THE UNIVERSITY OF MELBOURNE

bio21 institute

Annual Report 2020

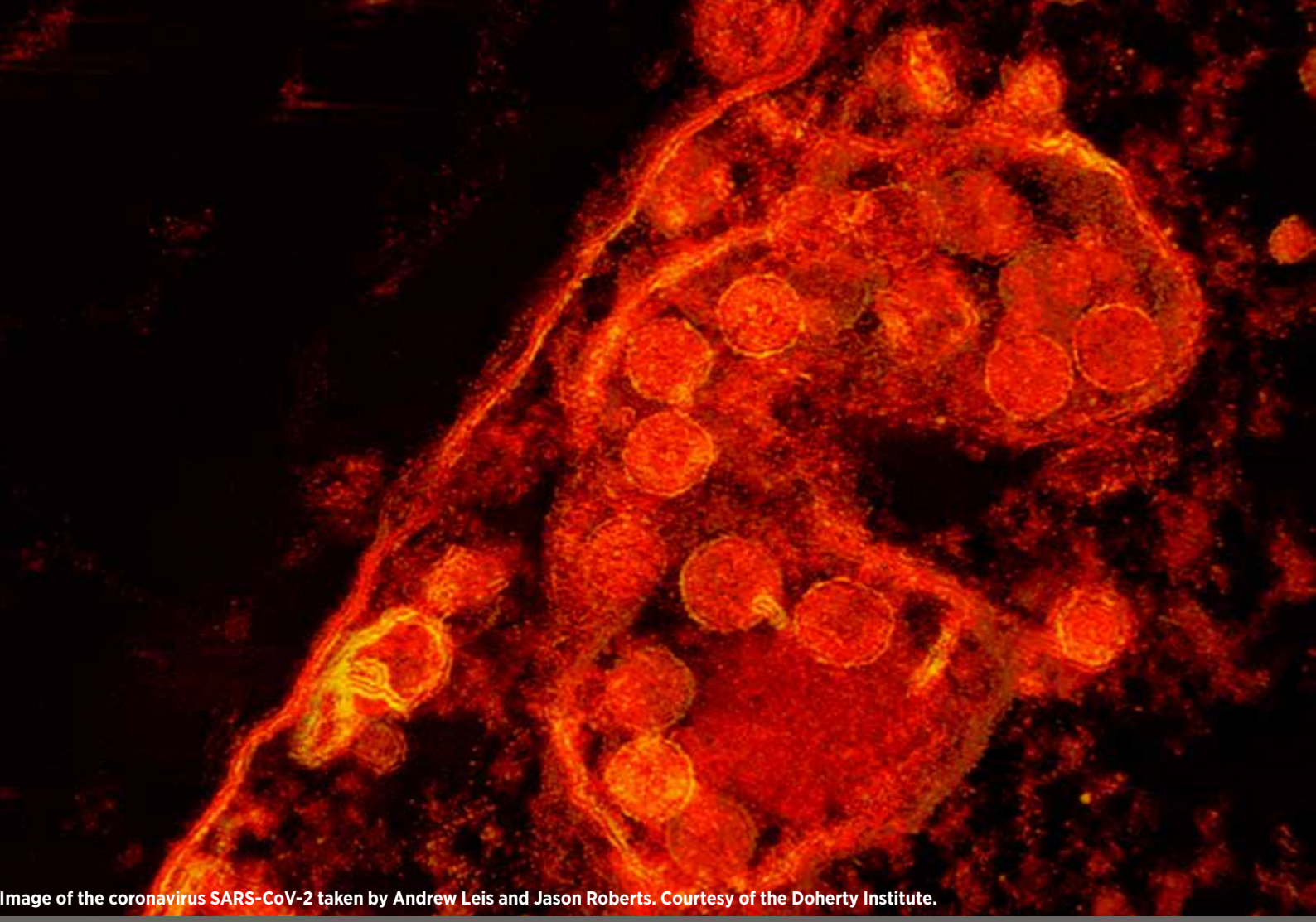

Image of the coronavirus SARS-CoV-2 taken by Andrew Leis and Jason Roberts. Courtesy of the Doherty Institute.

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Contents

Front cover image: Bio21 precinct aerial photograph, courtesy of Kane Jarrod Photography.

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, for example, the Elizabeth Blackburn Sciences

Ruth Bishop Building, courtesy of Kane Jarrod Photography.

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 ~ 800 research scientists, students and industry participants, the Bio21 Institute is one of the largest biotechnology research centres in Australia.

Bio21 Ruth Bishop Building front entrance, courtesy of Kane Jarrod Photography.

The University of Melbourne's Bio21 Molecular Science and Biotechnology 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.

Bio21's beautiful complex of architecturally designed and purpose-built buildings, including the Nancy Millis and Ruth Bishop buildings, house a diverse and active scientific community of ~800 research and professional staff members, students and industry scientists from a range of STEMM disciplines.

Over 40 academic research groups from the University of Melbourne's Faculty of Medicine, Dentistry and Health Sciences; Science and Faculty of Engineering and IT use molecular approaches to solve scientific problems.

Bio21 is a key research technology hub in the Melbourne Biomedical Precinct, with platform technology facilities that are equipped with powerful instruments that form a pipeline for early stage drug discovery: Melbourne Magnetic Resonance and Melbourne Protein Characterisation; Systems and Computational Biology; Mass Spectrometry and Proteomics and Metabolomics Australia in the Margaret Sheil Laboratories; and the Ian Holmes Imaging Centre.

Bio21 fosters industry-academic collaborations and supports the Victorian biotechnology industry including strategic partnerships with CSL, housing the CSL Global Hub for Translational Research as well as start-up industry groups Alterity Pharmaceuticals; Circa Group; Gertrude Biomedical; Rhythm Biosciences and SYNthesis med chem and Research in our incubator space.

Director's Message

Professor Michael Parker, Director of the Bio21 Institute

2020 was unprecedented.

In Victoria, 2019 had ended and 2020 started with bushfires. We stayed indoors to avoid the smoke that cast a dense brown fog over the city.

Now a new virus was spreading and on the 30 January the Director-General of the WHO declared the novel coronavirus outbreak a public health emergency of international concern, WHO's highest level of alarm.

How could something invisible to the naked eye, that is not even alive, spread across the globe, causing death, disease and economic disaster? And how would the pandemic impact research and higher education? This was not yet clear.

This virus; a molecular-infecting-machine, between 50 nm to 140 nm in diameter, that enters through our airways and infects cells bearing an ACE2 receptor, has struck the core of our humanity; our need to connect with each other. To defeat it, we had to isolate and physically distance ourselves, in the tried and true strategy of quarantine. The 111-day 'lockdown' Melbournians endured in the winter of 2020 has left its mark on us, but it showed us that if we work together we could eliminate the virus.

Quarantine, is a strategy that dates back to Florence in the 16th Century, employed to defeat the black plague, *Yersinia pestis*, when it was observed that the sickness entered the city with the travelling cloth merchants. City gates were locked and people confined to their homes. Clothes and personal items were burned, with the hope that the cleansing fire could contain the contagion. Before even understanding the source of the illness, or germ theory, they managed to contain the spread of the black plague, whilst other cities faired less well.

As we've experienced first-hand, quarantine is still the most effective way to stop the virus in its tracks. But conveying public health messages and enforcing a quarantine, that shuts down the social and economic activity of a city and state is not an easy thing to do and comes at a high economic, social and personal cost.

Since the 16th century our understanding of infectious disease and germs has advanced a great deal. The development of the light microscope from Antonie van Leeuwenhoek's first model (1632 to 1723) and their own experimental evidence allowed Robert Koch and Louis Pasteur in the 1850s to first see cells and 'germs', and to determine that they are the cause of disease, rather than black humours or foul vapours.

Capturing the coronavirus under the microscope: In 2020, Bio21's Eric Hanssen and Andrew Leis, in collaboration with the Doherty Institute's Jason Roberts, Julian Druce and Mike Catton, Director, Victorian Infectious Diseases Reference Laboratory (VIDRL), used Bio21's Transmission Electron Microscopes to obtain some of the first images of the isolated and cultured coronavirus.

These researchers follow in the footsteps of Ruth Bishop and Ian Holmes, a virologist at the Royal Children's Hospital and an electron microscopist at The University of Melbourne, who discovered the rotavirus in the stool samples of children with diarrhoea.

Ruth Bishop Building and Ian Holmes Imaging Centre completed: So, it is fitting that we should name our new building and microscopy facility in their honour. Despite all the disruptions of 2020, it is a joy and relief that Bio21's Ruth Bishop Building and Ian Holmes Imaging Centre was completed.

In the last months following its completion, Professor Eric Hanssen and his team have been busily moving, transporting, unpacking and assembling electron microscopes from the previous location of the Advanced Microscopy Facility in the Penington building and also new arrivals of microscopes that have been acquired through joint funding with Monash University, WEHI and CSL.

These cryo-EM instruments (aptly named Krios, Glacios and Arctica) make it possible to view snap-frozen biological samples. The resolution is phenomenal, reaching atomic

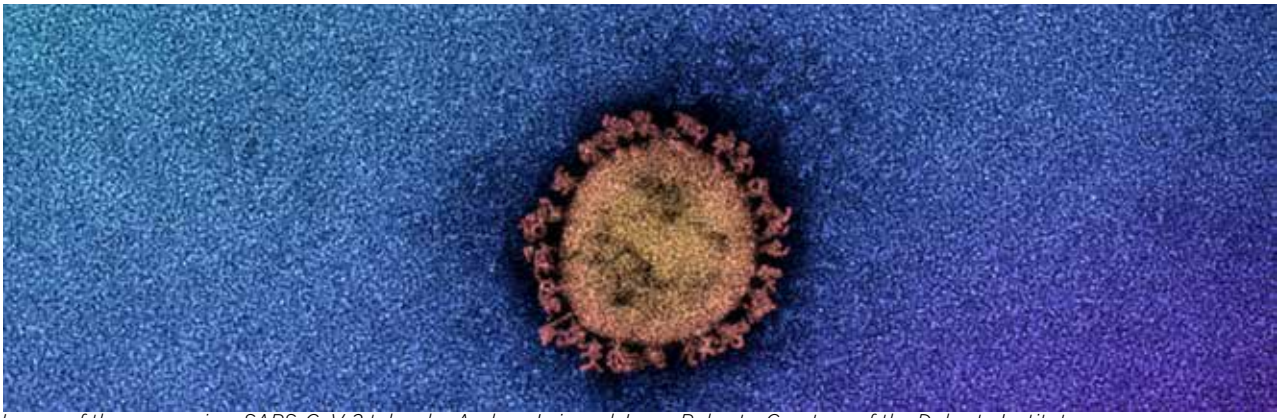


Image of the coronavirus SARS-CoV-2 taken by Andrew Leis and Jason Roberts. Courtesy of the Doherty Institute.

resolution.

It is wonderful that with the new building and centre, we have the capacity to house these powerful microscopes, that are a resource to researchers within Bio21, the University, Victorian biomedical research community and beyond.

Training the next generation of microscopists in cryoEM: Bio21's electron microscopes will be used as part of a $13 million ARC Industrial Transformation Training Centre (ITCC); the "ARC Training Centre for Cryo-Electron Microscopy of Membrane Proteins for Drug Discovery".

The new ARC Training Centre is being established in collaboration with Monash Institute of Pharmaceutical Sciences, Monash University, Bio21, University of Melbourne, University of Wollongong, WEHI and industry partners including SYNthesis spin-out Catalyst Therapeutics, Thermo Fisher Scientific, Biocurate, AstraZeneca, Pfizer, Genentech, Servier, Sanofi, Novo Nordisk and Dimerix Bioscience.

Bio21 will provide access to its cryoEM microscopes as a contribution to the ITTC centre. Eric Hanssen, who heads our Ian Holmes Imaging Centre, will also play a major role through his leadership of the platform.

Bio21's Isabelle Rouiller, Mike Griffin and I are among more than 20 investigators involved across the collaborating organisations, bringing combined expertise in structural biology, protein chemistry and structure-based drug design to the new centre.

Working together whilst apart: Whilst quarantine, lockdown and isolation is an effective first line of defence, it's bought us time to develop precise, targeted and effective vaccines.

Many researchers were not able to pursue their lab work, unless it was deemed an essential activity. Conferences and symposia were cancelled or moved online. So, whilst physically isolated, we turned to our technological tools to meet virtually and share data.

Like no time in history, scientists – across academic, industry and national boundaries - combined forces, shared data and insights online in a phenomenal effort to understand the virus in order to develop effective vaccines and drugs. This has been our secret weapon against the virus, allowing us to work together whilst apart.

Doing our bit for COVID-19 research:

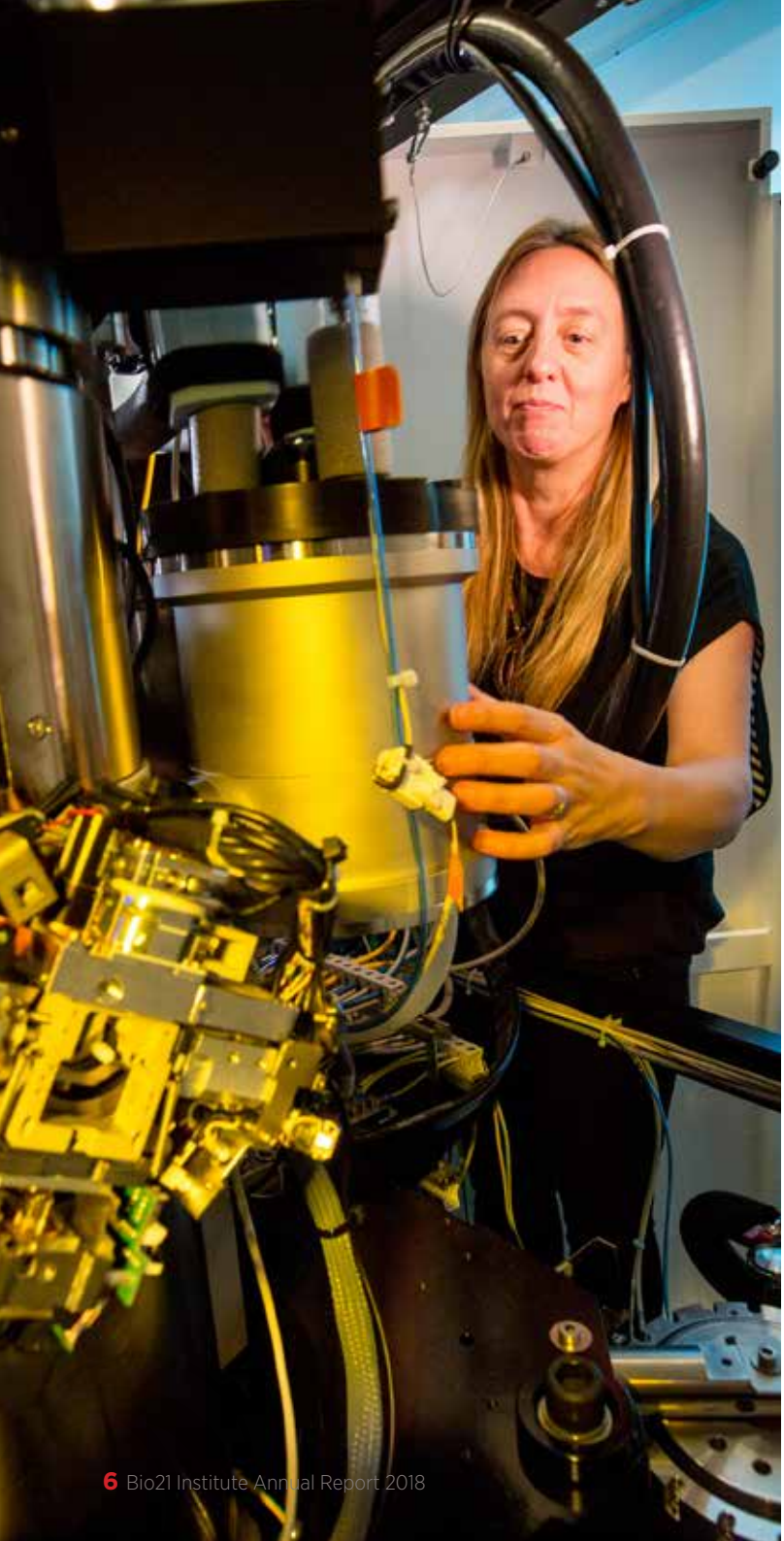
Perhaps some key dates can jog our memory at how rapidly information became available and was shared and vaccines developed:

•10 January, the SARS-CoV-2 virus genome was officially published and shared online by an Australian scientist, Eddie Holmes.

•29 January, The Doherty Institute was the first to grow the virus in cells in culture, which they also made available globally. And, first images of the virus outside of China were obtained on Bio21 TEM microscopes from Bio21's Andrew Leis working with the Doherty's (VIDRL) Jason Roberts.

•24 April, first atomic resolution structures published of SARS-CoV-2 proteins by cryoEM and X-ray crystallography [from the labs of Jason McLellan's in Texas, Rolf Hilgenfeld's at the University of Lübeck, and Zihe Rao's at Tsinghua University).

This data, shared globally formed the basis



upon which vaccine and drugs could be designed to combat the coronavirus.

In 12 months, we have seen over 200 vaccine candidates being tested, of which three are front runners to be rolled out globally. The Oxford/Astra Zeneca vaccine is being rolled out in Australia with help of Bio21 partner CSL. What an achievement!

As a scientific community that includes academic and industry members, as well as platform technology facilities run by expert teams, Bio21 researchers are in a unique position to make a valuable contribution during the coronavirus COVID-19 pandemic. As problem-solvers our work can provide hope and purpose.

Everything comes back to the structure! Determining the structure of the coronavirus is the first step for structure-based drug discovery. Our expertise in structural biology is key and Bio21 teams, including my own, are focussed on the task. **Craig Morton, together with Tracy Nero,** has literally millions of structures of compounds in a vast library that he has collated from publicly available and commercial sources, as well as through collaborators, to start to virtual screen for a 'good fit' with the coronavirus protein structures. In particular, it is the proteins the virus needs to infect cells, replicate itself, or to complete its lifecycle, that could be targeted for drug design.

Software tool with all viral structures of 'COVID-3D': **Associate Professor David Ascher** and his team at the Bio21 and the Baker Heart and Diabetes Institute have developed a software tool and library, dubbed COVID-3D. Published in Nature Genetics, COVID-3D contains information about all the protein structures that encoded in the SARS-CoV-2 (COVID-19) genome, including every known genetic mutation and its resultant mutant protein structure.

Drugs to stop viral replication: Bio21's **Professor Spencer Williams** and Professor Gideon Davies from the University of York in the UK, along with colleagues from the Universities of Warwick and Oxford, may have found a way to derail viral replication that could in turn become a broad spectrum anti-viral drug target by inhibiting a key enzyme called 'MANEA'.

Anti-inflammatory drug development: My own **Parker group, together with the Professor Karlheinz Peter,** cardiologist

and Deputy Director at the Baker Institute received a $200,000 boost in 2020, thanks to seed funding from the new Baker Department of Cardiometabolic Health at the University of Melbourne's medical school. This allows work to begin testing a novel drug class targeting the 'C-reactive protein', the best marker of acute inflammation in the body. A new anti-inflammatory drug could lessen the damage from heart attacks, extend the viability of transplanted organs, help treat autoimmune diseases such as multiple sclerosis, and even reduce fatal complications from viruses like COVID-19.

These are just a few examples of how Bio21 is doing its bit to combat COVID-19. And our industry tenants are contributing with Circa, SYNthesis and CSL offering expertise and reagents.

Although COVID-19 dominates our consciousness, Bio21's research has continued in other areas and we were very fortunate to see our researchers and their research continue to be funded into the future.

Research funded for the future: **ARC LIEF grants:** In 2020, Bio21 received a total of $2, 791, 874 directly to the Institute in ARC LIEF grants, with **Liz Hinde and Paul Gleeson** among others received a grant to establish a fluorescence lifetime imaging microscope that can track the intracellular journey of a proteins throughout the entire structural framework of a living cell; **Paul Gooley, Megan Maher and Mike Griffin** among others for urgently required upgrades in our Melbourne Magnetic Resonance facility. This funding will introduce new capabilities to the Australian NMR community to characterise important biological molecular interactions at low concentrations; **Spencer Williams, together with Frances Separovic, Craig Hutton and Paul Donnelly**, among others received a grant to establish a multi-institutional NMR platform across two of Victoria's leading research universities; my own LIEF grant came through together with **Isabelle Rouiller, Megan Maher and Nick Williamson,** among others, to acquire a fully automated and integrated hydrogen-deuterium exchange mass spectrometry system, a powerful tool for analysing the motion of proteins and their interactions with other molecules and **Eric Hanssen and Isabelle Rouiller** among others were on a grant with the University of Wollongong for a Gatan K3 high throughput camera system, that will allow them to visualise proteins and other subcellular components at high resolution.

ARC Discovery and Linkage grants: Bio21 members who received ARC Discovery grants for 2020 to pursue their research were:

Spencer Williams, to dissect a major sulfur cycling pathway; and to seek to understand how the immune system recognises microbial metabolites; **Elizabeth Hinde**, how chromatin structure is maintained; **Paul Gooley**, to uncover how proteins carry out multiple functions; **Marc Sani,** controlling the behaviour of nanoparticles in live cells by nanoscopy; **Ary Hoffman** is a recipient of a ARC Linkage Grant with Melbourne Water to improve stream management using ecological modelling and DNA barcodes.

NHMRC Ideas, Development and Investigator grants: Bio21 researchers **Isabelle Rouiller, Justine Mintern, Hamish McWilliam, Kristin Brown and Spencer Williams** received NHMRC Ideas grants, to seek to understand mechanisms that govern our body's immune system responses, our pain systems involved in cancer and repurposing drugs to treat Covid-19.

Bio21 researchers **Eric Reynolds** and his team, who have received $1,107,069 in a Development Grant to repair tooth enamel/ dentine by biomimetic mineralisation.

Paul Gooley and his team, were funded with $784,064 under the Targeted Calls for Research to exploring the role of nitrogen metabolism, energy metabolism and mitochondrial function in the pathophysiological mechanisms of paediatric ME/CFS.

Debnath Ghosal received $645, 205 in an Investigator Grant to understand how pathogens use their cytoskeleton to invade host cells.

Eric Reynolds received a $1, 900, 000 Investigator Grant (Leadership 3) to understand the bacterial type IX secretion system in polymicrobial dysbiosis and chronic inflammation.

I have also received $2, 231, 372 in an Investigator Grant (Leadership 3) to understand cell signalling as a basis for new therapeutics.

As we have all struggled to continue our research and, in some cases 'pivot' to COVID-19 research, it is good to see national recognition of the importance of scientific research through ARC, NHMRC and the university research block grant system. I encourage you to read about how our academic and industry researchers continue their research; by using molecular science approaches to improve human health and the environment.

However, I must say thank goodness 2020 is now behind us!

Bio21 Leadership - Deputy Director's Message

Professor Emeritus Frances Separovic AO

When I look at this screen shot of the new council of the Biophysical Society convening for the first time in February 2021, it makes me feel proud. I'm firstly honoured to have been elected President of the Society, but I also feel immense joy at the diversity of the group.

Of the 25 faces looking at me, there are 19 women and 6 men who clearly come from a diversity of backgrounds. It makes me feel like we've made some progress. In the words of Mahatma Gandhi, "Our ability to reach unity in diversity will be the beauty and the test of our civilization".

Universities have come to understand the value of 'diversity', but for much of my career, I was the only woman in the room. So, it is truly amazing to see so many women taking their place within this traditionally male-dominated professional society, bringing their enthusiasm, ideas and commitment to the table.

The image is a typical image that illustrates how work changed in 2020: we all learnt to connect and communicate with our colleagues via our screens using Zoom/ GoToMeeting/ Teams/Webex/Google Meet.

Whilst I am hopeful, however, COVID-19 has threatened some of the gains made by women in science.

It is sad to see, for instance, that in the area of COVID-19 research, female authors have accounted for only one-third of all authors on published COVID-19 papers since January 2020. [Pinho-Gomes et al. (2020) Where are the women? Gender inequalities in COVID-19 research authorship. BMJ Glob. Health 5:e002922 https://gh.bmj.com/content/5/7/e002922.]

What was difficult before the pandemic, became insurmountable for some during 2020. A glimpse through the Zoom 'windows' into people's homes and lives may provide a hint of why that might be. In 2020 working from home (WFH) blurred the line between home, work and even school, with children (and pets) demanding our attention and the washing and dishes, beckoning from the next room. This is backed up with statistics, with women purporting a sharp rise in household work https://ec.europa.eu/commission/presscorner/detail/en/ip_21_1011 .

As Deputy Director of the Bio21 Institute, University of Melbourne, and holding other positions, such as the President of the Biophysical Society, Council member of the Australian Academy of Science and IUPAB and titular member of IUPAC, I seek to use my influence to support better outcomes for women in science.

One barrier for women is a dearth of role models: "If you don't see it, you can't be it!" So I am pleased to see that as the Bio21 Institute grew in 2020 with new buildings and facilities, we continued to name them in honour of women: The Elizabeth Blackburn Science School, the Nancy Millis Building housing the Margaret Sheil Laboratories, and now the Ruth Bishop building.

The Zoom image also reminds me that, as some of us can return in 2021 to the Institute's labs and offices, others continue to work from home or find themselves overseas in lockdown.

Grounded... Since 2020 my former globe-trotting lifestyle dramatically ground to a halt. From mid-March 2020, work-related travel was no longer permitted by the University and most other organisations. There were no in-person conferences or international meetings: I did not attend the Commonwealth Chemistry Congress in Trinidad & Tobago, a conference in Manchester nor the IUPAB meeting scheduled in Brazil.

But I was able to participate in the International Science Council meeting of the Regional Office for Asia Pacific, council meetings of the Australian Academy of Science and the Biophysical Society via Zoom.

Out of necessity, we learnt to meet virtually or online and may do so for some time to come. This development can benefit people with caring responsibilities, primarily women, who may not otherwise be able to attend such events.

Contributing to science from home...

For many of us it was frustrating that our research in effect stopped, as it was not considered 'essential' or COVID-19 related. However, scientists continued to work

Professor Frances Separovic @FrancesBiophys @BiophysicalSoc Council met virtually today prior to #bps2021. Old and new council meet normally just prior to the start of the annual meeting, which starts this week with the subgroup symposia. #biophysics #TeamHB4

together, even whilst physically distanced. Although my own research is not related to the coronavirus, through society memberships I was able to make a small contribution to the societal and global discussions about how best to tackle this challenge we all face. As President-Elect of the Biophysical Society, I was involved in writing a letter to Congress about the need to support science in the fight against COVID-19. Also, I strongly supported the actions of the Australian Academy of Science, which has urged the Australian Government to be transparent about the data that underpins the decisions being made and path taken in relation to the coronavirus crisis in Australia.

A year for writing: So, despite being 'grounded' 2020 ended up being a productive year after all. Apart from the many online events I attended, I read a great deal of scientific literature. In 2020 I allowed myself more time to read and think about what was reading. I submitted several papers and, together with Marc-Antoine Sani, edited a book on NMR. This meant that I communicated with colleagues around the world, which helped to make me feel connected.

As the vaccines are rolled out in Australia, it becomes possible to once again to imagine a future in which we can travel overseas. Meanwhile, I am planning to see more of Oz in 2021.

One of the trips I remember most vividly and fondly were my 2019 trip to Antarctica as part of Homeward Bound (https://homewardboundprojects.com.au.) This experience sustained me through the pandemic as I now part of a fabulous cohort of women scientists who support each other to rise to become leaders in their field. This network, which is very active on social media – Twitter and LinkedIn - is invaluable and I believe, that as women, we do need to support each other.

We were all asked to make sacrifices in 2020 to contain the spread of coronavirus within our community to save lives. I am reminded of Henry V's speech before the battle of Agincourt, that we are all called to solidarity and heroism at this time but also the need to adapt. To quote Charles Darwin, "It is the long history of humankind (and animal kind, too) that those who learned to collaborate and improvise most effectively have prevailed".

Distinguished Professor Emeritus Frances Separovic AO

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

Communications during a Coronavirus Pandemic.

Following the directives of the Victorian State Government and when coronavirus cases in Victoria reached 429 new cases on the 23 March 2020, the University and Bio21 transitioned to a virtual campus on midnight, 24 March 2020. All 'priority' research continued but otherwise teaching, learning and research moved online, as we shifted to working from home.

From that moment everything changed.

Communication tools and channels played an important role, assisting us to adjust to the new situation and enabling us to continue to teach, research and engage with our group members, our Bio21 community and our academic collaborators, industry and government stakeholders and broader society.

With in-person communications no longer possible much of work life in 2020 took place through screens.

Through these windows we conducted lectures, seminars and workshops. We held team meetings, rearranged our research programs, planned experiments, reviewed the literature and explored computational tools. We also hosted social gatherings and engaged with the broader community including school groups.

Necessity led to new modes of communication. The world changed dramatically in a matter of days and weeks.

Internal Communications via email and the Bio21 intranet kept Bio21 community members informed about the operational changes in the building.

The internal fortnightly Digest newsletter including Director's messages and blogs served to keep Bio21 community members informed and connected.

From January to March, Bio21 was still able to host some in-person events. Bio21 research groups hosted AMGEN Scholars in their labs and an AMGEN Scholar Symposium took place on 21 February to showcase their work.

Bio21 PhD student Emily Selig organised a Bio21 Members Park Run to raise money for the Victorian Bushfire Relief that took place on the 4th February, starting at Royal Park, Flemington Road, near the North Park Tennis Park.

Bio21 hosted a first and last internal morning tea on 26 February, where new groups were welcomed whilst enjoying barista brewed Avist café coffee. We hosted an external event for the launch of Oxford Pharmagenesis on the 27 February and our last in-person gathering would be the International Women's Day event, 11 March.

From then on events 'pivoted' online. Whilst 'Big Picture' Seminars and Morning Teas were not possible, The Departmental Seminars from the Department of Biochemistry and Molecular Biology, as well as the School of Chemistry all took place online.

Bio21 hosted its '101' lecture series as a Zoom webinar in two parts (Part 1: 24 August – 9 December and Part 2: from 6 – 13 November) where attendees heard from

Amgen Scholars Research Symposium

our platform facility managers and team members:

- **Spectrometry & Proteomics Facility's** Nick Williamson, Shuai Nie Mass and Katie Ganio;
- **Melbourne Protein Characterisation's** Yee-Foong Mok and Troy Attard;
- **Advanced Microscopy Facility's** Eric Hanssen and Andrew Leis.
- **Melbourne Magnetic Resonance's** Shenggen Yao and Marc-Antoine Sani;
- **Systems and Computational Biology's** David Ascher; and
- the **Metabolomics Australia** team.

This was a popular workshop series attended by 456 researchers from academia and industry.

University High School's Year 9 students hearing from Dr David Jones on solar cells and PhD student Janice Mui as part of their Galileo program.

Our nearest neighbour, the Elizabeth Blackburn Sciences, an exemplar for delivering STEM remote learning, even supplied microscopes to their students to be able to use at home.

Chris Jones, Deputy Principal at University High and responsible for Elizabeth Blackburn Sciences explains: "Liam (Head of Science) and Alex (Inquiry Learning) have been working above and beyond to shift staff to the online environment, and I believe we are now exemplars of the work schools are completing."

Whilst events and engagement activities decreased during this period, media engagement, Pursuit, media releases and associated social media continued and, in some cases, increased. Our researchers engaged the media on topics relating to their research, including bushfires and coronavirus.

For example: Ary Hoffmann's Pursuit piece: "How do we protect our unique biodiversity from megafires?"; Stuart Ralph and Craig Morton's explainer: "Q&A: How could COVID-19 drugs work and what's out there?" and Troy Attard's interview with Andi Horvath for the University of Melbourne's podcast series 'Eavesdrop on Experts': "The tiny world of peptides." Whilst we have shown how flexible and adaptable we are, it is refreshing to be resuming in-person meetings and to have more people returning to our scientific 'home base' at the Institute. The past year has taught us to value the Institute and the critical role personal communication plays both within the Institute and more generally within research.















Associate Director Commercialisation – Professor Spencer Williams

2020: A Year to Remember

The last year is one that will live long in the memory of many of us. The emergence and rapid spread of a highly transmissible novel coronavirus within an immune naïve population wrought havoc globally, leading to us with little option but to adopt a powerful non-pharmaceutical intervention – global and local lockdowns, to reduce spread and the effects of COVID-19 disease. The year ended on a hopeful note as breakthrough mRNA and adenovirus vaccines emerged with unexpected efficacy, promising that the global pandemic may abate and life return to more normal times. Remarkably, despite the interruption to our social interactions through physical distancing, border closures and international travel, Australian economic activity remained surprisingly robust, and in the commercial sector investment in R&D continued. After all, research is a bet on the future, and life must go on. So, it is wonderful to see our Bio21 industry members make progress in developing their products to market, as well as initiatives receiving significant support to create manufacturing infrastructure for the translation of research to the clinic.

Highlights from Bio21 Industry tenants:

Long-term Bio21 Tenant Circa Group announced the next phase in industrialization of their key bio-based platform chemicals, levoglucosenone and Cyrene, with support from the European Union ReSolute project. With current pilot production of 1,000 kg per month in Tasmania, the ReSolute project will commission a plant capable of producing 1000 tonnes per year of these unique green solvents, helping the EU achieve its climate, energy and circular economy goals

Rhythm Biosciences announced the advancement of its clinical trial of coloSTAT, a low-cost screening kit for colorectal cancer. Despite significant COVID related interruptions, the number of trial sites were expanded, and its IP position strengthened with a patent granted in China, and a trademark granted in the USA.

SYNthesis med chem sold its 100% equity interest in its subsidiary, SYNthesis med chem (Hong Kong) Limited to Shanghai-based Viva Biotech for deal estimated at US$80 million. The acquired business is a contract research organisation (CRO) carrying out research and development of new preclinical small molecule drugs with operations in China, Australia, UK and US, and will become a wholly owned subsidiary of Viva.

CSL, Australia's largest Biotechnology company with its Global Hub for Research and Translational Medicine based at Bio21, has taken a leading role in the development and manufacturing of COVID vaccines. A commercial partner in the 'molecular clamp' vaccine developed at the University of Queensland, which advanced to a Phase 1 clinical study, and is undertaking local manufacturing in Melbourne of the Astra-Zeneca ChAdOx1 vaccine to support vaccination of the Australian community.

Translation of Bio21 research:

Funding of AU$2.5 million will kickstart a two-year manufacturing research project to advance local manufacturing of novel anticancer drugs. The funding includes $500k from the Innovative Manufacturing Cooperative Research Centre (IMCRC) and $1 million from Telix Pharmaceuticals and Cyclotek and will harness the combined expertise of the Prof Paul Donnelly in the School of Chemistry and Bio21 Institute and the Peter MacCallum Cancer Centre to increase the shelf-life of radiation drugs, so they can be shipped to patients globally.

The University of Melbourne, together

with First Biotech, established a new start-up company, Tianli Biotech. Tianli Biotech will support discovery and development programs to be led by Professors Alastair Stewart (Pharmacology) and Spencer Williams (Chemistry and Bio21 Institute) to develop a suite of new compounds for the treatment of respiratory and fibrotic disorders.

Recognition of Industry member, Enterprise Professor Andrew Wilks:

Prof Andrew Wilks was elected as a Fellow to the Australian Academy of Health and Medical Sciences. Andrew is a cancer researcher turned biotech entrepreneur. He has founded 10 companies, including Cytopia where he co-invented the drug Momelotinib, as well as the SYNthesis group of companies, headquartered at Bio21, where he serves as CEO. Congratulations Andrew!

Associate Director Platform Infrastructure – Professor Malcolm McConville

The Bio21 Institute supports six major technology platforms that are used by researchers from across the campus and Parkville precinct. These platforms allow analysis of biological systems in unprecedented detail, from single molecules to whole organisms. They include:

1. **The Mass Spectrometry and Proteomics Facility (MSPF)** and the University of Melbourne node of the **Metabolomics Australia (MA) facility** are co-located in the Margaret Shiel Laboratories, Nancy Millis Building. These facilities house a total of 30 mass spectrometers, including high resolution mass spectrometry instruments with capabilities in analysis of intact proteins, peptides, lipids, metabolites and metals, as well as tissue imaging.

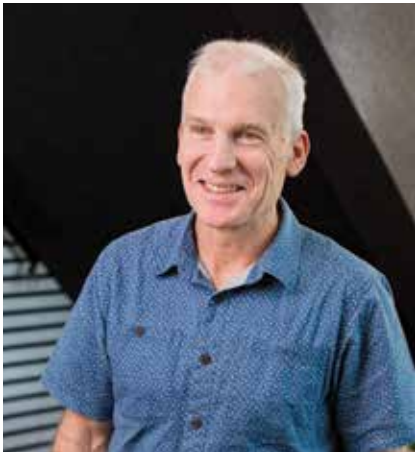
2. **The Ian Holmes Imaging Centre (IHIC)** for advanced electron microscopy is located in the new purpose-built Ruth Bishop Building. The facility houses 10 transmission and scanning electron microscopes including the new flagship Titan Krios microscope, the most advanced platform for single particle protein structural studies and cryotomography.

3. **The Melbourne Magnetic Resonance facility** is located in the 'cave' in the David Penington Building. It houses 8 NMR spectrometers, including the flagship 800 MHz Bruker instrument, as well as new Mössbauer and EPR spectrometers.

4. **The Melbourne Protein Characterisation facility** in the David Penington Building supports an array of state-of-the-art instrument for studying protein-protein interactions, solution properties and X-ray crystallography.

5. **The Systems and Computational Biology centre** in the Nancy Millis and Penington Buildings supports a high-performance computer cluster for analysing "big" data generated by our other platforms.

Each of the platforms are housed in state-of-the art laboratories and supported



by funding from the Bio21 Institute, the Deputy Vice Chancellor Research (DVCR) (including the Collaborative Research Infrastructure Program) 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.

The platforms are also 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.

Despite the challenges of accessing the platforms during 2020, new investment in the platforms exceeded $15 million, supported by funding from the Australian Cancer Research Foundation (ACRF), Mito Foundation, NCRIS and ARC LIEF equipment grants. Some major developments are summarized below:

Key developments in 2020:

The Advanced Microscopy Facility was moved to the new Ruth Bishop Building in early 2020 and rebadged the Ian Holmes Imaging Centre (IHIC). The Ruth Bishop Building is architecturally striking and retains the façade of the former Veterinary Research Institute, originally built in 1909. It was designed to accommodate the exacting requirements of the new instruments and represents a world class facility for cryo-electron microscopy. The new IHIC accommodates four new EM systems, including the new Titan Krios cryo-EM microscope and Aquilos cryo-FIB. This initiative was strongly supported by neighbouring institutions, such as WEHI and the Monash Institute of Pharmaceutical Science, as well as anchor industry tenant, CSL. The area around the Ruth Bishop building has been landscaped to provide a new amenity (including BBQ) for all members of the institute.

The IHIC received further support through the involvement of several Bio21 researchers, including A/Prof Isabelle Rouiller (Deputy Director of the ITTC and UoM node leader), A/Prof Mike Griffin and Prof Michael Parker in a new ARC Industrial Transformation Training Centre (ITCC) for Cryo-Electron Microscopy of Membrane Protein for Drug Discovery. The new ITTC centre, led by researchers from Monash Institute of Pharmaceutical Science, will utilise the CryoEM microscopes in the IHIC and build critical capability across the precinct.

The MSPF and MA facilities also received additional funding for major up-grades of their flagship mass spectrometry platforms. New installations in MSPF included the next generation ThermoFisher Orbitrap instrument, the new Orbitrap Exploris 480, as well as the new Bruker TimsTOF ion mobility instrument, adding capability in proteomic and lipidomic analyses, respectively. Similarly, MA upgraded their flagship instrument platforms with the installation of two new IDX Orbitrap instruments, the next generation of ThermoFisher's metabolomics platform, and two new Shimadzu GC-MS triple quadrupole instruments for metabolite profiling. Collectively, these acquisitions represent a step jump in capability and capacity in both facilities.

Bio21 researchers were highly successful in the Australian Research Council Linkage, Infrastructure, Equipment and Facilities (ARC LIEF) scheme, with five applications being awarded $2.8M collectively. These were:

• Liz Hinde, Paul Gleeson and colleagues received funding to establish a fluorescence lifetime imaging microscope that can be used to track protein-protein interactions and movement within living cells

• Paul Gooley, Megan Maher, Mike Griffin and colleagues received funding for the timely upgrade the flagship 800 MHz NMR spectrometer and a new NMR instrument which will be located in Melbourne Biomolecular Nuclear Magnetic Resonance (NMR) facility. This instrument will introduce new capabilities to the Australian NMR community enabling the characterisation of important biological molecular interactions at low concentrations.

• Spencer Williams, Frances Separovic, Craig Hutton, Paul Donnelly, and colleagues were also successful in obtaining funding for a multi-institutional NMR platform that would be shared with MIPS.

• Michael Parker, Isabelle Rouiller, Megan Maher and Nick Williamson and colleagues were awarded funds for a fully integrated hydrogen-deuterium exchange system, which can be used to study protein dynamics and interactions with other molecules, complementing capability in the MSPF, CryoEM and NMR facilities.

• Finally, Eric Hanssen and Isabelle Rouiller were part of a consortium led by researchers at the University of Wollongong to purchase a new Gatan K3 high throughput camera system for cryo-EM protein structure determination.

Additional funding initiatives have supported other major upgrades to the platforms. In particular, funding from the Australian Cancer Research Foundation (ACRF), together with ARC LIEF funding will support the purchase of a new 19F 500 MHz NMR spectrometer in 2021.

These initiatives represent a virtuous cycle – by ensuring that these platforms maintain state-of-the art capabilities and technologies, these funding initiatives allow researchers to undertake world-leading research, which in turn leads to success in competitive funding schemes. More broadly, they are part of a strategic plan to develop a comprehensive drug discovery pipeline (from protein target to lead compounds) within the Institute, facilitating the translation of basic discoveries in the life science to the clinic or market. This initiative has attracted substantial interest and investment from other precinct and industry partners, such CSL.

Virtual screening tools driving cancer drug discovery in Bio21's ACRF Facility for Innovative Cancer Drug Discovery

Bio21 was awarded an ACRF grant in 2018 to establish the ACRF Facility for Innovative Cancer Drug Discovery.

Significant progress was made towards establishing the ACRF Facility over 2020, despite limited access brought about by the Victorian Government COVID-19 restrictions.

Software programs and instruments were acquired and installed that support projects with virtual (computational) screening and protein-based assays for cancer drug discovery.

The agreement between ACRF and Bio21 Institute was signed off on 21 May 2019. The following items were acquired for the facility in 2020:

- **NMR spectrometer with 19-F probe – this item was purchased in September 2020 and was being installed in April 2021.**
- **Fragment compound library – this item was purchased in August 2020.**

We expect the ACRF Facility will be completed by mid-year 2021 and the official opening will be scheduled in sometime in late 2021 - early 2022.

Throughout 2020 a number of cancer projects were supported through the ACRF facility at Bio21, for example:

Chronic lymphocytic leukaemia and other B-cell malignancies including B-cell non-Hodgkin's lymphoma, Hodgkin's lymphoma, multiple myeloma; non-small cell lung cancer and ovarian cancer – TACI and BAFF (collaboration with Prof Fabienne Mackay, QIMR):

TACI is a receptor on 'B cells', immune cells of our body that produce antibodies against pathogen invaders. When TACI is bound by a molecule called BAFF, it activates B cells and contributes to the progression of B cell cancers in a number of ways. To prevent BAFF binding to TACI, researchers are looking for an inhibitor. But which inhibitor? Virtual screening software makes it possible to scan through libraries of small molecule structures from open source databases. One hundred putative inhibitors of TACI were identified by virtual screening and purchased in 2020. This initial scanning approach, helps researchers to narrow down the search for molecules, that they can then test further. To find the best binders, researchers use direct protein binding assays. The most promising binders will be further developed by medicinal chemistry.

Another project is looking at:

Triple negative breast cancer, colon cancer, lung cancer, pancreatic cancer, liver cancer, prostate cancer and ovarian cancer – PKCdelta (collaboration with Prof Yeesim Khew-Goodall, CCB, Adelaide)

Triple negative breast cancer (TNBC) is the most aggressive form of breast cancer; it is more likely to recur and metastasise than the other forms and due to a lack of targeted therapy, when standard of care chemotherapy fails, the average survival period for this patient cohort is ~12 months. It's been difficult for researchers to develop targeted therapies because of a lack of reliable biomarkers to predict chemoresistance that can be paired with a therapeutic target(s), as well as the many forms these cancer cells can take.

However, researchers have observed that an enzyme called PKCδ in ~25% of these cancer cells is more highly activated than in other cells, due to a specific phosphorylation event. These cells have been shown to persist and seed drug-resistant cancer cells. By preventing the phosphorylation of PKCδ, they hope to prevent resistant cells from developing.

Using virtual screening, the researchers identified 200 small molecular weight compounds that can potentially bind to PKCδ and prevent phosphorylation.

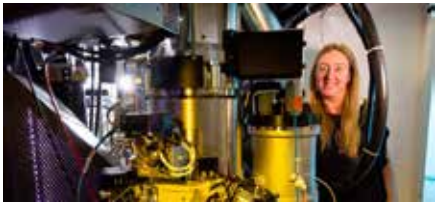
These are just a few examples where ACRF funding has allowed us to pursue drug discovery projects for cancers that are hard to treat. The strategy relies on identifying an Achille's heal of the cancer; a receptor or other protein that plays an important role in its metabolism or progression. Inhibiting this protein slows or shuts down the cancer completely. Virtual screening tools make it possible to speed up the discovery of drugs, quickly narrowing down the range of candidates for further analysis using protein binding and cell assays.

In this age of personalised medicine, these are powerful tools that allow us to pinpoint a specific Achille's heal of an array of different cancers that affect us. In this way, we may not find the cure for cancer, but many cures for many cancers.

Image above: Fragment Compound Library purchased for ACRF Facility for Innovative Cancer Drug Discovery .









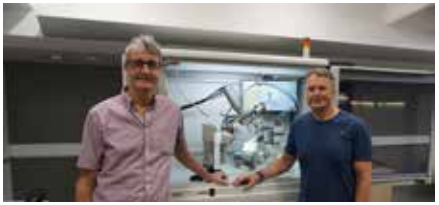
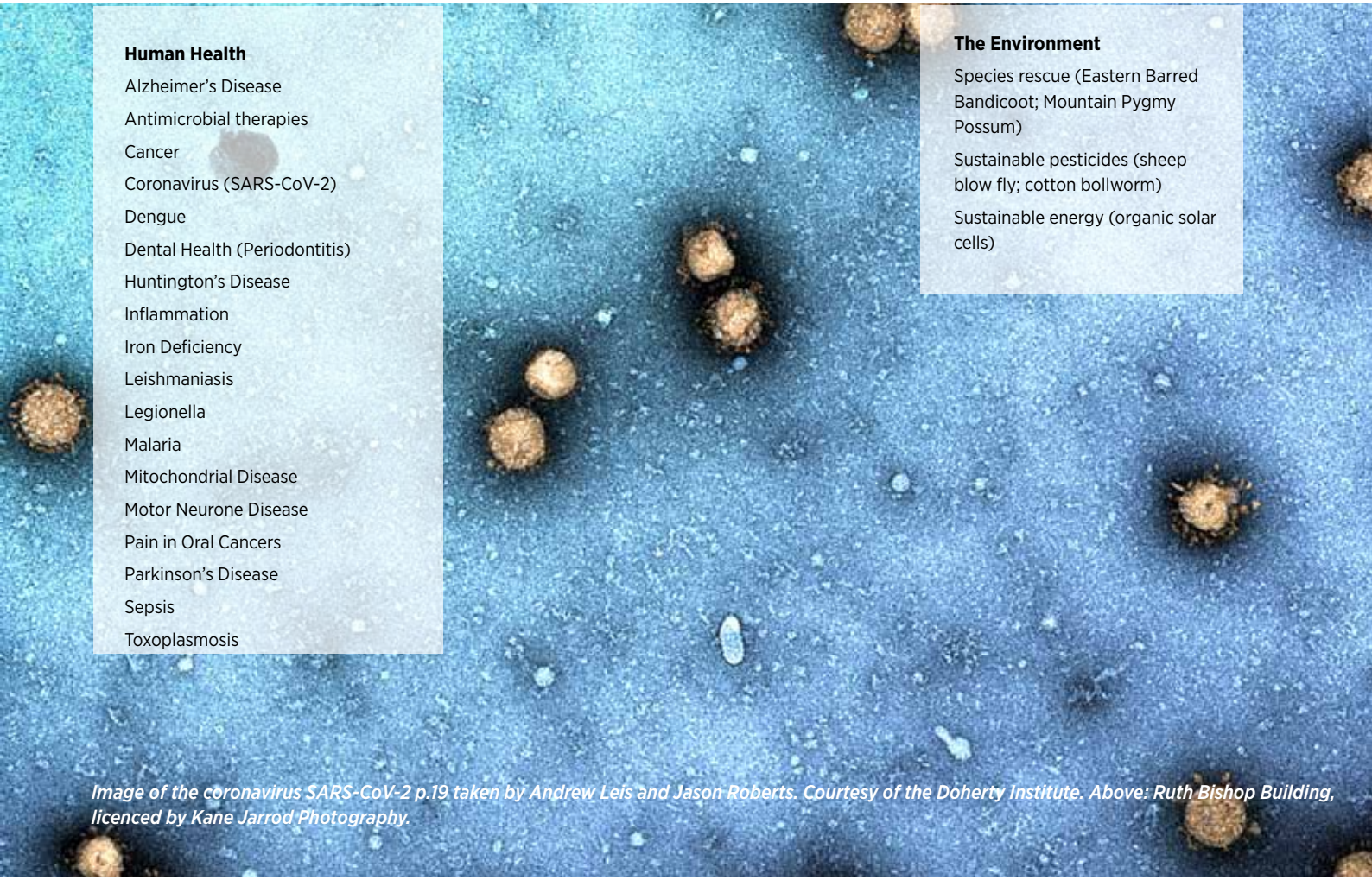



Image of the coronavirus SARS-CoV-2 p.19 taken by Andrew Leis and Jason Roberts. Courtesy of the Doherty Institute. Above: Ruth Bishop Building, licenced by Kane Jarrod Photography.

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 like COVID-19 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

Coronavirus (SARS-CoV-2)

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

Toxoplasmosis

The Environment

Species rescue (Eastern Barred Bandicoot; Mountain Pygmy Possum)

Sustainable pesticides (sheep blow fly; cotton bollworm)

Sustainable energy (organic solar cells)

Image of the coronavirus SARS-CoV-2 p.19 taken by Andrew Leis and Jason Roberts. Courtesy of the Doherty Institute. Above: Ruth Bishop Building, licenced by Kane Jarrod Photography.

Impacts of Research: Human Health

UNDERSTANDING THE RESPONSE OF OUR IMMUNE SYSTEM'S POWERFUL ARMY

Our immune systems can swing from cytokine storm to immune suppression when fighting infection; understanding why could help us tackle the flu and COVID-19

By Florienne Loder, University of Melbourne

COVID-19 has spread through global populations like a wild fire, consuming whole communities. However, looking back on the first hundred days of coronavirus transmission in Australia, we have been spared much of this.

Australian government directives enforcing physical distancing and good community compliance have contained the spread of the virus and 'flattened the curve' which has saved many lives.

As well as slowing the spread of coronavirus, these restrictions have also inadvertently slowed the spread of another highly contagious and deadly virus – the seasonal flu. This is a very good thing.

Influenza is a serious viral disease that can kill many people in a severe season. In Australia, the 2019 season saw 312,978 lab-confirmed cases, 3,915 hospitalisations, with 6.3 per cent admitted to Intensive Care Units (ICUs) and 902 deaths.

During flu infection and even after recovery, patients are at high risk of contracting secondary infections and developing fatal pneumonia, but until recently we did not know why. This is why patients are generally administered antibiotics. But this can encourage multi-resistant strains of bacteria in ICU.

Professor Jose A. Villadangos and his team at Bio21 Institute and the Peter Doherty Institute for Infection and Immunity have been trying to delve deeper, to uncover the underlying cause of this susceptibility to secondary infection after recovery from the primary infection.

They cast their eyes to the immune system. Working with Dr Antoine Roquilly, a clinician scientist at the University Nantes in France and his group, the team observed what occurs after recovery from severe trauma, flu infection, sepsis (a life-threatening complication of an infection) and a period of time spent in the ICU.

Their new research discovered that recovery from this initial trauma or severe infection leaves an 'immunological scar' that reduces the immune system's capacity to launch protective responses against subsequent infections.

This paralysis can last up to six months, making patients more susceptible to secondary infections like pneumonia.

We humans have not evolved to cope with the level of inflammatory assault that would send a person to ICU. Modern medicine is the only reason we survive.

But this comes at a cost: the same processes that are normally at work to stop inflammation after the resolution of infection, can 'overshoot' in ICU survivors, leaving them immunosuppressed. Building on the team's previous work, they found that macrophages (a type of white blood cell of the immune system) in the lungs also show similar immunosuppression after a severe infection or trauma.

[An excerpt from the article published in Pursuit]

Impacts of Research: Human Health

A protein, a project and a new department

Inflammation is increasingly being implicated in a range of conditions from heart disease, Alzheimer's disease, autoimmune diseases and even Covid-19.

The news cycle is short, but science stories of discovery are long, sometimes spanning decades. I'd like to share a tale of a science story that has been keeping me busy for over a decade. Although we celebrated a milestone a few weeks ago, it didn't make any headlines and was drowned out by more urgent news of the day. I'd like to share it here.

Professor Karlheinz Peter of the Baker Institute contacted me in 2008 after reading a media release about my work. He was interested in my expertise as a structural biologist and as we got to know each other we soon realised that we shared a common interest: we were both fascinated by the protein 'C-Reactive Protein' or CRP.

Karlheinz, a cardiologist, used CRP as a diagnostic marker for inflammation, but as a researcher he wanted to know more about this protein. What role did it play in inflammation? Was it just a marker, or did it cause or exacerbate inflammation? And what would happen if you could block its function?

I too was interested in this protein. Its 3D atomic structure had been determined in 1999 revealing a remarkable donut-shaped pentamer but little more was known about its function. What did it bind to, where and how? What effect did binding have on the behaviour of this protein and the immune response?

Combining biological in vivo tests and computational biology studies from the two teams, we revealed a new species of CRP, called pCRP*, that we published in Nature Communications. pCRP* was found to be the major CRP species in inflamed tissue and was shown to be responsible for activation of an immune response via the complement pathway. We also had a proof of concept that when membrane binding of CRP was blocked by the small molecule inhibitor, 1,6-bis(phosphocholine)-hexane, inflammation was abrogated.

We'd proved that blocking CRP stopped inflammation, but the small molecule we'd used was not suitable as a drug. Since then we've been scouring libraries of molecules for suitable candidates, modifying and testing them. This is an ongoing process, bringing together complimentary approaches, carried out by members of our respective teams.

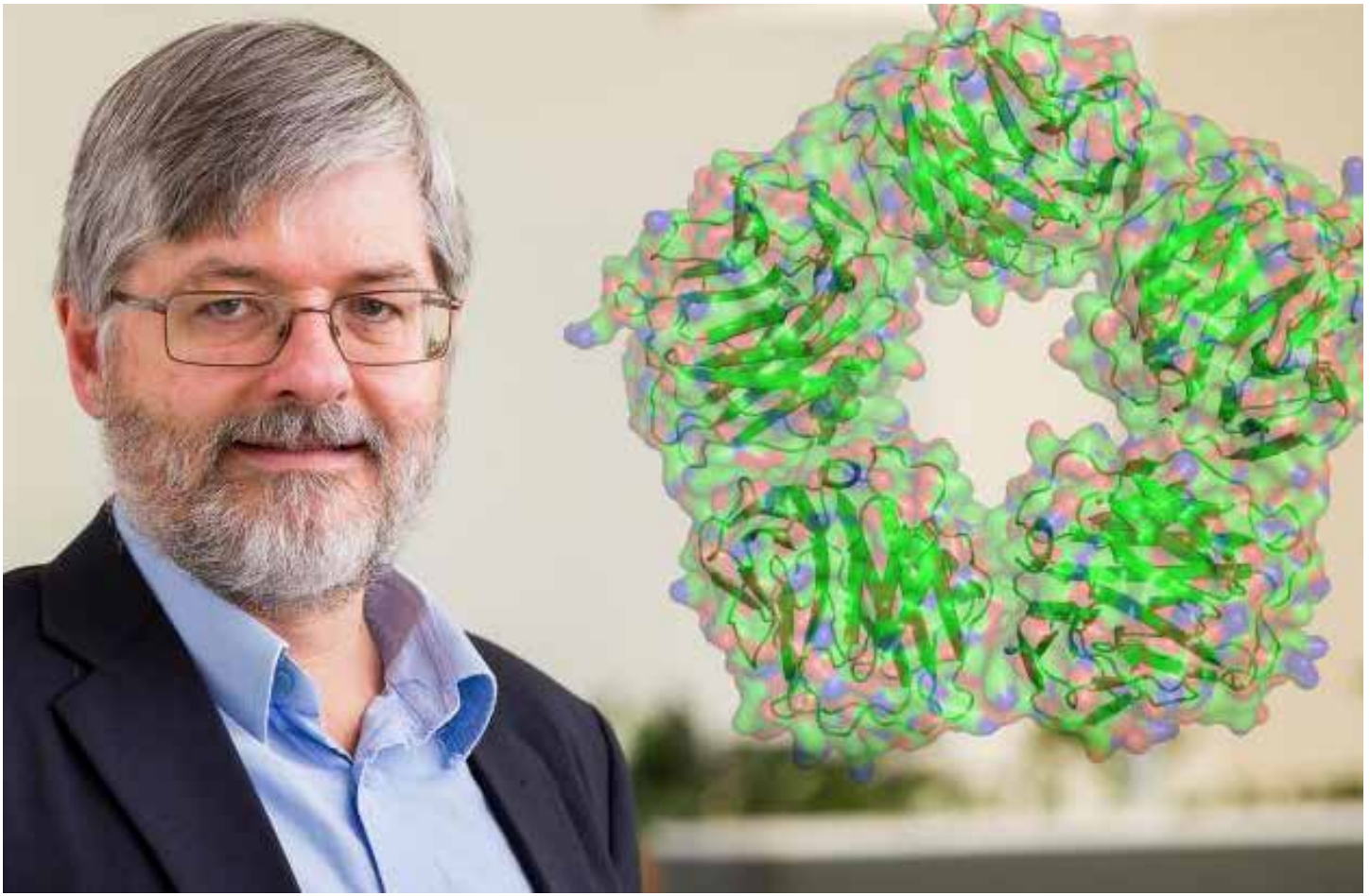
Tracy Nero, Craig Morton and Steffi Cheung have been handling the computational modelling and drug discovery, drug binding assays and structural biology.

Karlheinz Peter's team includes medicinal chemists, Guy Krippner and Geoff Pietersz, haematologist James McFadyen and a collaborator at the University of Freiburg, microsurgeon Steffen Eisenhardt. It became evident that bringing our complementary knowledge to cardiovascular problems was an incredibly effective way to drive this research.

As Karlheinz observed: "When you look at cardiovascular research in Melbourne, there are many excellent scientists across the city. If you manage to combine this unique skill set, especially across disciplines, then you have an enormous potential for collaborative research addressing cardiovascular health problems."

And so this year a new Baker Department of Cardiometabolic Health in the Melbourne Medical School at the University of Melbourne was formed. It brings together research groups from the Baker Heart and Diabetes Institute and the University of Melbourne. The new department is focusing on research and innovation to improve the lives of people with, or at risk of, cardiovascular disease, obesity and diabetes. Its work will include developing novel targets and therapeutics, using big data and new technologies, such as genomics, to transform prevention, diagnosis and disease management, a focus on clinical translation and contributing to clinical service delivery and prevention.

At Bio21, the Ascher, Donnelly and Parker groups are members of the new department. Among others, our 'CRP' project was selected for $200,000 seed funding from the new Department to progress our drug discovery work.



"Combining the expertise at the Baker Institute and the University of Melbourne through the new Baker Department of Cardiometabolic Health, allows us to harness all the unique talent and expertise available at both institutions. It works when the human 'chemistry' is right, but it also provides the environment to foster interdisciplinary collaborations, which often deliver the most disruptive scientific advances," says Prof Karlheinz Peter. The 'CRP'-collaboration story started with a media release and a meeting more than 10 years ago. The conversation sowed the seeds of an idea for a collaboration. It has developed into a promising drug development project which is now being progressed under the auspices of the new Baker Department of Cardiometabolic Health, created in a partnership between the Baker Institute and the University of Melbourne. But this is not the end of the story; it's possibly just the beginning of the second chapter. Inflammation is increasingly being implicated in a range of conditions from heart disease, Alzheimer's disease, autoimmune diseases and even Covid-19. With the seed funding and the new Department and resources of Bio21, we are in a great position to take the next steps.

Impacts of Research: Human Health
New tool outsmarts COVID-19 virus to help vaccine development

Melbourne researchers have developed a tool to monitor mutations that make it difficult to develop coronavirus (COVID-19) vaccines and drugs.

Ensuring treatments remain effective as the virus mutates is a huge challenge for researchers. The powerful new tool harnesses genomic and protein information about the virus and its mutations to aid drug and vaccine development.

University of Melbourne Associate Professor David Ascher and his team at the Bio21 Molecular Science and Biotechnology Institute and the Baker Heart and Diabetes Institute developed the software tool and library, dubbed COVID-3D.

Published in Nature Genetics, COVID-3D contains information about all the protein structures that coincide with the SARS-CoV-2 (COVID-19) genome, including every known genetic mutation and its resultant mutant protein structure.

"Although the SARS-CoV-2 virus is a relatively new pathogen, its ability to readily accumulate mutations across its genes was evident from the start of this pandemic," Associate Professor Ascher said.

"In the context of therapeutic drug design and discovery, these mutations, and the patterns by which they accumulate within the virus' protein structures, can affect the ability of vaccines and drugs to bind the virus, or to create a specific immune response against it. Because of this, scientists must not only try to control the virus, but outsmart it by predicting how it will change over time."

Several international universities and research institutions already use COVID-3D in vaccine and treatment development. "At Bio21 it is being used as part of ongoing efforts to understand and develop drugs to treat COVID-19," Associate Professor Ascher said.

To develop COVID-3D, Professor Ascher's team analysed the genome sequencing data of over 120,000 SARS-CoV-2 samples from infected people globally, including those that uniquely affect Australia, to identify mutations within each of the virus' proteins. They tested and analysed the mutations' effects on their protein structure using computer simulations.

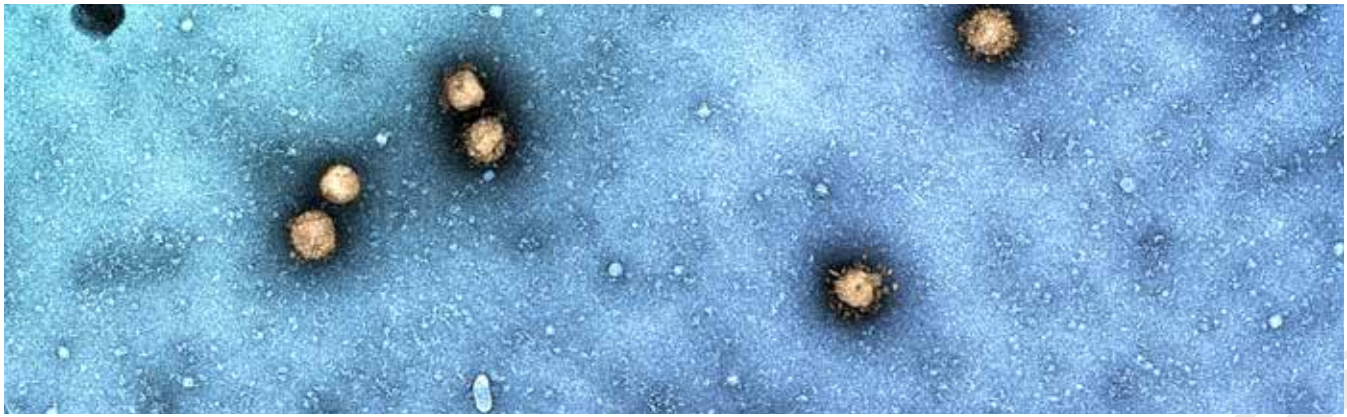
This data were used to calculate all the biological effects of every possible mutation within the genome. To help researchers account for possible future mutations, the team analysed mutations in the related coronaviruses SARS-CoV and Bat RaTG13.

Mutations or changes in an organism's genetic material are natural 'errors' in the cell replication process. They can give the virus new 'powers' of survival, infectivity and virulence. Fortunately, the researchers found SARS-CoV-2 is mutating slower than other viruses such as influenza, with about two new changes in its genome every month.

COVID-3D can help researchers recognise how mutations operate and identify more effective vaccine and drug targets. "It is only when you know how a mutation will affect the 3D shape of a protein, that you can predict if it will compromise your drug's ability to bind," Associate Professor Ascher said.

"As the global scientific and medical community gains better understanding of the biology behind the SARS-CoV2 infection and disease, this will be a powerful resource to predict problems with mutations and to guide the development of more effective therapies.

"COVID-3D continues to be updated with new protein structures, mutations and analyses to keep ahead of mutations that cause problems and increasing our understanding of the SARS-CoV-2 mechanisms of disease."



Impacts of Research: Human Health

Q&A: How could COVID-19 drugs work and what's out there? Associate Professor Stuart Ralph and Dr Craig Morton

Here we ask Associate Professor Stuart Ralph and Dr Craig Morton from University of Melbourne's School of Biomedical Sciences to explain how anti-viral drugs work and go through the different drug candidates that may help treat COVID-19.

Why do we have so many effective drugs for treating bacterial diseases, but relatively few for combating viruses?

Viruses lack the full molecular apparatus to replicate themselves, so instead they hijack the machinery of the host cells they infect in order to make more copies of themselves. So, while bacteria and parasites typically need thousands of genes to construct their own molecular machinery to replicate themselves, viruses are much simpler and can get by with far fewer genes. SARS-CoV-2 only has a few dozen genes, while some other viruses have just three or four.

Viruses like SARS-CoV-2 are simple structures that are hard to target because the use our own body's genetic machinery to replicate. This simplicity is the reason antibiotic-style drugs can't be used to treat viral infections. An antibacterial drug can be developed to combat a bacterium by jamming that mechanism it uses to replicate itself. But because a virus uses our own cells to replicate, drugs like these can end up hurting us more than the virus.

Another problem is that viruses can be very different from one another. For example, a human has more genetically in common with a horseradish than do the two viruses that cause influenza and chickenpox. This means finding a drug that can target a large variety of viruses, like antibiotics do for bacteria, is incredibly challenging.

How do drugs stop viruses from recognising host cells?

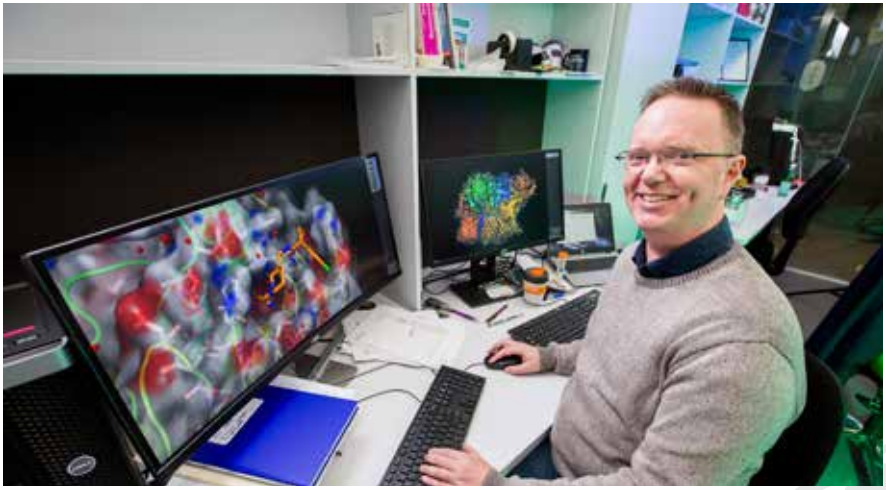
Viruses are generally picky about the type of host cell that will offer a hospitable environment for them to exploit. They feel their way across the surface of a host cell to determine if it has just the right combination of proteins and sugars that identifies it as an appropriate temporary home.

Coronaviruses are spheres with dozens of spikes that stick to the surface of a cell it is invading. The spike protein looks for an enzyme called ACE2 that is on the surface of several different types of human cells and which normally plays a role in regulating blood pressure. When the spike binds to ACE2 it triggers the fatty membrane that surrounds the virus to fuse with the membrane that surrounds our cells so that the viral contents spill into our cells – a bit like soap bubbles colliding and then merging in the bath.

Scientists are working to identify drugs that can interfere with this process, either by blocking the interaction between the spike and ACE2 directly, or stopping the spike proteins from triggering fusion of the virus with the human cell.

The controversial drug Hydroxychloroquine(link is external) likely works by interfering with this process, and Australian trials are underway to test if it has a role in preventing COVID-19.

Some researchers have also generated designer antibodies (infection-fighting proteins in our bodies) that may be able to block a coronavirus from recognising a host cell and so stop the virus from



entering. These appear to be effective in animal models, and we await human clinical data.

The same strategy of blocking viral entry has been used successfully to develop a drug called Maraviroc and an antibody treatment called Ibalizumab that are each effective against HIV, validating this general approach for making anti-viral drugs.

Can drugs stop viruses from replicating?

Once inside a host cell, a virus needs to make multiple copies of itself to proliferate. Different types of viruses use different ruses to trick the host cell into making these copies. Coronaviruses, for example, use some of their own molecular machinery to copy their ribonucleic acid genome, and this process has been exploited using a range of drugs that poison the viral replication machinery.

Several of these compounds are now being advanced as potential COVID-19 drugs. One of these is Remdesivir – originally developed to treat Ebola.

Viruses also need to use a collection of other building blocks to replicate themselves, including proteins, fats and sugars. New drugs that inhibit the virus from processing these other building blocks inside the host cell have recently transformed the treatment of important viral diseases, including hepatitis C and HIV.

Drugs that work on this basis, such as the HIV drug combination Kaletra™, have been trialled against COVID-19, but at least one large study found no benefit to this drug.

Finding existing drugs that help combat COVID-19 will be the fastest way toward treatments – antiviral Remdesivir was originally developed to treat Ebola.

What about drugs that stop viruses getting out of the cell?

The final part of a replication cycle is when the virus' progeny exit the host cell to seek out other new cells to infect. Sometimes this causes an explosion of the host cell left behind. However, coronaviruses hijack the cell's export machinery to exit without immediately destroying the host cell.

A number of important drugs, like the well-known anti-influenza drugs Relenza™ and Tamiflu™, work by stopping this active release of the virus from the host cell. Unfortunately, the machinery that influenza uses to do this differs from coronaviruses, and these drugs have proved ineffective against COVID-19.

What about drugs that treat our immune system?

Some of the patients who have died from COVID-19 suffer from an overreaction of their body's immune response to SARS-CoV-2 virus. A large UK study reported that the steroid drug Dexamethasone, which is an immune suppressant and anti-inflammatory, reduced mortality of COVD-19 patients on ventilators by around one third, but this trial is yet to be peer reviewed.

The Australian National COVID-19 Clinical Evidence Taskforce advises that some COVID 19 patients receiving oxygen might benefit from this drug but are awaiting more results from the Dexamethasone trial before making a more general recommendation for an Australian setting.

Is there a magic bullet on the horizon?

Discovering, developing and making a brand new drug safely available for any disease normally takes at least 10 years. So, the fastest way to find a treatment for COVID-19 is to identify an existing drug, already approved for some other disease, that is effective against the SARS-CoV-2 virus.

Remdesivir and Dexamethasone are two such drugs that are so far showing the most promise. But it's unlikely that researchers will find an existing drug that provides a single "magic bullet" for COVID-19. It is more likely that instead a variety of drugs will be identified that can help treat the disease in different ways in different people. Fingers crossed!

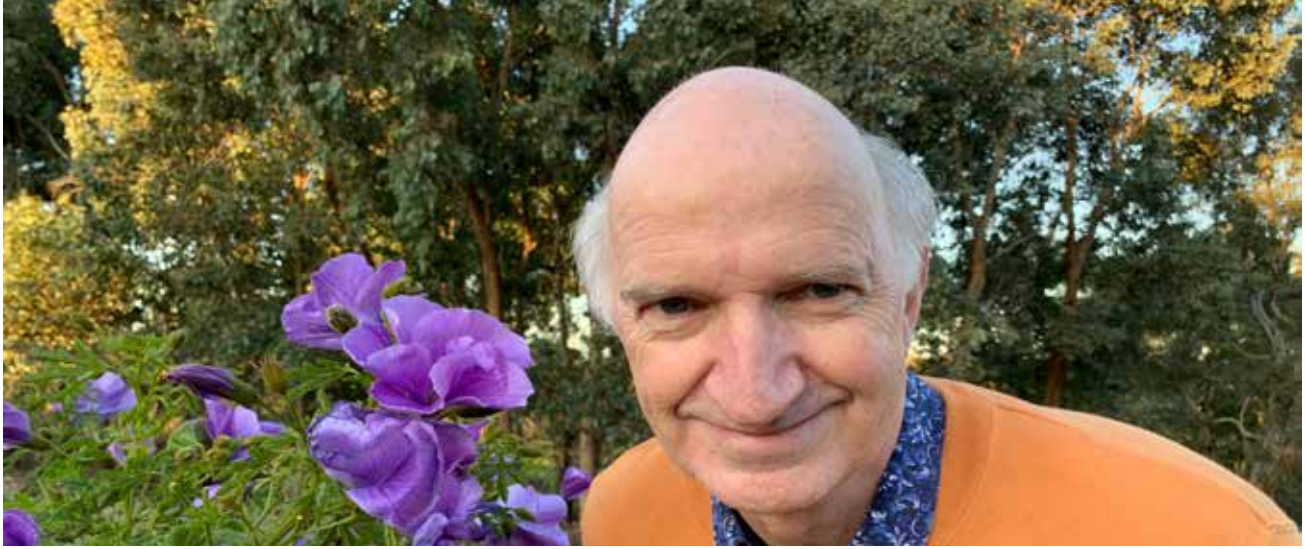
[An excerpt from the article published in Pursuit]

'Welcome'

Simon Baxter

Trent Perry

Debnath Ghosal



Insect Armageddon: low doses of the insecticide, Imidacloprid, cause blindness in insects

New research has identified a mechanism by which low levels of insecticides such as, the neonicotinoid Imidacloprid, could harm the nervous, metabolic and immune system of insects, including those that are not pests, such as our leading pollinators, bees.

A study published in the Proceedings of the National Academy of Science USA, led by researchers at the University of Melbourne and Baylor College of Medicine, shows that low doses of Imidacloprid trigger neurodegeneration and disrupt vital body-wide functions, including energy production, vision, movement and the immune system, in the vinegar fly, Drosophila melanogaster.

With insect populations declining around the world and intense use of insecticides suspected to play a role, the findings provide important evidence that even small doses of insecticides reduce the capacity of insects to survive, even those that are not pests.

"Our research was conducted on one insecticide, but there is evidence that other insecticides cause oxidative stress, so they may have similar impacts," Professor Philip Batterham, from the School of BioSciences and Bio21 Institute, at the University of Melbourne, said. "Our findings emphasize the importance of better understanding the mechanisms of action of insecticides, in particular on beneficial insects. Without further research we do not know if other insecticides are any safer."

Imidacloprid, has been banned from agricultural use by the European Union because of concerns about impacts on honeybees, but remains one of the top selling insecticides in the world. Attacking the central nervous systems of the insects, it increases the transmission of stimuli in the insect nervous system, activating receptors resulting in the insect's paralysis and eventual death.

The researchers arrived at the findings by studying the effects of Imidacloprid in vinegar fly larvae. In the field, the insecticide is generally used at concentrations of up to 2,800 parts per million (ppm). In the lab, researchers tested lower doses, identifying that the very small dose 2.5 ppm was enough to reduce the movement of fly larvae by 50 percent after just two hours of exposure.

"That's an indication of the impact of the insecticide on the function of the brain," said Dr Felipe Martelli, whose PhD work conducted at the University of Melbourne and the Baylor College of Medicine in the laboratory of Professor Hugo Bellen led to the current research paper. "From there, the accumulation of massive amounts of reactive oxygen species (ROS) or free radicals inside the brain triggers a cascade of damaging events that spread to many other tissues."

Researchers also tested the insecticide on adult flies, finding that flies exposed to very low doses (4 ppm) over 25 days became blind and developed movement problems that affected their ability to climb, symptomatic of neurodegeneration in other parts of the brain.

Impacts of Research: Environment

How do we protect our unique biodiversity from megafires?

Dr James Camac, Nicholas Bell and Professor Ary Hoffmann

This summer's devastating Australian fires and their continuing impact on biodiversity serve as a stark reminder of the challenges in nature conservation as we head into an increasingly volatile future driven by climate change.

It is no longer sufficient to protect land areas as part of a national reserve system in the hope that these areas can protect the rare and vulnerable species within them and maintain overall biodiversity.

The continuing impact of Australia's bushfires on biodiversity remind us of the challenges in nature conservation.

Megafires destroy vast tracts of land and are now occurring at a frequency and severity that prevents natural ecosystem recovery processes.

The Australian alpine region has historically experienced a major fire every 50 to 100 years. In the last two decades alone, we have witnessed four significant fires in 2003, 2007, 2009 and 2019(link is external), with some areas burnt more than three times since 2003.

While scientific evidence has highlighted that most Australian ecosystems, including those in our alpine regions, are resilient to the occasional severe fire, the increase in frequency and severity is likely to result in substantial and permanent impacts.

In a future that predicts increases in the intensity, duration and frequency of fires, drought and other severe weather, how do we protect Australia's unique biodiversity?

This is a big question when faced with a political system both within and outside Australia that either lacks the political will to reduce worldwide emissions or outrightly denies the science of climate change.

Across a timeframe of hundreds of thousands of years, biodiversity has persisted in natural environments despite substantial shifts in climate as a result of evolutionary processes that allows it to adapt to any gradual changes in climate.

However, the unprecedented rates of climatic change we're currently seeing now will likely be too rapid for most animals and plants to adapt – especially for long-lived species.

So, the persistence of vulnerable species under climate change is likely be governed by the availability of refugia within the landscape.

Landscape refugia are locations that contain various attributes (such as mountain topography) which act as a buffer to extremes in climate change.

At a genetic level, these refugia also typically harbor high levels of genetic variation both within and between species. Important genetic refugia are well known in the northern hemisphere, including some North American trees, where they have been identified in relation to glaciation (the formation, movement and recession of glaciers).

Identifying key biodiversity refugia within a landscape is no easy task.

This is because locations with high species richness are not always the same locations as those that are capable of buffering against environmental change while also maintaining high genetic diversity.

However, recent advances in genetics are providing scientists with the better tools to identify locations which have acted as refugia for thousands of years.

These particular refugia, called evolutionary refugia, highlight areas where populations have persisted though substantial environmental change and where genetic connectedness has provided an influx of new genetic material.

The groups in these refugia, both related and unrelated, often show overlapping patterns of genetic diversity – showing us that conserving evolutionary refugia can protect biodiversity across multiple organisms.

[This is an excerpt from an article first published on Pursuit.]

Impacts of Research: Sustainable Food Production: Making milk powder less energy intensive

Dr George Chen , Dr Judy Lee, Professor Sally Gras and Professor Sandra Kentish

In addition to the refrigerated dairy foods that many of us enjoy – milk, yoghurt and cheese for example – Australia also manufactures more than 220,000 tonnes(link is external) of milk powder each year.

Dairy powders are often used in commercial baking and the manufacture of chocolate, ice cream and infant milk, as a versatile product that doesn't need refrigeration and has a long shelf life.

However, to produce products like milk powder, whey protein powder, and lactose (milk sugar) powder, a lot of energy is consumed in water evaporation and drying.

But the Separation Technologies Team in the ARC Dairy Innovation Hub at the University of Melbourne, in collaboration with the University of Surrey in the United Kingdom, has now demonstrated that a by-product from cheese making can be used to more efficiently concentrate the milk, thereby reducing the energy used in the process by up to 20 per cent.

The cheese making by-product is known as salty whey, which is the salt and liquid expelled from making semi-hard or hard cheeses like Cheddar or Colby.

Salt is added to the protein-rich cheese curd when making these cheeses, however, less than a half of this added salt is retained in the curd. The rest is wasted as salty whey, which is expelled from the curd together with the excessive moisture during curd pressing.

But our pilot scale study shows that milk can be concentrated by 'pulling' water from the milk through a semi-permeable membrane and into the salty whey, thereby drying it out faster than current technologies. The salty whey is known technically as the draw solution, as it is used to 'draw' water across the membrane from the milk.

This process is called forward osmosis (FO), an emerging membrane technology which was originally developed for water treatment.

The process takes advantage of the osmotic pressure generated when water moves across a barrier, such as a membrane. Water will always move into an area with a high concentration of a solute, like salt, from an area with a low concentration solution.

Osmotic pressure is effectively the pressure that would be required to stop water from diffusing through this barrier by osmosis.

Since salty whey is readily available in cheese making plants it can be used as the draw solution to drive the process of concentrating milk products, before disposal. This avoids or limits the need for the re-concentration of the diluted draw solution in typical forward osmosis systems.

As water naturally flows from low concentration to high concentration solutions, the pumping energy used to deliver the high hydraulic pressure in conventional reverse osmosis processes is no longer required.

In addition to the energy saving in pumping, forward osmosis pre-concentrates milk before it is further evaporated, reducing the energy consumption in these downstream evaporation and drying processes.

Forward osmosis, which operates at below 50°C, can potentially be used as an alternative to traditional thermal treatment systems to remove water from other liquid foods such as fruit juices, avoiding the degradation of heat-sensitive compounds and the loss of their bioactive properties.

The pilot plant was located at the University of Surrey in the United Kingdom and used a draw solution that mimicked salty whey, to concentrate skim milk by a factor of two and a half. The total installed membrane area was 24 square metres, which is about 20 times smaller than might be needed for a full scale process.

The work demonstrated that less than 10 kWh of electric energy is required in this forward osmosis process to remove one tonne of water from skim milk, which is only half of what is typically required for traditional membrane concentration.

For the Australian dairy industry, implementation of this technology could potentially lead to savings of millions of dollars from the reduced steam requirements in thermal evaporators.

This emerging technology offers an energy efficient alternative to concentrate milk, if unlimited access to a brine stream can be made available within or in the proximity of dairy processing plants. This would be of particular benefit to the state of Victoria

that produced more than 60 per cent of the total 8.8 billion litres of milk in Australia in 2019.

Another important process in the dairy industry is the removal of salts, often referred to as demineralisation, which significantly increases the value of dairy products.

For example, when making infant formula and baby foods, a high degree of demineralisation, greater than 70 per cent, is required due to the limited kidney functions in babies and toddlers.

Demineralisation is typically achieved by passing dairy products through a bed of ion exchange resins, which bind strongly with salt ions to produce a demineralised stream. The regeneration of these resins, however, requires the use of additional chemicals that end up in waste streams and lead to high treatment costs.

To eliminate the need for resin regeneration, the Separation Technologies Team have been developing electrically driven processes, like electrodialysis and membrane capacitive deionisation, to separate charged salt ions from milk.

Different to pressure-driven filtration processes that are widely employed in industry, the suite of innovative membrane technologies developed within the ARC Dairy Innovation Hub can provide solutions to processors in not only the dairy industry, but also the broader food and beverage industries.

Together these technologies help address technical and environmental challenges that limit productivity and constrain the growth of business.

This work has been financially supported through a Victoria Fellowship awarded by the Victorian Government and by The ARC Dairy Innovation Hub supported under The Australian Research Council's Industrial Transformation Research Program (ITRP) funding scheme (IH20100005). The ARC Dairy Innovation Hub is a collaboration between The University of Melbourne, The University of Queensland and Dairy Innovation Australia Ltd.
[This article was first published on Pursuit.]

Occupational Health and Safety

Prue Johnson, OH&S Advisor Report

2020 is a year we will not forget anytime soon. We saw the introduction of COVIDSafe practices which are for the most part here to stay in some capacity for the foreseeable future.

Throughout the pandemic, Bio21 has remained committed to research with staff and students working from home where possible, and approved essential laboratory-based research still continuing on site. A big 'thank you' to the Bio21 research support services for ensuring the essential laboratories could continue to operate throughout the lockdown periods.

With the 2020 pandemic lockdown and adjusting to remote working, ensuring good Occupational Health and Safety (OH&S) compliance has been a challenging, but also gratifying task, as we strive to meet the needs of the Institute.

Our offices were set up ergonomically at home, able to borrow office furniture/ equipment to make the ease to working from home a smoother transition.

We saw maximum room capacities emerge in line with physical distancing guidelines, and a change in work habits as a result. Mask wearing, and elbow bumps also becoming part of everyday practices.

Zoom became the norm for teaching, meetings, conferences, and work social gatherings.

The RUOK campaign became more important during this time as the mental health of work colleagues was strained due to the lockdown and isolation. Supervisors played their part by checking in on their staff and students regularly, referring them to help if they required it.

As people return to on site work, everyone at the Bio21 Institute has helped keep Bio21 COVIDSafe, abiding by the new room capacities and rostering systems to ensure COVIDSafe practices are maintained, and work conducted in a safe manner.

We aimed to simplify processes wherever possible to ensure a safe and healthy workplace for all our institute members. In this we succeeded by being one of the first at The University of Melbourne to move to a QR based login/out system. Bio21 has adopted this tracing system successfully and it is being adopted by everyone as they return to on site work.

Throughout these difficult work times, progress was still achieved at Bio21. The Ruth Bishop building was completed and the Electron Microscopy platform moved into their new home, reinstating the service as the Ian Holmes Imaging Centre.

The audit closeout of the Bio21 Platform groups has been a big effort by all involved especially with the added complexity of working remotely to get items closed out.
Bio21 is committed to the health, safety and wellbeing of all its members and visitors. Without the support and cooperation Bio21 Institute members, we could not achieve this outcome.

Bio21 Equity, Diversity & Inclusion: International Women's Day

Bio21 celebrated International Women's Day with a morning tea Wednesday, 11 March. Bronwyn Kingwell, Senior Director, Research Therapeutic Lead, Cardiovascular and Metabolic Diseases, CSL was keen to impart a positive and hopeful message: "There is no better time to be a woman in health and biomedical sciences!"

To illustrate how things have changed, Bronwyn shared some insights from her 30-year academic career: how in order to maintain her NHMRC fellowship, she had to return to work fulltime shortly after having given birth, or lose her research money. To preserve a competitive track record, she was required to attend and present at international conferences, without childcare support and was then stopped by security guards at a conference, as she attempted to attend a poster session with her sleeping baby in a pram! This occurred only 13 years ago – her daughter has now commenced high school. This would not happen today.

It is a clear case of unconscious bias. Not so long ago, it was not common to see young mothers attending conferences, let alone with a baby. The security guards and conference organisers were possibly concerned about causing disruption to delegate traffic amongst the posters, without considering the impact of their actions on women scientists!

It is good to reflect on what has been achieved, even as there is some way to go yet. Through her national leadership roles over many years, including with the NHMRC and the Australian Academy of Health and Medical Sciences, Bronwyn has seen significant progress in gender equity. She observes that many great policies are now in place, but there is a need for them to evolve further and be taken up by individuals and workplaces. In particular, around parental leave.

"For women to have equal career opportunities, it's time that men were supported by their organisations and society to take up flexible work and carer leave opportunities, without stigma or fear of not being taken seriously in their profession."

It was so encouraging to see pictures of our science mums and dads using the parents' room at the recent Lorne conferences, sponsored by WEHI. It is practically now a given at every conference, that some form of childcare or parental support is offered.

I'd also like to congratulate Laura Edgington-Mitchell on the birth of her son, Alex and David Ascher on his daughter, Ariana, late last year. Most recently Sunnia Rajput, Research Fellow, Magnetic Resonance Facility, welcomed her daughter, Nora into the world and Rosemary O'Brien, Program Director, Construction – Planning and Delivery, Stage 2C returned from maternity leave this year after giving birth to her daughter Margaret. I'm aware of many other new and returning parents in our building. I encourage you to check in with them and see how they are getting along at home, or transitioning back to work. This is often one of the most daunting and challenging times for women in science and we need to acknowledge the barriers they face at this time and ensure that they are valued and supported as part of our Bio21 community.

Leann Tilley also spoke at the morning tea. Leann was named an ARC Georgina Sweet Laureate in 2015. In order to support women in quantitative biomedical sciences, she created two Georgina Sweet Awards: three $25,000 awards to Australian female researchers who demonstrate excellence in the area of quantitative biomedical science and a Travel Support for a female keynote speaker in quantitative biomedical Science (up to five awards of $3,000 each). These initiatives are helping to promote the next generation of women in science leaders.

It is encouraging that in February this year, the University of Melbourne was one of eight universities to be an Australian higher education and research (HER) awardee, attaining an Athena SWAN Institutional Bronze Award as part of the Science in Australia Gender Equity (SAGE) initiative.

Also, on International Women's Day this year, the Federal Government launched its 'Women in STEM Action Plan' and the 'STEM Equity Monitor' to drive the systemic transformation of gender equity and diversity in STEM.

"We welcome the Government's plan of action for delivering the vision of Australia's 10-year plan for Women in STEM and also an annual national data report on girls' and women's participation in science," Dr Wafa El-Adhami said.

Although we are seeing improvements for women overall, if we widen our lens to include women from diverse backgrounds,

the picture becomes more complex. There were gasps as Leann Tilley shared with us some statistics about the dearth of female academics from diverse cultural backgrounds at the University of Melbourne. It is perhaps another case of unconscious bias; making our unconscious biases conscious is an important first step. We can all play our part in counteracting these biases.

This insight has motivated Bio21 to change the name of our 'Bio21 Women's' Committee to 'Bio21 Diversity and Inclusion' Committee. I wish to thank the previous committee chairs, Uta Wille, Diana Stojanovski and Matt Dixon for their work in putting forward initiatives that support women in science. Thank you to Guy Jameson, who stepped into the role of chair of the Bio21 Equity, Diversity and Inclusion Committee in 2020. Last year Bio21 hosted a Bio21 IWD Forum, celebrating the work of our women at the Institute; our 'Women of Bio21' profile series has been very well received and this year's cupcake celebration, supported by CSL, have all been great initiatives put forward by the committee. Let's remove the barriers that divide us, for a better science and a better life!

Michael Parker

Director, Bio21 Institute

Guy Jameson is the Chair of the BIo21 Equity, Diversity and Inclusion Committee

International Women's Day & Women and Girls in Science

Bronwyn Kingwell speaks at the Internatonal Women's Day morning tea.

Megan Maher @DrMJMaher
Today I am enjoying spending time with my group while listening to amazing science at @ LorneProteins. Happy International Day of Women and Girls in Science! #SuperstarsofSTEM #science4all #February11 @ScienceAU @ WomenScienceDay @SMaghool @Nilakhi9@ Bio21Institute

David Ascher @DrDavidAscher· Feb 11 Day 3 @ LorneProteins starts off with beautiful cryo-EM data & structures. Thank you @WEHI_research for sponsoring the Parent Room again. Its helped Lorne pioneer family friendly conferences. I suspect the youngest group member also has a particular interest in protein structures!

Cupcakes kindly supplied by CSL.

Professor Frances Separovic FrancesBiophys
Today I am doing a course at the Australian Institute of Company Directors @AICDirectors so I can influence more #WomenInScience #GenderEquity #science4all #February11 #takeyourplace #TeamHB4 @Scienceau @WomenScienceDay @Bio21Institute

Véronique Paris @mozzieonique
Today I am at my desk planning my next sampling trips to study the role of mosquitoes in the transmission of Buruli ulcer! Read about it here: https://bit.ly/2Pvarwc #SuperstarsofSTEM #science4all #February11 @Scienceau @ WomenScienceDay @PEARG_Lab @Bio21Institute @GrndCtrl2_DrTom

Bronwyn Kingwell, Senior Director, Research Therapeutic Lead, Cardiovascular and Metabolic Diseases, CSL and Leann Tilley ARC Georgina Sweet Laureate.

Laura Edgington-Mitchell @LauraEM_Lab
Today I am a happy new mama, though missing friends at the @LorneProteins conference and trying to get some writing done in between feeds. #SuperstarsofSTEM #science4all #February11 @ Scienceau @WomenScienceDay @Bio21Institute

Dionne Argyropoulos @DionneArgy
Today I am at home writing up my MSc research into a research paper! This looked at how we can use population genetics to better understand the efficacy of #malaria insecticide spraying! @ Bio21Institute #SuperstarsofSTEM #science4all #February11

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.

Media Release: Radiation drugs with longer shelf life bring hope for cancer patients globally

People with cancers in the kidney, gut and prostate will have improved hope for early diagnosis and treatment with new research aimed at increasing the shelf life of revolutionary radiation drugs.

Funding of AU$2.5 million will kickstart a two-year manufacturing research project that will harness the combined expertise of the School of Chemistry, Bio21 Institute, University of Melbourne and the Peter MacCallum Cancer Centre to increase the shelf-life of radiation drugs, so they can be shipped to patients globally.

Telix Pharmaceuticals and Cyclotek, with co-funding from of the Innovative Manufacturing Cooperative Research Centre (IMCRC), will contribute AU$1 million to the project and will lead the research to create a manufacturing production process. They will also work with external partners, iPhase Technologies and GenesisCare, to develop and streamline the manufacturing process.

Radiation drugs, known as 'radiopharmaceuticals', can be used to locate and see cancer cells in the body including in hard-to- reach places using the imaging technology, Positron Emission Tomography (PET).

By capturing the radioactive isotope in a selective, "cage-like" molecule and fusing it to a targeting molecule, the radiation can be directly transported to the cancerous cells for detection of tumours.

In the case of kidney, neuroendocrine and prostate cancers, there are specific 'homing' molecules that can transport the radioactive cargo to the cancer cells, including those cancer cells that are hidden in the hard-to-reach nooks and crannies of the body like the gut, kidney and prostate.

Again, the process makes it possible to diagnose cancer cells that would otherwise go undetected. Once diagnosed, a higher energy radioisotope can then be used to destroy the cancer cells.

The ability of the drugs to target cancer cells also reduces the number of healthy cells that are damaged by more traditional ways of administering radiation therapy.

"It has taken years of basic research at the School of Chemistry, Bio21 Institute, to develop the carrier compounds that are the principle behind this technology," said Professor Paul Donnelly from the School of Chemistry, Bio21 Institute at the University of Melbourne. "It's exciting to see these compounds being developed for clinical use and manufacture."

Currently, isotopes are being produced locally within the Peter MacCallum Cancer Centre for cancer patients by the company, Cyclotek.

"The challenge is to create radio-labelled diagnostic and therapeutic agents with a longer half-life, that lend themselves to manufacture and distribution beyond the hospital walls," said Dr Michael Wheatcroft of Telix Pharmaceuticals.

Mr David Chuter, CEO and Managing Director of the IMCRC, said the manufacturing research project will open up a world of potential to treat cancer more effectively.

"The project will build the foundation to safely and cost-effectively manufacture life changing targeted cancer radiation drugs in Australia, and export them to the world."

The Ruth Bishop Building and Ian Holmes Imaging Centre

As the new coronavirus Covid-19 spreads across the globe, the importance of vaccines and the scientists who develop them, has become increasingly apparent to society.

As I write this, the global tally for coronavirus has reached over 850,000 infections, with more than 41,600 deaths. Victoria's cases have reached 917. Globally, governments' efforts are aimed at slowing the spread of this virus to save lives. Coronavirus can infect all of us, but it is particularly dangerous to older age groups.

What if I were to tell you that in the year 2000 that another virus - the Rotavirus, caused the deaths of over 500,000 children under the age of five? Even today, it remains the most common cause of diarrhoea in infants, with more than 200,000 children dying, because more than 90 million children still don't receive the vaccine. [Source: Pursuit]

Yet, it doesn't even feature on any news headlines, as those deaths took place amongst the poorest of the poor in the world's developing countries.

The number of deaths was halved by 2013 as a result of the introduction of the rotavirus vaccine.

It is fitting, as we face this pandemic, to honour Professor Ruth Bishop, AO, PhD, DSc, DMSc, FASM, FRACP (Hon), the scientist who in 1973 co-discovered the Rotavirus, the most common cause of severe diarrhoea among infants and young children, and announce her as the namesake for our new 'Stage 2C' building: The "Ruth Bishop Building".

In her own words: "In 1973 Ruth Bishop, Geoffrey Davidson, Ian Holmes, and Brian Ruck identified abundant particles of a 'new' virus (rotavirus) in the cytoplasm of mature epithelial cells lining duodenal villi and in faeces, from such children admitted to the Royal Children's Hospital, Melbourne. Rotaviruses have now been shown to cause 40-50% of severe acute diarrhea in young children worldwide in both developing and developed countries, and > 600 000 young children die annually from rotavirus disease, predominantly in South-East Asia and sub-Saharan Africa." [Source: J Gastroenterol Hepatol. 2009 Oct;24 Suppl 3:S81-5. doi: 10.1111/j.1440-1746.2009.06076.x. Discovery of rotavirus: Implications for child health. Bishop R1.]

This major breakthrough led Ruth to develop a clinical diagnostic test and helped pave the way for the development of a live oral vaccine:

"The discovery initiated a life's work for Ruth – understanding the virus, working out how it spreads and fighting back with treatments and vaccines, advising the World Health Organization (WHO) and the Bill and Melinda Gates Foundation. As a result, vaccination against 'gastro' has been part of the National Immunisation Program for all Australian infants since July 2007, with marked reductions in diarrhea deaths and hospitalisations." [Source: RCH blog]

Ruth obtained a B. Sc., majoring in microbiology, in 1954 followed by a M. Sc. in the same field in 1958 and a PhD in 1961, all from the University of Melbourne. Ruth then undertook a post-doctoral fellowship at the University of Liverpool in the UK. She returned to Australia to take up a position at the Royal Children's Hospital in 1965 where her work on rotavirus was initiated.

Bio21's new microscopy facility on the ground floor of the Ruth Bishop Building will be named after the Rotavirus co-discoverer and virologist, Professor Ian Holmes: the Ian Holmes Imaging Centre.

"Ian very generously and adventurously said, 'alright, we'll have a look at some of these biopsies with an electron microscope'", recalls Bishop. "His contribution was huge because he was an expert electron microscopist, perhaps one of the most experienced and expert in the world at that time. In the first biopsy of the first child we looked at there was this previously unidentified virus. It just rushed ahead from there, " recalls Ruth Bishop. [Source: Steven Pincock, Obituary]

"In 1973, electron microscopy revealed a previously unknown virus in the first bowel biopsy sample the team studied. The researchers subsequently found the virus in other patients' specimens. Bishop concedes that she did not appreciate the discovery's real significance until its publication provoked a global response. "It was like pressing a whole lot of light bulbs on a world map," she later recalled. "Everyone was saying 'we have found the virus too.' It was turning up everywhere." Later named for its wheel-like appearance in electron micrographs, rotavirus was soon recognized as the most common cause of severe

diarrhea in infants and young children worldwide." [Source: Bob Beale, 2002]

Prof Ian Holmes completed his undergraduate science degree at the University of Melbourne before completing a PhD on poxviruses at the Australian National University in 1961. In 1973, Ian applied his expertise in electron microscopy to intestinal biopsies collected by colleagues at the Royal Children's Hospital in Melbourne from children with non-bacterial gastroenteritis. In these samples he discovered a new human virus, rotavirus, which he quickly identified as orbivirus-like. Later he showed that rotavirus belongs to a new group within the family Reoviridae. Ian's rotavirus research over 27 years greatly contributed to the development of rotavirus vaccines, which are starting to have a dramatic impact on infant morbidity and mortality in many countries.

Bringing together expertise in the areas of microbiology, virology and electron microscopy, Ruth, Ian and their teams' work is exemplary for the kinds of collaborations that we encourage and strive for at the Bio21.

For her contribution to health security and the improvement of children's health, Professor Bishop was made an Officer of the Order of Australia in 1996, and in 2013, became the first woman to be awarded the Florey Medal by the Australian Association of Medical Research Institutes. In 2019 Ruth was awarded a Companion of the Order of Australia.

Ian Holmes received the David Syme Research Prize from The University of Melbourne (1977) and with Ruth Bishop, the Clunies Ross National Science and Technology Award (1998) for this work.

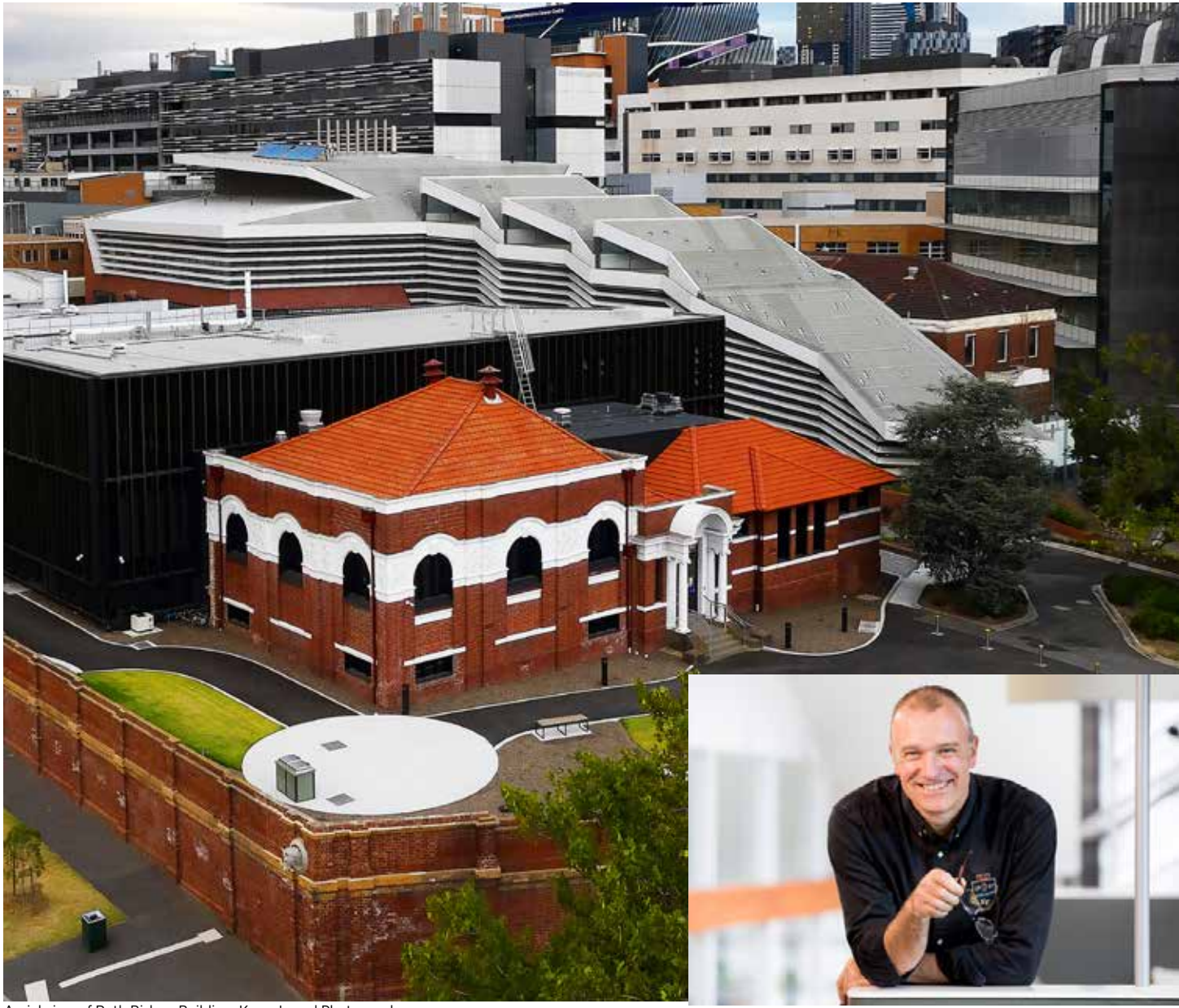
As we now socially isolate ourselves and become accustomed to frequent hand-washing, we put our faith in science to deliver a life-saving vaccine.

Thanks to the work and dedication of Ruth Bishop and Ian Holmes, a life-saving vaccine exists for rotavirus. However, it took more than 30 years to develop that vaccine. We hope and expect with modern technologies that a vaccine for the SARS-CoV-2 coronavirus will be much faster, perhaps less than two years away.

Michael Parker

Director, Bio21 Institute

[Director's Message, 1 April 2020]



Aerial view of Ruth Bishop Building, Kane Jarrod Photography.

Events and Conferences

Did you cancel your trip to a conference this year? Were you dreaming of boarding a plane and heading to New York, or Bern, Singapore or Siena? Like most people's holiday plans this year, SARS-CoV-2 has meant conference plans have either been postponed or they have become "virtual".

Conferences are a celebration of science; a coming together of scientists in a field in one place and time to exchange knowledge with colleagues and peers across the world. Conferences allow us to get a sense of where our field is headed; what's 'hot' and what's not, as well as experiencing the buzz in the room, when a ground-breaking announcement is made, or when a scientific 'hero' takes the podium.

Through keynotes, poster sessions and social events, conferences provide an opportunity to meet and engage with fellow scientists from across the world, in similar or intersecting fields of research in one area. For early career scientists, it may be an opportunity to present results to a larger audience for the first time and to forge connections for the next step of their career, after their PhD, or first postdoc, often planning to visit certain labs as part of their travel plans after a conference. Of course, it's always fun to explore a new global city or maybe a country, even for a day or two.

Bio21 itself has hosted both national and international conferences and our members have been involved in pitching and bringing important scientific conferences to Australia, as well as leading in the organisation of conferences, national and global.

For example, I am chair of the organising committee for the 26th Congress and General Assembly of the International Union of Crystallography triennial meeting to be held in Melbourne in 2023, a meeting that typically attracts ~2,000 delegates.

Guy Jameson is President-elect of the Society for Redox Research Australasia and their meeting, like many others this year is taking place virtually.

Phil Batterham continues to be involved in organising conferences and is the Chair of the Organising Committee for the International Congress of Genetics to be held in Melbourne in July 2023. The Congress has been held once every five years since 1898 in different cities around the world. It is sometimes referred to as the 'Olympics of Genetics'.

In 2017 Paul Gooley on behalf of the Australian and New Zealand Magnetic Resonance Society (ANZMAG) headed a bid for ISMAR2021 at the meeting in Quebec City, but lost to Osaka, Japan.

"While disappointed, I was invited by the ISMAR council to make a bid in 2019 at the Berlin meeting for 2023, which was surprising as it was out of the traditional geographical cycle. Nevertheless, I went to Berlin and this time was successful in attracting the biennial ISMAR meeting to Brisbane, to be held Sunday 27th August to Friday 1st September 2023."

Paul will co-chair the conference with Assoc/Prof Mehdi Mobli from University of Queensland and Prof Gottfried Otting from the Australian National University. He is currently co-chair of the next ANZMAG meeting to held in Victoria, likely to be postponed to 2022; he is also a Director of the society. He has been on the organising committees of numerous ANZMAG meetings, the XXIVth International Conference of Magnetic Resonance in Biological Systems held in Cairns 2010 and several COMBIO meetings.

Gavin Reid, Department of Biochemistry and Molecular Biology and the School of Chemistry, is the current President of the Australia and New Zealand Society for Mass Spectrometry and together with Stephen Blanksby and Pukala Lab has been successful in the bid to host the 25th International Mass Spectrometry Society Conference in Melbourne, in August 2024.

"I'm the current President (2016-2020) of the Australia and New Zealand Society for Mass Spectrometry, and I led the bid on behalf of the society to host this conference. I will serve as the Past President (2021-2024), Conference Convener and Chair of the Organising Committee for the IMSC meeting. We expect 1200-1400 delegates from around the world to attend. The meeting is held biennially, and this will be only the second time that it will have been held in the Southern Hemisphere, and also only the second time it will have been held in the Asia-Oceania region. In the past, I have been involved in the organisation of multiple national and international conferences, including the biennial ANZSMS conference, the annual Australasian Proteomics Society Conference, the biennial Australian Lipids meeting, the biennial Asia-Oceania Mass Spectrometry Conference, and the annual American Society for Mass Spectrometry conference".

Australia will also host the 26th International

Congress of Biochemistry & Molecular Biology (IUBMB World Congress) in 2024 in Melbourne, with the theme: Biomolecular Science: Discover, Create, Innovate. Bio21 members who are making a leading contribution to the organisation of the Congress include Prof Leann Tilley (Chair), Prof Danny Hatters (General Secretary and Meeting Chair) and Prof Paul Gleeson, (Regional Societies Representative).

Bringing together six Australasian Societies with scientific groups from South East Asian and the rest of the world, the organisers have already secured a substantive funding commitment from the Victorian State Government and are aiming to attract at least 2,500 delegates to a "world-class, future-focussed" Program.

In its 71-year history the IUBMB Congress has only been held twice in the Southern Hemisphere. The bid team were able to convince the IUBMB Executive Committee: It's time for Melbourne to showcase its impressive strength in Biochemistry and Molecular Biology!

2024 might end up being a good year for conferences as Eric Hanssen has also been successful in bringing the Asia Pacific Conference on Microscopy to Brisbane in 2024.

When Eric Hanssen attended the 12th Asia Pacific Conference on Microscopy, 3 – 7 February this year, he was wearing a number of hats: as a Plenary Speaker; a Co-Chair for the bid to host the next Conference in 2024 and as President of the Australian Microscopy and Microanalysis Society. Eric returned home with the crown: a successful bid to host the next conference in Brisbane, Australia in 2024, denoting Australia's strong commitment toward microscopy.

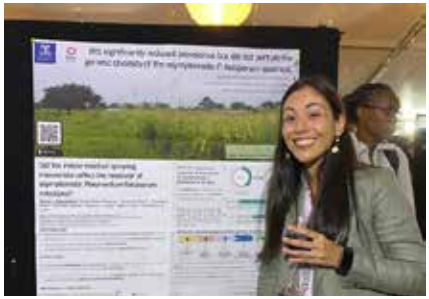
We look forward to these conferences in 2023 and 2024 only a few years into the future. In a post-COVID world, will we be doing things differently? Even if we're permitted to travel again, will conferences continue to be held virtually as well? What will be the longer-term impact of social media and digital presentations on conferences? I am sure of one thing, that conferences will continue to exist in some form, as scientists will always feel the need to meet other scientists, to network and to exchange ideas, to discover the latest cutting-edge equipment and services from our valued trade partners and to debate new paradigms as a global scientific community.

Graduate and Early Career Researchers

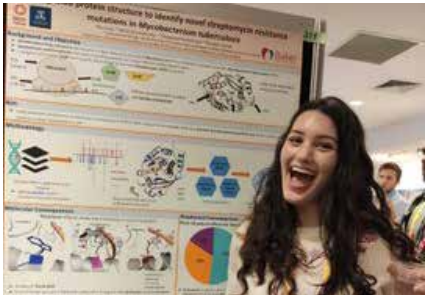
Riley Metcalfe receives Young Investigator Award at Lorne Proteins

Tom Jackson, Stojanovski lab, wins poster prize at Lorne Proteins @DrDStojanovski My smile says it all.... very happy for you @TomJackson1995 on your poster prize @LorneProteins ! #proudsupervisor

Stuart Ralph @sturalph · Feb 26 Eventual group-photo success- a fun conference, great to spend it with such a nice lab group #MAM2020



Dionne Argyropoulos @DionneArgy · Feb 26 Thank you for stopping by poster 10 last night #MAM2020 ! I'll be around today if anyone would like to know more!1



@DrDavidAscher Congrats @UniMelbMDHS Amgen @ASP_GPO scholar Noa from @UOW, who won a Lorne Proteins poster prize. She has achieved & learnt so much in a short time @BakerResearchAu @Bio21Institute. Her project on Strep resistance in GidB is a close collaboration that started with @DrKatHolt

Stuart Ralph @sturalph · Feb 26 Go @Emma_McHuge! Lovely clear talk about detection and regulation of splicing in Plasmodium falciparum #MAM2020

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. Our Bio21 heroes all are fantastic leaders who have a high profile within their discipline and outside it, nationally and even internationally. Their contribution is not part of their job description – it is exceptional!

In 2020 Bio21's **Professor Karen Day AM** was honoured with a Member (AM) in the General Division for significant service to science education, and to global public health. Professor Karen Day AM is a distinguished malaria researcher dedicated to the improvement of global health and continues to advance the field of malaria epidemiology and train the next generation of malaria scientists.

Professor Sally Gras, group leader in the Department of Chemical Engineering at Bio21 and our Associate Director, Engagement was one of 25 new Fellows elected to the Academy of Technology and Engineering (ATSE). Sally is a biochemical engineer interested in food and pharmaceutical products and through her research seeks ways to improve the processes that go to make those products. These products include cheese and yoghurt and her team works together with the Australian Diary manufacturing industry, which is worth about $3.3 billion annually to the Australian economy in terms of exports.

Bio21's **Professor Gavin Reid,** School of Chemistry, Faculty of Science and Department of Biochemistry and Molecular Biology, MDHS has been included on The Analytical Scientist Power List 2020.
In 2020 The Analytical Scientist Power List celebrated analytical achievement across the four corners of the globe by featuring 10 leading researchers based on each continent: North America, South America, Europe, Africa, Asia and Australia/Oceania.

Professor Andrew Wilks is a valued member of our Bio21 community where he is CEO of SYNthesis Group, headquartered at Bio21 since 2018. He is also CEO of SYNthesis Research and Executive Chairman of SYNthesis med chem, both companies having a presence in our Bio21 Business Incubator building. Andrew's election as a Fellow to the Australian Academy of Health and Medical Sciences honours his many achievements, as a cancer researcher, inventor and biotech entrepreneur. He has discovered enzymes (most famously the JAK kinases), invented promising drugs (e.g. lexibulin and momelotinib) and co-founded 10 companies.

He was also appointed Honorary Enterprise Professor of the University.

Grant Successes

Bio21 researchers receive NHMRC Research Grants and Fellowships

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

National Health and Medical Research Council (NHMRC) Ideas Grants:

Congratulations to Isabelle Rouiller, Justine Mintern, Hamish McWilliam, Kristin Brown and Spencer Williams who have received NHMRC Ideas grants. It is wonderful to see projects funded that will deepen our understanding of mechanisms that govern our body's immune system responses, our pain sensations, cancer metabolism and even repurposing drugs to treat Covid-19.

Eric Reynolds, NHMRC Development Grant ($1,107,069) to study tooth enamel repair, and an Investigator Grant (Leadership 3) to study the bacterial type IX secretion system in polymicrobial dysbiosis and chronic inflammation - $1, 900, 000

Paul Gooley, NHMRC Targeted Calls for Research funding ($784,064) to explore Nitrogen metabolism, energy metabolism and mitochondrial function in paediatric ME/CFS.

Debnath Ghosal, NHMRC Investigator Grant to study how intracellular pathogens breach host cytoskeleton - $645, 205

Michael Parker, NHMRC Investigator Grant (Leadership 3): Understanding cell signalling as a basis for new therapeutics - $2, 231, 372

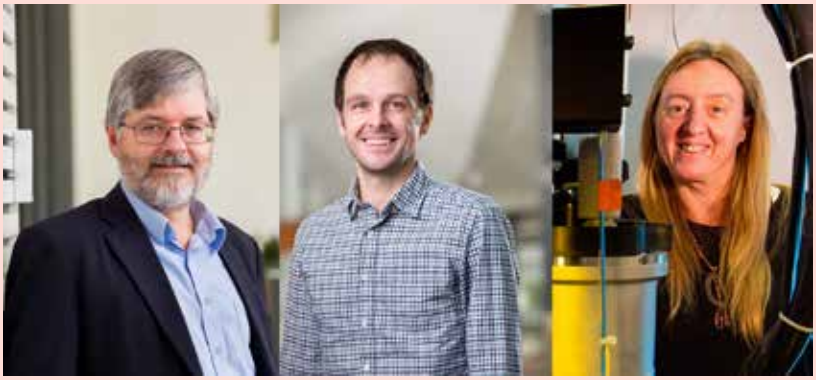
Bio21 researchers receive ARC Grant Funding for Projects and Centres

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) Discovery and Linkage Project grants: Bio21 recipients in 2020 were: **Spencer Williams, Elizabeth Hinde, Paul Gooley, Marc Sani and Ary Hoffman.** Funded projects funded will help us to understand sulfur cycling in nature; immune recognition of microbial metabolites; DNA health; protein multifunctionality and bioprogramming of nanoparticles. A linkage grant with Melbourne Water will help improve stream management.

Multi-million dollar grant for new ARC Training Centre:

A $4.7 Million grant towards a $13 million ARC Industrial Transformation Training Centre (ITCC) has been announced. MIPS will be the headquarters of the new ARC Training Centre for Cryo-Electron Microscopy of Membrane Proteins for Drug Discovery, established in collaboration with Bio21, University of Melbourne, University of Wollongong, the Walter and Eliza Hall Institute of Medical Research (WEHI) and industry partners including SYNthesis spin-out Catalyst Therapeutics, Thermo Fisher Scientific, Biocurate, AstraZeneca, Pfizer, Genentech, Servier, Sanofi, Novo Nordisk and Dimerix Bioscience.



Isabelle Rouiller (Deputy Director, UoM node leader), Mike Griffin and Michael Parker will be conducting training projects in the ITTC.

Bio21 researchers receive ARC Grant Funding

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

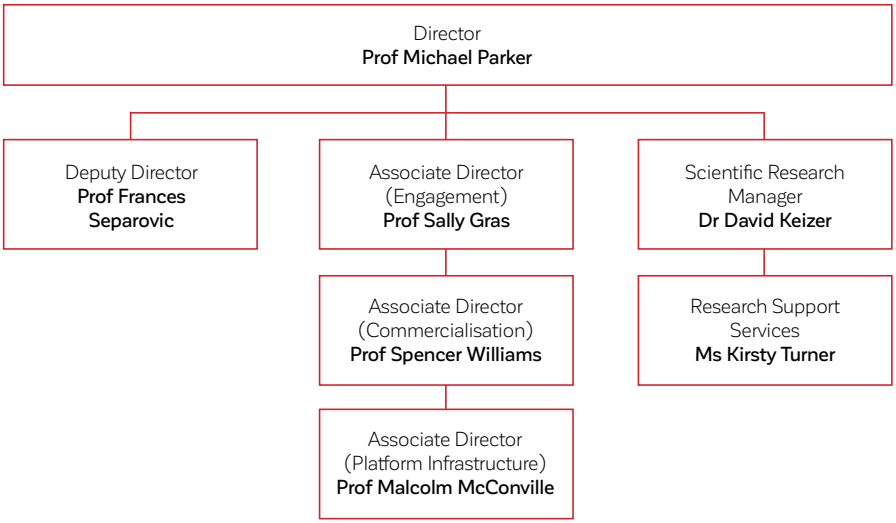
Australian Research Council (ARC) LIEF:

Bio21 teams have been successful with four University of Melbourne-led grants and one with the University of Wollongong. Bio21 received a total of $2, 791, 874 directly to the Institute. Bio21 recipients of LIEF grants were: **Liz Hinde, Paul Gleeson, Paul Gooley, Megan Maher, Mike Griffin, Spencer Williams, Frances Separovic, Craig Hutton, Paul Donnelly; Michael Parker, Isabelle Rouiller, Nick Williamson, and Eric Hanssen.**

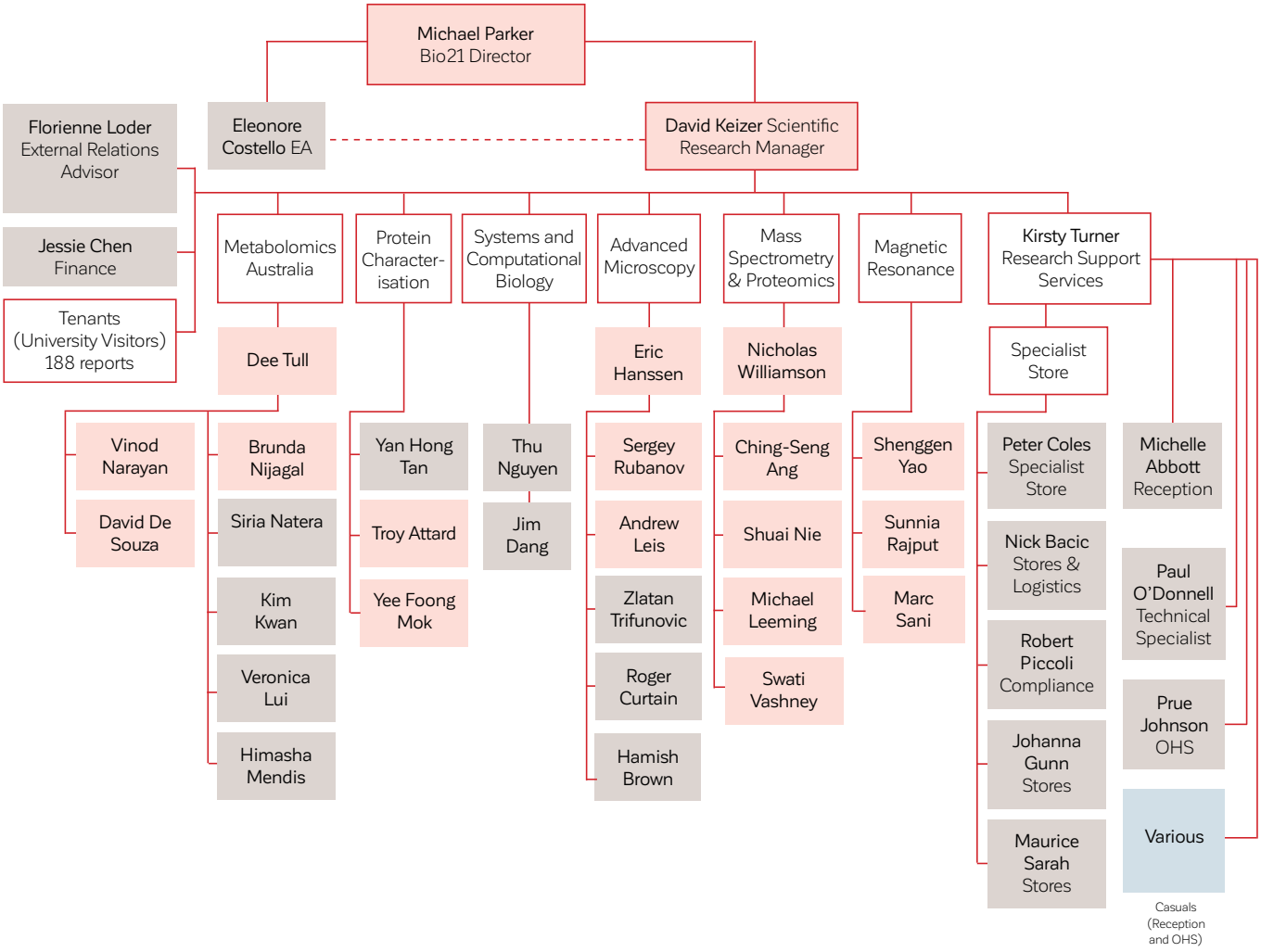
Australian Research Council (ARC) - Future Fellow:

Dr Elizabeth (Liz) Hinde, Department of Biochemistry, MDHS and School of Physics, Faculty of Science has received an ARC Future Fellowship. This is a wonderful achievement in this highly competitive environment with only 15% success rate this year.
Liz's project aims to track DNA repair factor recruitment in the nuclear landscape of a living cell and quantify the role of nucleus architecture in maintenance of genome integrity. She received $876,000 over four years to conduct her research.

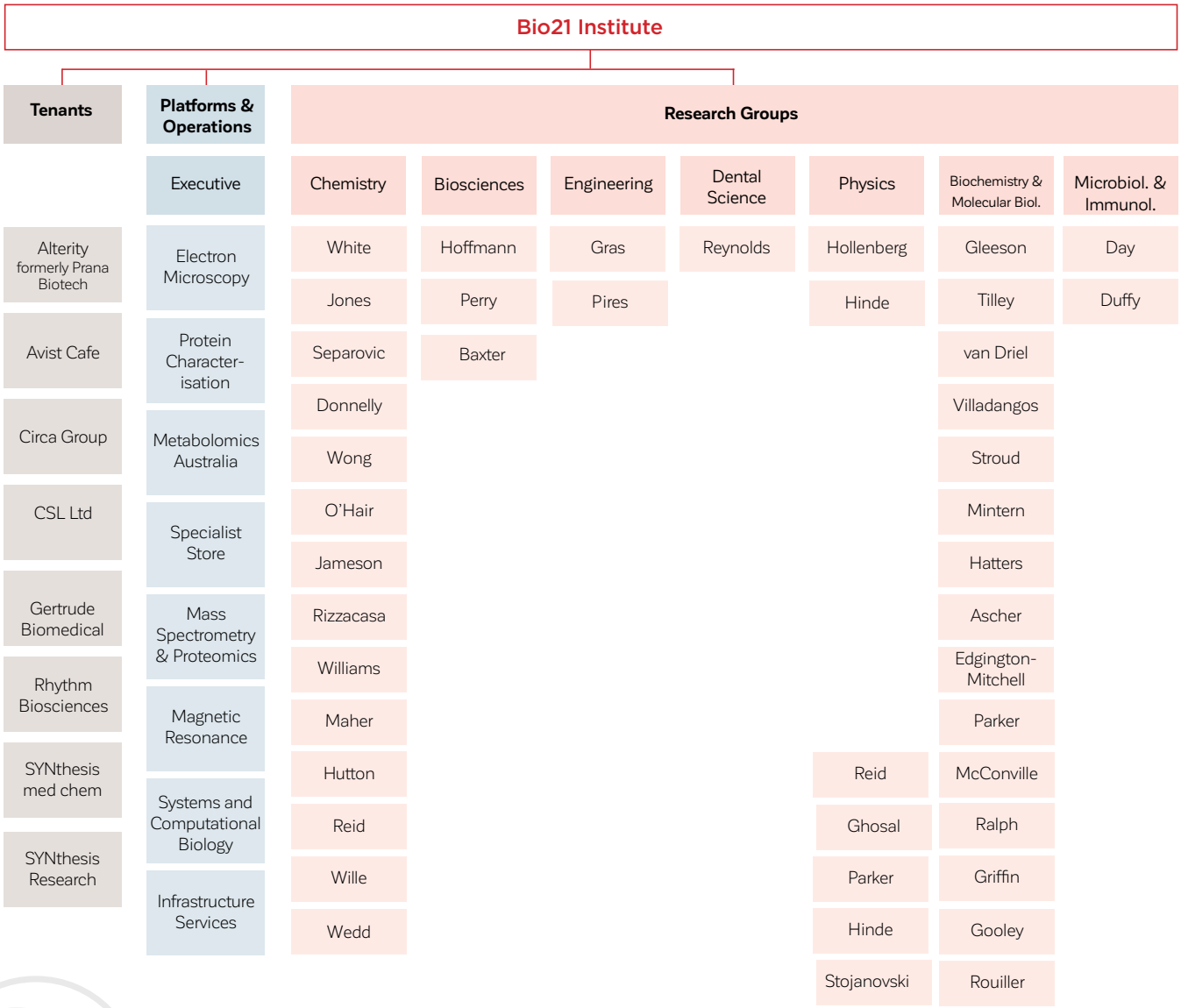
Governance


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 Malcolm McConville

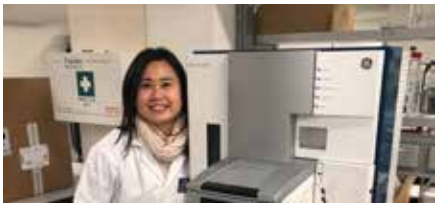
Bio21 Institute – Scientific Research Team



Bio21 Institute – Research groups

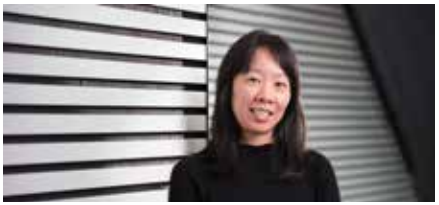
















Bio21 People

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

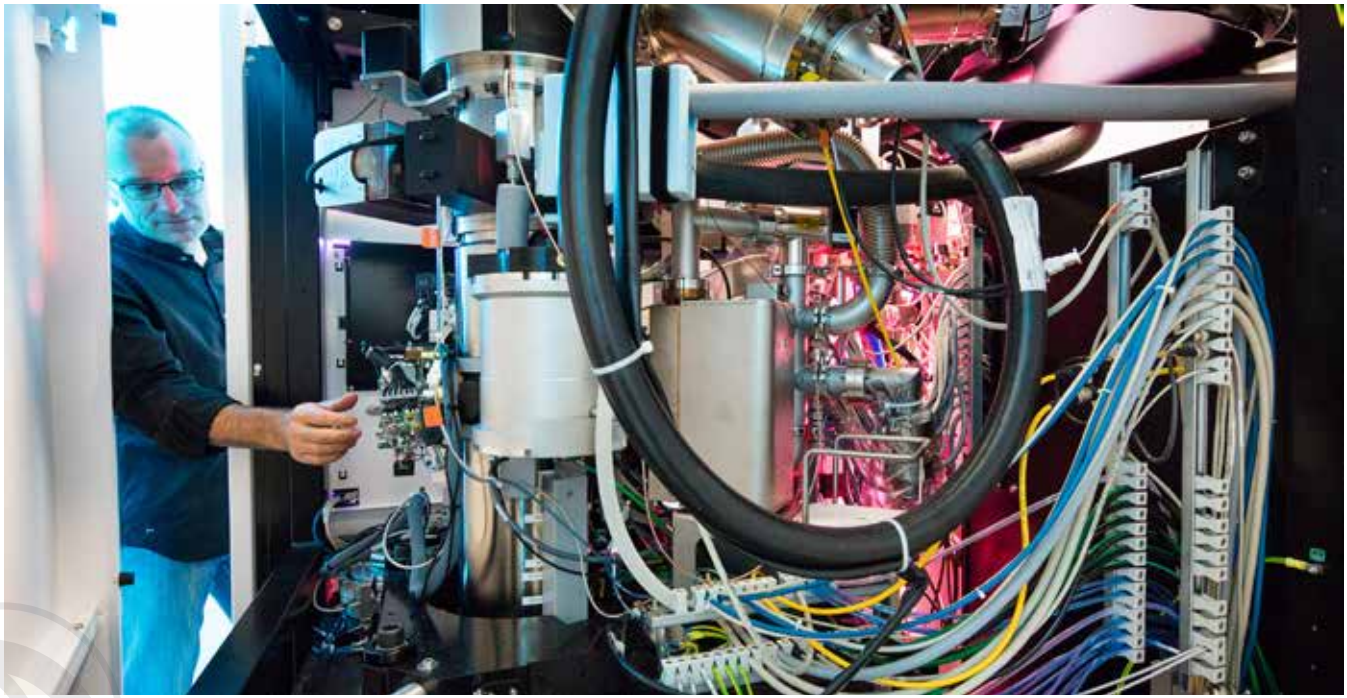
Eleonore Costello
EA to the Director and Scientific Research Manager

Michelle Abbott
Reception

Jessie Chan
Senior Management Accountant

Tony Whyte
Operations Officer

Florienne Loder
External Relations 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 Ary Hoffmann
Dr Simon Baxter
Professor Philip Batterham
Dr Trent Perry

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 Emeritus Frances Separovic
Professor Tony Wedd
Professor Jonathan White
Professor Uta Wille
Professor Spencer Williams
Dr Wallace Wong

School of Physics

Professor Lloyd Hollenberg
Dr Elizabeth Hinde

Faculty of Medicine Dentistry and Health Sciences

Department of Biochemistry and Molecular Biology

Dr David Ascher
Dr Laura Edgington-Mitchell
Dr Debnath Ghosal
Professor Paul Gleeson
Professor Paul Gooley
Associate Professor Michael Griffin
Professor Danny Hatters
Dr Elizabeth Hinde
Professor Malcolm McConville
Associate Professor Justine Mintern
Professor Michael Parker
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
Dr Douglas Pires

2020 Bio21 Steering Committee

Bio21 is overseen by a steering committee that includes the Director of the Institute, the Deans or delegates 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.

Associate Dean (Research) Medicine, Dentistry and Health Sciences

Professor Michael McGuckin

Mike McGuckin is the Associate Dean Research in the Faculty of Medicine, Dentistry and Health Sciences and has strategic oversight of a breadth of health research across the Faculty.

He is a former NHMRC Principal Research Fellow and before taking up his current role was the Deputy Director (Research) of the Mater Research Institute – The University of Queensland within the Translational Research Institute in Brisbane, where he also led an Inflammatory Disease Biology and Therapeutics Research Group.

Mike is the author of over 150 scientific publications with his research focused on mucosal infection, chronic inflammation and cancer in the gastrointestinal tract, and has held four patents. Mike's research investigated disease pathophysiology across three major fronts connected by the common thread of inflammation: cell surface mucins in cancers, chronic inflammatory diseases of the gut and beta cell stress in diabetes. He is now mentoring more emerging independent scientists who have taken over various aspects of his research program.

Mike is heavily involved in national and international peer review, has served on the Editorial Boards of four international journals, and has served as the lead member of the Academy of the Australian National Health and Medical Research Council for Gastroenterology. In addition, he is an elected Councillor and President-Elect for the International Society for Mucosal Immunology. Mike has previously served on the Board of Directors and Chaired the Medical and Scientific Committee for Cancer Council Queensland, was a member of the Research and Development Committee for the Autism Cooperative Research Centre and served on the Research Committee of the Gastroenterology Society of Australia, at the Translational Research Institute he Chaired the Facilitations Committee and served on the Research Committee and the Strategy and Commercialisation Committee. He also served for many years on the Mater Human Research Ethics Committee and the University of Queenslands Animal Experimentation Ethics Committee.

Head of School, Chemical and Biomedical Engineering, Faculty of Engineering and IT

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

Sandra Kentish

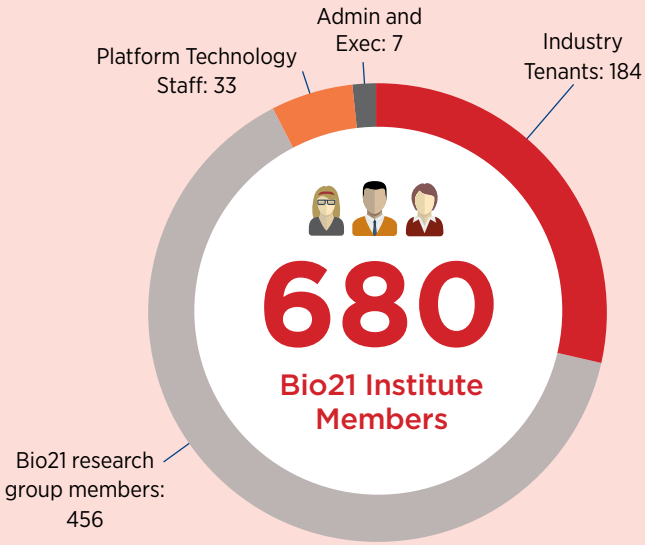
Professor Sandra Kentish is Head of the School of Chemical and Biomedical Engineering at The University of Melbourne. She is also an invited Professor at the Centre for Water, Earth and the Environment within the Institut National de la Recherche Scientifique (INRS) in Canada.

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 2020: $ 6,145,729

Total NHMRC Funding Announced in 2020: $11,037,099.1

22 Research Theses submitted

271 Publications

Events Attendees

Internal Events: ~200

External Events: ~100

Online Events: 456

Twitter: Director's Account

81,170
impressions in 2020

221
Followers by end of 2020

Twitter: Bio21 Account

982,523
impressions in 2020

3,108
Followers by end of 2020

Bio21 Institute PhD Theses submitted in 2020

Biosciences

Lab: Ary Hoffmann

Student: Marianne Coquilleau

Seasonality and community composition of parasitoid wasps of four agromyzid leafminer species (***Diptera: Agromyzidae***) in Victoria.

Lab: Phil Batterham and Trent Perry

Student: Mohamad Fakhrur Razi Ghazali

Profiling the molecular mechanisms underlying negative cross-resistance to insecticides using ***Drosophila melanogaster***

Lab: Phil Batterham and Trent Perry

Student: Felipe Martelli Soares da Silva

Systemic impacts of low dose insecticide exposures in ***Drosophila***: a mechanism centred on oxidative stress***r***

Chemistry

Lab: Paul Donnelly

Student: Hui Jing Koay
Exploiting the Gallium-Fluoride Bond in the Design of New Radiopharmaceuticals

Student: Jacob Alexander Rowan
Assessing the Efficacy of Bisdipyrrins as Ligands for ***in Vivo*** Applications in Disease

Student: Benjamin Spyrou
The Evaluation of Oxorhenium(V) and Oxotechnetium(V) Complexes for the Diagnosis of Alzheimer's Disease

Lab: Craig Hutton

Student: Tram Thao Thanh Nguyen
Total synthesis of effectors for modulating the human immune system

Student: Sadegh Shabanibalajadeh
Total synthesis of complex biologically active cyclic peptides

Student: Ameer Badri Taresh
Peptide Functionalisation Through Isoimide Intermediates

Lab: Frances Separovic

Student: Shiying Zhu
In-cell Structure Determination of an Antimicrobial Peptide by DNP solid-state NMR

Lab: Anthony Wedd

Student: Reza Tondfekr
Molecular characterization of the ATP7A protein and selected mutants

Lab: Jonathan White and Wallace Wong

Student: Sacha Novakovic
Synthesis and Photophysics of Zinc Porphyrin Based Dual Absorber-Upconverters

Lab: Uta Wille

Student: Narges Shamsaei Zafarghandi
Investigating fundamental radical reactivity in ionic liquids

Lab: Wallace Wong and David Jones

Student: Sonam Saxena
Alcohol-dispersible semiconducting polymer nanoparticle for application in organic solar cells

Biochemistry and Molecular Biology

Lab: Mike Griffin and Paul Gooley

Student: Riley Dunstan Metcalfe
A structural understanding of interleukin- 11 signalling

Student: Emily Eve Selig
Investigations of the mechanisms of action of human small heat-shock proteins against amyloid fibril formation and pre-formed amyloid fibrils

Lab: Danny Hatters and Gavin Reid

Student: Mona Radwan Ahmed Elsayed
In vitro investigation of dipeptide repeat proteins in C9ORF72-associated motor neuron disease and frontotemporal dementia

Lab: Justine Mintern and Jose Villadangos

Student: Patrick Schriek
The role of Complement and MHC in innate and adaptive immunity cooperation

Lab: Michael Parker and Michael Gorman

Student: Larissa Doughty
Discovering inhibitors of cell surface receptor function as the basis for novel therapeutics to treat cancer

Lab: Diana Stojanovski

Student: Laura Frances Fielden
Targeting the mitochondrion in Coxiella burnetii infection

Microbiology and Immunology

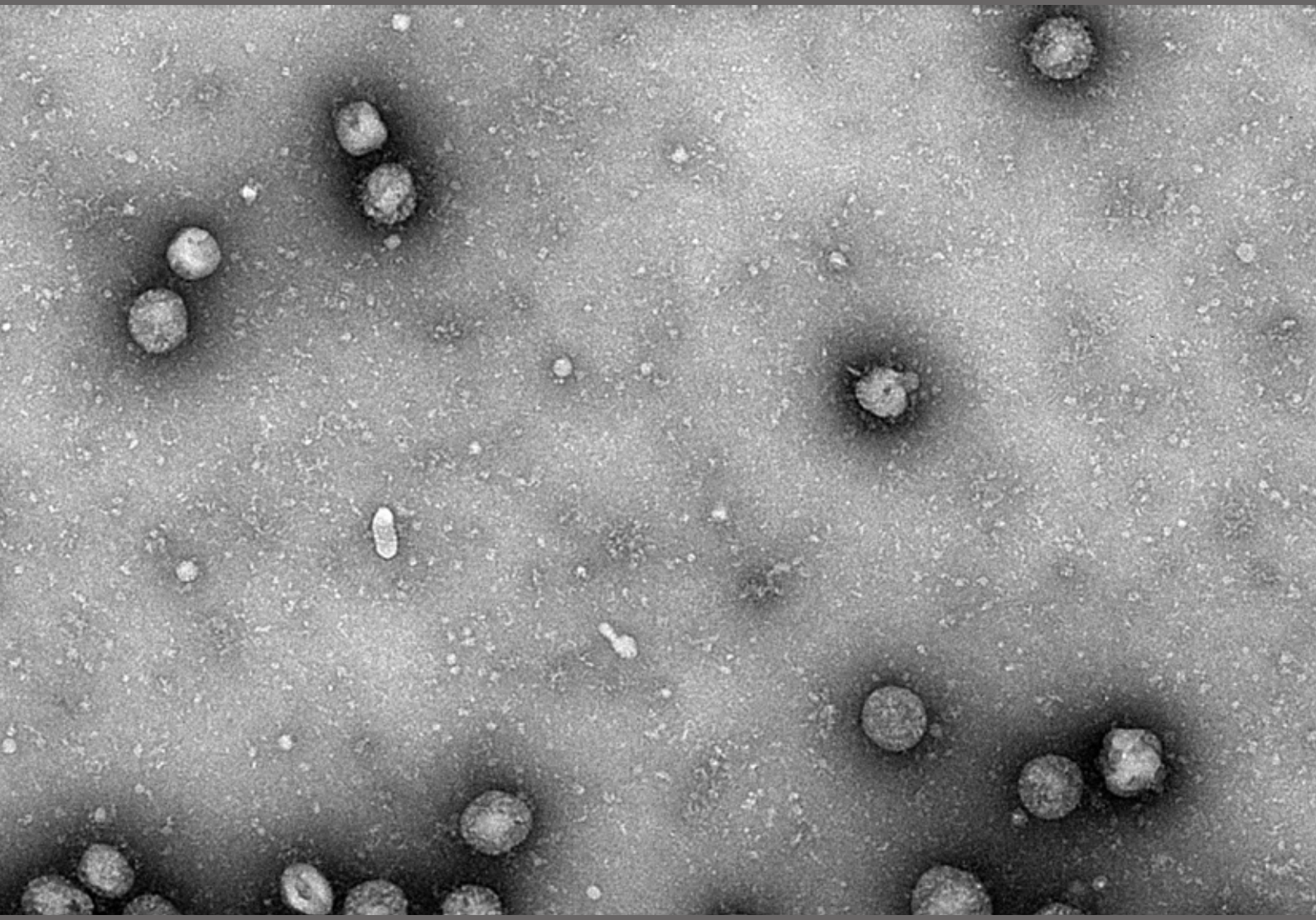
Lab: Michael Duffy

Student: Thi Hong Hanh Nguyen
Characterisation of bromodomain proteins in the malaria parasite ***Plasmodium falciparum***

Chemical and Biomolecular Engineering

Lab: Sally Gras

Student: Luke Anthony Richards
Cytochrome P450-mediated biotransformation of noscapine



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SYNthesis med chem

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