major tenant CSL into their new laboratory spaces in the building, and to relocate two University platforms from the basement of the David Penington building, Mass Spectrometry & Proteomics Facility and Metabolomics Australia) into the new Margaret Shiel laboratories. Despite this complex and challenging environment, it was pleasing to see the myriad of Institute support services and platforms utilised to ensure occupants in the new building were welcomed and supported during this complex and challenging period.

Thank you to all Institute members for cooperating in providing a safe work place for all.

Kirsty Turner
Manager
Research Support Services (including OHS)
Bio21 Institute
The University of Melbourne

Bio21 People

Bio21 Institute Leadership

Michael Parker
Director

Frances Separovic
Deputy Director

Malcolm McConville
Associate Director – Platform Infrastructure

Spencer Williams
Associate Director – Commercialisation

Sally Gras
Associate Director – Engagement

Administration and Operations Team

David Keizer
Scientific Research Manager

Kirsty Turner
Research Support Services Manager

Eleonore Costello
EA to the Director and Scientific Research Manager

Michelle Abbott
Reception

Jessie Chan
Senior Management Accountant

Tony Whyte
Operations Officer

Christine Baggs
EHS Coordinator

Florienne Loder
Communications and Engagement Advisor

Platform Technology Managers

Eric Hanssen
Advanced Microscopy

Nick Williamson
Mass Spectrometry and Proteomics

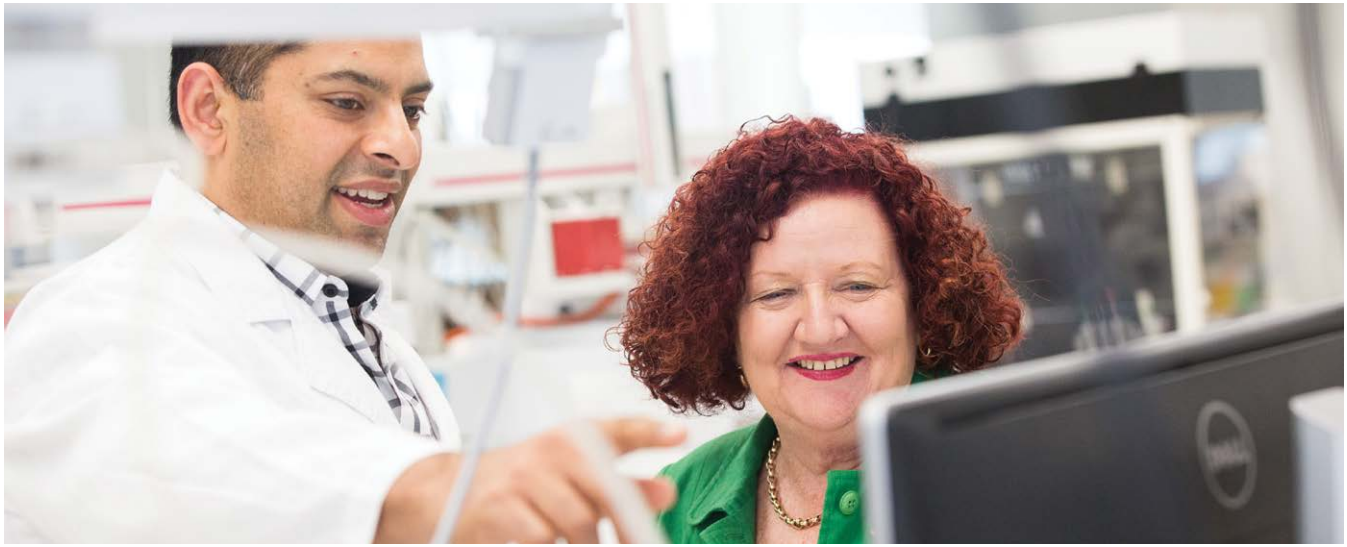
Dedreia Tull
Metabolomics Australia

Yan Hong Tan
Melbourne Protein Characterisation

Thu Nguyen
Systems and Computational Biology

David Keizer
Magnetic Resonance

Peter Coles
Specialist Stores Manager



Institute Departments and Laboratory Group Leaders

Faculty of Science

School of BioSciences

Professor Philip Batterham
Professor Karen Day
Dr Michael Duffy
Professor Ary Hoffmann
Professor Herbert Kronzucker

School of Chemistry

Professor Paul Donnelly
Associate Professor Craig Hutton
Associate Professor Guy Jameson
Dr David Jones
Professor Paul Mulvaney
Professor Richard O'Hair
Professor Gavin Reid
Professor Mark Rizzacasa
Professor Frances Separovic
Professor Tony Wedd
Professor Jonathan White
Associate Professor Uta Wille
Professor Spencer Williams
Dr Wallace Wong

School of Physics

Professor Lloyd Hollenberg

Faculty of Medicine Dentistry and Health Sciences

Department of Biochemistry and Molecular Biology

Dr David Ascher
Dr Laura Edgington-Mitchell
Professor Paul Gleeson
Associate Professor Paul Gooley
Dr Michael Griffin
Dr Danny Hatters
Dr Elizabeth Hinde
Dr Kathryn Holt
Professor Malcolm McConville
Dr Justine Mintern
Professor Michael Parker
Dr Stuart Ralph
Professor Gavin Reid
Associate Professor Isabelle Rouiller
Dr Diana Stojanovski
Dr David Stroud
Professor Leann Tilley
Professor Ian van Driel
Professor Jose Villadangos

Melbourne Dental School

Professor Eric Reynolds

Melbourne School of Engineering

Associate Professor Sally Gras

Bio21 Industry Tenants

CSL
Alterity Therapeutics (Previously Prana)
Circa
RWH (left during 2018)
Rhythm Biosciences (started at Bio21 Sept 2018)
SYNthesis med chem (started at Bio21 October 2018)
SYNtheis Research (started at Bio21 October 2018)

Fellows and Affiliates

Professor Andrew Holmes AC FAA FRS FTSE
Melbourne Laureate Professor Emeritus

2018 Bio21 Steering Committee

Bio21 is overseen by a steering committee that includes the Director of the Institute, the Deans of the Faculty of Science, the Faculty of Medicine, Dentistry and Health Sciences, the Melbourne School of Engineering and the Deputy Vice Chancellor Research of the University of Melbourne.

Director Bio21 Institute of Molecular Science and Biotechnology

Professor Michael Parker

Professor Michael Parker is Director of the Bio21 Institute, University of Melbourne and Head of Structural Biology, St. Vincent's Institute of Medical Research in Melbourne. He is also an NHMRC Senior Principal Research Fellow in the Department of Biochemistry and Molecular Biology at Bio21. After obtaining his D. Phil. in protein crystallography from Oxford University, Michael returned to Australia to re-establish a protein crystallography laboratory at St. Vincent's in 1991. The work of the laboratory is internationally recognised with the determination of more than 140 crystal structures of proteins involved in cancer, Alzheimer's disease and infection. He has published over 300 papers and his work has been recognised with numerous awards including the 1999 Gottschalk Medal of the Australian Academy of Science, a 2006 Federation Fellowship from the Australian Research Council, the 2011 Lemberg Medal of the Australian Society for Biochemistry and Molecular Biology, the 2011 Ramaciotti Medal for Excellence in Biomedical Research, the 2012 Federation of Asian and Oceanian Biochemists and Molecular Biologists Award for Research Excellence and the 2016 Bob Robertson Award of the Australian Society for Biophysics for outstanding contributions to biophysics in Australia and New Zealand. He was elected a Fellow of the Australian Academy of Science in 2010 and a Fellow of the Australian Academy of Health and Medical Sciences in 2015. He is currently Chair of the National Committee of Crystallography under the auspices of the Australian Academy of Science.

Deputy Vice Chancellor Research Chair, Bio21 Steering Committee

Professor Jim McCluskey

BMedSc MB BS MD *UWA* FRACP FRCPA FAA FAHMS

Professor James McCluskey has been Deputy Vice-Chancellor (Research) at The University of Melbourne, since 2011. Prior to this he was the Pro Vice-Chancellor (Research Partnerships), Associate Dean (Research), Faculty of Medicine Dentistry and Health Sciences and Chair of Microbiology and Immunology at The University of Melbourne.

Professor McCluskey trained in Perth as a physician and pathologist before spending four years at the National Institutes of Health in the USA. On returning to Australia in 1987 he worked at Monash University until 1991 before joining Flinders University and the Australian Red Cross Blood Service. Professor McCluskey joined the University of Melbourne in 1997 as Chair in Microbiology and Immunology.

He has published extensively on how genes control immunity, mechanisms of autoimmune disease, immune recognition and the basis of transplantation matching. His work has been recognised by the Rose Payne Award from the American Society for Histocompatibility and Immunogenetics (ASHI), the Ceppellini award from the European Federation for Immunogenetics, the International Roche Organ Transplantation Fund Recognition Prize in 2011, the Australian Museum Eureka Prize in 2013, the GSK Award for Research Excellence in 2015 and the Victoria Prize for Life Sciences in 2016.

He was elected a Fellow of the Australian Academy of Science in 2012 and Australian Academy of Health and Medical Sciences in 2015. He has been a consultant to the Australian Red Cross for more than 25 years leading transplant services and advising on organ transplantation matching.

He implemented molecular techniques for genetic matching of patients and donors and established the South Australian node of the Australian Bone Marrow Donor Registry in 1992. He served as Editor-in-Chief of the international immunogenetics journal *Tissue Antigens* from 2001-2015. He is a Director of the Walter and Eliza Hall Institute, Victorian Comprehensive Cancer Centre, Bionics Institute, University of Melbourne Commercial, Friends of ASHA for Indian Slums and is Chair of the Board of Nossal Institute Limited.

He has previously been a director of the Burnet Institute, the Florey Institute of Neuroscience and Mental Health and two national Cooperative Research Centres. He led the conception, construction and development of the Peter Doherty Institute for Infection and Immunity, a AUD$210M joint venture between the University of Melbourne and Melbourne Health.

Dean of Science

Professor Karen Day

Professor Karen Day is a distinguished malaria researcher dedicated to the improvement of global health. Born in Melbourne, she was educated at University of Melbourne where she obtained her BSc (Hons) with a double major in microbiology/biochemistry and a PhD in Molecular Parasitology from the Walter and Eliza Hall Institute of Medical Research (WEHI). As a young postdoctoral researcher she had the "life changing" opportunity to study the public health problems of Papua New Guineans working at the Papua New Guinea Institute of Medical Research.

Following her postdoctoral research, Prof. Day held positions in molecular epidemiology at Imperial College, London and in the Department of Zoology at the University of Oxford. She was appointed a Fellow of Hertford College in 2003, becoming one of the few women "dons" in science at Oxford. She was a Founding Partner of both the Wellcome Trust Centre for the Epidemiology of Infectious Disease (WTCEID) and the interdisciplinary Peter Medawar Pathogen Evolution Research Centre at Oxford, during which time she was appointed a Visiting Professor at the Harvard School of Public Health.

In 2004 she moved to New York University School of Medicine where she held several senior academic administrative roles at NYU including Chair of the Department of Medical Parasitology; Director of the Institute of Urban and Global Health; and led the development of a Masters Program in Global Public Health.

In 2014 Prof. Day was appointed the Dean of Science at The University of Melbourne where she also continues to be actively involved in running a multidisciplinary malaria research group whose aim is to understand the transmission of malaria to better define control strategies.

Dean of Medicine, Dentistry and Health Sciences

Professor Shitij Kapur

MBBS AIIMS PhD Toronto FRCPC FMedSci

Professor Shitij Kapur, FRCPC, PhD, FMedSci is the Dean, Faculty of Medicine, Dentistry and Health Sciences and Assistant Vice-Chancellor (Health), University of Melbourne. Shitij is a clinician-scientist with expertise in psychiatry, neuroscience and brain imaging. He trained as a Psychiatrist at the University of Pittsburgh, and undertook a PhD and Fellowship at the University of Toronto. He is a Diplomate of the American Board of Psychiatry and Neurology, similarly Board Certified in Canada and has a specialist medical license in the United Kingdom.

Professor Kapur's main research interest is in understanding Schizophrenia and its treatment. He has used brain imaging, animal models and clinical studies which have led to a better understanding of antipsychotic action, its relationship to brain dopamine receptor blockade, the

role of appropriate dosing of these drugs and has led to the development of the 'salience' framework of psychosis and the 'early onset' hypothesis of antipsychotic action. He is now working on how 'biomarkers' might be best incorporated into psychiatric care and drug development. Shitij has published 300 peer-reviewed papers; his work has received over 25,000 citations as he has made numerous presentations worldwide. He serves in advisory capacity to public charities and pharmaceutical companies and has received national and international awards including the AE Bennett Award of the Society for Biological Psychiatry and the Paul Janssen Award of the CINP. He is a Distinguished Fellow of the American Psychiatric Association and the Fellow of the Academy of Medical Sciences, UK, and Fellow of King's College London, UK. He led NEWMEDS, an EU-wide Innovative Medicines Initiative and currently leads STRATA, a UKwide program to enhance stratified medicine strategies in psychiatry.

Head of School, Chemical and Biomedical Engineering, Melbourne School of Engineering

Sandra Kentish

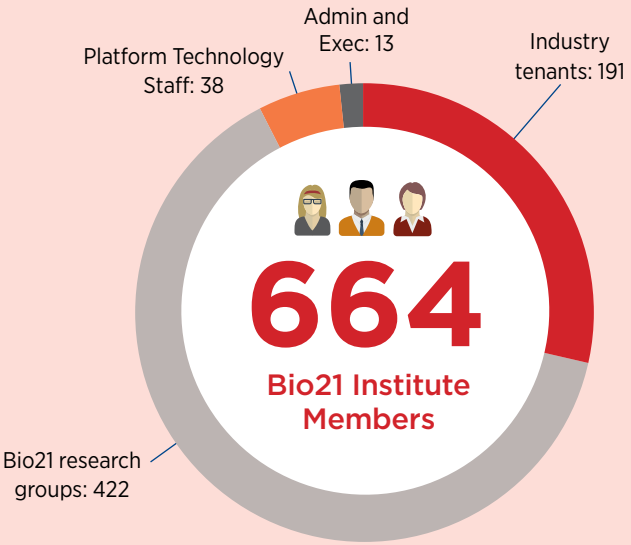
Professor Sandra Kentish is Head of the School of Chemical and Biomedical Engineering at The University of Melbourne. She is also an invited Professor at the Centre for Water, Earth and the Environment within the Institut National de la Recherche Scientifique (INRS) in Canada.

Professor Kentish has broad interests in industrial separations, particularly the use of membrane technology for energy, food and water applications. She is a Project Leader within the ARC Dairy Innovation Research Hub and a researcher within the Future Fuels CRC. She was the Discipline Leader in the CRC for Greenhouse Gas Technologies (CO2CRC) for Membrane Technology from 2003-2015. She was a member of the Research Advisory Committee for the National Centre of Excellence in Desalination from 2010-2016. She was the Deputy Director of the Melbourne Energy Institute from 2009-2012.

Professor Kentish was selected as one of Australia's Most Innovative Engineers by Engineers Australia in 2017 and as a Woman of Influence by the Australian Financial Review in 2018. She has also been awarded the Grimwade Prize in Industrial Chemistry, the Caltex Teaching Award of Excellence for Training of Chemical Engineers in Australasia, the Edward Brown Award and Kelvin Medal for Teaching Excellence within the University of Melbourne and the L.R. East Medal as Valedictorian of her Bachelor's Degree Class.

Before commencing an academic career, Professor Kentish spent nine years in industry, with positions in Altona Petrochemical Company, Kodak Australasia and Kimberly Clark Australia.

Institute in Numbers



External Funding Received:

Total ARC Funding Announced in 2018:	$4,376,125
Total NHMRC Funding Announced in 2018:	$6,263,134
Australian Cancer Research Foundation:	$2,000,000
Australian Wool Innovation:	$2,500,000

29 Research Theses submitted

259 Publications

Events

Internal Events: 288

External Events: 168

Visitors and Engagement

Visiting international government or academic delegations: 4

Visiting high school or undergraduate student groups: 10 (213 students in total)

Bio21 public events (3 public lectures + Open House Melbourne Weekend): ~643

Facebook:

482 likes by the end of 2018

Twitter:

99,313

impressions in 2018

Bio21 Institute Theses submitted in 2018

Biosciences

Lab: Ary Hoffmann

Student: Perran Ross
Environmental impacts on the use of modified mosquitoes for arbovirus control

Student: Xuan Cheng
Fitness trade-offs involved in adaptation to host plants, diapause-egg phenotypes and pesticides pressure in the redlegged earth mite, *Halotydeus destructor*

Lab: Karen Day

Student: Evelyn Seway Chou
Characterization and mechanisms of a novel density-dependent death phenotype in *Plasmodium falciparum*

Student: Shazia Ruybal-Pesántez
Genetic epidemiology of the Plasmodium falciparum reservoir of infection in Bongo District, Ghana

Lab: Philip Batterham

Student: Hang Ngoc Bao Luong
In vivo functional characterization of nicotinic acetylcholine receptors in *Drosophila melanogaster*

Chemical and Biomedical Engineering

Lab: Sally Gras

Student: Wilhelm Burger
Phage treatment of filamentous bacteria in activated sludge

Student: Anita Pax
The effect of shredding and freezing on Mozzarella cheese microstructure and functionality

Chemistry

Lab: Craig Hutton

Student: Biana Island
Amide assembly through Ag(I) promoted reaction of thioamides bearing self cleaving auxiliaries

Student: Jing (Katherine) Shang
Use of thioamides in peptide synthesis: strategies for ring expansion and peptide ligation at asparagine

Lab: Jonathan White

Student: Christian Werner Wichmann
Development of small molecule PET probes for imaging of the mTOR pathway

Student: Alexander McDonald
Synthesis and evaluation of Oncrasin based radiotracers for oncology

Student: Thomas Garrard
Synthesis and kinetics of novel ionic liquid soluble hydrogen atom transfer reagents

Lab: Mark Rizzacasa

Student: Angus Robertson
It's hip to be square: a cyclobutene diester approach to alkyl citrate natural products

Brendan Fisher
Towards the synthesis of the emestrin family of natural products

Lab: Paul Donnelly

Student: Stacey Rudd
Zirconium and copper immunoPET imaging agents for the diagnosis of cancer

Lab: Spencer Williams

Student: Dylan Glendon Martin Smith
A journey of synthetic chemistry towards immunogenic glycolipids and non-lipidic antigens

Student: Marija Petricevic
Design and synthesis of chemical tools for studies of carbohydrate active enzymes

Student: Pearl Zynia Fernandes
Design and synthesis of substrates and inhibitors for mechanistic insights into α-mannosidases and α-L-rhamnosidases

Biochemistry and Molecular Biology

Lab: Cheng/ Gleeson

Student: Gahana Ravi Advani
Mechanism of action of the potential tumour suppressor Csk homologous kinase (Chk) in colorectal cancer cells

Lab: Danny Hatters

Student: Candice Raeburn
Spatial and temporal surveillance of the mechanisms controlling proteome foldedness via a FRET-based biosensor

Lab: Diana Stojanovski

Student: Yilin Kang
Characterisation of the human TIM22 mitochondrial import translocase

Lab: Malcolm McConville

Student: Tim Chung-Ting Liu
The role of de novo myo-inositol synthesis and matabolism in *Leishmania* parasites

Lab: Leann Tilley

Student: Jessica Bridgford

Molecular mechanisms of artemisinin action and resistance in the malaria parasite *Plasmodium falciparum*

Lab: Michael Parker

Student: Karen Steffi Cheung Tung Shing

Understanding biological signalling in the βc cytokine receptor family

Lab: Nicholas Williamson

Student: Katherine Elise Scull

Probing the immunopeptidome: enhanced epitope discovery through sHLA technology and bioinformatics

Lab: Paul Gleeson

Student: Jing Zhi Anson Tan

Anterograde sorting and trafficking of the β-amyloid precursor protein and β-Secretase in Alzheimer's disease

Lab: Paul Gooley

Student: Md. Alamgir Hossain

Structural basis of the interaction between the C-terminal domain of rabies virus phosphoprotein and human STAT1

Lab: Villadangos/ Mintern

Student: Haiyin Liu

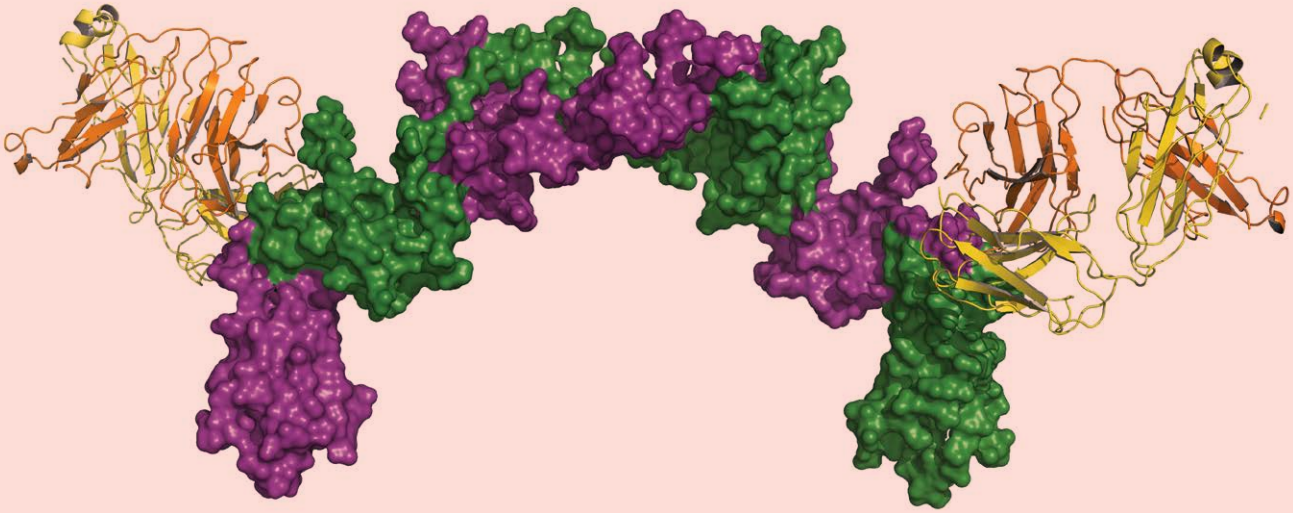
Regulation of MHC class II ubiquitination in antigen presenting cells

Dental

Lab: Reynolds

Student: Jiamin Aw

Host-pathogen interactions of *Porphyromonas gingivalis*



THE UNIVERSITY OF MELBOURNE

bio21 institute

Industry partners:

Alterity

CSL

circa

RHYTHM BIOSCIENCES

SYNthesis Research

SYNthesis med chem

the women's the royal women's hospital victoria australia

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