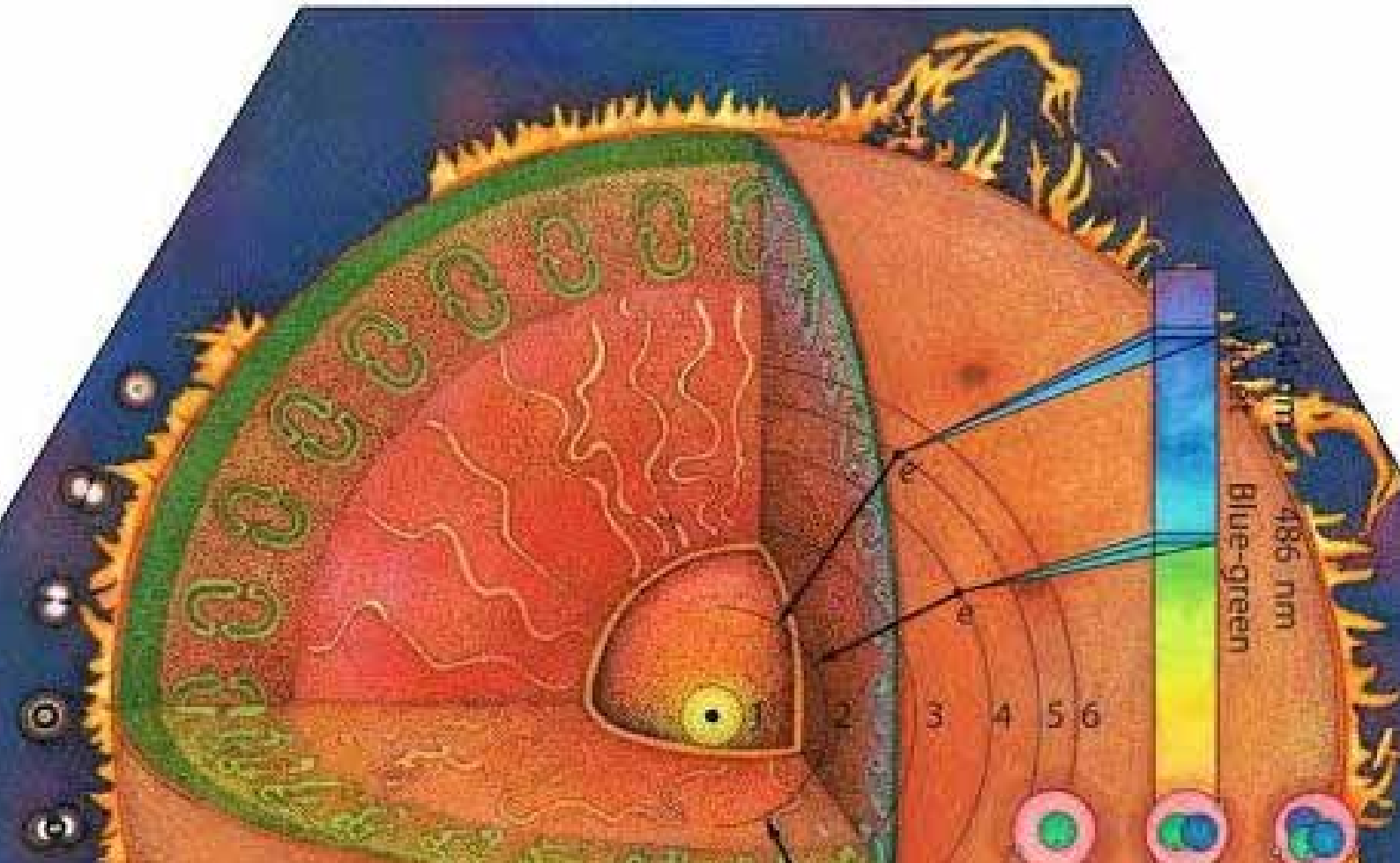
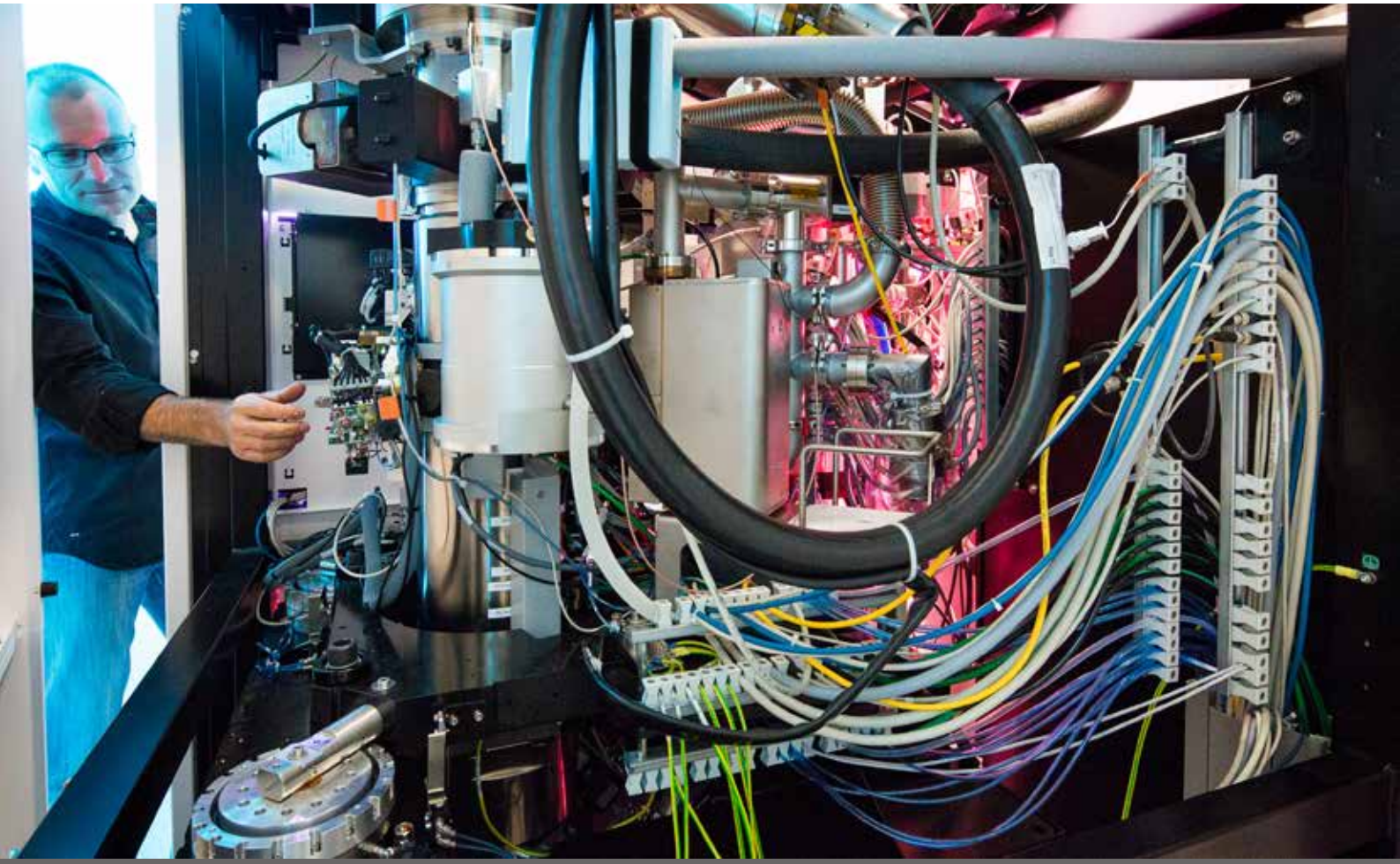
THE UNIVERSITY OF MELBOURNE

bio21 institute

Annual Report 2019





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Produced by the Bio21 Molecular Science
and Biotechnology Communications
and Engagement Advisor

Contents

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

2019 was the International Year of the Periodic Table of Chemical Elements.

2019 was the International Year of the Periodic Table of Chemical Elements. During National Science Week, Bio21 hosted a public event on the 'Art and Science of the Periodic Table', where our Deputy Director Professor Frances Separovic AO explained the periodic table and the history of its discovery to the audience. Complementing the science, the audience saw and heard from an artist, Damon Kowarsky, and his art. Damon was fascinated by the elements of the periodic table and their societal applications and so accepted a commission to illustrate a series of elements on panels for a display at Quantum Victoria. His beautiful artworks invite you to look closer, to discover the many facets and applications of the elements, hidden within the drawings, beautifully coloured by Hyunju Kim. The front cover of this Annual Report features Damon's depiction of the symbol for Hydrogen, the most abundant chemical substance in the Universe!

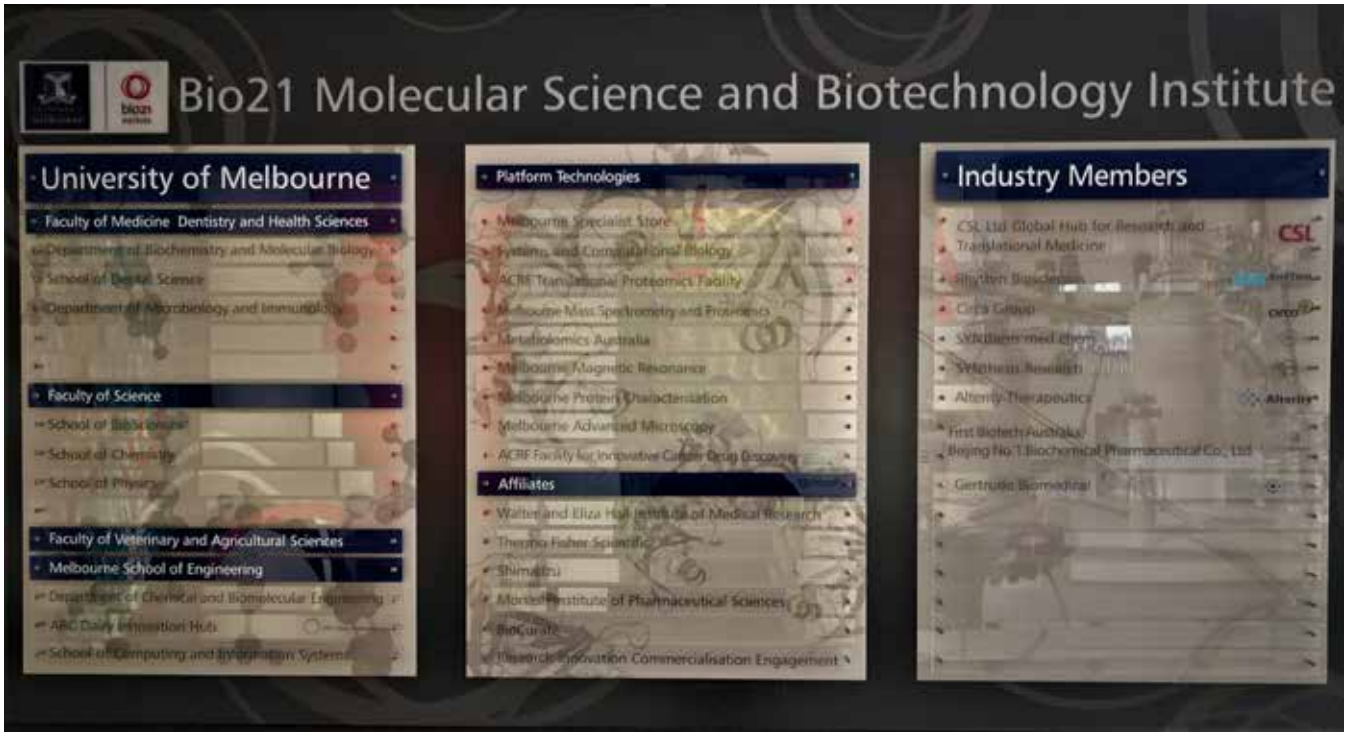
We also celebrated the occasion with a social media series that featured some of our researchers alongside their favourite element: Uta Wille was curious about Nitrogen – both as a fertiliser and a pollutant, causing smog as Nitrogen dioxide; Claire Weekly looked at lanthanides like Cerium and how they interact with bacterial proteins; Paul Donnelly created a compound (Cu(ATSM)) that delivers Cu into neurons to treat Motor Neuron Disease and Parkinson's Disease; Spencer Williams discovered a missing link in the Sulphur cycle, that allows gut bacteria to metabolise an abundant Sulphur-containing sugar (sulfoquinovose) for energy; Mark Rizzacasa synthesises natural products for therapeutic use and he chose to feature Carbon. All of Bio21's 'organic' chemists could claim Carbon as their favourite molecule – it is the element of life after all and forms the 'backbone' for many natural and synthetic compounds! 'F' for Frances: Frances Separovic, chose fluorine, for its usefulness in Magnetic Resonance Spectroscopy, and so the list goes on. It was a fun way of gaining insight into the diversity of research taking place within the Bio21 Institute. I encourage you to enjoy our spread of 'elements'.

As a molecular science institute, the elements are not only the objects of our study, but also the building blocks we use to synthesise new molecules and materials. We conduct fundamental research, to attempt to understand their role in biology – Guy Jameson is studying how iron is released into the body and what causes iron deficiency. Or to create new compounds such as the colourful dyes, harvesting specific wavelengths of light, used in plastic 'organic' solar cells in Wallace Wong's and David Jones' group.

Bio21 houses extremely powerful and sensitive instruments to detect elements and molecules. The Magnetic Resonance platform houses nine instruments, gigantic supercooled magnets, that make it possible to identify known isotopes in samples through their own unique signature – their 'nuclear resonance'.

The instruments within our mass spectrometry and proteomics facility use 'molecular mass' of the elements and compounds to identify the small molecules and proteins in a sample. These instruments process and record hundreds of thousands of molecules within a sample, at a great rate.

Our newest 'Melbourne Protein Characterisation' platform, is rapidly growing with a number of new instruments in the



past year. For example, protein crystals can be analysed with the Institute's X-ray diffractometer to obtain precise information on the structure of these molecules. It is revealing a whole unseen world of fascinating biological machines that can carry out a myriad of functions within our cells.

Over the past couple of years, we have acquired two cryoEM microscopes, that allow our researchers to look within snap-frozen biological samples and 'see' the objects of their study at atomic level resolution. As you may have realised, the instruments and facilities I've mentioned, are complementary and make it possible to use different approaches to 'see' and understand elements and molecules.

When I'm showing a visiting delegation around the Institute, I like to make a stop and point out our directory board at the entrance foyer, as it lists and categorises all the groups within the building; academic (from 3 STEMM faculties), industry (7 industry groups) and platform technology facilities and so highlights our many different disciplines within the Institute. Although the research at the Bio21 Institute is diverse, it is the common approach of 'molecular science' that unites us all.

But a list does not tell you how we bring people together across disciplines – what is the glue? Our common, fundamental curiosity for 'molecular science' is one 'glue'. But it is not enough to create a community.

As a Director of an Institute, I seek to provide an environment and to foster the culture that encourages people and groups from different disciplines and between academia and industry to engage with each other and to feel like they belong to Bio21. In some sense, Bio21 has from the outset been an 'experiment' in collaboration. Even before a building of bricks and mortar, glass and steel took its place along Flemington Road, visionary people were forging the 'idea' of Bio21.

Before 'Bio21' there was the Bio21 Cluster, established in 2001. The Bio21 Cluster was part of the Victorian Government's Science and Technology Initiative that seeded a series of innovative undertakings that saw biomedical research flourish in Victoria.

The Bio21 Institute emerged from the Bio21 cluster, officially opening in June 2005. The Bio21 Cluster became 'BioMedVic', which continued its work in advocacy and government engagement on behalf of the biomedical sector until it officially ceased its operations at the end of 2019. I attended the last celebration, that was tinged with sadness, but also with great pride. Its story is intertwined with our own. The collaborative environment, the vibrant Parkville Precinct, with the University of Melbourne, a strong cluster of world-leading research institutes (including the Bio21 Institute), co-located with the Royal Melbourne, Women's Hospital, Children's Hospital and the Peter MacCallum Cancer Centre at the Victorian Comprehensive Cancer Centre is its legacy.

Today, more than 40 per cent of Federal Government support for medical research flows to Victorian institutions, supporting 25,000 researchers and clinicians whose discoveries and inventions are changing lives. The commercial biomedical sector employs 21,000 people and generates more than $12.7 billion dollars a year.

So, I was glad to have the opportunity during the Faculty of Science's 'Science Festival', to participate in a panel discussion: 'Different perspectives, one solution. How can we cross the divide

between the physical and life sciences, engineering and the humanities?' The event showcased some wonderful examples of multidisciplinary and interdisciplinary research. I was permitted to present one slide only to illustrate what we're doing at Bio21:

So, what is the secret 'Bio21' recipe? It's not a secret and I'm happy to share it:

Tools: Platform technology facilities represent one kind of 'glue' within the Institute, attracting researchers from various disciplines, who wish to use our tools to verify, visualise and locate molecules in order to address a diverse range of research questions.

Shared Spaces: The Bio21 atrium in the David Penington Building, the new common area, Level 2 of the Nancy Millis building, along with other spaces, including our auditorium, balconies and the Avist café; these meeting, 'break-out' and gathering spaces, are important elements of the building design. In order to bring people together, we need spaces and places to meet, listen, learn, connect and talk. These spaces – beyond our laboratories – create opportunities for serendipitous encounters that may lead to conversations, collaborations and possibly friendships that occurred at the right time and place. Also, once the Stage 2C project, our 'Ruth Bishop' building is completed, we will have access to outdoor spaces in the summer.

Events: A good party; fine food and drink (e.g. coffee), as well as the opportunity to hear the news of the day, have always drawn people together. So too, through our regular morning teas, 'Big Picture' seminars and also our International Women's Day celebration in March this year, members of our community from across the Institute regularly have the opportunity to gather and meet and to learn about each other's work.

Projects: Finally, we are brought together by our need to solve a problem and our realisation that we cannot do this on our own. We need the specialised knowledge and skills of others to bring in different perspectives to solve our research problem. A good example of this is the Nature Microbiology paper led by the Tilley and Griffin groups. The problem of understanding how the malaria parasite proteasome works has brought many researchers together and the resulting list of authors spans research and platform facility groups from within the Institute, bringing in expertise in malaria, cryo-EM, X-ray crystallography and computational biology. This paper is just one of many such publications that result from collaborations within the Institute.

It is our successful recipe – through tools, shared spaces, events and projects – that sets Bio21 apart and gives us the edge in many research projects and grant applications. It exemplifies how collaborative culture fuels research success. And, as new research institutions are being conceptualised, ours is a model that many may seek to replicate.

At the time of writing this message we are confronted with the COVID-19 pandemic and in response we have transitioned into a 'virtual institute' for a time. We now face the additional challenge of retaining a sense of an 'institute', a community, or a 'village', without the ability to physically meet. Although we are physically separated, we are using the new digital tools at our disposal to communicate and connect, to continue to exchange ideas and progress our scientific projects. For some of us, our expertise and the Bio21 platforms give us the opportunity to re-focus our attention to identifying drug candidates to treat the SARS-CoV-2 virus infection and to forge new alliances with the Doherty Institute and CSIRO.

In this 2019 Annual Report, I encourage you to learn more about the research we are undertaking, the industry and academic groups we've welcomed into our community and the way we create a collaborative culture and communicate our research to the next generation and the general public.

Professor Michael Parker

Director, Bio21 Institute

Bio21 Leadership

Deputy Director's Message

Professor Emeritus Frances Separovic AO

Although I officially retired from the School of Chemistry (but not from the Bio21 Institute), 2019 inadvertently became one of my busiest years, which coincided with a significant year for chemistry: the International Year of the Periodic Table. It was wonderful and humbling to receive a Queen's Birthday Honour, an Order of Australia, and to have a symposium held in my honour. One of the most gratifying things in life, and which most scientists hope to achieve, is to make a difference and contribute to knowledge in a field that we are passionate about. So, it was marvellous during the Symposium to hear from my colleagues and peers, who have become friends over the years, about the contribution they felt I made to the fields of nuclear magnetic resonance (NMR), membrane biophysics, amyloid peptides from Alzheimer's disease and new antibiotic peptides. When forging a career and attempting to overcome barriers, you are not yet aware where your journey may lead or whether it is worth the effort: it can at times be a lonely pursuit. Looking back, I am glad I was able to make a contribution and inspire others to pursue their own research careers, particularly as a 'role model' and mentor to other women. I was also thrilled that my name was put forward to the Parkville Metro Rail Tunnel Creative Project to have my story presented as a mural illustrated by a local artist. It was amazing to see my life presented in a visual way. I am grateful to those who recognised my talents and encouraged me at various points in my life.

As one chapter in life closes, another opens up. An increasing focus of my attention, time and energy is advocacy for women in science and concern about what we are doing to our planet. In 2019 I had the opportunity to participate in two key events that combined both these concerns. Firstly, I was privileged to introduce the World Chemistry Leaders meeting at the IUPAC 2019 Congress in Paris, France, on 10 July.

IUPAC stand for the International Union of Pure & Applied Chemistry and is 'the world authority on chemical nomenclature and terminology, including the naming of new elements in the periodic table; on standardized methods for measurement; and on atomic weights, and many other critically-evaluated data.' For example, IUPAC contributed to the work of revising the units of measurement - kilogram, ampere, kelvin and mole - to physical constants, by coordinating the redefinition of the mole, published earlier in Jan 2018. As I gave my introductory speech at the Congress, I took the opportunity to reiterate IUPAC's core values of promoting diversity and ethical behaviour, values that are inherent to the Sustainable Development Goals adopted by world leaders in September 2015 at an historic United Nations summit. The 17 Sustainable Development Goals of the 2030 Agenda for Sustainable Development officially

came into force on 1 January 2016 and, during the 2019 IUPAC meeting, I highlighted two goals that I thought were particularly relevant and prescient:

(i) SDG#12, Responsible Consumption and Production: Innovations in chemical industry have the potential to reduce resource use, degradation and pollution along the whole product life cycle, while increasing quality of life with cleaner, more resilient economies. Daily, news headlines highlight the waste crisis within which we currently find ourselves, locally and globally. The chemistry community has contributed to the problem but is also part of the solution. One way we can start to find solutions is to look beyond the lab and to engage in the broader societal conversations around this issue. During National Science Week in August 2019, Bio21's Uta Wille was a panel member of a Science Festival Keynote: The Future of Plastic.

(ii) SDG#5, Gender Equality: The 2019 Chemical & Engineering News survey shows that women are slowly consolidating corporate gains with 19% as board directors and 14% as executive officers at chemical companies. Women now make

up 41% of PhD recipients in chemistry, a significant gain, but still represent less than 20% of tenured and tenure-track faculty at the top 50 chemistry schools.

On International Women's Day 2017, I was honoured to become an IUPAC Distinguished Woman of Chemistry but, as I participated in the events of the IUPAC 2019 Congress, I could not help but notice how few women exist at the higher levels of the chemistry community. I was fortunate to share the stage with Ilham Khadri, CEO of Solvay, but several panels or prize awardees during the week, included only one woman or no women at all. Change can be frustratingly slow, but this was a reminder for me that much still needs to be done before we achieve gender parity in chemistry. Within our own community, it is pleasing to see women leaders join Bio21, such as Associate Professor Megan Maher, School of Chemistry, whose team brings expertise in the area of X-ray crystallography.

Another opportunity I had in 2019, was a 'trip of a lifetime': I was selected to be part of Homeward Bound #TeamHB4. Homeward Bound is a leadership initiative, set against the backdrop of Antarctica, which aims to heighten the influence and impact of women in making decisions that shape our planet. The journey culminated in a three week visit to Antarctica. Together with 99 other women, working in diverse scientific disciplines from around the world, I boarded the Hebridean Sky heading for the Southern Ocean. Living and working together in close quarters, we participated in workshops and discussions about communication and leadership. The activities were designed not only to improve our communication skills but also to help us recognise what we stand for and what drives us. As an 'elder' on the journey, I realised that I already had overcome many barriers that these women were yet to face and so had unique insights to contribute. Set against the backdrop of the breathtaking environment of Antarctica, it was an incredible experience, that also highlighted the urgency of the challenges of climate change.

As well as HB4, 2019 was a year of intense travel for me as part of my membership of various international committees and working groups and I also visited overseas collaborators. Finally, to celebrate the 150th anniversary of Dmitri Mendeleev's publication of the Periodic Table of the Elements, I opened an exhibition commissioned by Quantum Victoria of artworks depicting the elements. In a series of hexagonal panels, artists Damon Kowarsky and Hyunju Kim, had hidden clues about the role that elements play in our everyday life.

Bio21 subsequently invited Damon Kowarsky to speak at a National Science week event, 'The Science and Art of the Periodic Table', where we heard from our platform leads, Nick Williamson on mass spectrometry, Andrew Leis about electron microscopy and me on NMR spectroscopy. At the time, Damon used Zoom to join the discussion from Belgrade. Now we are constantly meeting up with each other virtually but in 2019 it was not so common. How quickly things can change.

Professor Emeritus Frances Separovic AO FAA

Deputy Director, Bio21 Institute

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

As a scientific research community that consists of academic, industry and professional staff members, Bio21's research efforts contribute to solving some of the great environmental, agricultural and health problems confronting our society and world. Yet, it is often difficult for scientists to make ourselves heard amongst the multitude of social media channels.

Effective science communication can be as much about listening to what our audience needs; what their problems and concerns are and identifying the barriers they face in hearing or implementing our solutions, as it is about actually communicating.

Responsibly communicating science is also critical. The 3rd of June 2019 marked the publication of Fairfax guidelines on the reporting of medical research, in an effort to improve the quality of reporting.

In 2019 Bio21 also provided researchers and students with many opportunities to share and effectively communicate their research in engaging, entertaining and informative ways:

2019 was the International Year of the Periodic Table of Elements, celebrating 150 years since Dmitri Mendeleev's publication of the first version of the table of elements. Bio21 celebrated the year with a social media series highlighting our researchers and their work with particular elements.

Our International Women's Day Symposium was a particular highlight for the Institute community, celebrating our academic, industry and professional women working in various disciplines throughout the Institute. It celebrated our women but also the diversity and quality of the research they conduct. The 'Women of Bio21' series, that is published online and posted in the Institute's lifts, has also been a great way to highlight the challenges and achievements of the women in our scientific community.

A number of University and media stories highlighted the extraordinary progress being made to eradicate dengue in tropical countries by members of the Hoffmann group. Media has covered the exciting progress of clinical trials for a drug compound Cu(ATSM) developed by the Donnelly group at the Institute against MND and Parkinson's Disease and Uta Wille has contributed to panel discussions and radio programs discussing the problem of plastic and the potential solutions proposed by Uta Wille and her team.

In 2019, 120 high school students participated in tours and activities at Bio21, including our year 10 work experience program; 388 members of the general public came through the Institute's doors during the Open House Weekend and engaged with our scientists about their research at displays. Bio21 hosted five 'Big Picture Seminars', an International Women's Day Symposium; a public event about the 'Art and Science of the Periodic Table,' six internal morning teas and hosted over twenty external events, over the year not

including the regular weekly departmental and industry seminars. And this was just the events. Communications and Engagement at Bio21 also included engagement with traditional media – newspapers and radio interviews by our academics and through website and social media channels, not to mention the ways in which individual researchers engaged with their stakeholders in their discipline areas at national and international fora.

It was a busy year but was it a particularly busy, or extraordinary year? Not really. The number of events, engagement activities and media output reflect that communication and engagement are embedded within the activities of the Institute. It is part of the Institute's remit to our society, government and industry.

As a research community, as part of The University of Melbourne, we share our knowledge and expertise and translate our research findings. We also inspire and educate the next generation of students to pursue a scientific career path or to apply their scientific understanding to a broad range of significant roles in government, industry and the community and other non-traditional academic pathways beyond Bio21. Our Communications and Engagement Advisor plays a critical role coordinating our Institute's communication and engagement but every member has an opportunity to participate and contribute in some way. The many activities rely on the willingness of our researchers to share their expertise and knowledge and to volunteer their time.

2020 is turning out to be an extraordinary year. With the enormity of the task combatting the spread of the coronavirus SARS-CoV2 or 'Covid-19', our country's leaders have turned to scientists to inform decision-making and our national and state response. Bio21's scientists are also part of these efforts, illustrating how effective science communication is now more important than ever.

'Welcome'- New Arrivals

First Biotech

Gertrude Biomedical

Douglas Pires

Megan Maher

Debnath Ghosal

Associate Director Commercialisation – Professor Spencer Williams

A major mission of the Bio21 Institute is to encourage and support commercialisation activities in the area of biotechnology and molecular science and thereby foster the local food, agri- and biotechnology industries, providing economic and social benefits for Victoria. These activities include supporting industry tenants, big and small, in the Bio21 incubator and Nancy Millis buildings.

As well, our researchers are active participants in ongoing commercial-focused projects and often seek to protect and develop intellectual property arising from their work. Many studies have shown that an academic researcher's responsibility to serve the public may not be met adequately by publication alone, but rather through commercialisation activities that allow refinement of a discovery or invention to maximize its practical application.

Professor Leann Tilley and Dr Stanley Xie were awarded funding from the Global Health Innovative Technology Fund to work with Takeda Pharmaceuticals and the Medicines for Malaria Venture to develop new antimalarials that target malaria parasite protein synthesis. This work is also supported by an NHMRC Development grant. Professor Sally Gras was the recipient of an ARC Linkage grant in collaboration with Bega Cheese, focused on Vegemite production (LP190100090), entitled 'Intelligent bioprocessing for next-generation nutritional yeast extracts'.

Several drugs developed by University of Melbourne researchers, including those at Bio21 continue to progress through human clinical trials with commercial partners: Clarity Pharmaceuticals, a company founded on research from Bio21 Institute researcher Paul Donnelly and work at ANSTO, reported that 64Cu/67Cu-SARTATE, a theranostic cancer agent combination, received US FDA approval for its Investigational New Drug (IND) application for a Phase 1-2a trial in paediatric patients with somatostatin receptor-2 positive, relapsed or refractory, high-risk neuroblastomas.

OccuRx, a company founded on research by Spencer Williams, received approval to conduct a Phase I study for OCX063, a drug developed for the treatment of fibrotic and inflammatory ocular diseases.

Collaborative Medicinal Development, a licensee for the use of CuATSM arising from work at Bio21 performed by Paul Donnelly, Kevin Barnham and Tony White, started a multi-centre clinical trial to evaluate the efficacy and safety of CuATSM in subjects with Amyotrophic Lateral Sclerosis (also known as Motor Neuron Disease).

The University has a deep long-term engagement with CSL. We were therefore delighted by the announcement in August 2019 that they were planning to relocate their global headquarters to 'Elizabeth House', a new 16-storey building to be built at 645 Elizabeth St. This exciting development recognizes the growing importance of the Parkville Biomedical Precinct and will strengthen the precinct and streamline interactions with CSL laboratories based at Bio21, local hospitals, the University of Melbourne and local medical research institutes. The project is slated for completion in 2024.
Industry tenants that joined Bio21 in 2019 include Gertrude Biomedical, a startup company seeking to develop small molecule drugs targeting a transcription factor complex involved in aberrant vasculature for their growth and spread; and First Biotech, an Australian subsidiary of Beijing No. 1 Biotech that is investing in drug development programs emanating from the University of Melbourne.Industry tenant Circa Group announced that a Circa-led consortium won a €12M EU Horizon 2020 Flagship grant to build a 1,000 tonne CyreneTM plant. This will support further scaleup of their innovative plant sourced solvent. Circa also announced a range of exciting new applications, including the reclamation of valuable components of

Academia and industry join forces against malaria

Professor Leann Tilley and Dr Stanley Xie from the Bio21 Institute are working with experts from the Japanese company, Takeda Pharmaceuticals, and Swiss-based foundation, Medicines for Malaria Venture (MMV), in a double-pronged effort to develop new antimalarial drugs.

With the support of the Global Health Innovative Technology (GHIT) Fund, an initiative that co-funds partnerships between the Government of Japan, pharmaceutical industry, Bill & Melinda Gates Foundation, and Wellcome Trust, the team will pursue their finding that a class of anticancer drugs discovered and developed by Takeda Pharmaceuticals, also has demonstrated activity against the malaria parasite. They will also work to develop a novel class of compounds that targets malaria parasite protein synthesis. The team has received a total of ¥230,064,905 ($2,042,011) from the GHIT Fund to conduct this work, as part of two separate projects.

$14m invested to create vaccine for debilitating periodontal gum disease

A vaccine for periodontal gum disease, which affects a third of all adults globally, is in development following a $14 million investment into newly-formed biotechcompany Denteric Pty Ltd.

The company was set-up to develop and commercialise the research outputs of a long-running programme originating from the University of Melbourne working in collaboration with CSL.

The announcement was made at the official launch of the University's Centre for Oral Health Research (COHR).

The Series A investment comes from the Medical Research Commercialisation Fund's (MRCF) Biomedical Translation Fund, a Commonwealth-backed fund managed by Brandon Capital Partners, CSL Ltd., Australia's largest biotechnology company, and the University of Melbourne.

Denteric will focus on developing a therapeutic vaccine for treating periodontal disease, a debilitating and painful form of gum disease which affects one in three people globally. The disease damages periodontal soft tissue and alveolar bones, which support

teeth, due to an accumulation of bacteria.

Moderate to severe periodontitis affects more than 50 per cent of Australians over the age of 65 and is associated with diabetes, heart disease, rheumatoid arthritis, dementia and certain cancers.

University of Melbourne Professor Eric Reynolds, founder and CEO of the Oral Health CRC, now COHR, said the creation of Denteric is the perfect example of public-private collaboration within the thriving Melbourne Biomedical Precinct.

CSL Limited Senior Vice President of Research Dr Andrew Nash said it's exciting to see the treatment progress to the next stage of development.

University of Melbourne Deputy Vice-Chancellor (Research) Professor Jim McCluskey said: "We welcome the significant investment in this critical research, which has the potential to change the lives of people around the world."

Republished from the Melbourne Newsroom.

end-of-life EV batteries, and as a solvent for production and dispersion of graphene.

Industry tenant Alterity Therapeutics (formerly Prana Biotechnology) reported that it successfully completed its phase 1 study of PBT434, a novel, orally bioavailable small molecule inhibitor of alpha-synuclein aggregation.

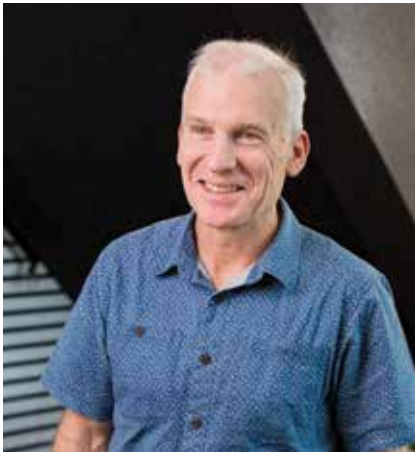
Finally, several exciting Big Picture Seminars were held, which included Dr Larry Dick, Seofon Consulting (USA) on 'Drug Discovery in the Ubiquitin Proteasome System', and a three-way presentation by Drs Joseph Arron (Genentech), Matt Sleeman (Regeneron), and Brent McKenzie (Genentech) on 'The science behind drug discovery in Industry'.

At the time of writing, COVID-19 is dramatically affecting the Australian and International communities, providing opportunities for Bio21 Researchers to work on solutions to a wide range of societal problems. We expect that this will lead to a range of new initiatives for 2020.

Associate Director Platform Infrastructure – Professor Malcolm McConville

The Bio21 Institute supports a number of major technology platforms around mass spectrometry (Melbourne Mass Spectrometry and Proteomics Facility and Metabolomics Australia), NMR (Melbourne Magnetic Resonance), advanced cryo-electron microscopy, super-resolution light microscopy (Melbourne Advanced Microscopy Facility), protein characterization (Melbourne Protein Characterisation Facility) and high performance computing (Systems and Computational Biology).

These platforms underpin the research activities of most internal research groups, as well as a large number of research groups from outside the Institute. The latter include researchers from across the University of Melbourne, neighbouring Medical Research Institutes, Universities, industry and Government agencies. Each of the platforms are housed in state-of-the art laboratories and supported by funding from the Bio21 Institute strategic fund, the Deputy Vice Chancellor Research (DVCR) (including the Collaborative Research Infrastructure Committee) and national funding agencies (including the Australian Research Council Linkage Infrastructure Equipment and Facilities (LIEF) and National Collaborative Research Infrastructure Strategy (NCRIS) funding mechanisms). Long term support for these platforms has been critical for maintaining the highly experienced (mostly postdoctoral) professional staff that run the platforms and drive innovation in their applications, as well as for upgrading equipment and capability. Long term support for these platforms has also made them major research hubs within the Institute, where PhD students and post-doctoral researchers meet, and external researchers from academia, industry and Government agencies, engage with Bio21 researchers. The platforms continued to expand and to renew their capability over 2019, supported, in part, by funding initiatives such as the Australian Cancer Research Foundation (ACRF) Innovative Cancer Drug Discovery, Mito Foundation,



NCRIS and ARC LIEF equipment grants. Some major developments are summarized below. As part of a major initiative, the University has invested heavily in expanding the cell and structural biology capability of the Bio21 Advanced Microscopy Facility (AMF) with the acquisition of a number of new instruments in 2018-2019. In addition to the Talos Cryo-electron microscope (installed in 2018), the AFM has recently installed a new Glacios cryo-EM and has a planned installation of a 300 KV Krios Cryo-EM instrument in mid-2020. These instruments are revolutionizing our ability to determine the 3D structure of proteins at near atomic resolution and complement other established structural biology approaches, such as X-ray crystallography and Nuclear Magnetic Resonance (NMR). The Talos Cryo-EM has already been used by Bio21 researchers to determine the structure of a large protein complex from the malarial

parasite that is a drug target for new antimalarials. The AFM has also acquired new capability in scanning and transmission electron microscopy which allows researchers to image subcellular structure and even proteins in their biological context. In particular, the recent acquisition of a Leica Cryo Correlative microscope makes it possible to track the location and movement of fluorescent proteins in cells using a combination of light and electron microscopy. The major expansion of the AFM is being accommodated through the construction of a new purpose-built facility, within the old Veterinary Science building on the Bio21 site.

The new building is both architecturally arresting, as well as built to accommodate the exacting requirements of the new instruments and will be completed in mid-2020. The development of this world class facility has further strengthened links with neighbouring institutions, such as the Walter and Eliza Hall Institute, the Peter MacCallum Cancer Institute and the Monash Institute of Pharmaceutical Sciences, who have coinvested in the facility.

Bio21 also houses a major node of the Biological Optical Microscopy Platform (BOMP) which provides complementary capability to the AFM with a suite of confocal and super resolution microscopes and a focus on imaging live cells. The Bio21 node installed a new super resolution Zeiss Elyra/LSM880 microscope in August 2020, providing new capability for single molecule tracking in live cells

The new Margaret Shiel Mass Spectrometry Laboratories in the Bio21 Nancy Millis building houses one of the largest proteomics and metabolomics facilities in the country. The facility has more than 25 mass spectrometers, with instruments from all major vendors, as well as a combined staff of 15 post-doctoral research officers and technical staff (four from proteomics and 11 from Metabolomics Australia). The proteomics facility expanded its fleet of high

resolution Orbitrap mass spectrometers with the acquisition of two new generation instruments, the Orbitrap Eclipse and Orbitrap Exploris 480. Supported by both the University and the Mito Foundation the acquisition of these new instruments will help drive research programs directed at understanding the basis of mitochondrial diseases amongst many other research projects. New funding from both the University and National Collaborative Research Infrastructure Scheme (NCRIS) also enabled the upgrade of the Bio21 Metabolomics Australia facility with installation of two Orbitrap IDX instruments in late 2019. These instruments will greatly increase depth of coverage of metabolite levels in biological samples (including the identification of novel metabolites), and allow researchers to understand the molecular basis of many diseases and identify new biomarkers that can be used in advanced diagnostics.

A new Bio21 platform centred around protein production and protein functional characterization was established in 2019 in a new purpose-built laboratory. The Melbourne Protein Characterization (MPC) facility brings together capacity for large scale protein expression in insect and mammalian cells, protein purification, as well as a range of instruments for detailed protein characterization, including analytical ultracentrifugation, and an X-ray diffractometer. The facility acquired a new Biacore S200 Surface Plasmon Resonance instrument (supported by the ACRF) and a Wyatt 18 Angels Lighting Scattering instrument for measuring protein-protein and protein-drug interactions. Finally, the facility provides researchers with new capability around drug discovery through access to the OpenEye virtual drug screening software which was supported by the Australian Cancer Research Foundation Innovative Cancer Drug Discovery. The MPC, together with the other platforms, brings together capability in various steps in the drug development pipelines and has attracted significant interest and investment by industry partners, such as CSL.

Arrival of Cryo-electron microscopes at Bio21

In 2019 Bio21 Institute received a cryo-electron microscope (EM) Glacios. The instrument belongs to the Monash Institute of Pharmaceutical Sciences (MIPS), but in exchange for housing the microscope we receive shared access to it.

Since the commissioning of the Talos Artica (200kV cryoTEM) and the Talos L120C (120 kV microscope) in 2019, we now have a good collection of CryoEM microscopes at Bio21 which will be further strengthened with the arrival of two other instruments mid-2020.

Globally, Australia has been a late-adopter of this new, but revolutionary technology that won Jacques Dubochet, Joachim Frank and Richard Henderson, the Nobel Prize in Chemistry 2017.

With considerable investment and also recruitment, we're catching up and starting to see results from these remarkable instruments.

What is special about these instruments?

CryoEM allows you to peer into samples that have been 'snap frozen'. For a layman's analogy, it is like frozen peas: they have advantages over canned peas, retaining their look, freshness, vitamins and taste, while canned peas (fixed cells and proteins) have a slightly different look and very different taste.

We are now able to visualise protein structures in solution and in their native state, providing further insights into the behaviour and function of proteins and molecules in cells, particularly the interactions of drugs with drug targets.

When the new microscopes arrive next year, we will be able to do the same but in the context of the cellular environment. This technology complements the data we receive from mass spectrometry, magnetic resonance spectroscopy and X-ray crystallography, also housed in the Institute.

But with all the buzz and excitement around cryoEM, let us not forget the other electron microscope capabilities we house at Bio21.

Most of us look at electron microscopy as a two dimensional technique. But for the last 50 years the third dimension has always been there for us to use. Since its inception, Bio21 has had the capability to do tomography and even cryo-tomography, providing a very much-needed third dimension in applications such as, cell biology, nanomaterials and solar cells.

This is the equivalent of you receiving a CT-scan whereby the machine rotates around your injured limb. In the case of EM, it is the sample rotating in the microscope.

It produces a very high resolution, three dimensional (3D) structure, encompassing the whole sample size (which must remain within the limits of the lower microns and 300 nm in thickness).

In the last four years, with the purchase of an automated block-face imaging SEM and a new automated serial section ultra-microtome, we have expanded our capability in 3D imaging to reach volumes in the $1mm^3$ range, at resolutions closer to 10 nm.

Hence, we are now able to conduct 3D imaging in a sample size range spanning from molecules (angstrom range resolution) through to tissues (nanometer range resolution).

The missing piece in the puzzle is the elemental composition of the sample of interest. For this we turn to 'microanalysis'. We have five microscopes capable of visualizing each atomic element from Boron upwards (at a few nm resolution) in a tissue, in individual particles, or even in bulk samples. For lighter elements (B to Zn), we are one of the few facilities worldwide that can do this under cryogenic conditions.

All of these wonderful "toys" will be relocated mid-2020 in our new home-to-be, the Bio21 'Ruth Bishop building (Ex VRI, building 403), currently under construction.

So, whatever you are hoping to look at in your samples, please come and speak with me and the team in the Advanced Microscopy Facility, and we will endeavour to find the most effective method for your analysis.

Associate Professor, Eric Hanssen

Advanced Microscopy Facility

CryoEM insights into the nanomachine that powers the cell's garbage disposal system

Capitalising on the revolution brought about by structural cryo-electron microscopy (cryo-EM), a Bio21 team led by Dr Mike Griffin and Prof Leann Tilley has generated molecular movies of a sophisticated nano-machine, called the proteasome.

The proteasome is the cell's waste disposal system. They showed that the barrel-shaped proteasome has a cap, called PA28, that "dances" back and forth, opening and closing a gap at the interface.

"We refer to this as the dancing proteasome motion" says Prof Tilley "and we think it opens an escape route to let shredded protein pieces out of the proteasome ready for recycling".

Dr Griffin explains that "Some cells such as cancerous blood cells make proteins at a gangbusters' rate, creating so much waste they are particularly reliant on their proteasome. As a consequence, proteasome inhibitors can be used clinically as anti-cancer agents. Similarly, malaria parasites multiply rapidly inside human red blood cells and in doing so, generate a lot of waste protein. Proteasome inhibitors are under development in Prof Tilley's lab as potential antimalarial drugs."

To understand how living matter works, it helps to have detailed structural views of the molecular machinery. It is now possible to obtain that information, due to a revolution in structural biology, called cryo electron microscopy (cryoEM) – a revolution that was recognised by the 2017 Nobel Prize in Chemistry.

As Dr Griffin explains, "for the first time, we are able to directly image the internal mechanics of molecular machines – to see life, itself, in action."

The Bio21 Institute recently established a cryoEM capability in its Melbourne Microscopy Facility and the team wanted to use it to collect the first-ever views of a proteasome working with a PA28 cap. But first they needed to purify the proteasome. Malaria parasites are only one twentieth the diameter of a human hair, so Dr Stanley Xie and Dr Tuo Yang used parasites generated during many months of culture to get enough pure protein for cryoEM studies. A heroic effort, but it was worth it.

Biacore S200 arrives at Bio21

The Biacore S200 arrived at the Bio21 Institute on Monday, 17 June. This instrument allows the study of interaction between biomolecules (e.g.: protein-protein interaction, protein-small molecules interaction, etc.). It is funded by the Australian Cancer Research Foundation as part of the ACRF Facility for Innovative Cancer Drug Discovery.

Assoc/Prof Eric Hanssen and Dr Andrew Leis of Bio21's Advanced Microscopy Facility collected the cryoEM data. Putting together many thousands of electron microscopy images, a picture of PA28 emerged. It looked like a conical lid sitting at the end of the proteasome barrel. The team called on the structural biology expertise of Dr Riley Metcalfe to solve the structure. At the top of the cap, flexible streamer-like loops form dynamic swirls.

As Riley explains, "we could also see loops at the bottom of PA28 and we could see how they engage with the surface of the barrel. This clasp mechanism opens up a pore in the top of the barrel, creating a channel through to the shredding enzymes in the barrel core."

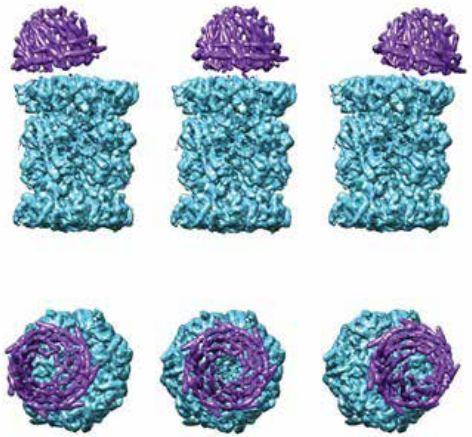
Craig Morton, Bio21 Institute, and Michael Kuiper, CSIRO Data61, used computer-based simulations to show that the dancing motion could let small peptide products escape through the interface between the cap and the barrel – providing short-cut access to and from the shredder.

Schematic illustrating shows how no-longer-needed proteins are fed into the proteasome barrel. Proteins are degraded and then released through the PA28 activator. The dynamic nature of the interface between PA28 and the proteasome may enable short-cut egress of peptide products.

The team's work has been published in Nature Microbiology. Their cryoEM-based molecular movies provide new insights into the mechanism of action of this important waste disposal system. Importantly, the new high-resolution structure of the malaria parasite proteasome is also helping the design of inhibitors that specifically target the *Plasmodium* proteasome. New antimalarial drugs are desperately needed to prevent the more than 400,000 deaths caused each year by the malaria parasite.

The team's cryoEM structure will facilitate the rational design of new inhibitors.

Figure: Dancing proteasomes. Reconstructed multibody-refined cryoEM densities showing the "dancing" of the PA28 cap (purple) on the proteasome core (aqua).



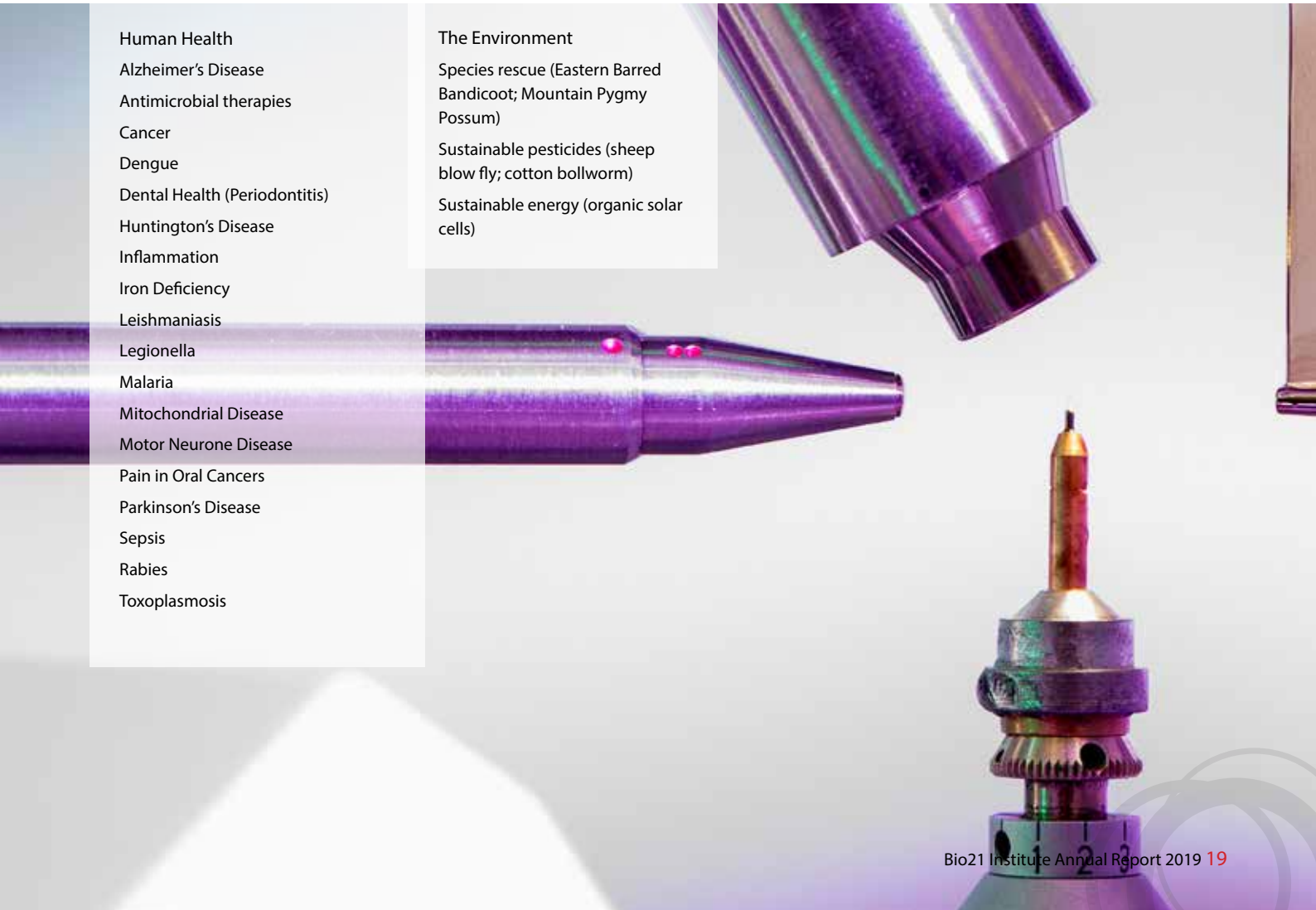
Welcome to Dr Douglas Pires

Douglas Pires is a Senior Lecturer in Digital Health, and group leader and researcher in the School of Computing and Information Systems, Melbourne School of Engineering at the University of Melbourne.

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

Iron Deficiency

Leishmaniasis

Legionella

Malaria

Mitochondrial Disease

Motor Neurone Disease

Pain in Oral Cancers

Parkinson's Disease

Sepsis

Rabies

Toxoplasmosis

The Environment

Species rescue (Eastern Barred Bandicoot; Mountain Pygmy Possum)

Sustainable pesticides (sheep blow fly; cotton bollworm)

Sustainable energy (organic solar cells)

Scientists Crack Rabies Virus Weaponry

Researchers have found a way to stop the rabies virus shutting down the body's immune defence against it.

Rabies kills an estimated 60 000 people a year, most of them in developing countries, overwhelmingly through dog bites.

Monash University's Greg Moseley from the Monash Biomedicine Discovery Institute(link is external) and University of Melbourne's Paul Gooley from the Bio21 Institute were senior authors in the study, published in Cell Reports(link is external).

"It's been known for a long time that many viruses target the human protein STAT1 and related proteins to shut down the host's immune defences, and it's also assumed that this is very important for diseases," long-term rabies researcher Dr Moseley said.

However, it was not known exactly how P-protein ¬– the main 'immune antagonist' of lyssaviruses including the rabies virus – takes hold of STAT1, due to a lack of direct structural data on STAT1 complexes with viral proteins.

"The challenge was to produce the key proteins on the viral and host sides in a test tube and keep them stable so we could interrogate the interaction directly; this hadn't been done before, at least for the full-size human protein," Dr Moseley said.

The researchers then brought the two proteins together and, using nuclear magnetic resonance spectroscopy, showed the precise regions where the viral protein sticks onto STAT1 and holds onto it to keep it away from locations in the cell where it needs to be to activate the immune response.

"We were able to find new regions and new sites for mutations and so could target these in a virus, completely preventing it from being able to grab hold of STAT1," Associate Professor Gooley, an expert in nuclear magnetic resonance spectroscopy, said.To the researchers' knowledge, this was the first direct structural analysis of binding of full sized STAT1 to a viral protein, even though many viruses such as measles and Hendra target this protein.

Using a 'wild' strain of rabies virus, collaborators at the Pasteur Institute in France showed that by disabling this binding they could strongly weaken even a highly pathogenic virus. The findings of their five-year study are the subject of a recently lodged international patent.

A global drive is underway to find better ways to counter rabies, which is caused by the rabies virus and also other lyssaviruses including an Australian bat virus.

Methods such as culling dogs have not worked to control rabies and while mass vaccination is effective, catching and injecting animals is problematic. "The development of a new safe and highly effective rabies vaccine that can be given orally or as 'baits' would be a major step forward," Dr Moseley said.

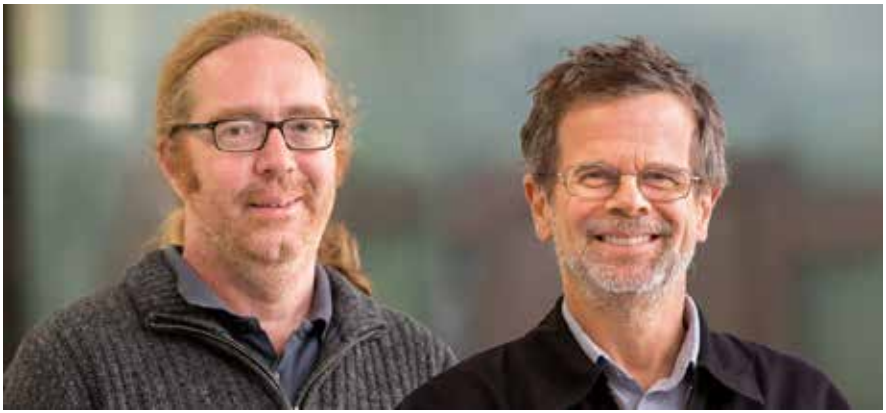
Associate Professor Gooley said he is excited to have been involved in a project that could lead to a safer oral vaccine for rabies to eliminate it, especially in developing countries.

"Like Greg I'm a discovery scientist, driven by curiosity. I enjoy solving scientific problems," Associate Professor Gooley said.

"The state-of-the-art technological tools and methods used in the study could also be applied more broadly to counter other viruses that target STAT proteins."

First author on the paper was then PhD student Dr Alamgir Hossain.

The study was supported by grants from the Australian National Health & Medical Research Council Australia, Australian Research Council and Grimwade Fellowship, and the Miegunyah



Greg Moseley, Monash Biomedicine Discovery Institute and Paul Gooley, Bio21 Institute

A sweet solution for a persistent parasite

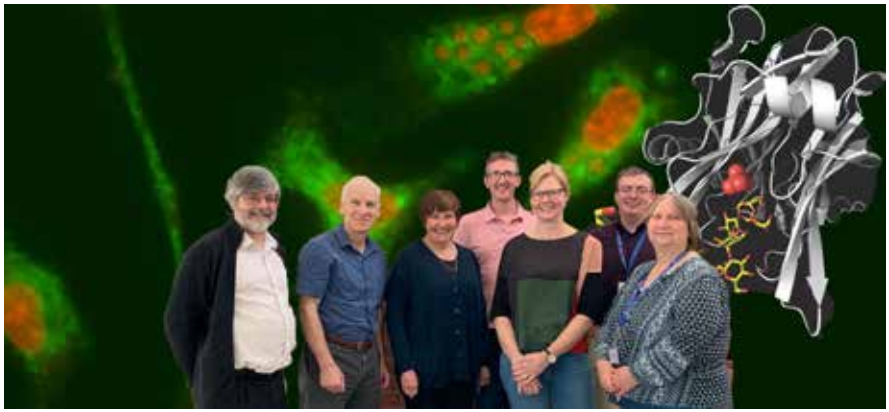
New research was published 11 September 2019, Cell Host and Microbe that shows how an important group of human pathogens cause disease, opening up fresh avenues for much needed therapies.

Leishmaniasis is a sandfly-borne disease caused by Leishmania parasites.

According to the World Health Organisation, there are an estimated 700 000 to 1 million new cases of this neglected tropical disease and some 26 000 to 65 000 deaths annually, with millions more people infected without symptoms. The disease is increasing in many regions of the world, including the Middle East, Africa and Central America where there are regional conflicts and breakdown in health services.

No vaccines exist and drugs to treat the disease are inadequate, often failing to kill the pathogens and commonly causing toxic side-effects.

Leishmania are able to persist for many years in their human host by hiding inside immune cells, such as macrophages. Macrophages are normally responsible for killing invading pathogens, but Leishmania are able to avoid this fate and grow stealthily within these host cells, eventually forming large 'granuloma' lesions that can lead to open ulcerating sores, organ damage and, in some cases, death. Many people who carry the parasite remain asymptomatic, but immunosuppressed individuals, for example those with HIV/AIDs or suffering from malnutrition, are particularly vulnerable. Until recently very little was known about how Leishmania managed to grow within these host cells and resist most antibiotics.



In this collaborative study between research groups at the University of Melbourne's Bio21 Institute and the University of York, researchers have shown that Leishmania make an unusual carbohydrate reserve, termed mannogen, that protects them from fluctuating nutrient levels in the host.

"Leishmania are weird. While we use glycogen made from glucose as an energy store, they use a different sugar, mannose, to build mannogen. While we need glycogen to live, the parasites need mannogen to survive," explains Professor Spencer Williams, carbohydrate chemist, who contributed to this work.

The University of Melbourne researchers have identified a new family of enzymes that use sugars scavenged from the host to make mannogen, that can then be reused by the parasite when nutrient levels are low. These versatile enzymes, called mannosyltransferase/phosphorylases or 'MTPs' for short, also have a role in regulating the metabolism of these parasites and represent an entirely new enzyme class. The findings are the culmination of 10 years' work and provide a fundamental understanding of Leishmania metabolism for the development of specific drugs.

"We believe that the evolution of mannogen synthesis in Leishmania, which first involved acquiring genes from bacteria cohabiting in their common insect vector, was critical in allowing these parasites to adapt to their animal and human hosts and colonize immune cells" explains Fleur Sernee, who together with Julie Ralton, is lead author on the publication.

"As mannogen metabolism is critical for the survival of these parasites, developing inhibitors to block the enzymes that regulate this carbohydrate store is a potential way to specifically kill Leishmania parasites," explains Malcolm McConville.

"We can exploit the parasite's food preference for mannogen and specifically target this metabolic pathway, without side-effects to humans."

Bio21 researchers from the Parker group and from York University, were involved in defining the 3D structure of these enzymes. These studies allowed the researchers to map the evolution of this new enzyme family whose members acquired the ability to both make and degrade mannogen, and regulate the metabolism of these pathogens.

Impacts of Research: Human Health

Lightning strikes twice for potential Parkinson's disease and MND drug

A phase 1 human clinical trial of a compound developed by researchers at the Bio21 Molecular Science and Biotechnology Institute and the University of Melbourne and Florey Institute of Neuroscience and Mental Health is showing promise in alleviating the symptoms of Parkinson's disease. The results come just months after similar findings were reported in a separate motor neurone disease trial.

The compound, CuATSM, was given to three separate cohorts of Parkinson's patients (19 in total), in the early stages of the disease, for six months.

The aim of the open-label trial was to ensure safety of the compound, as well as determine the oral dose that would give patients drug levels equivalent to those seen in mouse models of Parkinson's disease where CuATSM treatment inhibited brain damage.

Encouragingly, the greater the dose of CuATSM the greater the benefits in the current trial, with those people on the highest dose improving on both a quality of life score and on measures of movement disability due to Parkinson's disease.

Professor Paul Donnelly, Bio21 Institute, School of Chemistry, University of Melbourne, "A collaboration of chemists at the Bio21 Institute, School of Chemistry; neuroscientists at The Florey and University of Melbourne, and clinicians at the Royal Melbourne Hospital has fuelled promising results in clinical trials with Cu(ATSM) as a potential treatment for Parkinson's Disease"

"Years of basic science and preclinical work on Cu(ATSM) as a potential treatment for Parkinson's disease and MND has led to clinical trials" says Prof Paul Donnelly."

Professor Ashley Bush, director of the Melbourne Dementia Research Centre, said, "Although the MND and Parkinson's trials were both phase 1, meaning we can't make any claims about treatment efficacy, the fact that we see patient improvements at the equivalent doses where we saw independently validated improvements in various mouse models of both diseases gives us confidence that we are on the right path."

Professor Kevin Barnham, head of Neurotherapeutics at The Florey, said, "Like detectives, we don't really believe in coincidences. Taken together, the results from the two trials are very encouraging. When we began developing this compound 15 years ago we were quietly optimistic. So, while it is

still too early to claim definitive success, we're doing the hard yards to discover exactly how the compound saves brain cells, and hope to report on this before the end of the year."

The trial was conducted by Professor Andrew Evans at the Royal Melbourne Hospital(link is external), in conjunction with Collaborative Medicinal Development(link is external), a USA- and Australia-based biotechnology company that licensed CuATSM from the University of Melbourne in order to advance its development.

The results were presented to international experts at the XXIV World Congress on Parkinson's Disease and Related Disorders in Canada on June 13.

17th element #IYPT2019: Chlorine (Cl) ions are needed for healthy bones. They cross membranes of bone cells with help of ClC-7 proteins. Larissa @Bio21Institute studies how signals inside bone cells regulate ClC-7 to better treat bone diseases like osteoporosis & osteosarcoma.

6th element on the periodic table #IYPT2019 #InMyElement Carbon is the backbone of life. Organic chemistry = carbon chemistry: life, pharmaceuticals & plastics! Mark Rizzacasa @Bio21Institute synthesises natural compounds like episilvestrol to test as therapies for cancer

8th element on the periodic table, #IYPT2019: Cerium is a rare earth element recently found to be essential for the growth of some bacteria. @Bio21Institute, Claire Weekley @claireweekley is characterising bacterial proteins to understand their interactions with Ce and other rare earth elements.

46th element on the periodic table, #IYPT2019: Palladium catalyses many chemical transformations @Bio21Institute Wallace Wong uses Pd to help construct fluorescent dyes and semiconducting polymers @organotronics @excitonscience @SciMelb

7th element: International Year of the Periodic Table of Chemical Elements – Iypt2019. Nitrogen is a fertiliser, pollutant and building block of life. Bio21's Uta Wille shows how N can be better taken up by crops & how it contributes to 'smog' in our cities.

34th element on the periodic table, #IYPT2019: Selenium (Se) imparts antioxidant properties into organic compounds. @Bio21Institute's Jonathan White has harnessed both its chalcogen-bond forming and antioxidant properties towards the development of drugs to prevent DNA damage in patients undergoing radiation treatment

Ninth element of the periodic table, #IYPT2019, Fluorine is found useful by @FrancesBiophys @Bio21Institute as it has low background and high signal when used in 19F NMR to determine protein dynamics and interactions in membranes.

16th element International Year of the Periodic Table of Chemical Elements – Iypf2019 Smelly Sulfur (S) is a common preservative & building block of life. @Bio21Institute Spencer Williams has uncovered why greens are good for our gut & the missing piece in the biogeochemical sulfur cycle: 'SQase'.

9th element #IYPT2019 Cu runs through telephone lines, but is also crucial to healthy brain function. @Bio21Institute, Paul Donnelly CuATSM, a copper containing molecule that gets into brain cells and is now showing promising results in trials with MND patients.

Trials promise good news for countries with dengue and Zika virus

An international team of scientists have reported an effective and environmentally sustainable way to block the transmission of mosquito-borne dengue virus, in trials carried out in Malaysia.

The breakthrough has major implications for countries with hot climates such as island nations in the South Pacific to Saudi Arabia, Africa and South America, all of which experience dengue, Zika, yellow fever and chikungunya.

Using a strain of the bacteria *Wolbachia*, which inhibit mosquitoes from transmitting viruses to humans, researchers at the Universities of Melbourne and Glasgow and the Institute for Medical Research in Malaysia were able to successfully reduce cases of dengue at sites in Kuala Lumpur. Their data, published today in Current Biology, shows that mosquitoes carrying the wAlbB strain of *Wolbachia*, when released into the wild, had the effect of reducing the incidence of dengue cases by 40 per cent.

Previously, scientists including Professor Ary Hoffmann from the University of Melbourne, have carried out successful mosquito releases using a different strain of the *Wolbachia* bacteria, but while this strain was able to invade wild populations in some conditions, it did not appear to be suitable for use in the very hot conditions experienced in equatorial countries such as Malaysia.

Now, this international team of researchers from Melbourne, Glasgow and Malaysia has shown that the wAlbB strain of *Wolbachia* is stable and effective, even in daily peak temperatures of 36°Celsius and higher, as commonly experienced in areas of Malaysia where dengue is prevalent.

Professor Hoffmann, from Melbourne University's Bio21 Institute, said the findings could make a difference to a number of countries who have dengue.

"This study provides us with a new Wolbachia strain for field release and highlights disease impact within a complex urban setting where dengue incidence rates are high," he said. "The intervention succeeded despite ongoing pesticide applications and other challenges that can make it hard for the *Wolbachia* to become established. The approach holds promise not only in Malaysia but also in other countries."

Each year there are around 90 million symptomatic cases of dengue, with severe disease in around 1 per cent of cases, including life-threatening haemorrhage or shock syndrome. In Malaysia alone, over 100,000 dengue cases were reported in 2016, with an annual cost estimated at $US175 million.

Researchers released batches of *Aedes aegypti* mosquitoes carrying the wAlbB strain of *Wolbachia* into the wild, in six different sites in greater Kuala Lumpur with high levels of dengue transmission. The *Wolbachia* carrying mosquitoes – both male and female – then went on to mate with the wild mosquito population, resulting in the spread and establishment of the virus-inhibiting bacteria. In some sites, *Wolbachia*-carrying mosquitoes were measured at over 90 per cent frequency more than a year after the mosquito releases ended.

The success of lowering dengue cases at these sites has led to a cessation of insecticide fogging in these areas, highlighting both the environmental and economic benefits of this method.

Professor Steven Sinkins, from the MRC-University of Glasgow Centre for Virus Research, said the breakthrough is promising news for countries that endure mosquito-borne diseases.

"These findings show that we have a strain of *Wolbachia* that can be used to effectively reduce the number of dengue cases in very hot climates. The next step is to deploy this strain in more and larger sites, but we are now

confident that this will become an effective way to control dengue on a large scale."

The paper, 'Establishment of *Wolbachia* strain wAlbB in Malaysian populations of 2 *Aedes aegypti* for dengue control' is published in Current Biology. The work was funded by the Wellcome Trust.

Pursuit: Getting Revegetation right with genetics by Ary Hoffmann

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, University of Melbourne

New research shows that revegetation programs need to consider incorporating plants with a varied genetic background for long-term success.

By Professor Ary Hoffmann, University of Melbourne.

Eucalypts, wattles, banksias, grevilleas and other Australian native plants are some of the most fascinating and unique flora on Earth.

They also play an important part in revegetation programs around Australia, which aim to restore plant-life to areas where the species used to grow, before activities like agriculture, forestry, urbanisation or mining caused degradation.

Genetic variation is critical to allow populations to adapt to current and future environmental stresses. Picture: CSIRO

But for any revegetation to be successful, recent work has shown how important it is to make sure that the genetic variation in plant populations matches or even exceeds what was previously present at a site.

This variation is critical for minimising any negative effects of inbreeding and reduced adaptive potential in plant populations.

INBREEDING AND ADAPTATION

In plants, inbreeding can result in incompatibilities between ovules (the female reproductive structure in seed plants) and pollen, preventing the plants producing viable seed in the following generations.

Inbreeding can be avoided by ensuring that there is ample genetic variation in populations from unrelated individuals.

Genetic variation is also critically important in allowing populations to adapt to current and future environmental stresses.

In the absence of genetic variation, such as when the entire population consists of a single clone, these plant populations will have limited ability to withstand any new pests and diseases, or to adapt to changing levels of heat stress and drought.

This is because the populations are all composed of a single genotype, with a similar DNA-encoded ability to withstand disease and other environmental challenges.

However, when there's a diversity of genotypes reintroduced, some are more likely to survive

these stresses than others, allowing the population to adapt to environmental changes.

And this process of adaptation is a core component of evolution through natural selection.

Plant populations may now need even higher levels of genetic variation to survive a future with hotter temperatures. Picture: Getty Images

THE IMPACT OF CLIMATE CHANGE

Stressful conditions are becoming particularly common as a result of climate change.

Already, there is evidence of tree and shrub death in our ecosystems as a result of the direct and indirect effects of climate change, such as when drought in combination with disease or pest pressure kills plants.

Habitat restoration programs are currently determined as successful by the number of plants that survive a few generations, but this is not adequate to ensure any longer-term survival and success.

Genetic variation in the population needs to be assessed when considering the long-term viability of restored populations.

In fact, plant populations may now need even higher levels of genetic variation than they did in the past if they are to survive several decades into a future with hotter temperatures and more variable rainfall – combined with a host of new pests and diseases.

EXPLORING GENETIC DIVERSITY

As part of our research, we undertook a review of global literature on a range of genetic studies into revegetation, in order to investigate how often adequate levels of genetic variation have been factored in.

We found that in 46 per cent of cases, revegetated populations of plants captured similar levels of genetic diversity to natural groupings of plants, particularly where plantings were based on multiple seed sources.

However, outcomes were variable.

It is important to record and report genetic aspects of restoration practices. Picture: Amelia Caddy (Bush Heritage Australia)

In 52 per cent of cases, the revegetated groups had lower levels of genetic diversity than in the past. And this low diversity may mean these populations are much less likely to survive into the future, even if they presently appear to be growing well.

Unfortunately, one of the main conclusions of our review is that genetic data is rarely collected before revegetation begins or even considered when assessing the success of the project.

Most organisations undertaking a revegetation program are essentially paid by plant number, not by genetic diversity.

This means that there is very little incentive to try to capture more diversity, even if this is critical for the long-term survival of our plant populations.

If we look to the future, it is important to record and report genetic aspects of restoration practices so that we can promote better genetic and ecological outcomes.

This is particularly crucial in revegetated areas that are specifically set up to counter the effects of climate change into the future.

But this is unlikely to work effectively unless there are appropriate incentives available to support this effort.

Doing so helps to ensure that some of Australia's beautiful native plants will survive long into the future.

This is a shortened excerpt, first published in Pursuit.

Research Support Services

Kirsty Turner

Research Support Services Manager

Bio21 is a multi-disciplinary research institute that includes research groups from three Science, Technology, Mathematics and Medicine (STEMM) faculties, encompassing eight departments and schools. We also house platform technology facilities, as well as industry research teams from Australia's largest pharmaceutical company, CSL Ltd. and start-up companies in our Business Incubator space. This makes for a diverse and complex organisation. Ensuring good Occupational Health and Safety (OH&S) compliance is a challenging, but also rewarding undertaking, as we strive to not only meet the needs of the Institute, but also of the individual departments, schools, facilities and industry groups. To do this successfully, relationships based on mutual respect and trust are key, as is good communication. It involves working with different OH&S Committees, with an aim to simplify processes wherever possible to ensure a safe and healthy workplace for all our community members.

2019 was once again a big year for Bio21, which saw the construction of the Stage 2C 'Ruth Bishop' building project commence, and our participation in a Worksafe OHS audit in September 2019.

The 'Ruth Bishop' building will house Bio21's impressive collection of powerful and delicate electron microscopes. In order to prepare and work through predicted and unexpected disruptions that arose as part of the construction process, we strove to develop a good working relationship with the builder, KANE, from the very beginning. Some disruptions to the Institute community included temporary closure of lifts, parking spaces and occasional power shutdowns, all of which have significant impacts on research taking place in the Institute. The good relationship with KANE meant that we could give ample notice to our academic and industry community members about these disruptions, and could put in place collegial mitigation strategies to prevent hazards developing. It has been wonderful to see the fantastic progress of the construction throughout 2019, and to be completed in 2020.

2019 also saw Bio21's platforms and laboratories audited by Worksafe. Whilst the thought of participating in any audit can send shivers up your spine, I see audits as an opportunity to improve processes and procedures, and to find ways in which to simplify our workplace practices whilst meeting our obligations in regards to legislative requirements, standards and codes. All Bio21 platforms and laboratories who participated in this audit did very well, and it is a credit to all working across the Institute. As a result of the audit, we are prioritising the improvement of our contractor management system within the Institute.

Across our events and engagement, we have also seen an increased demand from conference organisers to provide childcare to attendees. This has confronted us with interesting challenges and questions around contractor management, and suitability of spaces, particularly around OH&S. As this question is being asked more and more, I see

this as a positive development to providing a more inclusive workplace for scientists who have care-giving responsibilities.

Success for Bio21 was also realised in 2019 with the approval of our Capital Assets Group (CAG) grant proposal, with funds from this grant going towards the much-needed refurbishment of the Bio21 Incubator space. This is critical so that we may continue to provide a safe and attractive workspace in the building for our industry tenants. In 2019, Bio21 welcomed a new tenant 'Gertrude Biomedical' to our community.

Mental Health is also an important, but sometimes overlooked aspect of OH&S, and the loss of our treasured colleague Alex Korte shocked our tight knit community early in 2019. As we grieve for Alex, we remember his humour and spark that he brought to the Institute. His passing highlighted how many lives he touched across the Institute, and how interconnected each and every one of us is at the Institute.

As we have had to adjust to working remotely during the coronavirus pandemic in 2020, we are facing unprecedented challenges in keeping our community members safe and connected, as well as maintaining our research instruments to keep them on standby for COVID-19 research among other things. We will continue our unified efforts with Faculties and industry tenants to ensure the health and safety of our Institute members and visitors remains at the forefront of our plans to judiciously return to campus during these uncertain times. Thank you to all Bio21 members for cooperating in providing a safe workplace for all.

After completing her PhD Zal Hakki undertook a teaching degree and taught for two years at a secondary school. Now she is developing a drug to treat steroid-resistant asthma. Zal loves to spend time with family and enjoying home-cooked meals by her grandmother.

Dr Ineke Muir, who heads the Vascular Biophysics team, CSL Research. She investigates the effects of shear forces on preclinical drugs and therapies, to predict how they will behave in the bloodstream. She's also a mum and avid bike rider and an occasional bookworm.

Fiona Houghton, Dept Biochemistry and Molecular Biology, Bio21, Gleeson Lab. Fiona loves photography and travelling, as well as enjoying nature on her farm in Gippsland.

Associate Professor Justine Mintern heads the Vaccine Biology Lab that seeks to design more sophisticated immunotherapies for use in infection and cancer. She is also a bit of a movie buff.

Qiong Yang studies the evolution of insecticide resistance in red-legged earth mite, a major agricultural pest. She enjoys time with her children, being outdoors, yoga and craft.

Asmini Athman is the Lab Manager & OHS Advisor of the MDHS Infrastructure & Facilities team. She enjoys seeing the world, fostering friendships and reading.

Yan Hong Tan is the acting Centre Manager of the Melbourne Protein Characterisation Facility and the ACRF Facility for Innovative Cancer Drug Discovery. Yan Hong enjoys exploring new cultures and landscapes.

Women of Bio21 Committee Report

In 2020 the Women of Bio21 committee will become the Bio21 Equity, Diversity and Inclusion Committee, to better reflect the diverse Bio21 community.

Dr Diana Stojanovski and Dr Matt Dixon

The Women of Bio21 committee continued their work building on the successes of 2018. In 2019 the committee was chaired by Diana Stojanovski and Matthew Dixon, who shared the responsibilities. In 2019 we continued our 'Women of Bio21' profile series, hearing from our exceptional scientists and their unique paths into science, their challenges and their successes. The collated profiles of these amazing women can be found at https://www.bio21.unimelb.edu.au/tags/women-science .

The committee conducted an institute wide survey to identify the key issues and hurdles faced by women at Bio21. The survey identified three key areas amongst the themes - the need for better mentoring, targeted funding opportunities for women and support for mothers returning to work. The results of the survey will be used by the committee to advocate for change, both locally and at the University to provide Bio21 community members with opportunities, such as mentoring initiatives for career paths, creating a supportive work environment and developing institute-specific funding.

To begin to address this, Bio21 introduced a number of research travel awards to recognise early career researchers and provide them with opportunities to travel and attend conferences. A number of our outstanding ECR women were awarded prizes.

The main event for the year was the Bio21 International Women's Day symposium. Women from across Bio21, including industry, academia and the technology platforms, presented their scientific journeys and the leading research they undertake. The event was a celebration of our extraordinary women and the world leading research they undertake at the Bio21 Institute.

The Women of Bio21 on the steps of the Nancy Millis building following The International Women's Day Symposium, 2019. Photo Peter Coles.

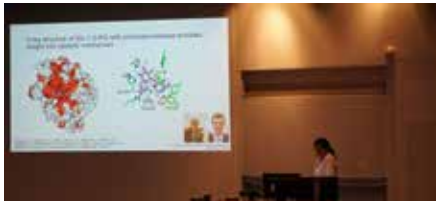
The Bio21 Institute provided in principal support to a state government funding bid to establish the Equity in Medical Research Alliance in Victoria. The alliance will include both established and newly formed gender equity groups. EMRA will provide a united voice to drive change.

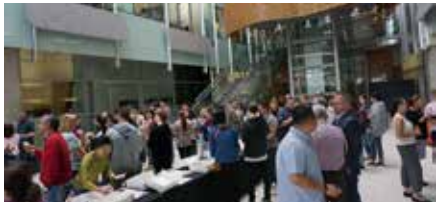
In 2020 the Women of Bio21 committee will become the Bio21 Equity, Diversity and Inclusion Committee, to better reflect the diverse Bio21 community.

International Women's Day Forum at Bio21

Thank you to CSL for supporting this event.












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 2019, Gertrude Biomedical moved into the Bio21 Business Incubator building (building 404). They join CSL, Circa Group and Alterity, formerly Prana Biotech, Rhythm Biosciences and SYNthesis med chem as industry research groups who are part of the Bio21 community.

Gertrude is located in level 1 of the Bio21 Business Incubator Building (Building 404). 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.

Gertrude Biomedical is a small spin-out company from a strong collaboration between researchers at the University of Queensland and Vincent's Institute in Fitzroy. Those that are familiar with the geography around the St. Vincent's campus, will guess how the name came about. The company aims to develop novel small molecule compounds to inhibit the function of a transcription factor for the treatment of human diseases which depend on aberrant vasculature for their growth and spread.

Following the tradition set by CSL at Bio21, Gertrude Biomedical see location within the Bio21 Incubator as a strategic move and are keen to interact with academic researchers and the Bio21 platforms in areas of Gertrude's interest.

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.

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.

Welcoming Gertrude Biomedical to Bio21

We are delighted to welcome a new industry tenant, Gertrude Biomedical, to Bio21. They will be located in level 1 of the Bio21 Business Incubator Building (Building 404).

GERTRUDE
BIOMEDICAL

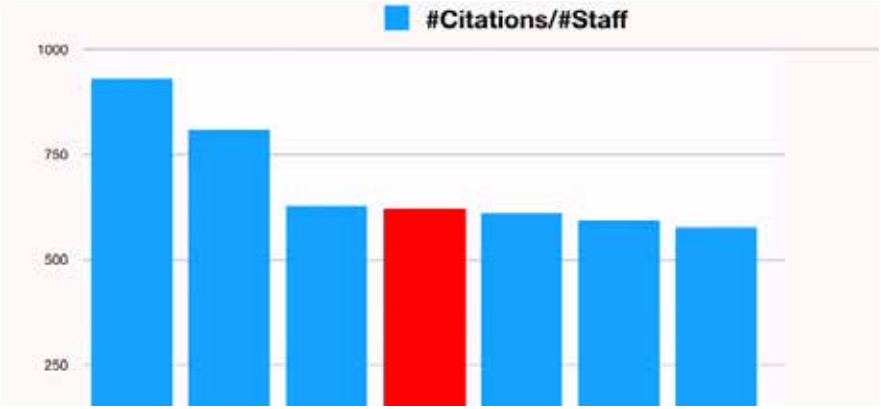
Lost in Translation

"This is an important industry-university 'Lost in Translation' could be the theme of much of Australian biomedical research: In Australia, particularly here in the Parkville biomedical precinct, we punch above our weight when it comes to the quality and output of our scientific publications – we're world class at so called 'basic' or fundamental research, but we're a bit lost when it comes to translation.

We know what it is. We know we ought to do it. But the 'how' is the challenge and it calls for a mind and culture change in the Australian research community. This was a sobering, but not altogether surprising finding from an analysis that our Bio21 colleague, Professor Andrew Wilks of SYNthesis, presented at a precinct forum at WEHI:

"Working with my colleague Maggie Lieu from Clarivate Analytics we determined that the Parkville Precinct ranks 3rd (!) In the world, behind San Diego, Stanford and San Francisco, but ahead of other Life Science Clusters such as Boston (!) And Cambridge, UK. Our spin-out culture however is woeful: there are 120 start-ups located within 1 square mile in Boston's Kendall Square, whereas you can count the start-ups within the Melbourne Biomedical Precinct on your hands. We are good at the discovery stuff, but very poor at the translation," he said.

"Working with my colleague Maggie Lieu from Clarivate Analytics, we asked a simple question: 'How does our productivity in the life sciences compare with other research precincts, such as Boston, San Diego or Cambridge UK?' The approach was to ask 'How many citations have papers published by Parkville scientists, and how many scientists contributed to those papers?' Simply by dividing the number of citations by the number of scientists we defined a crude metric for comparing each of these



life science precincts. For the spin-out activity, we simply counted the number of companies created in the sector in the last 20 years."

The US and European countries have been more willing to commercialise their research findings and we have much to learn from them.

A Focus Group is Formed

As a first step to addressing the 'how' a 'Melbourne Therapeutics Development Leadership Group' (MTD-LG) was formed with the support of the State Government through Gareth Goodier who was the Executive Chair of the Melbourne Biomedical Precinct that was run out of the Victorian Department of Premier and Cabinet. The group had its first meeting at this time two years ago. The founding members were Monash Institute of Pharmaceutical Sciences (MIPS) (Chris Porter, Bill Charman), Centre for Drug Candidates Optimisation (CDCO) (Sue Charman), UoM Department of Pharmacology and Therapeutic Department (Danny

Hoyer), CRC for Cancer Therapeutics CTx (Ian Street, Brett Carter), SynMedChem (Andrew Wilks), BioCurate (Glenn Begley), Florey Institute (Ross Bathgate), WEHI (Doug Hilton, Guillaume Lessene) and Bio21 (myself). It has now expanded to include Cell Therapies, Florey, Certara, Peter Mac, The Murdoch Children Research Institute (MCRI), Victorian Comprehensive Cancer Centre (VCCC) and CSL. It's great to see Bio21 industry members CSL and SYNthesis|SynMedChem actively contributing.

This precinct-based focus group is for organisations with interests in therapeutic development of small molecules, biologics and cell therapies. The group aims to harness the critical mass of expertise, skills and infrastructure within the precinct to promote and catalyse activity in therapeutic development, raise awareness, share expertise and provide a common landing point for potential collaborators. There is a lot of work to be done!

Chris Porter, Co-Chair writes: "… we aim to promote our competitiveness with other international therapeutic discovery and development hubs."

With two representatives per organisation, membership of the focus group is open to organisations directly involved in one or more aspects of the discovery and development of new therapeutics, including those involved in the small molecule development pipeline and development of biologics and cell-based therapies, from target identification and validation to clinical evaluation. The 3-monthly meetings are co-chaired by Prof. Christopher Porter (MIPS) and Assoc. Prof. Guillaume Lessene (WEHI).

The aims are:

- To develop a long-term vision for drug discovery and development at the precinct level
- To assess the strengths and weaknesses of the precinct in the area of drug discovery and development
- To represent drug discovery at the precinct level and serve as point of contact for precinct-wide initiatives
- To develop precinct-wide policies that facilitate drug discovery and development activities
- To identify and jointly apply for local, federal or international funding opportunities to support precinct-wide initiatives that benefit the whole drug discovery community
- To foster inter-organisational partnerships and collaborations
- To promote/develop joint programs that develop translation, entrepreneurship and innovation, especially aimed at university students
- To drive talent development and retention
- To work together to foster an emphasis on data quality and integrity so the precinct becomes recognised as a world-leader in scientific reproducibility
- To advocate the strengths of the precinct in drug discovery

A Survey

One of the first initiatives of the group was an information-gathering exercise: in conjunction with the Melbourne Biomedical Precinct Office (MBPO), it conducted a survey in May 2019 to capture information on all the active biomedical organisations in Melbourne, including Bio21. The purpose of the survey was to establish the scope and scale of capabilities in the therapeutics development sector and to identify areas where strategic investment would strengthen our position as a world leading precinct.

In particular, it was an attempt to capture major equipment/infrastructure that might benefit potential collaborators. The survey results are intended to be made publicly available via the Melbourne Therapeutic Development - Leadership Group website in the future.

A Symposium: 'Innovation to Translation! Symposium 2019'

Another great initiative that has arisen out the focus group was the recent: 'Innovation to Translation! Symposium 2019 in the Melbourne Biomedical Precinct' event on the 21st November at WEHI.

The meeting, organised by and for early to middle career researchers across the precinct, showcased local success stories, precinct capabilities, opportunities for collaboration and mentorship opportunities. Attendees heard from speakers about

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 2019 has been a big year for the Bio21 Institute being the International Year of the Periodic Table of Elements. Bio21 took the opportunity to showcase our researchers working with elements on social media with a fun series.

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 'Science and the Art of the Periodic Table' activity during National Science Week.

We hosted Bio21 'Big Picture' Seminars, hearing from among others Professor Ron Heeren; Professor Emma Johnstone AO, Dean of Science, Professor of Marine Ecology and Ecotoxicology at UNSW Sydney; Professor Emeritus Maree Smith; Dr Larry Dick, Seofon Consulting, Natick, Massachusetts and Dr Joseph Arron, Genentech, Dr Matt Sleeman, Regeneron and Dr Brent McKenzie, Genentech and Dr Damien Bates, Biocurate.

We brought our community together and introduced new members, including Assoc Prof Megan Maher, Dr Debnath Ghosal and Dr Douglas Pires at our regular Bio21 morning teas.

Several large conferences and symposia were hosted at Bio21, including the RACI Synthesis Symopsium, the Georgina Sweet Awards and the Bio21 Methods Symposium, and our platform technology groups hosted a series of '101 workshops'.

We were visited by Prof X Peng & Prof H Li from Sun Yat-sen University and a delegation of mayors representing a number of cities within the Sichuan Province.

A number of high school groups visited Bio21, including Loreto Mandeville Hall, Elizabeth Blackburn Sciences, St Catherine's, Our Lady of Mercy, Heidelberg, Marist College Bendigo and even one hundred students from St Joan of Arc Primary School.

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.

Melbourne Theatre Company Cast briefed by Bio21 researchers for 'Photograph 51'

The cast of the Melbourne Theatre Company's production of the play 'Photograph 51' were briefed by Bio21's Megan Maher on Tuesday, 15 October.

The play, ran in the Arts Centre Melbourne, Fairfax Studio from 1st November - 14th December is the story of Rosalind Franklin, who used X-ray diffraction to contribute to the elucidation of the structure of DNA. These contributions were sadly under-recognised by the scientific community. The cast members were keen to understand the science of X-ray crystallography, and the constraints and barriers that Rosalind may have faced as a woman in science.

Bio21 Hosted Events

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

Prof Em Maree Smith, PhD AC FTSE FAHMS, Director, Centre for Integrated Preclinical Drug Development (CIPDD), The University of Queensland presented the 'Big Picture Seminar': 'Addressing Chronic Pain: A Major Health Problem in Australia and Globally', 4 November. Her drug EMA401 that targets the AT2 receptor shows promise in trials.

Artist Damon Kowarsky and scientists, Prof Frances Separovic AO, Dr Nick Williamson and Dr Andrew Leis, explained how we harness our knowledge of the elements to solve scientific puzzles in medicine, the environment and agriculture in a National Science Week event, "The Art & Science of the Periodic Table," 14 August.

The 4th Georgina Sweet Awards for Women in Quantitative Biomedical Science were held 14 October 2019 including guest speaker Prof Sue Thomas, Chief Executive Officer, Australian Research Council.

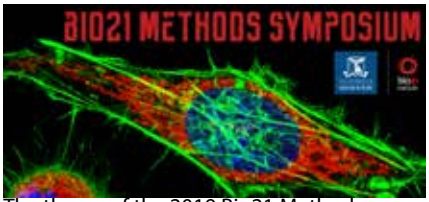
Dr Larry Dick, Seofon Consulting, Natick, Massachusetts presented a 'Big Picture': Drug Discovery in the Ubiquitin Proteasome System: A Biotech to Big Pharma Journey', 22 October. He shared the structure of the proteasome, its importance as a therapeutic target against cancer and malaria.

Qiong Yang studies the evolution of insecticide resistance in red-legged earth mite, a major agricultural pest. She enjoys time with her children, being outdoors, yoga and craft.

Professor Ron M.A.Heeren presented the 'Big Picture' Seminar: "Cellular Complexity and Heterogeneity Revealed with Translational Imaging Mass Spectrometry," 5 February.

Joseph Arron, Genentech, Matt Sleeman, Regeneron and Brent McKenzie, Genentech, discussed the science behind the development of therapeutic drugs into the clinic in a Bio21 'Big Picture': 'The science behind drug discovery in Industry' , 20 September. A Q&A panel was hosted by Damien Bates, Biocurate.

Professor Emma Johnston AO, Dean of Science, Professor of Marine Ecology and Ecotoxicology at UNSW Sydney presented the Bio21 'Big Picture' Seminar: "The four main mechanisms by which humans are speeding up the ecology of our oceans: organic enrichment, bioinvasions, heat, and disturbance." 15 March 2019.



The theme of the 2019 Bio21 Methods Symposium was "Emerging Technologies for New Challenges," 24th October. Methods and technologies being used to address today's fundamental biological questions were presented.

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 'Art and Science of the Periodic Table' event as part of National Science Week, just to name a few.

Open House Melbourne Weekend

Bio21 hosted Melbourne's Open House weekend, 27 & 28 July 2019 and had 388 members of the public visit the Institute, to admire the architecture and experience our science. Visitors could take tours through our Magnetic Resonance Facility, the Nancy Millis building and Margaret Sheil laboratories, the Advanced Microscopy Facility and Level 2 and 4 laboratories.

Visitors engaged with the displays in the atrium, including: 'Powerful Proteins', 'Creative Chemistry', 'The Problem of Parasites', 'Mozzies, Blowflies and Bandicoots', 'Excited about Solar' and 'The Secrets within Cells' showcasing some of the diverse questions being investigated using molecular science within the Institute.

St Joan of Arc Primary School visits Bio21

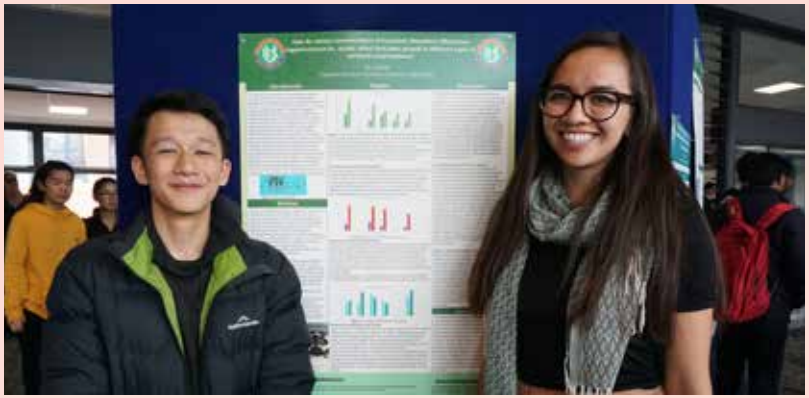
One hundred students from Grade 5 and 6 at St Joan of Arc Primary School visited Bio21 on Wednesday, 16 October to learn about molecules.

Year 10 Work Experience at the Bio21 Institute

The Bio21 Institute, as part of the Faculty of Science's Work Experience program, hosted 12 year 10 students from schools across Melbourne and Victoria from 24 – 28 June. Students participated in a diverse program of experiments, activities and projects, that gave students 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.

Marist College, Bendigo visit Bio21

VCE Biology students from Marist College Bendigo visited Bio21 on the 16th October were keen to learn about genetics research. Professor Phil Batterham spoke with the students about the important role the fruit fly, *Drosophila melanogaster* has played in genetic research and Dr Dezerae Cox took the students through the lab, giving them an experience of microscopy and sharing the Huntington research of the Hatters lab.



Paul Huang and Alex Louie, Head of Enquiry Learning, The University High School

Prof X Peng & Prof H Li from Sun Yat-sen University visit Bio21

Deputy Director, Frances Separovic, enjoyed talking with Prof X Peng & Prof H Li from Sun Yat-sen University about their work on the metabolomics of antibiotic resistant bacteria during their visit to the Bio21 Institute.

Sichuan Mayoral Delegation Visits Bio21

A delegation of mayors representing a number of cities within the Sichuan Province visited Bio21 as part of their tour of medical research organisations within the precinct on Tuesday, 10 December.

Elizabeth Blackburn Sciences' students impress with Scientific Poster Presentations

Students from Elizabeth Blackburn Sciences presented their research projects as part of the VCE subject 'Extended Investigations' on 9 October to their fellow students, parents and teachers. Nick Bell mentored Paul Huong for his research topic 'How do various concentrations of inoculant, *Rhizobium leguminosarum bv. Viciae*), affect fava bean growth in different types of sterilised soils and medium?'

Bio21 Institute Community Events

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.

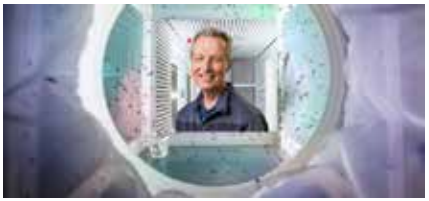
One of the ways in which Bio21 nurtures its culture is through regular internal morning teas throughout the year often linked with fundraising for various causes, where Bio21 members come together over a cup coffee and some sweet treats to hear from the Director about goings-on, to welcome new members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

Bio21's Soccer Team Wins Bronze in First Ever Season

For the first time ever, the Bio21 Institute competed in the University of Melbourne's inter-institute social soccer competition in 2019. Over the course of the season from April to October, Bio21 played weekly 7-a-side matches against other institutes across the Parkville precinct. The team consisted of 18 (12 male, 6 female) researchers from across the institute, ranging from Honours and PhD students to Research Assistants and Postdocs. Led by team captain Andreas Pannek, who scored a massive total of 32 goals, Bio21 won 11 games with 2 draws and 5 losses. After finishing the regular season in 4th place (out of 10 teams), Bio21 qualified for the finals where they just missed out on making the Grand Final. However, the team managed to finish the season in style with a dominant 7 - 0 victory over PDI in the Bronze medal match.

Bio21 Media and Social Media

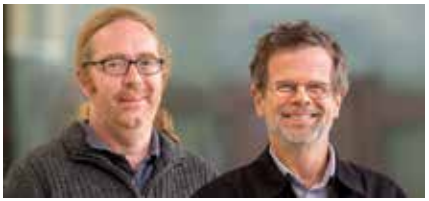
Bio21's researchers engage with the popular media to communicate their science to the public .



Trials promise good news for countries with dengue and Zika virus: An international team of scientists have reported an effective and environmentally sustainable way to block the transmission of mosquito-borne dengue virus, in trials carried out in Malaysia.

Ary Hoffmann was interviewed by the BBC and Sky News about the trial.

Bio21 Institute @Bio21Institute·Dec 4
Plants need nitrogen, but too much causes greenhouse gas emissions and water pollution. How do we improve the efficiency of nitrogen fertilisers for agriculture & our planet? Uta Wille @scimelb @Bio21Institute funded to find out #ARCGrantsAnnouncement https://bit.ly/2Lm7lbA



Scientists crack rabies virus weaponry: Researchers have found a way to stop the rabies virus shutting down the body's immune defence against it. In doing so they have solved a key scientific puzzle and have laid the foundation for the development of new anti-rabies vaccines. Paul Gooley was interviewed on 3AW with Ross and John. The story appeared in The Australian and Townsville Bulletin.

Bio21 Institute @Bio21Institute·Dec 4
Nature's compounds are a treasure-trove for medicine. How do we synthesize them? Mark Rizzacasa @ scimelb @Bio21Institute funded to find out #ARCGrantsAnnouncement https://bit.ly/2Lm7lbA

Uta Wille on 'Weekends with Libbi Gorr' & Frances Separovic on the Myf Warhurst show

Uta Wille and Brad Clarke chatted to Libbi Gorr on ABC Melbourne about 'The Future of Plastic' ahead of the Science Festival panel keynote event.

Bio21 Institute @Bio21Institute·Dec 4
Ferritin stores iron in the body ready for use on demand. When things go wrong you get iron deficiency or toxicity. How does the body regulate iron metabolism? Guy Jameson @gnljameson @scimelb @ Bio21Institute funded to find out #ARCGrantsAnnouncement https://bit.ly/2Lm7lbA

Graduate Research Students and Early Career Researchers

As a place of learning, it is important to remember one of the primary missions of the university is training. And as a multidisciplinary research Institute, equipped with platform technology facilities and technical support staff, the Bio21 Institute provides a unique 'village' for students to receive training in a range of high-end technologies.

It is a privilege to supervise students through what is often one of the most formative periods of their lives. The technical knowledge that students acquire is probably secondary to more generic skills of planning, presentation and research that they acquire over the course of their studies. Thus, while science is ever-changing and in many cases either passes its use-by date or is superseded, the ability to use scientific ways of thinking to penetrate and dissect difficult concepts will stay with our students through the rest of their lives. For some their MSc/Hons studies will be the end of their formal scientific training. For others, it is a step on the path to a higher degree. But for all, the deeper knowledge of science and the understanding of the nature of research will support them to become productive and informed citizens who can critically and authoritatively challenge the muddy thinking, poor reasoning and sometimes deliberate obfuscation that often clouds commentary in the media and the global political discourse.

If nothing else, a lot can be said about the insight that research training provides into the scientific method. Carl Sagan offered the following pithy quote that summarizes this well:

"At the heart of science is an essential balance between two seemingly contradictory attitudes – an openness to new ideas, no matter how bizarre or counterintuitive they may seem to be, and the most ruthless scrutiny of all ideas, old and new. This is how deep truths are winnowed from deep nonsense."

One of the interesting features of modern scientific training is that it still reflects the apprenticeship nature of the scientific enterprise – training by doing. And it is a paradox of modern research that our Universities still use the training of students as the main vehicle through which we conduct the most ground-breaking of research. It is worth considering this point closely – the fundamental knowledge that we create in the engines of discovery that comprise our universities, more often than not comes not from the hands of seasoned experts, but rather from the novice. Of course this is not done alone: the supervisor provides the physical equipment and intangible intellectual assets; the University provides the foundational education in the technical aspects of science; and the community of a department, or institute, such as Bio21 both supports and challenges us to conduct our research with the rigour that Carl Sagan would demand. Truly, it takes a village to raise a scientist.

Spencer Williams

Associate Director, Commercialisation

Bio21 Travel Awards

Bio21 students awarded G.I Feutrill travel awards

Congratulations to the PhD students, who received G.I Feutrill Awards to assist them with travel costs associated with attendance at Organic Conferences in 2019:

•Tom Fellowes (White Group) attended the Gordon Conference for Physical Organic Chemistry 'The Intersection of Organic Structure, Reactivity and Mechanism' at Holderness College, New Hampshire US, June 3-28 2019.

Title of Poster: "Development of a Chalcogen Bonded DNA Binder'

•Liselle Atkin (Rizzacasa Group) attended the Gordon Research Conference on Natural Products in New Hampshire, USA this year and presented a poster.

•Sadegh Shabani (Hutton Group) conference presentations:

•S. Shabani CA. Hutton, "Macrolactonisation of Peptides via a Thioamide Strategy" 7th Solid Phase Peptide Synthesis Symposium, 5-7 September 2019, Queensland, Australia.

•S. Shabani, J. White, CA. Hutton, "Towards the total synthesis of asperipin-2a: a novel fungal ribosomal post-transationally modified peptide (RIPP)" 26th International Symposium: Synthesis in organic chemistry, 15-18 July 2019, Cambridge, UK.

EMCRA Collaborative Award Winners

Congratulations to Joanna Sacharz, The Stroud Lab who is an EMCRA Collaborative Award Winner!

Congratulations to Dr Boris Reljic of the Dept of Biochemistry and Molecular Biology who spoke about his work with Dr Justin Hardee and Dr Lincon Stamp on contraction-induced mitochondrial plasticity.

Congratulations to Dr Claire Weekley, of the Department of Biochemistry and Molecular Biology, discussing her work with Dr John Karas on the structure of the protein tetraspanin CD151.

Congratulations to Laura Edgington-Mitchell who is working with Rachel McQuade. Their research addresses the role of legumain in the gut.

'People's Choice' award at the 3MT Grand Final

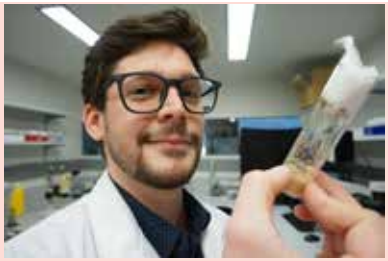
Congratulation to Felipe Martelli, Batterham group, who received the people's choice award at the 3MT Thesis Competition Grand Final, 7 August.

Melbourne Protein Group poster prize

Congratulations to Melbourne Protein Group poster prize winners Beth Anderson and Bronte Johnston.

EMBO Fellowship

Congratulations to Yilin Kang, Stojanovski group, who has been awarded a prestigious EMBO fellowship to join Prof. Anu Suomalainen's laboratory at the University of Helsinki in Finland as a postdoctoral fellow.



Congratulations to Tyra for winning the Best Talk Prize at the RACI Synthesis Symposium.

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:

Bio21 group leaders, Paul Gooley and Danny Hatters, Department of Biochemistry and Molecular Biology and Craig Hutton from the School of Chemistry have been promoted to the position of full Professor at the University of Melbourne, commencing 1 January 2020. Paul, Craig and Danny's promotions, recognise their contributions to Bio21, the University and the wider society.

Glub Melbourne Award
Phil Batterham

2019 Margaret Sheil Award

Congratulations to Prof Emeritus Frances Separovic, AO FAA on receiving the 2019 Margaret Sheil Award.

The Margaret Sheil Leadership Award recognises an outstanding female leader working in a chemistry-related field who has helped to inspire and mentor junior female chemists and/or helped to provide a more equitable workplace.

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 Discovery Projects and Early Career Researcher grant outcomes were announced by the Minister for Education Dan Tehan, 4 December. Congratulations to Guy Jameson, Paul Donnelly, Mark Rizzacasa, Uta Wille, Eric Reynolds, David Ascher, Trent Perry, Phil Batterham and Michael Parker.

National Health and Medical Research Council (NHMRC):

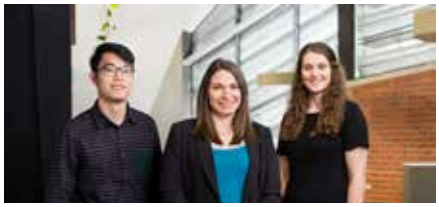
Leann Tilley, Department of Biochemistry and Molecular Biology, received a Development grant of $445,920.00 to fund the: "Development of a novel drug class for the treatment of Plasmodium falciparum malaria."
David Ascher, Department of Biochemistry and Molecular Biology, who has received an Investigator grant of $1,554,485.00 to pursue his work: "Using protein structure to combat antimicrobial resistance".

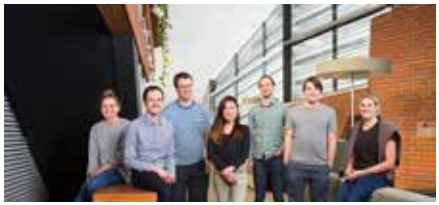
Congratulations to Karen Day for NIH funding to pursue world-leading malaria research

Professor Karen Day has secured almost US$3 million funding from NIH to further her world-leading malaria research at the Bio21 Institute.

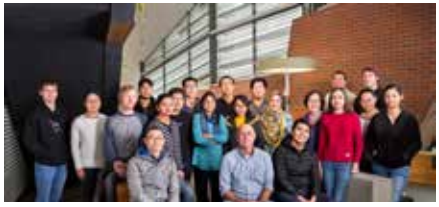


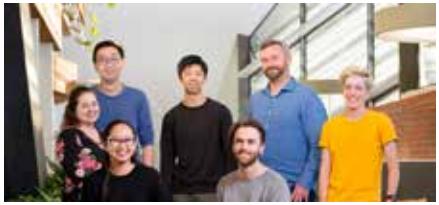


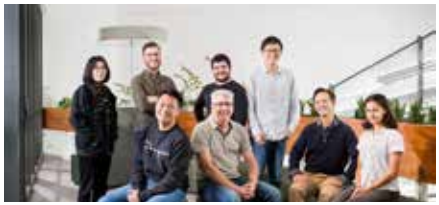


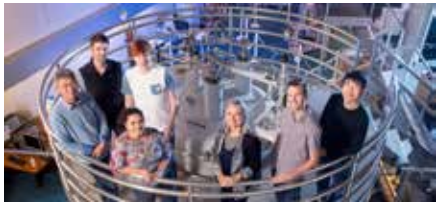





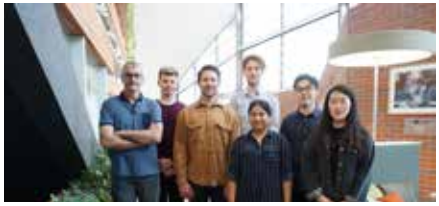



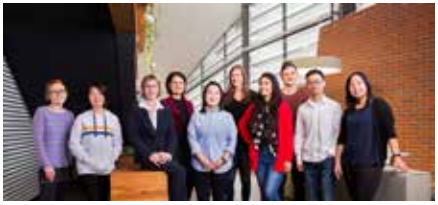





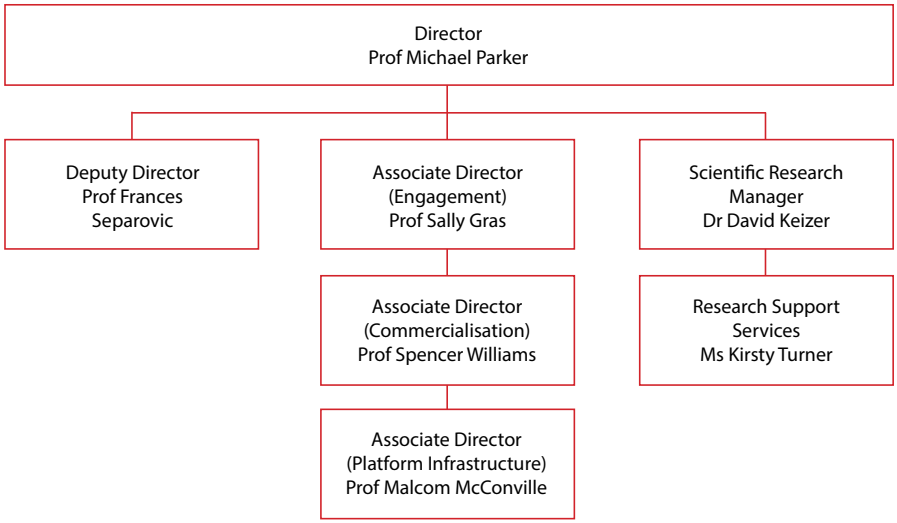




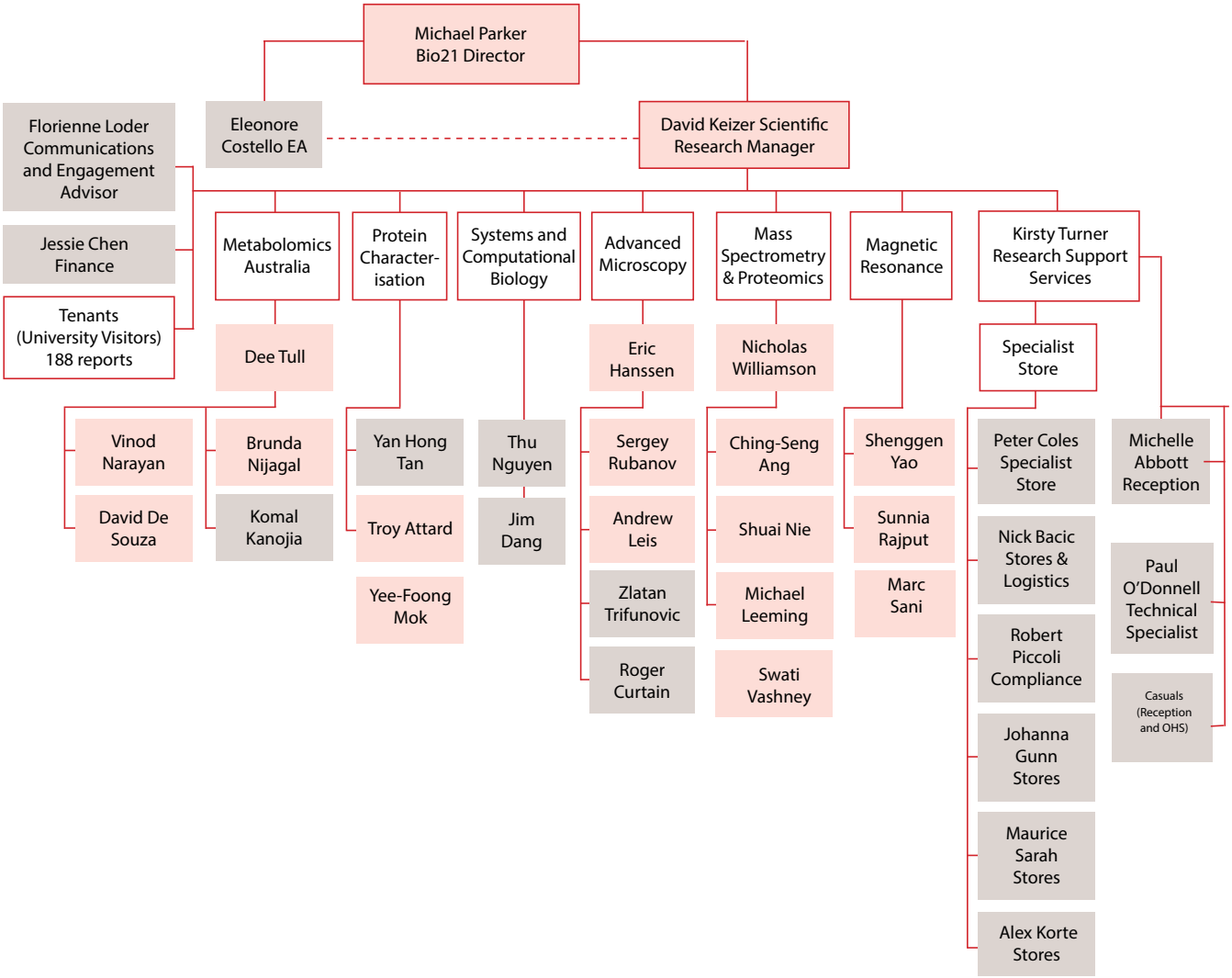




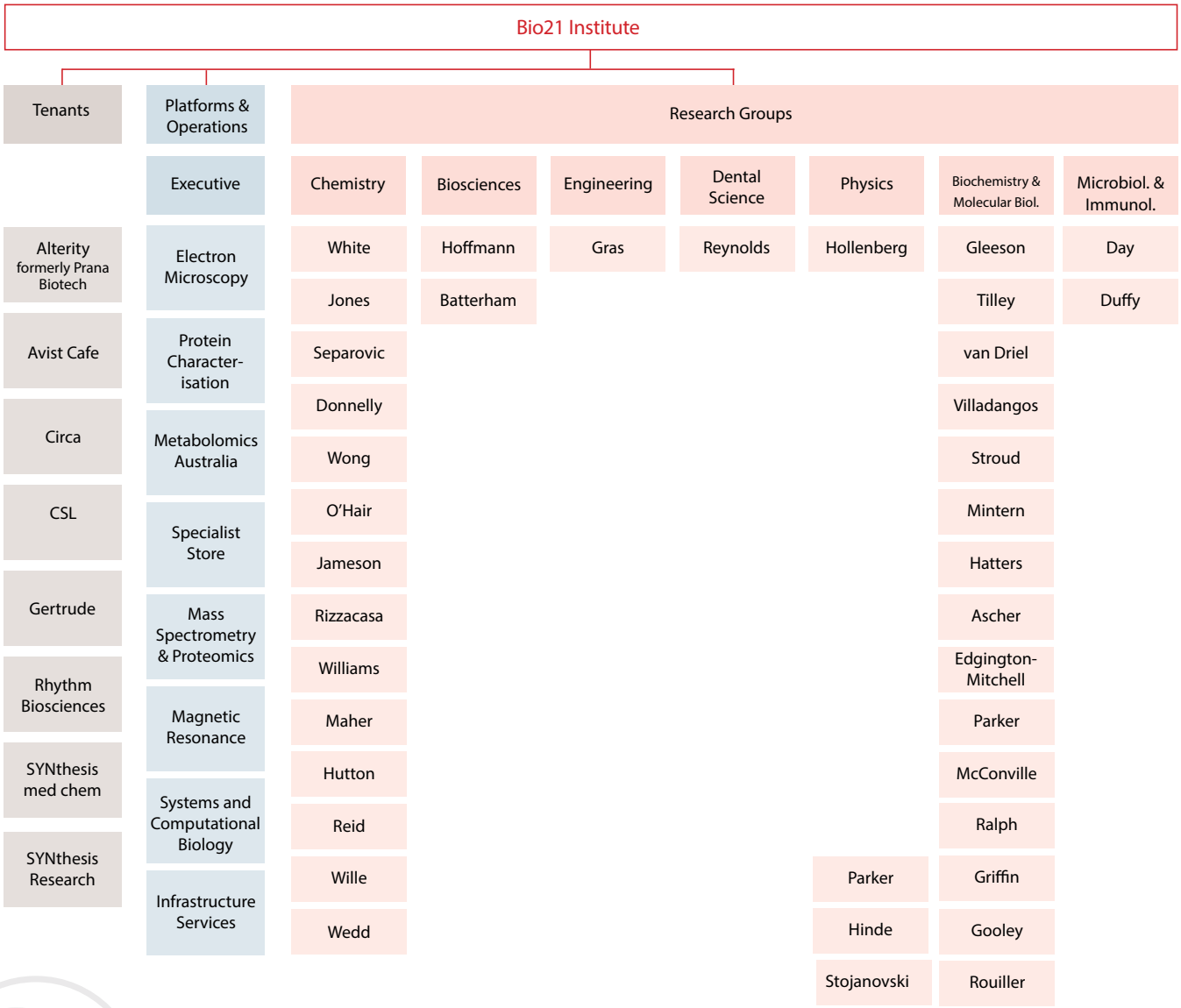
Governance


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

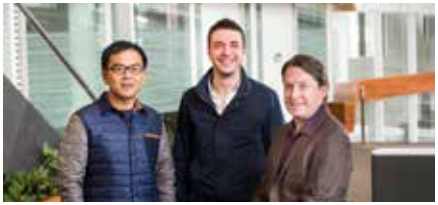
Bio21 Institute – Scientific Research Team



Bio21 Institute – Research groups

















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

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 Ary Hoffmann

School of Chemistry

Professor Paul Donnelly

Associate Professor Craig Hutton

Associate Professor Guy Jameson

Dr David Jones

Associate Professor Megan Maher

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

Professor Paul Gooley

Dr Michael Griffin

Professor Danny Hatters

Dr Elizabeth Hinde

Professor Malcolm McConville

Associate Professor Justine Mintern

Professor Michael Parker

Dr Douglas Pires

Associate Professor 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

Department of Microbiology and Immunology

Professor Karen Day

Dr Michael Duffy

Melbourne School of Engineering

Professor Sally Gras

2019 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 Aleks Owczarek

I hold the position of Professor in Mathematics and Statistics of the University of Melbourne and am currently in the role of Dean of the Faculty of Science. Previously, I was Head of School/ Department of Mathematics and Statistics between 2011-2016 and Deputy Dean between 2017-2018. I was also Director of the Melbourne Graduate School of Science/ Associate Dean (Graduate Program) between 2009 and 2016. I currently hold an Australian Research Council Discovery Program grant on the Interplay of Topology and Geometry in Polymeric Critical Phenomena and am a Fellow of the Australian Mathematical Society. I am on the Advisory Panel of senior referees for the Journal of Physics A: Mathematical and Theoretical. My area of expertise is mathematical statistical mechanics and, in particular, the area of phase transitions and critical phenomena of model polymer systems, namely lattice walk models, which lies within the discipline of mathematical physics. My work endeavours to uncover the universal geometric and topological features of long chain molecules, such as DNA, in a variety of generic conditions. The models I study arise naturally in "Discrete Mathematics and Combinatorics" and in "Stochastic Processes". I am part of a 'Mathematical Physics and Statistical Mechanics Group' working on these topics. I have several projects in the general area of the statistical mechanics of lattice polymer and vesicle models where there is scope for Master of Science and PhD projects, and some where post-doctoral collaboration would be fruitful. Please contact me if you are interested. The two main topics of interest are (1) numerical analysis, both Monte Carlo computer simulation and also exact enumeration techniques, of lattice walks, and (2) the exact solution of interacting directed walk systems. My School web profile is here, where information about past and present students and grant funding can be found.

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

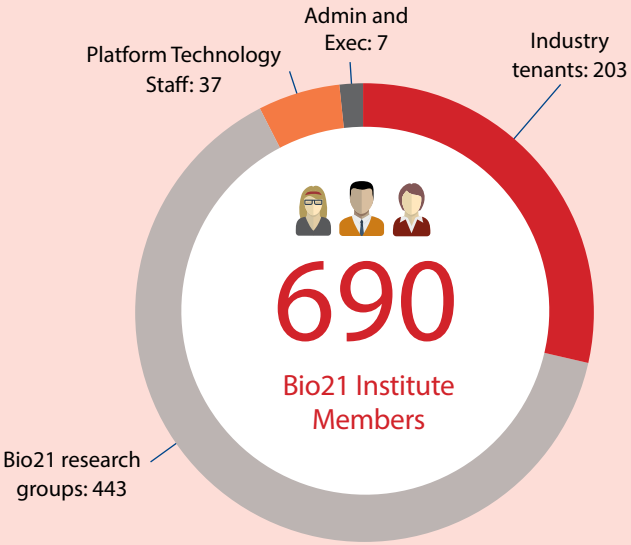
Professor Sandra Kentish is Head of the School of Chemical and Biomedical Engineering at The University of Melbourne. She is also an invited Professor at the Centre for Water, Earth and the Environment within the Institut National de la Recherche Scientifique (INRS) in Canada.

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

27 Research Theses submitted

311 Publications

Events

Internal Events:

External Events:

Visitors and Engagement

Visiting international government or academic delegations: 2

Visiting school or undergraduate student groups: 8 (346 students in total)

Bio21 public events (6 public lectures + Open House Melbourne Weekend): ~967

Facebook:

589 likes by the end of 2019

Twitter:

388,3K

impressions in 2019

Bio21 Institute Theses submitted in 2019

Biosciences

Lab: Ary Hoffmann and Umina

Student: Joshua Douglas

Predicting pest issues from common and curious pests of crop seedlings in south-eastern Australian

Chemistry

Lab: Craig Hutton

Student: Ashleigh Farnsworth
Radiolabelled peptides and amino acids for PET imaging of cancer

Student: Varsha Jagannath Thombare
New methods for the synthesis of biologically active cyclic peptides

Lab: Richard O'Hair

Student: Athanasios Zavras
Coinage metal hydrides: reactive intermediates in catalysis and significance to nanoparticle synthesis

Lab: Spencer Williams

Student: Palika Abayakoon
Development of a molecular description of the Embden-Meyerhof-Parnas sulfoglycolysis pathway

Lab: David Jones

Student: Calvin Jun Hao Lee
Morphological advancements through sidechain engineering for organic photovoltaic applications

Student: Saghar Masoomigodarzi
Designing New Singlet Fission Materials for High Performance Organic Solar Cells

Lab: David Jones and Wallace Wong

Student: Bolong Zhang
Donor-emitter fluorophore pairs in luminescent solar concentrators: from material synthesis to device fabrication

Student: Nicolau Saker Neto
Exponential iterative coupling for low dispersity conjugated polymers

Lab: Uta Wille

Student: Joses Nathanael
The oxidative damage of biological molecules by air pollutants NO2 and NO3

Lab: Wallace Wong

Student: Quentin Hong
Discotic compounds and columnar materials within organic photovoltaic material blends: synthesis and characterisation

Student: Can Gao
Organic chromophore aggregates for solid-state photon upconversion

Biochemistry and Molecular Biology

Lab: Gleeson

Student: Alessandra Webers
Neuroinflammation, microglia and the cell biology of Alzheimer's Disease

Lab: Paul Gooley

Student: Shoni Bruell
Mechanism of activation of the relaxin family peptide receptors RXFP1 and RXFP2

Student: Tasneem Vaid
Determination of ligand binding conformations at α1-adrenergic receptor subtypes based on NMR and MD studies

Student: Jingyu Zhan
Structural analysis of critical interactions in the replication machinery of rabies virus

Lab: Paul Gooley and Mike Griffin

Student: Fengjie Wu
Structure and conformational dynamics studies of α1A-adrenoceptor

Lab: Danny Hatters

Student: Xiaojing Sui
The impact of proteostasis imbalance on proteome solubility

Lab: Stuart Ralph

Student: Kit Kennedy
Delayed death by plastid inhibition in Plasmodium falciparum

Lab: Stuart Ralph and Michael Duffy

Student: Amy Distiller
Investigating the Epitranscriptome of Plasmodium falciparum

Lab: Leann Tilley

Student: Laure Dumont
Investigating the metabolic regulation capacity of the malaria parasite P. falciparum

Student: Tuo Yang
Investigation of the mechanisms of action of and resistance to artemisinin and other endoperoxide antimalarials

Student: Oliver Looker
Assembly of the Plasmodium falciparum virulence complex

Lab: Ian van Driel

Student: Victoria Scheiding
Immune defense mechanisms against Legionella longbeachae

Lab: Ian van Driel

Student: Victoria Scheiding
Immune defense mechanisms against Legionella longbeachae

Dental Science

Lab: Eric Reynolds and Neil O'Brien-Simpson

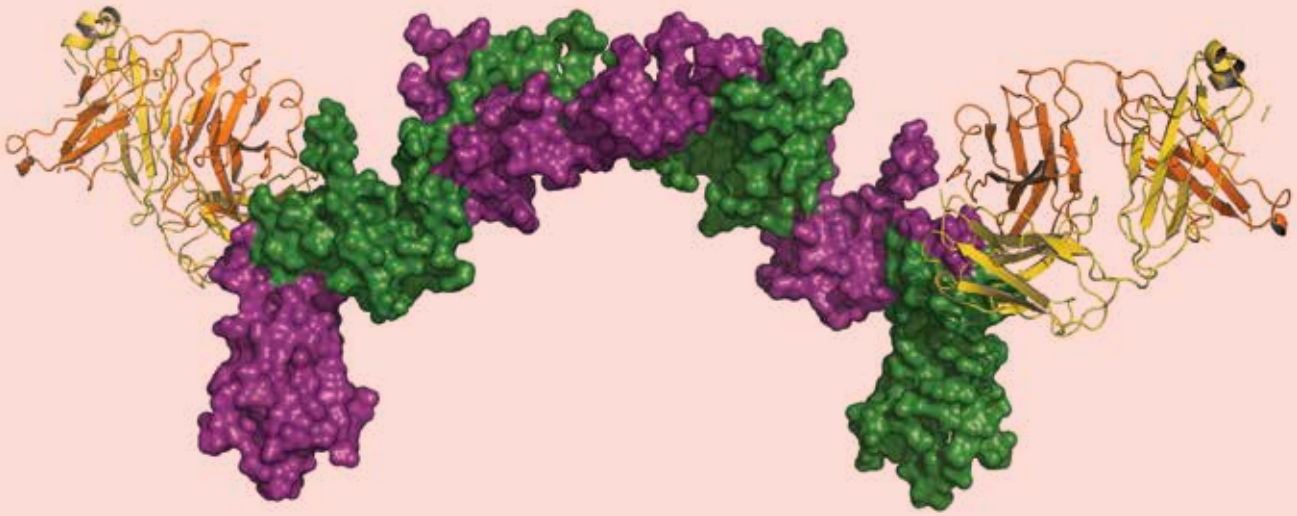
Student: Zhe Sun
The development of a biodegradable nano-particle vaccine delivery system

Lab: Eric Reynolds and Seers
Student: Abu Sayeed Mohammad Mahmud
Characterization of specific inhibitors of Porphyromonas gingivalis gingipains based on their cognate propeptides

Microbiology and Immunology

Lab: Karen Day, Michael Duffy and Kathryn Tiedje

Student: Charles Akugbey Narh
Evolution of drug-resistance genes in the

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University of Melbourne
30 Flemington Road, Parkville Victoria 3010

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