

2017

Biomolecular Interaction Centre



Research Report



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Our Mission

The Biomolecular Interaction Centre is a multi-disciplinary research centre dedicated to the study of molecular interactions critical to biological function.

Understanding these interactions is central to a range of fundamental sciences, new treatments for disease and a wide range of highly functional products.

The Centre was founded in 2007 at the University of Canterbury. It includes researchers from Canterbury, Victoria, Otago and Auckland universities, and has a growing network that includes collaborators from many of New Zealand's Crown Research Institutes, and Callaghan Innovation.

BIC has a strong and increasing network of international collaborators.

Director's Comment



Volker Nock and Renwick Dobson
Co-Directors
Biomolecular Interaction Centre

Ten years as a premier research centre

We are celebrating ten years! It seems timely to reflect on the past decade, celebrate our current position and look forward towards further significant growth.

Beginnings

The Biomolecular Interaction Centre was created by a motivated group of biotechnologists from various organisations who wished to improve regional research in the field. In 2006, the group developed a proposal to the Tertiary Education Commission (TEC) for capital equipment funding. This was strongly supported by the University of Canterbury, Plant & Food Research, the Institute of Environmental and Scientific Research, Lincoln University and the University of Otago. In 2007 BIC purchased approximately \$2M worth of capital equipment, including a surface plasmon resonance instrument, confocal microscope, isothermal nanocalorimeter and circular dichroism spectrophotometer. This equipment proved to be a major boost and has facilitated strong collaborative research and learning ever since. However, while BIC was very successful it became apparent it needed a major investment in people.

Somewhat fortuitously, in the latter half of 2009 the University of Canterbury decided to invest in the development of high quality research institutes. The aim was to take research in the University to a new level by funding the development of Centres to concentrate on world-class cross-disciplinary science research, encourage and support staff and students, and attract high quality staff and students from overseas. The Centres also had a mandate and obligation to take ideas into the wider community.

After success in what was a very competitive bidding process, BIC became

a full research institute on 1 April 2010, led by co-Directors Professors Juliet Gerrard and Conan Fee, with Adjunct Professor Bill Swallow focused on translation and commercialisation. Dr Susie Meade was appointed as Research Programmes Leader from 2010 until 2015. Rebecca Hurrell took on the role of Institute Manager in July 2016.

Dr Volker Nock and Associate Professor Renwick Dobson became co-Directors in 2017.

Linking with industry

In 2013 Industrial Research Limited negotiated with BIC and the University to co-locate a team of scientists within BIC. Now part of Callaghan Innovation, this Protein Science and Engineering Team has brought vast expertise to BIC and UC. This has been a highly collaborative and mutually beneficial arrangement.

A national focus

BIC has worked hard over the past ten years to grow a national network. Three of its nine Principal Investigators are now based at other New Zealand institutions. Professors Juliet Gerrard and Anthony Poole are at the University of Auckland and Professor Emily Parker is at Victoria University of Wellington. In early 2018, Associate Professor Paul Gardner will move to the University of Otago.

The remaining five PI's are based in four academic departments across UC's Colleges of Science and Engineering. Professor Conan Fee has moved recently from the Department of Chemical and Process Engineering to establish a new School of Product Design. Associate Professor Renwick Dobson and Dr Grant Pearce are based in the School of Biological Sciences. Dr Volker Nock is in the Department of Electrical and Computer Engineering and Professor Antony Fairbanks is based in the newly established School of Physical and Chemical Sciences.

Many new Associate Investigators have joined BIC and this has seeded a multitude of new collaborations. We look forward to seeing these develop and grow into larger externally funded research projects. BIC has also developed an international reputation that it nurtures by creating a pathway for international visitors to reside in the Centre and spark new ideas and further international connections.

BIC today

BIC successfully occupies a niche specialisation in the cross-disciplinary area of biotechnology, specifically targeting biomolecular interactions as the key to understanding and manipulating biological function. Biotechnological applications arising from understanding biomolecular interactions, both *in vivo* and *in vitro*, are enormous and cross many discipline boundaries.

Thus, BIC now brings together researchers and students from biochemistry, chemistry, chemical and biomolecular engineering, food science, veterinary science, agriculture, mathematics and modelling, visualisation, genetics, material physics and nanotechnology.

The strength of BIC is its focus on fundamental science, with strong links into applications-based research and implementation pathways. It has become self-sustaining by attracting significant external research funding each and every year. We have maintained a significant cohort of summer students, postgraduates and postdoctoral fellows.

BIC has established some funding priorities. We currently support up to two new postgraduate scholarships annually and invest strategically in short-term postdoctoral fellows to maximise research outputs. We seed fund new research with grants of up to \$10,000 each, with an emphasis on funding projects that are collaborative and initiate a pathway to external grants. We

provide travel support to UC-based PI's and contribute significant funding to research projects via our flagships.

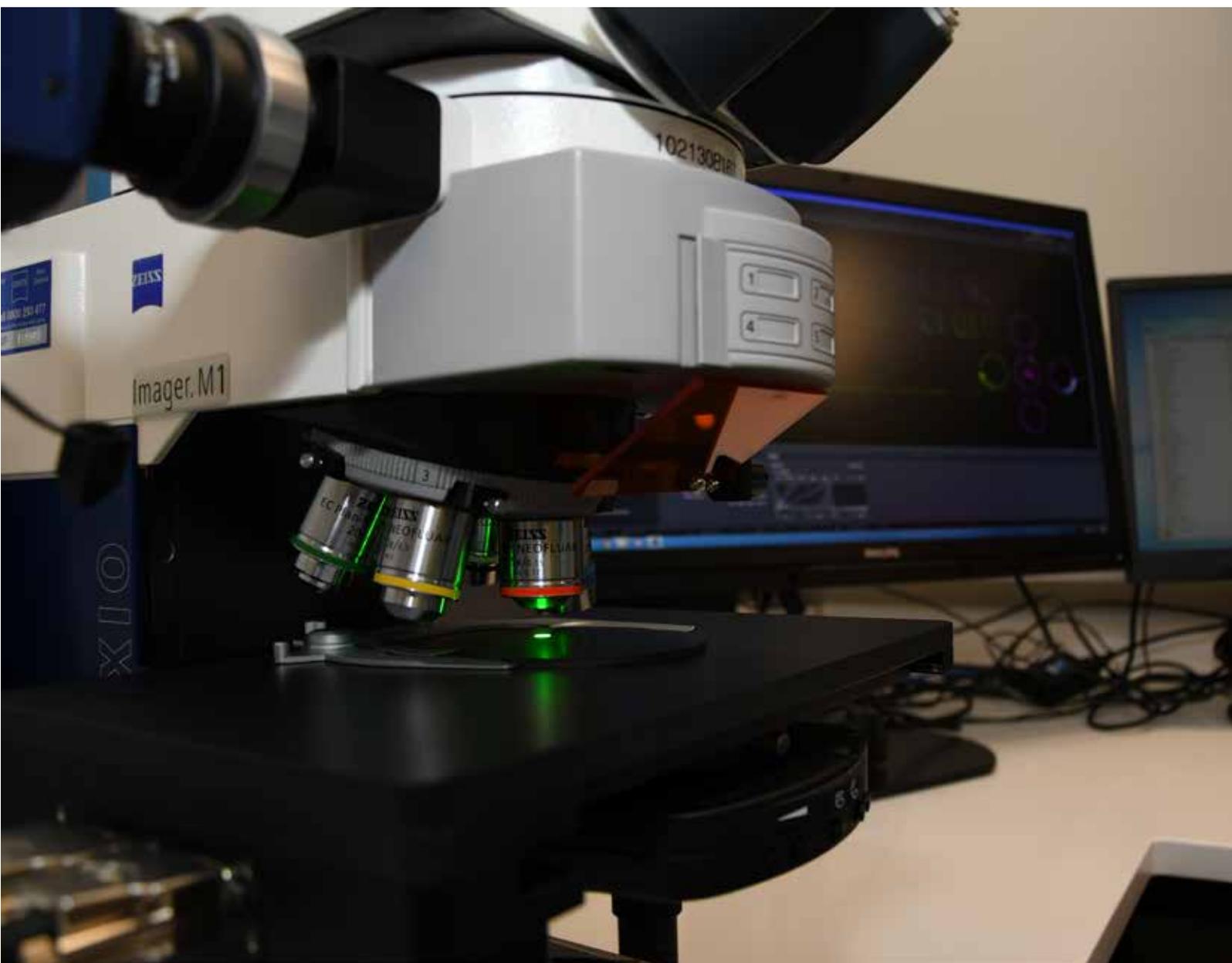
We have continued engagement across our network by holding up to three symposia a year. This is an opportunity to disseminate BIC research, create new linkages and foster collaboration.

As of November 2017 we were managing 36 external research grants, including three newly funded MBIE Smart Idea's projects and a Marsden Fast-Start.

After a decade, the Biomolecular Interaction Centre has established itself as a premier research institute at the University of Canterbury and we expect the next ten years will be just as exciting.

Volker Nock

Renwick Dobson





Michal Bernach, PhD Candidate, Biomolecular Interaction Centre and School of Biological Sciences, University of Canterbury

Income

Biomolecular Interaction Centre income (all sources)

	2013	2014	2015	2016	2017*
Research budget					
External Reserach Income	\$2,467,186	\$2,911,487	\$3,359,533	\$2,301,979	\$1,165,499
Research Expenditure	\$2,402,033	\$2,958,996	\$3,362,568	\$2,281,940	\$1,165,499
Operational budget					
Overhead Income	\$307,584	\$385,252	\$391,410	\$355,900	\$136,762
PBRF Income	\$77,719	\$125,426	\$209,807	\$275,780	\$288,434
Other Income	\$492,309	\$404,813	\$463,478	\$411,181	\$451,136
Total income	\$877,612	\$915,491	\$1,064,695	\$1,042,861	\$876,332
Operational Expenditure	\$1,227,558	\$894,650	\$882,047	\$870,807	\$984,344
Surplus (Deficit)	(\$349,946)	\$20,842	\$182,648	\$172,054	(\$108,012)**

*Forecast as at 31 October 2017. **Deficit forecast based on reversal of overhead income over multiple years, realised in 2017.

BIC's
external
revenue has
remained
significant

Flagship One

Evolving and Engineering Biomolecules

Flagship Leader: Associate Professor Renwick Dobson

Under this flagship theme, we are exploring fundamental questions of how molecules evolve, function and interact. We are focused on harnessing biomolecular interactions, creating enzymes with novel properties, rewiring cells to produce biomolecules in short supply, utilising long-term evolution experiments to better understand structure, function and evolution and mining evolutionary diversity for new function.

Flagship highlights

Biomedical Symposium

A half-day symposium, in collaboration with the University of Otago, Christchurch School of Medicine, was held in September. This brought together leading researchers in the biomedical sciences (the application of the biological sciences, especially biochemistry, molecular biology and genetics, to the understanding, treatment and prevention of human disease).

MBIE Smart Ideas success : Development of a simple, general and novel assay platform for detecting and quantifying analytes in non-laboratory settings.

This proposal, led by BIC PI's Volker Nock, Conan Fee and Renwick Dobson, along with Neil Pattinson, builds on their recent demonstration of peptide fibrils that reversibly form hydrogels, creating "stimuli responsive hydrogel membranes". Using this technology, the team will develop a novel assay platform with broad application due to its simplicity, ease of use, and temperature tolerance. This will allow screening tests to be undertaken in remote and adverse environments by relatively untrained users. There is an urgent need for cheap and effective screening devices that can be used in non-clinical settings. Diabetes is a good example, due to its rapidly expanding population incidence. Glycated haemoglobin is an accepted and universal biomarker for diabetes. They will aim to produce a proof-of-concept assay device for glycated haemoglobin to test our technology. This simple assay will monitor the passage of blood through a "stimuli responsive hydrogel membrane", which is dependent on the concentration of glycated haemoglobin.

Future development of the platform will seek to develop simple assay test solutions to address water testing issues in remote areas and "pen-side" testing for animal diseases. To inform the engineering and design of the assay platform they first need to understand how the peptide self-assembles into hydrogels and how we can control reversible assembly and disassembly.

Other highlights

Protein and modification characterisation by intact and semi-intact protein mass spectrometry

Mass spectrometry is a key technology for researchers involved in protein science. It allows identification of primary sequence, quantitation of proteins/peptides, and characterisation of side chain modifications.

Traditional protein mass spectrometry takes a deconstructionist or bottom-up approach, where a protein is first enzymatically digested into smaller peptides. These are characterised by mass spectrometry, after which the protein puzzle is pieced together. There are good technical reasons for this approach, however in the process any information about the protein's original state is lost. BIC AI's Stefan Clerens, Antonia Miller and PI Ren Dobson have embarked on a collaborative project to put in place enabling methodology for intact (top-down) and semi-intact (middle-up/middle-down) protein mass spectrometry that includes characterisation by fragmentation of the protein.

Full-spectrum bacteria: Fluorescent promoter-reporter plasmids for constitutive labelling of bacteria and whole-cell bacterial bioreporters

A team of BIC researchers, led by Mitja Remus-Emsermann, have undertaken a project funded by a BIC seed grant to generate a suite of genetic constructs that can be used in multiple ways for synthetic biology purposes. Relying on fluorescent protein technology, the team have produced a total of 26 genetic constructs so far, so called plasmids, which confer one of eight different fluorescent colours in conjunction with four different combinations of antibiotic resistance markers.

This initial set of plasmids can be used to track differentially labelled bacteria using microscopy *in situ* to determine micrometer scale behaviour. The team are in the process of extending this toolbox with different plasmids that can be integrated into the genome of bacteria so that they can be maintained without antibiotic pressure. This will yield a set of 96 plasmids that are suitable to literally light up different bacterial species, ranging from nasty plant and human pathogens to biocontrol bacteria that keep plants and humans healthy. Their next step is to test the genetic constructs in a broad range of bacteria.

Insights into bacterial sensor proteins

This project is a new collaboration between BIC AI Dr Monica Gerth, University of Otago, BIC PI Ren Dobson, and BIC MSc. student Anna Smith. Their combined expertise in the areas of microbiology and structural biology is being directed towards exploring particular types of bacterial sensor proteins – chemoreceptors. Chemoreceptors are biomolecules that are promising scaffolds for engineering biosensors; however there are currently huge gaps in our understanding of how these molecules function. Furthermore, the sensor domains of these proteins are known to undergo rapid evolution compared to other proteins. This project will allow the teams to explore the structural consequences of the rapid evolution/expansion/diversification of these biomolecules.

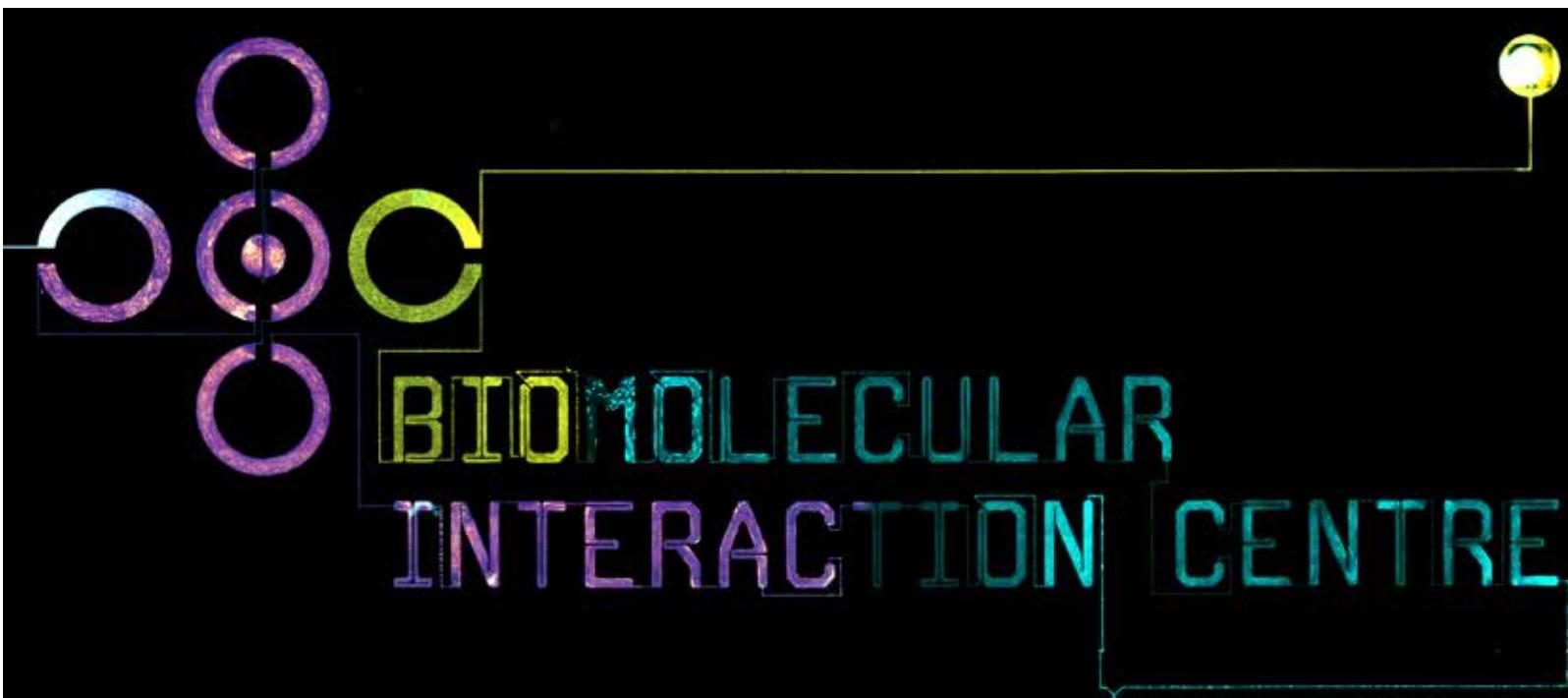
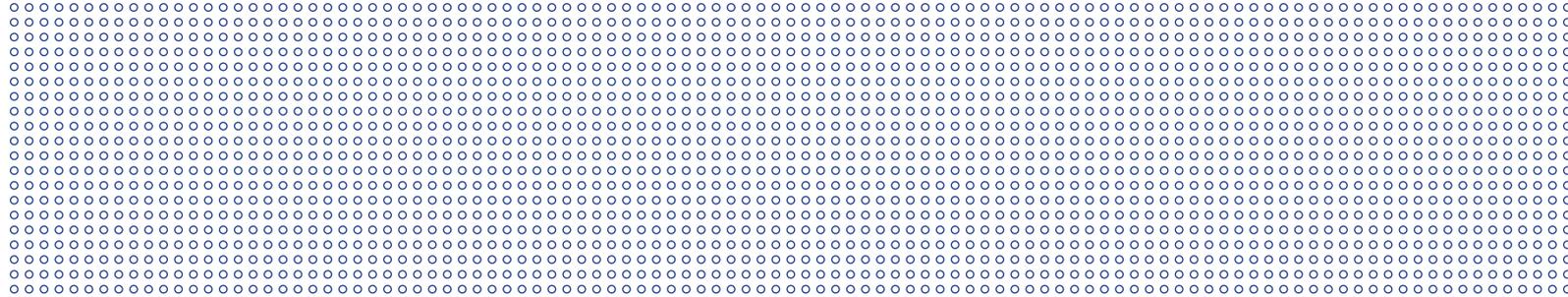


Figure 1 Example of three different bacterial strains expressing a cyan, yellow or red fluorescent protein respectively in a microfluidic device. This was the result of collaboration between the BIC PI Dr Volker Nock, Postdoctoral Fellow Dr Rebecca Soffe, BIC AI Dr Mitja Remus-Emsermann and doctoral student Rudolf Schlechter.

Flagship funding

AI's Dr Stefan Clerens, AgResearch and Dr Antonia Miller, Callaghan Innovation, and PI Renwick Dobson received \$10,000 of seed funding for their project *protein and modification characterisation by intact and semi-intact protein mass spectrometry*.

AI Dr Mitja Remus-Emsermann received \$10,000 of seed funding for his project *full-spectrum bacteria: fluorescent promoter-reporter plasmids for constitutive labelling of bacteria and whole-cell bacterial bioreporters*.

AI Dr Monica Gerth, University of Otago, and PI Associate Professor Ren Dobson received seed funding of \$7,600 for their project looking at *structural insights into bacterial sensor proteins*.

BIC Postdoctoral Researcher Dr Dorien Coray, along with PI Paul Gardner and AI Mitja Remus-Emsermann, received \$9,951 seed funding for their project looking at *visualizing RNA and protein dynamics at the single cell level for optimization of gene expression across microbial populations*.

AI Dr Mitja Remus-Emsermann received \$4,000 of flagship funding to attend QMB and purchase consumables, as well as to top up a doctoral scholarship.

BIC Postdoctoral Researcher Dr Dorien Coray received flagship funding to attend and speak at QMB on BIC-supported research.

Funding success

PI Associate Professor Paul Gardner has secured \$1,000,000 of MBIE Smart Idea's funding for his project looking into *building bioinformatic software for controlling protein expression*. This project is a collaboration between Paul and Callaghan Innovation's UC-based Protein Science and Engineering Team.

BIC postdoctoral fellow Dr Jennifer Crowther has been awarded \$100,000 from the Canterbury Medical Research Foundation to carry out her own independent research into developing a bioassay for angiotensinogen to identify women prone to pre-eclampsia.

PI's Associate Professor Ren Dobson and Professor Conan Fee have secured further funding from the Riddet CoRE to support projects related to complexity in food systems. In addition to PI funding of \$123,000, they have secured funding for a new PhD student (Amanda Board) to develop tools that will allow us to explore protein behaviour in complex foods. The work will be co-supervised by BIC AI Professor Geoff Jameson (Massey University).

PI Associate Professor Ren Dobson obtained \$46,992 of funding from the Lotteries Health Research Fund towards the purchase of a new AKTA Pure FPLC instrument.

Flagship Two

Engineering Biotechnology

Flagship Leader: Dr Volker Nock

This flagship brings together rapid prototyping and advanced manufacturing technologies from the engineering disciplines to help inform molecular and cellular life sciences. To achieve this, the flagship incorporates a diversity of input from the physical sciences and engineering with the aim to develop new platforms that help unravel the complexity of biology.

We work with cells, animals and plants and our research spans the biological hierarchy from molecules to whole organisms. We are focused on the following broad areas of activity: 3D printed devices for bioseparations, biomolecular interactions on surfaces, biomolecular interactions related to disease, biochemistry on chips and sourcing of advanced materials from nature's pantry. In a drive to increase cross-disciplinary research, several major projects are currently being funded under this flagship.

Flagship highlights

A half-day symposium will be held in November to celebrate our Engineering Biotechnology flagship and ten years of BIC.

MBIE Smart Ideas success : A simple, general and novel assay platform for detecting and quantifying analytes in non-laboratory settings.

This successful MBIE Smart Idea's proposal, led by BIC PI's Volker Nock, Conan Fee and Renwick Dobson, along with Neil Pattinson, builds on their recent demonstration of peptide fibrils that reversibly form hydrogels, creating "stimuli responsive hydrogel membranes". Using this technology, over the next three years the team will develop a novel assay platform with broad application due to its simplicity, ease of use, and temperature

tolerance. This will allow screening tests to be undertaken in remote and adverse environments by relatively untrained users.

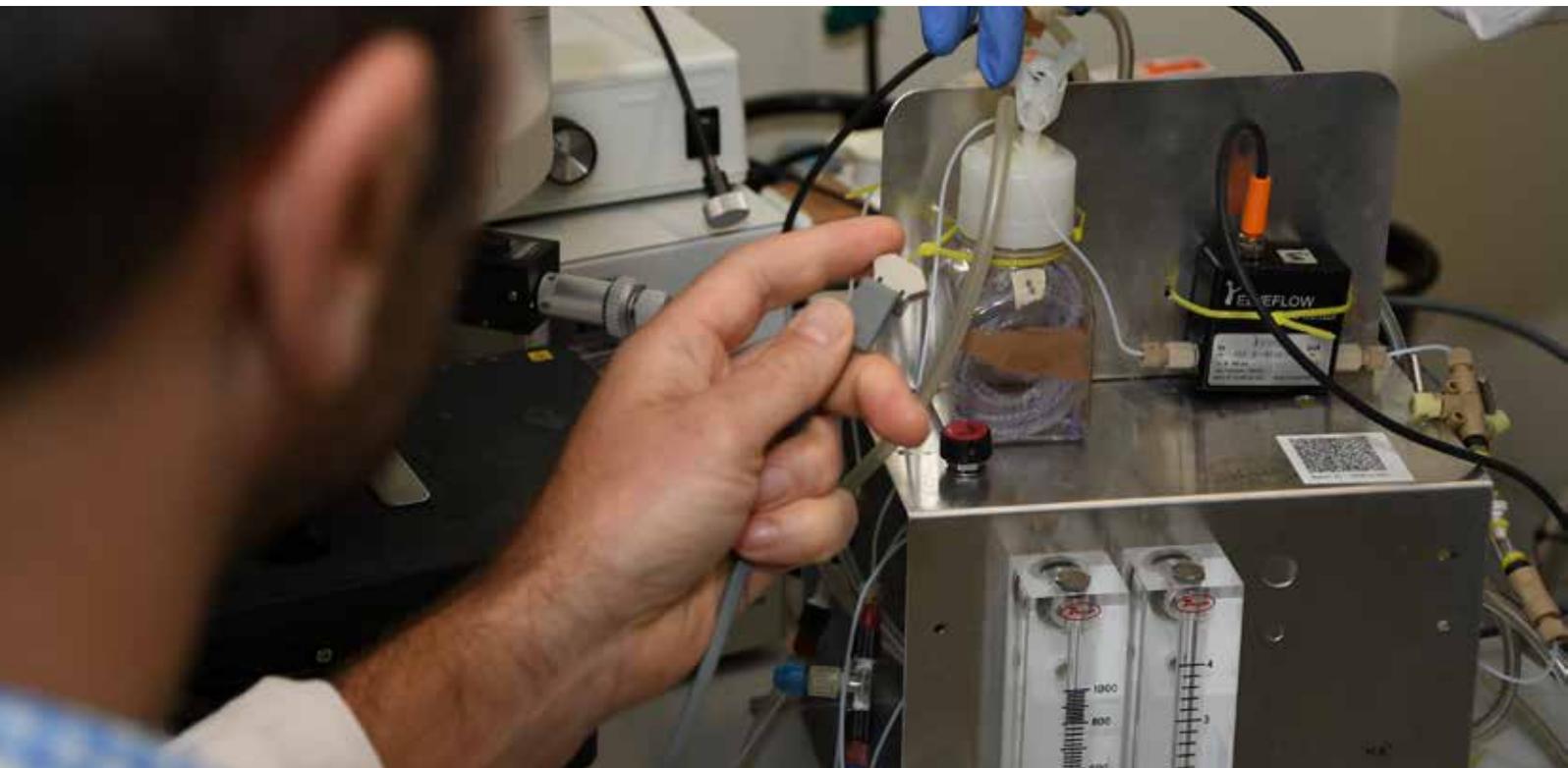
There is an urgent need for cheap and effective screening devices that can be used in non-clinical settings. Diabetes is a good example, due to its rapidly expanding population incidence. Glycated haemoglobin is an accepted and universal biomarker for diabetes. They will aim to produce a proof-of-concept assay device for glycated haemoglobin. This simple assay will monitor the passage of blood through a "stimuli responsive hydrogel membrane", which is dependent on the concentration of glycated haemoglobin.

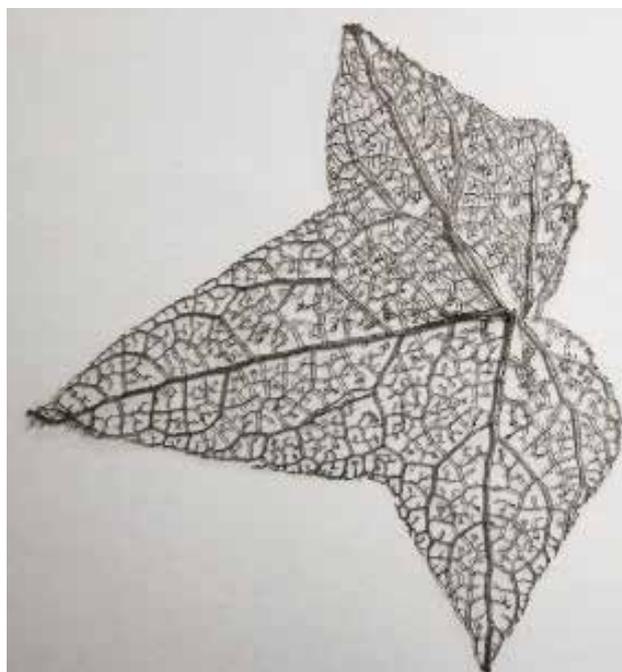
Future development of the platform will seek to develop simple assay test solutions to address water testing issues in remote areas and "pen-side" testing for animal diseases.

The project also involves BIC AI Dr Jane Allison, of Massey University, Albany, and Wellington-based aptamer development company AuramerBio.

Perfusable microvascular networks on-chip inspired by nature

Postdoctoral Fellow Dr Rebecca Soffe, in the group of PI Volker Nock, has been studying *perfusable microvascular networks on-chip inspired by nature*. The project looked at developing a platform to investigate microvascular networks, using recent developments in fabrication technology (hydrogels), taking inspiration from nature (leaves). This enabled the investigation of various microenvironmental factors influencing cell behaviour to be investigated, such as shear stress, chemical stimulation, nutrient supply, and oxygen (depletion to saturation).





The resulting ivy leaf photomask (left), produced by depositing a thin film of chrome onto the leaf nervature coated with photoresist, and (right) the microfluidic platform, filled with four different dyes.

Flagship funding

PI Conan Fee and AI Tim Woodfield, along with BIC Postdoctoral Fellow Tim Huber have been awarded a postgraduate scholarship covering fees and a \$25,000 per annum stipend for three years for their project *developing highly vascularized 3D printed tissue scaffolds for soft tissue replacement*.

Dr Rebecca Soffe was awarded \$7,750 of seed funding for her project looking at *perfusable microvascular networks on-chip inspired by nature*.

BIC AI Dr Gabriel Visnovsky was awarded \$5950 to support PhD student Daniel Smith to travel to Almeria, Spain to attend the University of Almeria for two months. Daniel worked with the Department of Chemical Engineering in the microalgae group on the construction of tubular photobioreactors and their operation on lab, pilot and semi-commercial scale. He attended a one-month international course on microalgae bioprocesses.

AI Dr Monica Gerth, University of Otago, and PI Ren Dobson received seed funding of \$7,600 for their project looking at *structural insights into bacterial sensor proteins*.

Funding success

PI's Ren Dobson, Conan Fee and Volker Nock, along with Neil Pattinson, AurimerBio and Massey University's Jane Allison, have secured \$1,000,000 of MBIE Smart Ideas funding for their project to develop a simple, general and novel assay platform for detecting and quantifying analytes in non-laboratory settings.

BIC AI Dr Mitja Remus-Emsermann, in collaboration with Dr Volker Nock, was awarded a Marsden Fast-Start for a project looking at using synthetic communities to visualise bacterial plant leaf community development and pathogen invasion processes at the single-cell resolution. The two were also successful in securing UC Doctoral Scholarship funding for *artificial leaf surface development as a surrogate for microbial colonization of plant leaves*.

PI Conan Fee has been awarded \$158,800 over the next two years to work on a Scion-led Smart Idea's project looking at *sequestering natural and anthropomorphic trace metals from water*. This project is in collaboration with recent New Zealand start-up company Ligar Polymers and the University of Surrey (UK).

BIC AI Pete Gostomski of UC's Department of Chemical and Process Engineering has been awarded \$945,000 of Marsden funding to lead a project looking at *removing nitrate from contaminated water using methane*.

BIC AI Dr Aaron Marshall, in UC's Department of Chemical and Process Engineering is an investigator on a Marsden project led by Professor Alison Downard looking at *tailored environments for highly active and stable electrocatalysts*.

BIC AI Dr Laura Domigan, School of Biological Sciences, University of Auckland has led a successful proposal to secure \$1,000,000 in MBIE funding for her Smart Idea looking at *lens protein adhesives for use in ocular surgery*. The project also brings in BIC PI Professor Juliet Gerrard, (School of Biological Sciences, University of Auckland) and Professor Trevor Sherwin (Faculty of Medical and Health Sciences, University of Auckland).

PI Volker Nock was successful in securing MacDiarmid Institute PhD scholarship funding with Prof. Maan Alkaiis on the *development of flexible microdevices for characterization of the role of bionanomechanics in cancer*, and with Dr Jenny Malmström on the *design and characterisation of stimuli-responsive hydrogel biointerfaces*.

Flagship Three

Chemical Biology

Flagship Leader: Professor Antony Fairbanks

Chemical Biology involves the application of chemical techniques, tools, methods of analysis and often compounds produced by synthetic chemistry to the study and manipulation of biological systems.

The vast majority of world-leading chemistry departments now have a strong research presence in the chemical biology field, as the underpinning tools of synthetic organic chemistry are applied directly to contemporary biological problems.

The creation of this flagship aims to synergise synthetic chemistry capabilities, both at UC and elsewhere in New Zealand, with topical and interesting biology problems. In particular, the aims are to use synthesis and a wide variety of other chemical techniques to further our understanding of and to modulate highly complex biomolecular interactions.

Flagship Highlights

Chemical Biology Symposium

A half-day symposium was held in April to launch this new flagship which attracted ~80 attendees. Speakers included scientists from the Ferrier Research Institute at Victoria University of Wellington, the University of Auckland, the University of Otago, and Massey University.

Mutating an enzyme substrate to test a catalytic mechanism

This project, undertaken by BIC Postdoc Dr Rachel North, BIC AI Dr Phillip Rendle, and BIC PI's Professor Antony Fairbanks and Associate Professor Ren Dobson, is testing a hypothesis concerning the mechanism of the enzyme N-acetylmannosamine-6-phosphate 2-epimerase. The team aims to probe the enzyme's mechanism by the synthesis and investigation of a modified substrate (N-acetylmannosamine-6-phosphate) in which the C5 hydroxyl group has been methylated (Figure 1).

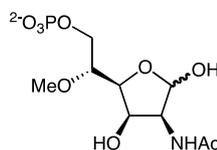


Figure 1. The substrate analogue of N-acetylmannosamine-6-phosphate in which the C5 hydroxyl is now a methyl ether.

The enzyme was successfully purified, and kinetic studies are currently underway to test whether the substrate analogue is an inhibitor. This kinetic assay requires the coupling of four enzymes, which ultimately results in the turnover of NADPH, the concentration of which can be followed at 340 nm.

The team have also successfully produced protein crystals that have been co-crystallized with the substrate analogue to assess its binding mode. These crystals will be taken to the Australian Synchrotron in December for data collection.

Given progress so far we can estimate that the project will result in at least two manuscripts, co-authored by members of BIC, UC, and the Ferrier

Institute. Ultimately, this project has developed closer interactions between these institutes, with the potential to open up new opportunities for funding in the future.

MBIE success: Manufacture of structure-optimised homogenous glycoprotein therapeutics

Glycoproteins are amongst the world's most valuable commercial products. In 2015, the combined global market for protein therapeutics was already a staggering US\$174 billion, and this is predicted to rise to ~US\$250 billion by 2020. A very significant proportion of these proteins are glycoproteins, i.e. proteins with sugars covalently attached (predominantly N-glycans), and these sugars are vital for their *in vivo* activity. However current methods for manufacturing glycoproteins are extremely expensive, time-consuming, and invariably produce inseparable mixtures of products (glycoforms), only a fraction of which may display the desired activity. All current glycoproteins are sold as complex mixtures of materials.

BIC PI Professor Antony Fairbanks has a vision to develop a totally novel approach to making glycoproteins. With \$1,000,000 of funding from MBIE for his Smart Ideas proposal he will work alongside Drs Antonia Miller and Craig van Dolleweerd of Callaghan Innovation's UC-based Protein Science and Engineering Team on objectives that are three-fold:

- To develop a process that will produce pure glycoprotein products.
- To precisely select the structure of the carbohydrate component to optimise function.
- To significantly reduce the overall manufacturing costs by increasing production efficiency and yields.

New analytical capabilities - High Performance Anion Exchange Chromatography (HPAEC-PAD)

BIC recently purchased a Dionex ICS 5000: a high performance anion exchange chromatography system. This analytical facility allows the high-resolution analysis and separation of anions. The detector system used is electrochemical (pulsed amperometric detection, PAD, sometime also called pulsed electrochemical detection, PED), and so is extremely sensitive; significantly more so than typical HPLC detectors.

A wide variety of different columns are available for use with the system, which allow a very broad range of analytical applications.

In addition to anions, as the eluent used is sodium hydroxide, weakly acidic organic compounds, such as reducing sugars are also very amenable to analysis. The ICS system is therefore capable of mono-, oligo-

and polysaccharide analysis and profiling, and finds applications in disciplines as disparate as Glycobiology and Food Science.

Flagship funding

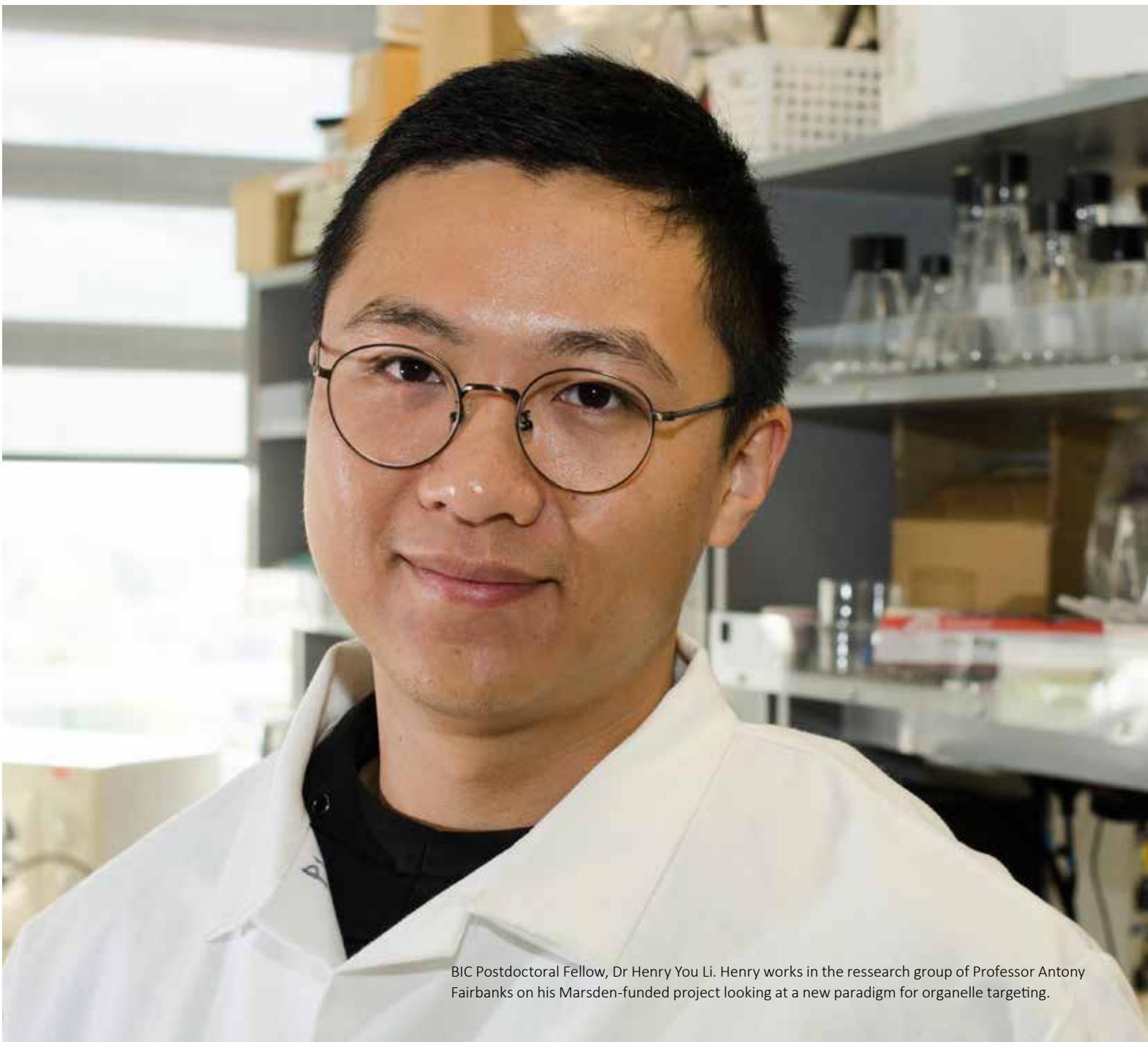
BIC Postdoc Dr Rachel North and BIC AI Dr Phillip Rendle of the Ferrier Institute of Wellington, along with BIC PI's Antony Fairbanks and Ren Dobson, were awarded \$10,000 for their collaborative project looking at *mutating an enzyme substrate to test a catalytic mechanism*.

New BIC AI's Dr Tim Allison and Dr Jodie Johnston were awarded \$7,000 each to help establish their research

groups at the University of Canterbury. Both will shortly take up permanent academic positions in UC's newly established School of Physical and Chemical Sciences.

Funding success

PI and Flagship leader Professor Antony Fairbanks was successful in securing funding (\$1,000,000) for an MBIE Smart Idea to study the *manufacture of structure-optimised homogenous glycoprotein therapeutics*. This research program will be undertaken in collaboration with Callaghan Innovation's UC-based Protein Science and Engineering Team.



BIC Postdoctoral Fellow, Dr Henry You Li. Henry works in the research group of Professor Antony Fairbanks on his Marsden-funded project looking at a new paradigm for organelle targeting.

Flagship Four

From Interaction to Application

Flagship leader: Dr Antonia Miller

We have continued to build on our ability to take ideas from the research laboratory into the real world by continuing to progress initiatives to support the evaluation of current and future research in the context of application to industry. Three new MBIE Smart Ideas proposals were funded in the 2017 round, meaning we now have considerable momentum in this Flagship. We have also continued our run of success with UC's Tech Jumpstart competition.

Tech Jumpstart

Tech Jumpstart is a competition run by the University of Canterbury. It provides researchers with the opportunity to transform their ideas and research into commercial reality. In 2017 BIC PI's and AI's were involved in three of the five winning entries. Each winning entry receives \$20,000 of KiwiNet funding and further commercialisation support. The projects are described below:

High-performance printed heat exchangers

BIC PI Professor Conan Fee from the School of Product Design, and BIC Postdoctoral Fellow Dr Tim Huber in Chemical and Process Engineering won for their 3D printed heat exchangers; an original class of heat exchangers that could be a game changer in design and efficiency. Using 3D printing technology, they offer new possibilities in fields including motorsport, air conditioners or laptop processors where cooling can take place faster in radical new shapes while providing increasingly important reductions in weight.

Laser detection of nitrates in waterways and soils

BIC AI Dr Deborah Crittenden, along with Associate Professor Sally Gaw, both from the School of Physical and Chemical Sciences, have won for their innovative laser detection tool, that has the ability to measure nitrates in the field using both soil and water samples. It promises to be portable and cost-effective with a low-environmental impact and the capability of selecting only nitrates from the sample, avoiding other deposits or substances with similar structures. With the introduction of new legislative caps on nitrogen discharge, a portable measuring tool would enable farmers to conveniently measure nitrate levels on the farm, helping them to keep discharges within the new limits. Technology incubator Astrolab will provide an additional \$35,000 worth of practical services to this project.

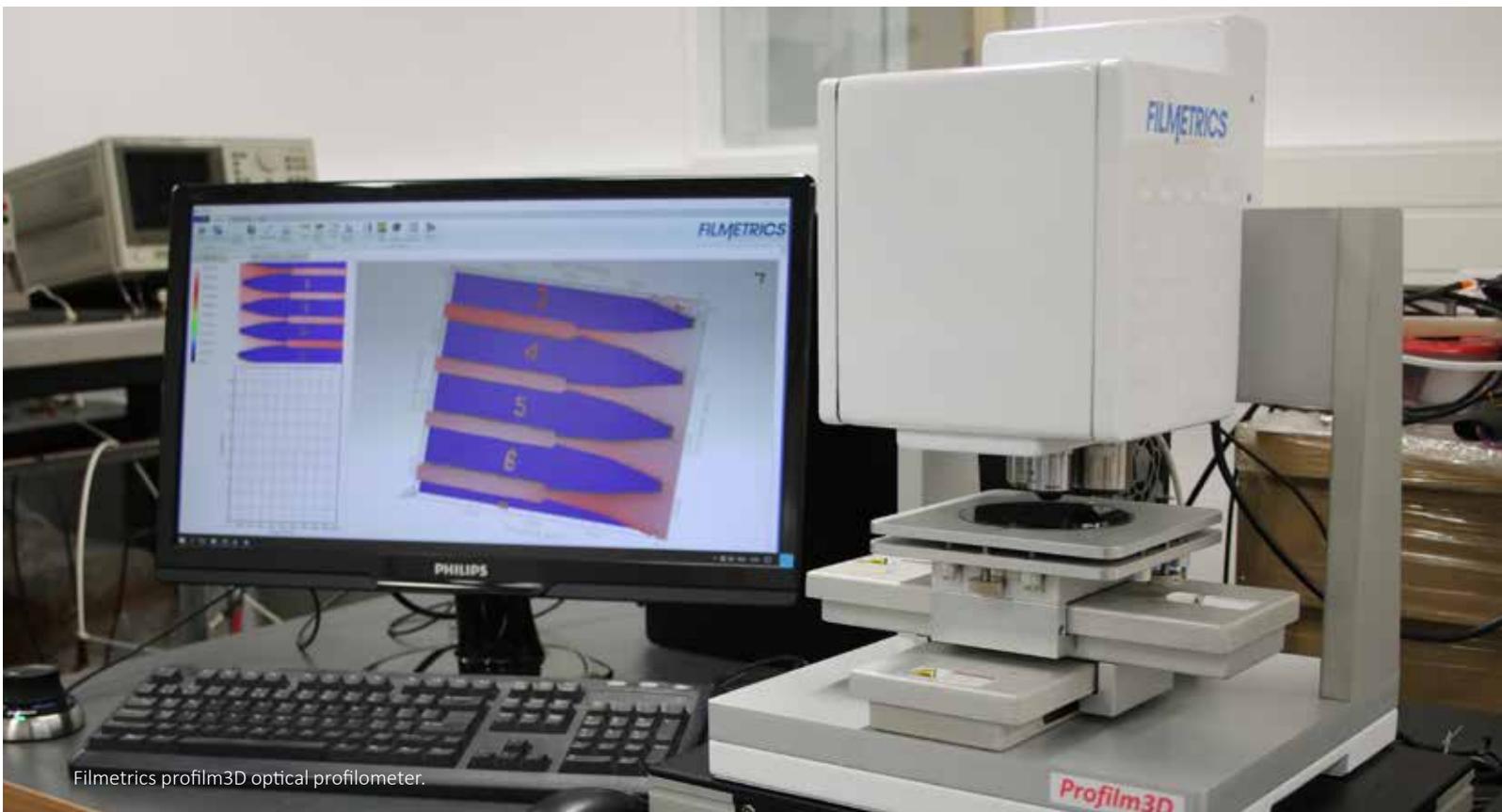
Miniature electrochemical sensing elements for detection of nitrate

Dr Vladimir Golovko of the School of Physical and Chemical Sciences and BIC AI Dr Aaron Marshall of Chemical and Process Engineering won for their novel electrochemical sensing system for nitrates. Along the lines of a digital thermometer, the electrode has the advantages of long life and durability, plus the ability to send information via a networked monitoring system. A system such as this would provide regional councils with a real-time view of nitrates in waterways across their catchment areas, enabling them to enforce the new legislative caps on nitrogen discharge.



Left to right: Dr James Hutchinson, CEO KiwiNet, Dr Tim Huber and Professor Conan Fee.

Equipment



Filmetrics profilm3D optical profilometer.

Outstanding facilities and new strategic capability are critical to BIC's mission of delivering world-class research in biomolecular interactions at the interface of engineering and science. As such, BIC continues to invest strategically in capital equipment and on-going maintenance. Our capital expenditure plan is carefully crafted to focus on bringing new capability to BIC and complement facilities in the wider University.

High performance anion exchange chromatography (HPAEC-PAD) (\$74,700)

This purification and analytical system allows the separation, quantification and identification of carbohydrates, amino acids and a variety of other biomolecules. It is similar to an HPLC, but works on the basis of anion-exchange. This is new capability for BIC and the University. From late-2017 it will be housed in the new Regional Science and Innovation Centre.

Anton Paar LOVIS DMA4100 (microviscometer/densitometer) for the AUC (\$50,613)

New Zealand's first analytical ultracentrifuge (AUC) was purchased by the University of Canterbury in 2013. It allows researchers to probe the molecular mass of biomolecules in solution and to characterise interactions

between different biomolecules (e.g. protein-DNA interactions). The addition, in 2017, of a viscometer/densitometer brings new capability for this facility by allowing for the direct measurement of solution density and viscosity – parameters essential for data analysis. Previously these parameters were estimated, but this is difficult (impossible) for complex fluids, such as cell lysates or milk, which more closely mimic the natural environment in which proteins function.

Infors refrigerated multitron incubator with cooling (\$23,100)

This strategic purchase supports BIC research, particularly in the School of Biological Sciences where there is a need to grow cultures at attenuated temperatures for the expression of difficult proteins, such as the membrane proteins. Research into membrane proteins is Marsden-funded work currently being carried out in the Dobson research group.

Fimetrics profilm3D optical profilometer (\$60,000, with support from the College of Engineering)

Optical profilometry allows for large area, sub-micrometer resolution optical characterisation of 3D topographies. It provides very fast 3D scanning of flat and curved biomaterial constructs, microfluidic device molds, micron-scale device geometries, and 3D printed constructs, such as column arrangements and tissue engineering scaffolds. The equipment complements existing nano-and micron-scale characterisation techniques available in the BIC-aligned UC Nanofabrication facility.

Our Growing Capability

BIC has seen exciting growth across in research throughout 2017. A large number of honours, masters and doctoral students, and postdoctoral fellows have commenced studies on a broad range of topics in the research groups of our PI's and AI's throughout 2017. Some of their projects are externally funded, and others partially or fully support by BIC *via* contestable funding rounds and flagship funding. Here we profile a few of our newest doctoral students.

Michal Bernach

Artificial leaves

Michal Bernach is a new BIC PhD student who wants to get the insight into the life of foliar bacterial communities on the surface of artificial leaves. His project is a joint effort between the School of Biological Sciences, Department of Electrical and Computer Engineering and the Biomolecular Interaction Centre. Michal will be co-supervised by Drs Mitja Remus-Emsermann and Volker Nock.

Michal came to Christchurch from Poland, where he finished his Master's in the Faculty of Biotechnology at the University of Wroclaw. Afterwards, he completed an internship at Max Planck Institute of Molecular Plant Physiology in Potsdam and worked as laboratory technician at International Institute of Molecular and Cell Biology in Warsaw.

During his scientific journey he had opportunity to work in different fields. While working on his Master thesis he focused on organization of bacterial chromosomes by DNA binding proteins. He also learnt techniques to investigate changes in plant metabolism and characterization of protein structure.

It is really exciting for Michal being able to work on an **artificial leaf project**, which allows him to put his knowledge to use but also opens for him the doors to new fields of science. He's looking forward what the future brings and enjoys the beauty New Zealand has to offer.

Although Michal was awarded a full BIC scholarship of \$25,000 per annum for three years, he was subsequently awarded a UC Doctoral Scholarship. BIC is continuing to support Michal studies.

Ziqi Yu

Effect of protein and lipid co-oxidation on food quality

Ziqi Yu has commenced a PhD, co-funded by BIC and AgResearch, on the effect of protein and lipid co-oxidation on food quality. Ziqi is based at AgResearch in Lincoln, working under the supervision of Dr Anita Grosvenor, along with Dr Stefan Clerens and UC's Dr Grant Pearce.

Ziqi got her Master's degree from Wageningen University, Netherlands, in food technology, specialising in ingredient functionality. She undertook an internship at Copenhagen University, in the department of food science.

Her previous lab experience has been focused on characterising the changes in protein structure and properties that occur under the influence of heat treatment and enzymatic modification. This led to experience in proteomics. What drew her attention most during this time was how protein properties and modifications can be correlated with health and biological studies to improve quality of life. She is ultimately dedicated to contributing in this area.

While carrying out her internship at Copenhagen she became passionate about the study of protein interactions. Redox proteomics is an electrify area to Ziqi and the description of this innovative, ground-breaking PhD project, funded by AgResearch and BIC caught her eye. She is looking forward to learning and developing new techniques as she gets into her studies.

Ziqi is excited to have travelled across the world to New Zealand and she is ready to see where this journey will lead.

Dinesh Bhandari

A new approach to studying *Legionella* mobility and persistence in engineered water systems

Dinesh joined the Biomolecular Interaction Centre and ESR as a PhD student in September. He will be working on an ESR Marsden-funded project studying *Legionella* mobility and persistence in engineered water systems using micro mimics. Dinesh's study will focus on *Legionella pneumophila*, amoeba and biofilm aspects of the project under the supervision of ESR's Dr Liping Pang and BIC AI Dr Mitja Remus-Emsermann.

Before starting his PhD, Dinesh worked for 3.5 years as a Health Research Officer at Public Health Research Laboratory and Microbiology, Institute of Medicine Nepal. His special experience and interest is in infectious disease aetiology and antimicrobial resistance patterns of bacteria. Dinesh has an MSc in Medical microbiology from Tribhuvan University.

When not working, Dinesh loves to spend his time in woods among birds and animals. Six years ago, he was a trainee naturalist with a national park in Nepal where he escorted the visitors for jungle activities and tracking wild animals. Alongside, he collected animal's specimens for biological study of their ecological adaptation and evolution so that efforts could be made toward their conservation in natural habitat. Dinesh used to play football and cricket until after a serious injury to his shoulder and knee. He loves listening to music and he is a big fan of Pink Floyd.





Sujani Ariyadasa

Sujani Ariyadasa

Mimicking *Legionella* in engineered water systems

Sujani Ariyadasa joined BIC and ESR in August as a PhD student in ESR's Environmental Science group. Sujani will be working on a Marsden-funded project over the next three years to develop a surrogate system that mimics the behaviour of *Legionella* in engineered water systems under the supervision of ESR's Liping Pang and BIC PI's Conan Fee and Renwick Dobson.

Sujani comes from Sri Lanka. She obtained her BSc in Microbiology and Biochemistry from the University of Bangalore, India and her MSc in Molecular and Applied Microbiology from University of Peradeniya, Sri Lanka. Before starting her PhD Sujani worked for the Sri Lanka Institute of Nanotechnology and Credence Genomics, a DNA sequencing laboratory.

Outside work, Sujani likes to travel and to spend time with friends. She also loves animals (especially cats and dogs!). Sujani is also a long-distant sea swimmer (competing national level) although she hasn't done much swimming recently.

Rudolf Schlechter

Spatial distribution patterns of synthetic bacterial communities on the plant leaf surface

Rudolf is a PhD student keen to understand how bacterial live, interact, thrive and form communities on plant leaves. His research is aligned to a collaborative project developing leaf surrogates between the School of Biological Sciences, the Department of Electrical and Computer Engineering, and the Biomolecular Interaction Centre. Rudolf will be focused on factors that shape bacterial community structures *in planta*, uncovering the ground rules that shape these structures to be applied later on artificial leaves. This project is under the supervision of Dr Mitja Remus-Emsermann, with Professor Paula Jameson and Dr Matthew Stott as co-supervisors.

Rudolf has been always fascinated by the molecular and cellular adaptations outlining plants and microbes' interactions. Before arriving to Christchurch, Rudolf started his research journey in Santiago de Chile, where he completed his degree at the Faculty of Biological Sciences, Pontificia Universidad Católica de Chile. During his thesis project, he investigated defence mechanisms of grapevines against the powdery mildew. Later on, he worked in Switzerland, where he investigated the role of endocytosis in plant-pathogen interactions at ETH Zurich. So far, he has gained experience in live-cell imaging, high-resolution fluorescence microscopy, cellular and molecular biology. Currently at UC, Rudolf will apply his skills to study and learn more about non-pathogenic, leaf-colonising bacteria and their spatial distribution on plant surfaces.

Rudolf is highly motivated to work on this innovative and promising project, and to get inspired by New Zealand's cultural and natural richness.

Don Sinclair

Development of highly vascularized 3D printed tissue scaffold for soft tissue replacement

Don will commence his BIC-funded PhD in early 2018 in the research group of Professor Conan Fee, co-supervised by Dr Tim Huber and Professor Tim Woodfield (University of Otago, Christchurch School of Medicine). His topic will be on the *development of highly vascularized 3D printed tissue scaffold for soft tissue replacement*.

Don has just completed his Bachelor of Engineering with Honours at UC majoring in Chemical and Process Engineering with a minor in Bioprocessing.

Our Growing Capability

The Biomolecular Interaction Centre has continued strong investment in postdoctoral fellows. We are lucky to have a large cohort of externally funded fellows working on a range of research projects, and we have also funded a number of short-term fellowships funded directly by our Centre. Here we profile some of the 2017 cohort of fellows.

Fabian Dolamore

Fabian Dolamore is a new Postdoctoral Fellow in the Biomolecular Interaction Centre. He will spend the next three years on an MBIE-funded Smart Ideas project looking at the development of a simple, general and novel assay platform for detecting and quantifying analytes in non-laboratory settings. Fabian's specific role is around developing molecular dynamics knowledge of the assay and applying these findings to engineering the assay platform.

Fabian has recently completed his PhD in Chemical and Process Engineering at UC (also under BIC), which focused on developing a modelling tool for chromatographic systems using computational fluid dynamics to optimize performance via manipulation of the stationary phase morphology.

Azadeh Hashemi

Azadeh Hashemi (or as some people know her Azy) is a new Research Associate in the Biomolecular Interaction Centre. She just submitted her thesis which focused on developing a process for fabrication of protein-based biodegradable materials with micro- and nanoscale regular and bioimprinted surface features. She will spend the next few months studying further the behaviour of cells on biodegradable films with surface bioimprints. She is hoping to publish a couple of papers from these results and what was left from her PhD.

Azadeh did her undergrad in Applied Physics, and master's degree in Plasma Engineering, both in Iran. She came to New Zealand four years ago to do her PhD at the Electrical and Computer Engineering with Dr Volker Nock. She has learnt so much during these years and loved her experience as a student at UC and her life in Christchurch.

Henry You Li

Henry is a new Postdoctoral Fellow in the Biomolecular Interaction Centre working in the group of Professor Antony Fairbanks. Henry will spend the next three years on a

Marsden-funded project looking at a new paradigm for organelle targeting. The project is developing a revolutionary drug-targeting system that could one day be used to treat a range of fatal, inherited diseases caused by genetic enzyme deficiencies – lysosomal storage disorders – of which there are around 200 sufferers in New Zealand. Their key focus is on developing organelle targeting to deliver recombinant enzymes and other drugs to their target cells.

Henry did his undergraduate studies in biology, and had two years Master's training in cell death signalling pathways. Then he worked on transcription regulation for the next three years and obtained PhD in molecular biology and biochemistry. In his current project, Henry wants to use his expertise in biochemistry and develop new skills in carbohydrate chemistry. Henry comes from China and enjoys living and working in Christchurch.

Tim Huber

Tim completed his undergraduate degree in Biomimetics/Bio-inspired Engineering at the University of Applied Sciences, Bremen, Germany in 2007. He then continued there as a research associate in the Biomaterials group promoting natural fibre reinforced polymers for industrial applications and product design before moving to begin his PhD in Mechanical Engineering at UC in 2009. His research was focused on the synthesis and analysis of all-cellulose composites using ionic liquids, trying to mimic already established industrial processes for this new class of materials. After receiving his doctorate in 2013, he spent ten months as a postdoctoral fellow at the Bioproducts Discovery and Development Center at the University of Guelph, Canada. Since 2014 Tim has been working as a postdoctoral fellow at the Biomolecular Interaction Centre at UC working on the 3D printing of biopolymers, especially cellulose, for the use in chromatographic media and other applications, as well as the development of new 3D printing technology.

Tim, along with Professor Conan Fee were recent winners in UC's Tech Jumpstart

competition for their 3D printed heat exchangers.

Jennifer Crowther

Jennifer Crowther is currently on a short-term BIC funded postdoctoral fellowship investigating interactions of milk proteins within the research group of Associate Professor Ren Dobson. While in this role, Jennifer applied for and was granted \$100,000 from the Canterbury Medical Research Foundation to fund her own independent research into developing a bioassay for angiotensinogen to identify women prone to pre-eclampsia. Jennifer will commence this research project in early 2018.

Jennifer recently completed her PhD within the Biomolecular Interaction Centre, which focused on understanding the differences between the cow and goat forms of a particular milk protein involved in causing milk allergies.

Rebecca Soffe

Rebecca is working as a postdoctoral fellow in the research group of Dr Volker Nock on the Science for Technological Innovation National Science Challenge. This Challenge, Kia kotahi mai – Te Ao Pūtaiao me Te Ao Hangarau, aims to develop new and innovative technologies to create commercially successful, breakthrough products.

Rebecca's specific project is to develop a sensor capable of detecting insulin in free blood, towards a point-of-care insulin device. The device will assist those with diabetes for improved insulin management.

Rebecca completed her undergraduate studies in Electrical and Electronic Engineering, at the University of Canterbury. She then moved to Melbourne to undertake her PhD at RMIT University in mechanotransduction utilising microfluidic platforms. The focus of the research was to investigate the influence of different shear stress stimulation conditions, on intracellular calcium signalling.

Rachel North

Rachel is a postdoctoral fellow in the Dobson research group working on a Marsden-funded project looking at *how bacteria scavenge sialic acids from their human host*. Her particular focus is on sialic acid transporters, which mediate the import of sialic acid across the cytoplasmic membrane.

Rachel did her PhD at the University of Canterbury, also under the supervision of Dr Renwick Dobson. During this time she developed particular expertise in enzymology, membrane protein production and structural biology.

Daniela Remus

Daniela is a postdoctoral fellow in the Dobson research group. Her particular focus is on bacterial sialic acid transporters, which

mediate the import of sialic acid across the cytoplasmic membrane.

Daniela has recently moved to New Zealand. She did her PhD at the University of Wageningen, the Netherlands under the supervision of Michiel Kleerebezem and a postdoc at the University of Basel, Switzerland with Dirk Bumann. During this time she has developed particular expertise in bacterial genetics and molecular biology as well as in mucosal immunology and infectious diseases.

Nicole Wheeler

In early 2017, Nicole Wheeler joined BIC for a brief postdoctoral fellowship. Nicole's work focusses on the gradual loss of function of redundant genes during niche adaptation. Over two months she studied

this phenomenon in flightless birds and in pathogenic bacteria, and developed a machine learning-based method for predicting the emergence of new pathogens using these reproducible signatures of adaptation. After finishing this role she left New Zealand to take up a position as a postdoctoral fellow at the Wellcome Trust Sanger Institute, where she will continue her work developing approaches to understanding and predicting key traits of pathogenic bacteria based on their genome sequence.

Nicole did her PhD in biochemistry under the supervision of Associate Professor Paul Gardner, where she developed a method for detecting the degradation of protein coding genes in genomic DNA, and used this to study the evolution of bacterial pathogens.



Left to right: Jennifer Crowther, Fabian Dolamore, Rachel North and Daniela Remus.

Our People

Principal Investigators



Associate Professor Renwick Dobson



Professor Antony Fairbanks



Professor Conan Fee



Associate Professor Paul Gardner



Professor Juliet Gerrard



Dr Volker Nock



Professor Emily Parker



Dr Grant Pearce



Professor Anthony Poole

Advisory Board

Chair: Distinguished Professor Ted Baker, University of Auckland

Deputy Chair: Professor Richard Furneaux, Ferrier Research Institute, Victoria University of Wellington

Professor David Beebe, University of Wisconsin – Madison

Professor Ian Wright, Deputy Vice-Chancellor, Te Tumu Tuarua, University of Canterbury

Professor Jan Evans-Freeman, Pro Vice-Chancellor – Engineering, Amorangi Pūkaha, University of Canterbury

Professor Wendy Lawson, Pro Vice-Chancellor – Science, Amorangi Pūtaiao, University of Canterbury

Management staff

Rebecca Hurrell, Institute Manager

Technical Staff

Ms Rayleen Fredericks, Department of Chemical and Process Engineering, University of Canterbury

Mrs Jackie Healy, School of Biological Sciences, University of Canterbury

Dr Sarah Kessans, School of Biological Sciences, University of Canterbury

Associate Investigators

Dr David Ackerley, School of Biological Sciences, Victoria University of Wellington

Dr Jane Allison, Centre for Theoretical Chemistry and Physics, Massey University

Dr Tim Allison, School of Physical and Chemical Sciences, University of Canterbury

Prof Vic Arcus, Department of Biological Sciences, University of Waikato

Dr Craig Billington, Institute of Environmental Science & Research

Prof Stephen Brennan, Molecular Pathology Laboratory, Canterbury Health Laboratories

Dr Stefan Clerens, Food and Bio-Based Products, AgResearch Ltd

Assoc Prof Dave Collings, School of Environmental and Life Sciences, University of Newcastle

Dr Deb Crittenden, School of Physical and Chemical Sciences, University of Canterbury

Dr Simone Dimartino, School of Engineering, University of Edinburgh

Dr Laura Domigan, School of Biological Sciences, University of Auckland

Dr Jolon Dyer, Food and Bio-Based Products, AgResearch Ltd

Prof Gary Evans, Ferrier Research Institute, Victoria University of Wellington

Dr Monica Gerth, Department of Biochemistry, University of Otago

Dr Brent Gilpin, Institute of Environmental Science & Research

Assoc Prof Pete Gostomski, Chemical & Process Engineering, University of Canterbury

Prof Mark Hampton, Centre for Free Radical Research, University of Otago Christchurch School of Medicine

Assoc Prof Richard Hartshorn, School of Physical and Chemical Sciences, University of Canterbury

Prof Geoff Jameson, Institute of Fundamental Sciences, Massey University

Dr Jodie Johnston, School of Physical and Chemical Sciences, University of Canterbury

Prof Martin Kennedy, Department of Pathology, University of Otago Christchurch School of Medicine

Prof Tony Kettle, Centre for Free Radical Research, University of Otago Christchurch School of Medicine

Dr Nigel Larsen, Plant and Food Research

Assoc Prof Shaun Lott, School of Biological Sciences, University of Auckland

Dr Peter Mace, School of Biomedical Sciences, University of Otago

Dr Aaron Marshall, Chemical & Process Engineering, University of Canterbury

Dr Antonia Miller, Protein Science and Engineering Team, Callaghan Innovation

Assoc Prof Ken Morison, Chemical & Process Engineering, University of Canterbury

Assoc Prof Jim Morton, Lincoln University

Dr Andrew Muscroft-Taylor, Protein Science and Engineering Team, Callaghan Innovation

Dr Ali Reza Nazmi, Scion Research Ltd

Dr Wayne Patrick, Department of Biochemistry, University of Otago

Professor David Palmer, Faculty of Agriculture and Life Sciences, Lincoln University

Dr Mitja Remus-Emsermann, School of Biological Sciences, University of Canterbury

Assoc Prof Phillip Rendle, Ferrier Research Institute, Victoria University of Wellington

Prof Ian Shaw, School of Physical and Chemical Sciences, University of Canterbury

Dr Mark Staiger, Mechanical Engineering, University of Canterbury

Prof Peter Tyler, Ferrier Research Institute, Victoria University of Wellington

Assoc Prof Arvind Varsani, School of Life Sciences, Arizona State University

Dr Gabriel Visnovsky, Chemical & Process Engineering, University of Canterbury

Assoc Prof Tim Woodfield, Department of Orthopaedic Surgery and Musculoskeletal Medicine, University of Otago Christchurch School of Medicine

BIC Adjuncts

Adjunct Professor

Prof Stephen Brennan, Canterbury Health Laboratories

Prof Juliet Gerrard, University of Auckland

Prof Geoff Jameson, Massey University

Prof Richard Neutze, University of Gothenburg, Sweden

Prof Emily Parker, Victoria University of Wellington

Prof Anthony Poole, University of Auckland

Prof Carol Robinson, Oxford University

Adjunct Associate Professor

Dr Jolon Dyer, AgResearch Ltd

Dr Nigel Larsen, Plant & Food Research

Assoc Prof Jim Morton, Lincoln University

Dr James Murphy, Walter and Eliza Hall Institute of Medical Research, Australia

Dr Simone Dimartino, University of Edinburgh

Adjunct Senior Fellow

Dr Brent Gilpin, Institute of Environmental Science & Research

Dr Antonia Miller, Callaghan Innovation

Dr Andrew Muscroft-Taylor, Callaghan Innovation

Assoc Prof Phillip Rendle, Victoria University of Wellington

Dr Hironori Suzuki, Japan

Adjunct Fellow

Dr Leonardo Negron, Callaghan Innovation

Dr Luigi Sasso, Delft University of Technology, The Netherlands

Dr Rachel Williamson, Australian Synchrotron

Postdoctoral fellows and research staff

Dr Leyla Bustamante

Dr Dorien Coray

Dr Penel Cross

Dr Jennifer Crowther

Dr Fabian Dolamore

Dr Azadeh Hashemi

Dr Tim Huber

Dr Wanting Jiao

Dr Sarah Kessans

Dr Henry (You) Li

Dr Gert-Jan Moggré

Dr Rachel North

Dr Daniela Remus

Dr Rebecca Soffe

Mr Mathieu Vilmy

Dr Nicole Wheeler

Postgraduate students

Stewart Alexander – PhD with Antony Fairbanks

Sujani Ariyadasa – PhD with Ren Dobson, Conan Fee and Liping Pang, in collaboration with ESR

Fatemeh Ashari Ghomi – PhD with Paul Gardner

Helen Ashmead – PhD with Juliet Gerrard, in partnership with Callaghan Innovation

Jude Ayogu – PhD with Antony Fairbanks

Yu Bai – PhD with Emily Parker

Michal Bernach – PhD with Mitja Remus-Emsermann and Volker Nock

Dinesh Bhandari – PhD with Mitja Remus-Emsermann and Liping Pang, in collaboration with ESR

Kyle van de Bittner – PhD with Emily Parker

Amanda Board – MSc with Ren Dobson

David Coombes – BSc(Hons), with Ren Dobson

Jennifer Crowther – PhD with Renwick Dobson, in partnership with AgResearch

Michael Currie – PhD with Ren Dobson

James Davies – PhD with Ren Dobson

Fabian Dolamore – PhD with Conan Fee and Simone Dimartino

Yifei Fan – BSc(Hons) with Emily Parker

Mohammad Firoozinia – PhD with Emily Parker

Fiona Given – PhD with Emily Parker

Anne Gordon – PhD with Conan Fee and Simone Dimartino

Kyrin Hanning – PhD with Mitja Remus-Emsermann and Liping Pang in collaboration with ESR

Azadeh Hashemi – PhD with Volker Nock and Maan Alkaisi

Cormac Hayes – PhD with Antony Fairbanks

Christopher Horne – PhD with Ren Dobson

Amanda Inglis – MSc with Emily Parker, in partnership with ESR

Jenna Gilkes – PhD with Ren Dobson

Bethany Jose – PhD with Paul Gardner

Manmeet Kaur – PhD with Juliet Gerrard

Jeremy Keown – PhD with Grant Pearce

Parastoo Khajeaian – PhD with Emily Parker

Sam Kim – PhD with Juliet Gerrard, in partnership with Callaghan Innovation

Alicia Lai Sook Wei – PhD with Anthony Poole

Michael Love – BSc(Hons) with Ren Dobson

Deepti Mahapatra – MSc with Renwick Dobson, Jolon Dyer and Juliet Gerrard, in partnership with AgResearch

Andrea Mascherpa – PhD with Antony Fairbanks

Hannah McKerchar – PhD with Ren Dobson

Hossein Najaf Zadeh – PhD with Conan Fee, Don Clucas and Tim Huber

Suhas Nawada – PhD with Conan Fee and Simone Dimartino

Vi-Vie Ng – PhD with Volker Nock and Mathieu Sellier

Louise Orcheston-Findlay – PhD with Volker Nock

Harshal Panidepu – PhD with Conan Fee

Sivasinthujah Paramasivam – PhD with Antony Fairbanks

Amy Phillips – PhD with Juliet Gerrard, in partnership with the MacDiarmid Institute

Prasanna Ponnumallayan – PhD with Conan Fee

Vivek Poonthiyil – PhD with Antony Fairbanks

Arvind Ravichandran – PhD with Renwick Dobson

Roya Rezanavaz – PhD with Conan Fee and Simone Dimartino

Alannah Rickerby – PhD with Anthony Poole

Rudolf Schlechter – PhD with Mitja Remus-Emsermann

Don Sinclair – PhD with Conan Fee, Tim Huber and Tim Woodfield

Anna Smith – MSc with Ren Dobson

Jordyn Smith – MSc with Emily Parker

Balaji Somasundaram – PhD with Conan Fee

Kajitha Suthagar – PhD with Antony Fairbanks

Oliver Sterrit – PhD with Emily Parker

Ayelen Tayagui – PhD with Volker Nock and Ashley Garrill

Serena Watkin – PhD with Volker Nock and Ren Dobson, in partnership with Callaghan Innovation

Renee Watson – PhD, with Paul Gardner

Anthony Weatherhead – MSc with Ren Dobson

Michael Weusten – PhD with Emily Parker

Nicole Wheeler – PhD with Paul Gardner

Amy Yewdall – PhD with Juliet Gerrard, in partnership with US ARO

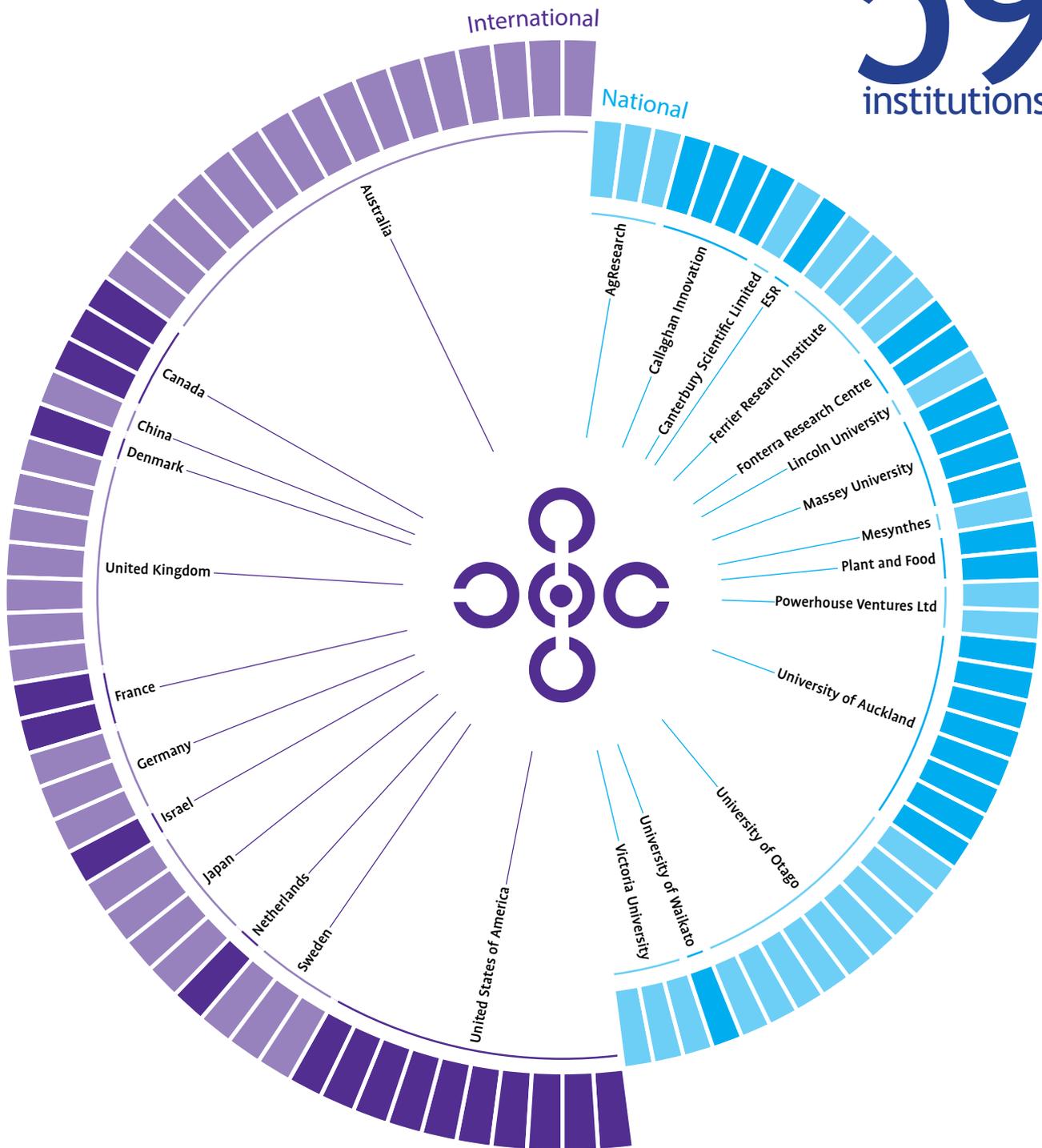
Ziqi Yu – PhD with Grant Pearce and Stefan Clerens, in partnership with AgResearch



Left to right: Dr Dion Thompson, Dr Craig van Dolleweerd and Dr Andrew Muscroft-Taylor of Callaghan Innovation's UC-based Protein Science and Engineering Team.

Our Networks

Connecting
59
institutions



AgResearch

Jolon Dyer, Lincoln

Stefan Clerens, Lincoln

Anita Grosvenor, Lincoln

Ali Hodgkinson, Ruakura

Biotelliga

Stephen Ford

Callaghan Innovation

Craig van Dolleweerd, Christchurch

Antonia Miller, Christchurch

Andrew Muscroft-Taylor, Christchurch

Leonardo Negron, Lower Hutt

Campbell Sheen, Christchurch

Dion Thompson, Christchurch

Canterbury Scientific Limited

Tony Mathews

Clive Seymour

Institute of Environmental Science & Research (ESR)

Craig Billington

Brent Gilpin

Liping Pang

Ferrier Research Institute

Leyla Bustamante

Gary Evans

Richard Furneaux

Wanting Jiao

Emily Parker

Phillip Rendle

Peter Tyler

Fonterra Research Centre

Paul Andrews

Skelte Anema

Lincoln University

Jim Morton

David Palmer

Massey University

Jane Allison, Auckland

Patrick Biggs, Palmerston North

Heather Hendrickson, Auckland

Geoff Jameson, Palmerston North

Bill Williams, Palmerston North

Mesynthes

Barney May

Plant and Food

Nigel Larsen

Powerhouse Ventures Ltd

Stuart Lansley

Jennifer Anderson

University of Auckland

Margaret Brimble

Austen Ganley

Juliet Gerrard

David Goldstone

Shaun Lott

Alok Mitra

Chris Squire

Jadranka Travas-Sejdic

David Williams

Laura Domigan

University of Otago

Azam Ali

Stephen Brennan, Christchurch

Greg Cook

Peter Fineran

Monica Gerth

Mark Hampton, Christchurch

Tony Kettle, Christchurch

Kurt Krause

Peter Mace

Jim McQuillan

Wayne Patrick

Tim Woodfield, Christchurch

University of Waikato

Vic Arcus

Victoria University

David Ackerley

Petrik Galvosas

Kate McGrath

Australia

Ashley Buckle, Monash University

John Carver, Australian National University

John Fuerst, University of Queensland, Brisbane

Sally Gras, Bio21, Melbourne

Michael Griffin, University of Melbourne

Danny Hatters, Bio21, Melbourne

Craig Hutton, Bio21, Melbourne

Milton Kiefel, Griffith University

Jenny Martin, University of Queensland

Bridget Mabbutt, Macquarie University

Joel Mackay, University of Sydney

Bostjan Kobe, University of Queensland

James Murphy, Walter and Eliza Hall Institute

Matt Perugini, La Trobe University

Rachael Williamson, Australian Synchrotron

Celine Valery, RMIT, Melbourne

Claudia Vickers, University of Queensland

Canada

Karen Cheung, University of British Columbia, Vancouver

Derek Wilson, York University

China

Wenhui Wang, Tsinghua University, Beijing

Denmark

Eske Willerslev, Copenhagen University

France

Simonetta Gribaldo, Institut Pasteur, Paris

Claude Verdier, University Joseph Fourier, Grenoble

Germany

Muge Kasancheff, Max Planck Institute for Biophysical Chemistry

Haydyn Mertens, EMBL, Hamburg

Gerald Urban, University of Freiburg, Freiburg

Mark Hoepfner, University of Kiel

Israel

Meir Haber, Biota

Japan

Eiji Morita, Osaka University, Osaka

Jun Ogawa, Kyoto University, Kyoto

Hironori Suzuki, Japan

Robert Sinclair, Okinawa Institute of Science & Technology

Netherlands

Luigi Sasso, Delft University of Technology

Norway

Siinan Umu, Cancer Registry of Norway

Sweden

Rosmarie Friemann, University of Gothenburg

Richard Neutze, University of Gothenburg

Britt-Marie Sjöberg, Stockholm University, Stockholm

United Kingdom

Sean Devenish, University of Cambridge

Carol Robinson, University of Oxford

Graham Richards, University of Oxford

Colin Kleanthous, University of Oxford

Adrian Mulholland, University of Bristol

Nick Thomson, Wellcome Trust Sanger Institute, Cambridge

Jerry Turnbull, University of Liverpool

Fran Platt, University of Oxford

United States of America

David Beebe, University of Madison, Wisconsin

David Boehr, Pennsylvania State University

Tim Cooper, University of Houston

Andre Hudson, Rochester Institute, New York

Eileen Jaffe, Fox Chase Cancer Center, Philadelphia

David Kaplan, Tufts University, Boston

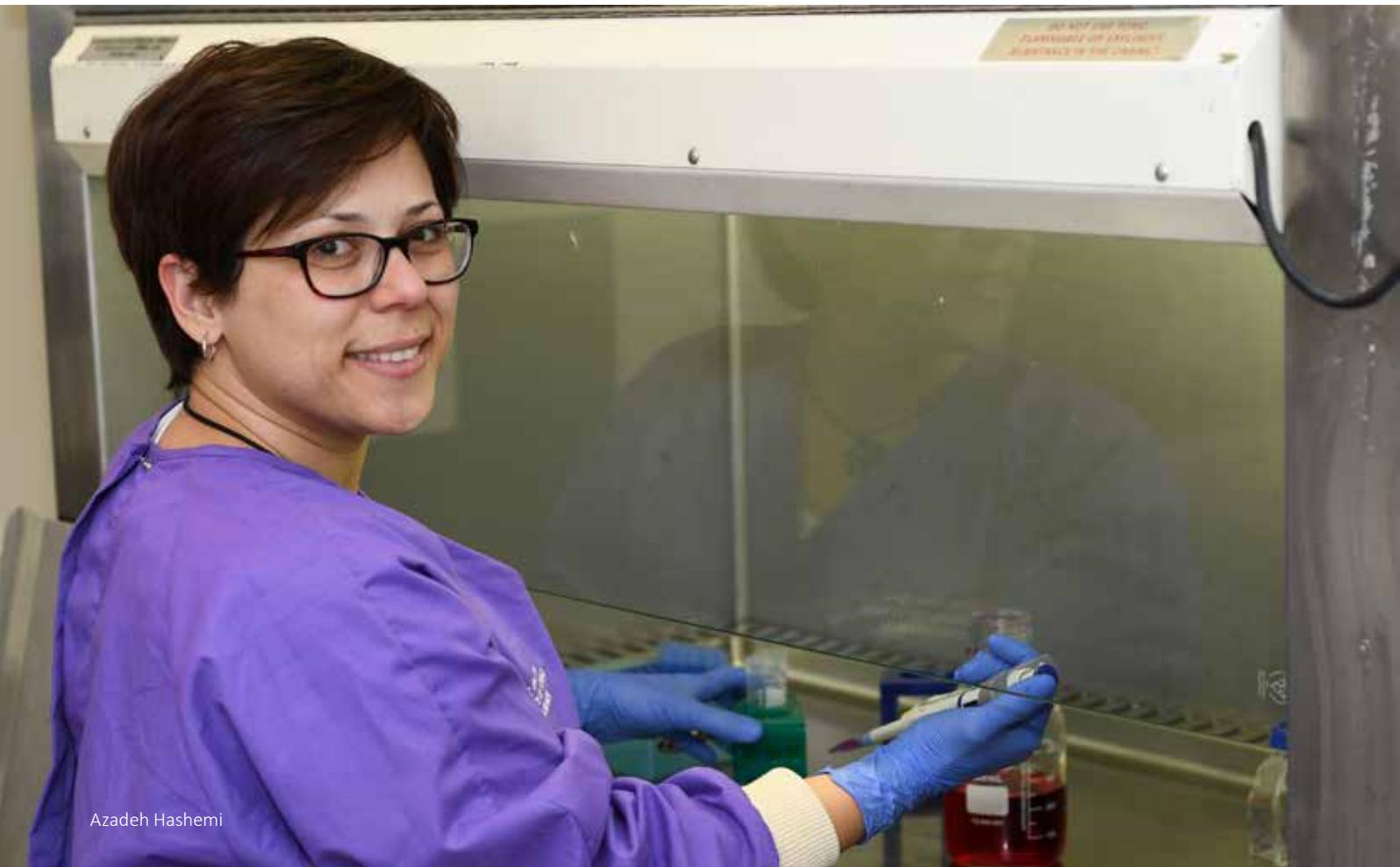
Thomas Laue, University of New Hampshire, Durham

George Lorimer, University of Maryland, Washington

Charlene Mello, University of Massachusetts, Boston

Vern Schramm, Albert Einstein College of Medicine, New York

Mark Silby, University of Massachusetts, Dartmouth



Azadeh Hashemi

Outputs

47
refereed
journal articles

19
conferences and
presentations

2
book chapters

Journal articles

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Conferences and presentations

Lincoln University, NZ, October 21st, 2016, 'Convergent Synthesis of Bioactive Glycopeptides and Glycoproteins'.

Gordon Research Conference on Carbohydrates, Mt Snow, Vermont, USA, June 26th 2017, 'Protecting Group Free Transformations of Reducing Sugars in Aqueous Solution'.

Eurocarb 2017 (19th), Barcelona, Spain, July 3rd 2017, 'New methods for the synthesis of glycoconjugates from reducing sugars in water'.

CIC bioGUNE, Bilbao, Spain, July 12th 2017, 'ENGase-catalysed production of bioactive glycopeptides and glycoproteins'.

CIC biomaGUNE, San Sebastian, Spain, July 18th 2017, 'ENGase-catalysed production of bioactive glycopeptides and glycoproteins'.

Conference on Progress on Chemical and Pharmaceutical Investigation of Carbohydrate and Glycoconjugates, University of Pavia, Italy, September 22nd 2017, 'Convergent Synthesis of Bioactive Glycopeptides and Glycoproteins.'

11th IUPAC International Symposium on Bioorganic Chemistry (ISBOC-11), University of Konstanz, Germany, September 27th-29th 2017, 'Convergent Synthesis of Bioactive Glycopeptides and Glycoproteins.'

University of Konstanz, Germany, September 28th 2017, 'Protecting Group Free Transformations of Reducing Sugars in Aqueous Solution'.

University of Basel, Switzerland, October 2nd 2017, 'ENGase-catalysed production of bioactive glycopeptides and glycoproteins'.

Christian Albrechts Universität of Kiel, Germany, October 10th 2017 'ENGase-catalysed production of bioactive glycopeptides and glycoproteins'.

Dobson RCJ. (2017) Bacterial sialic acid metabolism and regulation. QMB2017, Proteins, Queenstown.

Dobson RCJ. (2017) Bacterial sialic acid import and regulation. Victoria University Wellington: School of Biological Sciences Seminar Series.

Dobson RCJ. (2017) Bacterial sialic acid import. University of Auckland: New Zealand Membrane Protein Biology Symposium.

Dobson RCJ. (2017) The anatomy of an adapted enzyme. Bangalore, India: The National Centre for Biological Sciences (NCBS) Seminar Series, 14 Jul 2017.

Dobson RCJ. (2017) The anatomy of an adapted enzyme. Glasgow, UK: AUC2017, 27 Jul 2017.

Dobson RCJ. (2017) The anatomy of an adapted enzyme. University of Otago, Dunedin: GSA/NZSBMB 2017.

Dobson RCJ. (2016) The anatomy of an adapted enzyme. Christchurch: Joint NZMS-NZSBMB conference.

Dobson RCJ. (2016) Using hydrogen/deuterium exchange mass spectrometry to untangle allosteric mechanisms. University of Otago, Christchurch: Otago Mass Spectrometry Symposium.

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Dr. Danielle Maddock, Nellie Sibaeva (PhD student), Alannah Rickerby (PhD student), Jasper Perry (UC MSc student), Prof. Ant Poole.

Photo credit: Dr. Charlotte Johnson.

Current Grants

Renwick Dobson, growing up milks, AgResearch. \$184,860 (2013–2016).

Antony Fairbanks, Doctoral Scholarship, Callaghan Innovation. \$105,000 (2016-2018).

Conan Fee, Simone Dimartino, Mathieu Vilmy and Don Clucas, three dimensional printed adsorptive media, MBIE Smart Idea. \$1,835,528 (2013–2017).

Paul Gardner, bioinformatic approaches to functionally characterise RNAs, Rutherford Discovery Fellowship. \$800,000 (2011–2017).

Sally Gaw, fate and behaviour of wastewater PCP's in constructed wetlands and on-site land application systems, NIWA. \$30,000 (2013–2017).

Juliet Gerrard, enhanced protein functionalities, PGP, \$567,300 (2012–2017).

Juliet Gerrard and Ren Dobson, red meat combifoods, AgResearch. \$96,720 (2011–2018).

Matthew Nicholson and Emily Parker, Fungal factories for manufacture of high value industrial bioproducts, MBIE. \$953,186 (2014-2017).

Renwick Dobson, Riddet Institute. \$68,520 (2017).

Renwick Dobson and Volker Nock, laminar flow devices for measuring the diffusional coefficients of macromolecules and macromolecular interactions: towards devices for medical testing, Callaghan Innovation. \$49,344 (2016 -2018).

Renwick Dobson, how do bacteria scavenge sialic acids from their human host?, Marsden Fund. \$770,000 (2016-2019).

Conan Fee, Riddet Institute. \$54,480 (2017).

Paul Gardner, provide bioinformatics expertise to allow genomic comparisons and co-supervision of two students, CoRE Bio-Protection. \$26,686 (2016-2017).

Paul Gardner, to identify determinants of virulence and adaptation in the kiwifruit pathogen *Pseudomonas syringae* pv. *actinidiae*, CoRE Bio-Protection. \$64,596 (2016-2018).

Volker Nock, using the lab-on-a-chip to understand the protrusive force exerted by pathogenic hyphae, Brian Mason Scientific and Technical Trust. \$11,763 (2015-2017).

Volker Nock, hyphae-on-a-chip – a microfluidic platform for the study of protrusive forces in hyphal invasion,

Marsden Fast-Start. \$300,000 (2016-2019)

Grant Pearce, effect of protein and lipid co-oxidation on food quality, BIC/AgResearch. \$83,000 (2016-2019).

Antony Fairbanks, a new paradigm for organelle targeting, Marsden fund. \$870,000 (2016-2019).

Ren Dobson, Lotteries Health Research Fund towards the purchase of an AKTA Pure FPLC. \$46,992 (2017).

Ren Dobson, Conan Fee and Volker Nock, along with Neil Pattinson, develop a simple, general and novel assay platform for detecting and quantifying analytes in non-laboratory settings, MBIE Smart Idea. \$1,000,000 (2017-2020).

Ren Dobson, \$5,000 of seed funding to develop a Marsden application for the 2018 round.

Paul Gardner, to building bioinformatic software for controlling protein expression in collaboration with Callaghan Innovation's UC-based Protein Science and Engineering Team, MBIE Smart Idea. \$1,000,000 (2017-2020).

Jennifer Crowther, to develop a bioassay for angiotensinogen to identify women prone to pre-eclampsia, CMRF. \$100,000 (2018-2019).

Mitja Remus-Emsermann and Volker Nock, using synthetic communities to visualise bacterial plant leaf community development and pathogen invasion processes at the single-cell resolution, Marsden Fast-Start Fund. \$300,000 (2017-2020).

Mitja Remus-Emsermann and Volker Nock, for artificial leaf surface development as a surrogate for microbial colonization of plant leaves, UC Doctoral Fund. \$82,500 (2017-2020).

Conan Fee, sequestering natural and anthropomorphic trace metals from water, MBIE Smart Idea, Scion-led. \$158,800 (2017-2019)

Volker Nock and Maan Alkai, doctoral scholarship funding for the development of flexible microdevices for characterization of the role of bionanomechanics in cancer, MacDiarmid Institute. \$80,000 (2017-2020).

Volker Nock and Jenny Malmström, for the design and characterisation of stimuli-responsive hydrogel biointerfaces, MacDiarmid Institute. \$80,000 (2017-2020).

Antony Fairbanks, to study the manufacture

of structure-optimised homogenous glycoprotein therapeutics, in collaboration with Callaghan Innovation's UC-based Protein Science and Engineering Team, MBIE Smart Idea. \$1,000,000 (2017-2020).

Dorien Coray, visualizing RNA and protein dynamics across microbial populations: developing a reporter system with pedagogical and research applications, Brian Mason Scientific and Technical Trust. \$14,919 (2017-2018).

Mitja Remus-Emsermann, study *Legionella* mobility and persistence in plumbing systems using micro mimics, ESR. \$82,500 (2017-2020).

Mitja Remus-Emsermann, concurrently tracking multiple sources of water contamination using synthetic DNA tracers, ESR. \$48,088 (2017-2020).

Conan Fee and Renwick Dobson, developing micro mimics for investigating *Legionella* mobility and persistence in the plumbing systems, ESR. \$82,500 (2017-2020).

Richard Hartshorn, high strength protein biomaterials through photo-induced crosslinking, AgResearch. \$51,150 (2010-2018)

Emily Parker, new molecular targets in bacterial disease, CoRe Maurice Wilkins. \$19,800 (2015-2017)

Emily Parker, engineering high value enzymes using forward and reverse evolution, Waikato University. \$452,845 (2013-2017).

Emily Parker, CoRE Maurice Wilkins. \$363,000 (2015-2017).

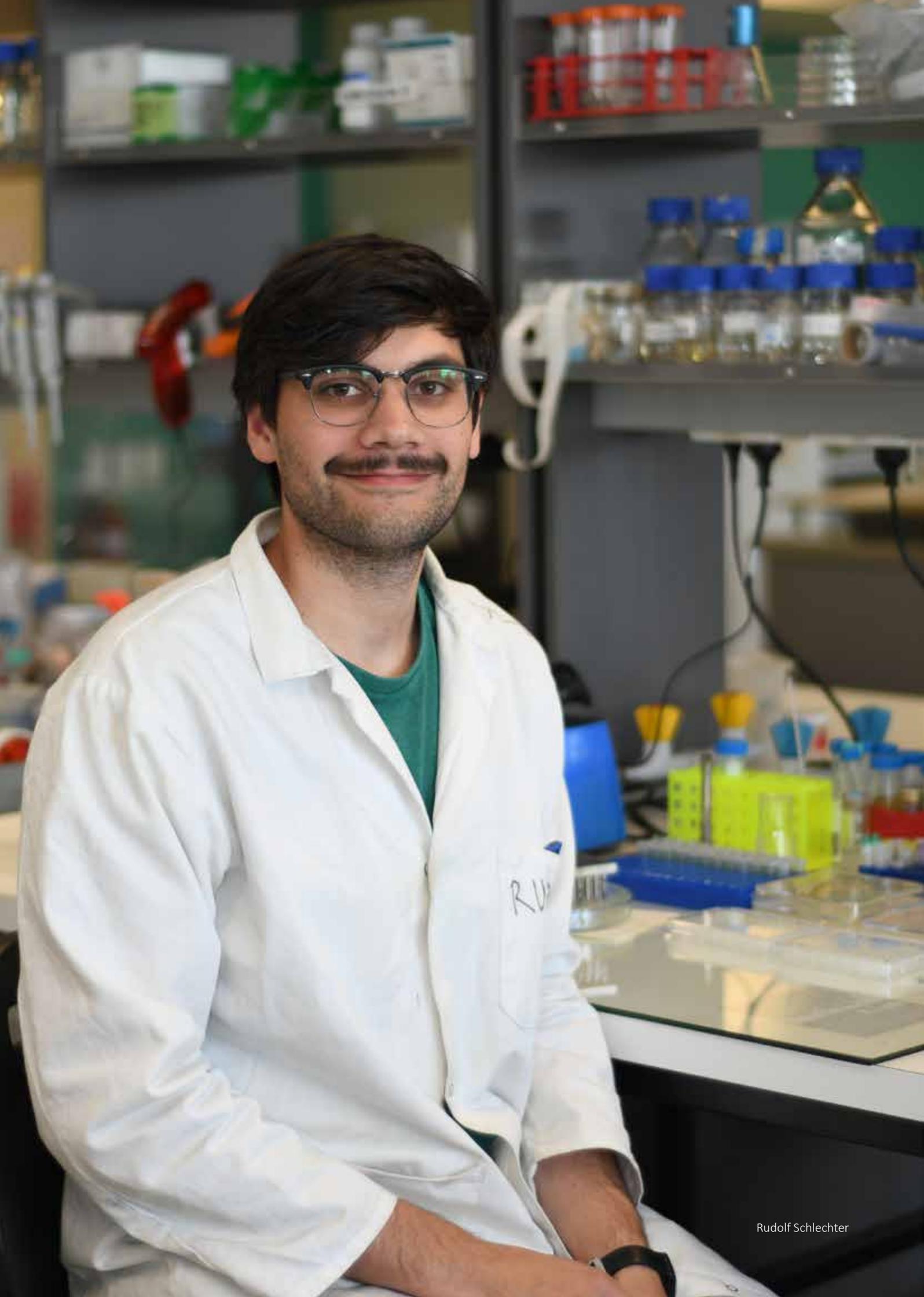
Emily Parker, allosteric regulation and the dynamics of a molecular pendulum that controls a catalytic clock, Marsden Fund. \$760,000 (2015-2018)

Emily Parker, virucidal action of naturally occurring enzymes found in waste stabilisation ponds, ESR. \$61,000 (2014-2017).

39
external
research grants



Dr Jennifer Crowther



Rudolf Schlechter

Grants Disbursed

BIC supports the development and growth of biomolecular interaction research by funding projects that support our aim to promote excellent, high impact, interdisciplinary and collaborative research.

2017 Grants

Principal Investigator funding to establish new research projects, \$25,000.

Principal Investigator travel funding, \$25,000.

Renwick Dobson and Volker Nock, leveraged postgraduate scholarship funding for *laminar flow devices for measuring the diffusional coefficients of macromolecules and macromolecular interactions: toward devices for medical testing*, \$21,000 plus fees per annum for three years, (co-funded by BIC and Callaghan Innovation).

Grant Pearce, leveraged postgraduate scholarship funding for *effect of protein and lipid co-oxidation on food quality*, \$21,000 plus fees per annum for three years, (co-funded by BIC and AgResearch).

Al's Dr Stefan Clerens, AgResearch and Dr Antonia Miller, Callaghan Innovation, and PI Renwick Dobson received \$10,000 of seed funding for their project *protein and modification characterisation by intact and semi-intact protein mass spectrometry*.

Al Dr Mitja Remus-Emsermann received \$10,000 of seed funding for his project *full-spectrum bacteria: fluorescent promoter-reporter plasmids for constitutive labelling of bacteria and whole-cell bacterial bioreporters*.

Al Dr Monica Gerth, University of Otago, and PI Associate Professor Ren Dobson received seed funding of \$7,600 for their project looking at *structural insights into bacterial sensor proteins*.

BIC Postdoctoral Researcher Dr Dorien Coray, along with PI Paul Gardner and Al Mitja Remus-Emsermann, received \$9,951 seed funding for their project looking at *visualizing RNA and protein dynamics at the single cell level for optimization of gene expression across microbial populations*.

Al Dr Mitja Remus-Emsermann received \$4,000 of flagship funding to attend QMB and purchase consumables, as well as to top up a doctoral scholarship.

BIC Postdoctoral Researcher Dr Dorien Coray received flagship funding to attend and speak at QMB on BIC-supported research.

PI Conan Fee and Al Tim Woodfield, along with BIC Postdoctoral Fellow Tim Huber have been awarded a postgraduate scholarship covering fees and a \$25,000 per annum stipend for three years for their project *developing highly vascularized 3D printed tissue scaffolds for soft tissue replacement*.

Dr Rebecca Soffe was awarded \$7,750 of seed funding for her project looking at *perfusable microvascular networks on-chip inspired by nature*.

BIC Al Dr Gabriel Visnovsky was awarded \$5950 to support PhD student Daniel Smith to travel to Almeria, Spain to attend the University of Almeria for two months to learn techniques and partake in a month-long international course on microalgae bioprocesses.

Al Dr Monica Gerth, University of Otago, and PI Ren Dobson received seed funding of \$7,600 for their project looking at *structural insights into bacterial sensor proteins*.

BIC Postdoc Dr Rachel North and BIC Al Dr Phillip Rendle of the Ferrier Institute of Wellington, along with BIC PI's Antony Fairbanks and Ren Dobson, were awarded \$10,000 for their collaborative project looking at *mutating an enzyme substrate to test a catalytic mechanism*.

New BIC Al's Dr Tim Allison and Dr Jodie Johnston were awarded \$7,000 each to help establish their research groups at the University of Canterbury. Both will shortly take up permanent academic positions in UC's newly established School of Physical and Chemical Sciences.

Postdoctoral fellowship funding of \$70,000 to support short-term projects to Dr Jennifer Crowther, Dr Daniela Remus, Dr Tim Huber, Dr Azadeh Hashemi and Dr Nicole Wheeler.

to
grow
our research
vision

