Drive discovery for healthy ageing

INSTITUTE FOR MOLECULAR BIOSCIENCE

THE UNIVERSITY OF QUEENSLAND
AUSTRALIA

CREATE CHANGE

HOME TO GAME-CHANGING HEALTH DISCOVERIES

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AUSTRALIA

CREATE CHANGE

The Institute for Molecular Bioscience is unveiling the secret to healthy ageing

Our research marks the beginning of a new future. Exploring the molecular realm, we examine the smallest units of life to discover how the world works. Our research continually pushes the boundaries of the scientific frontier, searching for answers to some of the world's most challenging problems.

Our questions are driven by the issues that plague us; our discoveries are inspired by life. We open the pipeline to new channels of research that have the potential to change the world as we know it.

The future age of better health

Thanks to the wonder of scientific and medical research, people are now living longer than ever. With ageing comes disease and disability. We need to retain our quality of life as we grow older.

With your help the Institute for Molecular Bioscience (IMB) can do something about it.

Heart disease is the leading cause of death worldwide, killing one Australian every 12 minutes and responsible for almost 30 per cent of all deaths.[1]

Degenerative disease is caused by the progressive cell changes, affecting tissues or organs, which increase over time. In some cases, the main or partial cause behind such diseases is genetic; however, a virus or injury can result in illness[2].

Pain is one of the most under-recognised and undertreated medical problems. It is the leading cause of the incidence of injury, disease and disability worldwide.[3] One in five Australians suffers from chronic pain, which costs the Australian economy $34 billion a year and significantly diminishes a person's quality of life.[4]

Inflammation is the body's first line of defence against threats such as infection or injury. But when inflammation is unable to turn itself off, it can trigger many chronic diseases such as cancer, arthritis, obesity, inflammatory bowel disease and even dementia.[5]

SOURCES

1. The Heart Foundation: https://www.heartfoundation.org.au/
2. Australian Institute of Health & Welfare: https://www.aihw.gov.au/reports-data/health-conditions-disability-deaths/chronic-disease/overview
3. Developments in Neuroethics and Bioethics: http://www.sciencedirect.com/science/article/pii/S2589295918300092
4. Access Economics: https://www2.deloitte.com/au/en/pages/finance/topics/deloitte-access-economics.html
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The Institute for Molecular Bioscience

IMB is Australia's #1 research institute*, with a track record of translating research discoveries into spinout drug discovery companies with molecules in clinical trials. We are committed to improving the health and sustainability of our local and global communities.

Our scientists have capitalised on one of the greatest periods of discovery in history – the unlocking of the genetic and molecular basis of life and its diversity – to become a global leader in multidisciplinary life sciences research.

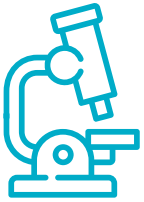
Our success stems from our integrative research approach. IMB scientists work together in a unique collaboration of some of the world's best minds in varied disciplines including chemistry and structural biology, genomics of development and disease, and in cell biology and molecular medicine.

We sit at the edge of discovery, harnessing different types of expertise to tackle problems from various angles, fill the gaps in our knowledge and make discoveries that help solve some of the world's greatest health and environmental challenges.

Together, we can drive discovery and impact through the development of preventions, diagnostics and solutions. Partner with IMB to create change and improve the future.

Snapshot

1454
INTERNATIONAL COLLABORATIONS



OVER
$1.3B
OF COMMERCIAL INVESTMENT ATTRACTED TO IMB RESERCH

OVER
$28M
IN RESEARCH FUNDING

OVER
20%
OF ALL PATENT FAMILIES AT UQ ARE DERIVED FROM IMB RESEARCH

** Nature Index, natureindex.com*


ALMOST
30%
OF DEATHS
WORLDWIDE

Heart Disease: Revealing how hearts are made and broken

Heart disease is the leading cause of death worldwide, responsible for almost 30 per cent of all deaths.[6] Unlike most tissues, the heart is not able to repair itself, so any damage from a heart attack is permanent. Getting sufferers to the hospital as soon as possible is imperative, to reduce the amount of damage to the heart. If severely damaged, a transplant can be the only way back to a healthy heart,[7] but suitable donor organs can be few and far between, with a wait time of 3-6 months.[8] For Australia, with its many remote areas, transporting heart attack sufferers to a hospital in time can be a major challenge.

Developing new ways to reduce injury to the heart following an attack is crucial. But to do this, researchers require access to human heart muscle – a rare resource indeed. That's where IMB's Dr Nathan Palpant expertise provides a solution.

He creates billions of human heart muscle cells from stem cells – living, beating cells in a dish – to understand how the heart develops and identify new ways to treat the major health burden associated with cardiovascular disease.

"We think the answers to heart repair almost certainly lie in a better understanding of how a heart develops."

"There are different types of stem cells," Dr Palpant explains. "One type in the adult body helps us maintain the health of our organs. Unfortunately, the heart doesn't have this type of stem cell, so it can't regenerate when injured."

The highly specialized stem cells used in Dr Palpant's lab are pluripotent, which means they can give rise to all of the cell types that make up the body. Researchers can now reprogram a cell to go back in time, so to speak, by making pluripotent stem cells from, for example, human skin cells.

"We are essentially re-setting the cell's clock back to the beginning of development, reprogramming an adult cell back to an embryonic cell," Dr Palpant says.

"Through our understanding of how the heart develops in the body, we can then re-create the conditions to instruct pluripotent stem cells to make whatever cardiovascular cell type we want in a dish, including heart muscle, blood vessels, blood, and much more."

Using this technique, Dr Palpant and his team are able to transform the pluripotent stem cells into heart cells.

"It's amazing for me to see that a heart muscle we create from stem cells behaves like it does in our own body. You can come into my laboratory and see human heart muscle cells beating in a petri dish."

"The power of this research is enormous," he says. "We can generate unlimited numbers of stem cells and use them to develop new drugs and further our understanding of heart disease."

IMB RESEARCHER

Dr Nathan Palpant
WEB: imb.uq.edu.au/profile/1142/nathan-palpant

SOURCES

6. World Health Organisation: https://www.who.int/news-room/factsheets/detail/the-top-10-causes-of-death
7. Heart Foundation: https://www.heartfoundation.org.au/images/uploads/publications/Heart-Transplants-Donations.pdf
8. Australian and New Zealand Cardiothoracic Organ transplant registry annual report 2018

Degenerative Disease: Turning back time in our cells for healthier lives

By 2060, almost a quarter of the Australian population will be aged over 65 years.[9] Age is the biggest risk factor for many diseases – by identifying the underlying processes that drive ageing and modifying them, we can try to either stave off or dramatically reduce the incidence of diseases such as dementia, rheumatoid arthritis, some cancers and importantly reduce the general physical decline associated with old age.

Currently we can only delay our physical decline through diet and exercise. A breakthrough in therapies would lessen or reverse this decline to prevent both human suffering and the economic burden of age-related diseases.

Dr Christian Nefzger is keen to improve the quality of life for the ageing population by improving the function of a failing organ or developing preventative therapies. He is studying 40 different cell types to get an understanding of what changes in cells as they age.

"The ultimate aim is to help aged cells regain youthful functions that they have lost over time, such as changes in metabolic rate or the ability to repair after damage," explains Dr Nefzger.

"We are studying genetic master regulators called transcription factors – they switch on the genes to manufacture proteins in cells. Every cell has a different set of genes switched on because they have different jobs – liver cells make liver-related proteins, skin cells make skin proteins, and so on. The master regulators control which parts of the DNA are being used, but their activity levels change with age, compromising youthful cellular function."

Reversing ageing in different cell types

Collaborating with Monash University in Melbourne, Dr Nefzger has boosted the activity of specific master regulators in aged intestinal stem cells which drives the cells into a more youthful state by correcting metabolic defects and restoring their capacity to renew. He is now applying this technique to different types of cells.

By identifying which master regulators are changing with age, Dr Nefzger is looking for medications to restore the activity levels of youth.

"I am identifying drugs that modify the activity of master regulators using publically available databases and then test their effects on aged animals and cells – if the drugs are already approved for use in humans, this is a much quicker way to get therapies to patients"

By pinpointing and targeting what makes cells age, Dr Nefzger hopes to "reprogramme" aged cells back towards working more efficiently, like young cells do.

"If we can take the focus away from simply treating the symptoms of ageing, we can move towards the development of therapies that target the ageing process – with the aim to delay, prevent and in some cases, reverse diseases of ageing and critically the inherent physical decline."

Dr Nefzger's inspiration to research ageing is fuelled by seeing his father unable to enjoy a healthy retirement.

"After working hard all their lives, it is my goal to help people embrace the latter stages of life, enjoying active and healthy retirements without succumbing to degenerative diseases."

IMB RESEARCHER

Dr Christian Nefzger
WEB: imb.uq.edu.au/cellular-reprogramming-ageing

SOURCE

9. Australian Institute of Health & Welfare: https://www.aihw.gov.au/reports/older-people/older-australia-at-a-glance/

BY 2050,

2 Billion

PEOPLE AGED OVER 60


1 in 5
AUSTRALIANS SUFFER
FROM CHRONIC PAIN

Pain: Using nature's biofactories to make affordable medicines

Chronic diseases such as obesity and pain don't discriminate, affecting people all over the globe. But the accessibility of treatments can vary widely depending on where you live.[9] For those in low- and middle-income countries, 50 to 90 per cent of the population have to pay for medicines themselves,[10] making treatment impossible for many people to access.

IMB's Professor David Craik has a radical solution to this problem: turning plants into pharmaceutical biofactories. Growing drugs in fields instead of manufacturing them in factories would result in cheaper, more accessible medicines.

Professor Craik is hoping to transform sunflower seeds, tealeaves and even potato chips into the drug delivery packages of the future.

"Our goal is to produce plants capable of growing pharmaceuticals, creating a new generation of affordable, accessible drugs to treat a range of conditions including cancer, pain and obesity," Professor Craik says.

"Tablets or injections are common ways of dispensing pharmaceutical treatments, but plant-grown medicines would be particularly impactful for people in the developing world, opening up the possibility of patients growing medicines in their own backyards."

Professor Craik and his team, in collaboration with Professor Marilyn Anderson AO of La Trobe University in Melbourne, are turning their vision into a reality—using plants as 'biofactories' to produce pharmaceuticals through clever chemistry.

The key to turning plants into drug-producing factories are molecules called cyclotides, circular proteins that plants naturally produce. Their circular shape makes cyclotides very stable and difficult for digestive enzymes to break down, making them an ideal candidate for drugs that can be taken orally.

The cyclotide drugs that the IMB team are developing are specific, which means they are less likely to cause side effects.

"Cyclotides bridge the gap between traditional oral drugs such as common painkillers, which are expensive but non-specific in their function, and protein-based drugs such as insulin, which are very specific but expensive and require injection," Professor Craik explains.

"Current pharmaceuticals can be out of reach for many in developing countries due to their high price and the lack of infrastructure available to transport and store specialised drugs, such as those that require refrigeration,

"Pharmaceuticals contained in seeds, leaves or food would be much more affordable to transport, and the infrastructure is already in place to do so."

Developing pain relief drugs

The team is optimising a pain relief drug already in development in Arabidopsis plants, producing anti-obesity peptides in potatoes, and developing anti-cancer peptides in sunflower and soybean.

The research has already attracted the support of the Clive and Vera Ramaciotti Foundations and IMB is currently seeking industry and philanthropic partners to advance this research.

IMB RESEARCHER

Professor David Craik
WEB: imb.uq.edu.au/protein-structure-in-drug-and-insecticide-design

SOURCES

10. Preventing chronic diseases: a vital investment. Geneva: WHO; 2005.
11. JD Quick, HV Hogerzeil, G Velasquez, L Rago. Twenty-five years of essential medicines. Bull World Health Organ 2002; 80: 913-4.

As an older adult, pain in my knee plagued me for years, leaving the simplest movements and tasks a hurdle to jump over on a daily basis. Luckily over time, I was able to treat this knee pain through movement and exercise and the pain eventually was relieved.

Twelve years after I thought the worst pain was behind me, I started to experience pain in my middle back. Ironing, cleaning the house, cooking for my family and going on walks all became out of the question. Then, right before Christmas in 2016, I woke up one morning unable to even get out of bed. After seeing several specialists, my diagnosis was spinal stenosis, which is the narrowing of the spaces between my vertebrae, putting pressure on the nerves traveling through the spine. Sessions with a physiologist were recommended along with the option of undergoing a risky and unpromising surgical procedure of the spine, but neither of these treatments would guarantee that I would have my old pain free body back.

For now, I've been able to find some relief through clinical Pilates sessions, but the pain is always still lurking and at the age of 71, I'm nervous about what my future mobility might look like. As a grandparent to six grandchildren, I want nothing more than to be present with them and not be limited or distracted by my back pain. My hope would be that an answer to help sufferers of chronic pain is uncovered, giving people facing this insidious issue more certainty about their future.

GIOVANNA LEUNG

CHRONIC PAIN SUFFERER, BRISBANE, QLD

Inflammation: Flipping the switch for a longer, healthier life

Inflammation is undeniably the disease of the 21st century.[12] As many as one in three Australians are suffering with a chronic inflammatory disease - such as cancer, arthritis, obesity or inflammatory bowel disease. It is the disease of ageing and underlies neurodegenerative diseases like Alzheimer's and Parkinson's disease. Together, inflammatory diseases place a significant social and economic burden on the community.[13]

Inflammation is the body's first line of defence against threats such as infection or injury. But when inflammation is unable to turn itself off, it can trigger many chronic diseases.

IMB's Associate Professor Kate Schroder is an immunologist fascinated by the biology of the innate immune system. She is tackling debilitating inflammatory diseases by studying how the inflammation pathway works in healthy cells, in particular how it switches off, with the goal of developing new drugs to fight infection or inflammatory disease.

"Now we understand how this pathway naturally turns off in health, we can investigate why it doesn't turn off in disease – so it's very exciting," Dr Schroder says.

Dr Schroder's work at IMB's Centre for Inflammation and Disease Research focuses on inflammasomes, which are machine-like protein complexes at the heart of inflammation and disease.

"These complexes form when an infection, injury or other disturbance is detected by the immune system, and they send messages to immune cells to tell them to respond," Dr Schroder says.

"If the disturbance can't be cleared, such as in the case of amyloid plaques in Alzheimer's disease, these molecular machines continue to fire, resulting in neurodegenerative damage from the sustained inflammation."

Developing new drugs to fight inflammatory disease

Dr Schroder's team discovered that inflammasomes normally work with an in-built timer switch, to ensure they only fire for a specific length of time once triggered.

"The inflammasome initiates the inflammation process by activating a protein that functions like a pair of scissors, cutting itself and other proteins," Dr Schroder says.

"What we've found is that after a period of time this protein cuts itself a second time to turn off the pathway. If we can tweak this system, we may be able to turn it off manually in disease."

Through collaboration, the Schroder lab has identified new anti-inflammatory compounds that block inflammasomes. This is the basis for potential new anti-inflammatory drugs that UQ researchers are hoping to bring to market – a breakthrough that could ease the burden of this 21st-century disease.

IMB RESEARCHER

Associate Professor Kate Schroder
WEB: imb.uq.edu.au/inflammasomes

SOURCES

12. Beyond Obesity and Lifestyle: A Review of 21st Century Chronic Disease Determinants: http://dx.doi.org/10.1155/2014/731685
13. World Health Organisation: https://www.who.int/nutrition/topics/2_background/en/


1:3
AUSTRALIANS HAVE
A CHRONIC
INFLAMMATORY
DISEASE

For 43 years, my body was under constant attack- from itself. 5 out 7 days a week, I'd end up with a painful rash covering my body. Depending on the day, a range of other symptoms would also appear, from swollen ankles and pink eye to extreme shivers and debilitating migraines. I woke up each morning wondering what type of pain I would have and where in my body it would present itself. Throughout my life I saw dozens of medical specialists, they could never give me an answer behind my condition, writing me off as a hypochondriac in need of psychological help.

At the age of 43, I received an email that changed my life forever. A distant relative who had been experiencing similar symptoms to what I had, married a geneticist who raised the idea that the condition may be genetic. I then underwent genetic testing to reveal a gene mutation, resulting in my diagnosis of Cryopyrin Associated Periodic Syndrome (CAPS), an extremely rare auto-inflammatory condition causing chronic low-grade inflammation throughout the body. Upon receiving the diagnosis, I began treatment and after the first course of prescribed injections, I felt as if a veil had been lifted and I finally got a taste of a pain free existence.

While I have seen a drastic improvement to my health in the last few years, I am by no means cured and still suffer from a range of symptoms from CAPS. Because CAPS is so rare, it didn't have a treatment until 2004 and while the current treatment is beneficial, it's not comprehensive which is why the need for further research is so badly needed.

KAREN RAYMOND

AUTO-INFLAMMATORY DISEASE SUFFERER, ADELAIDE, SA

We break the status quo with a new way of thinking

IMB's researchers are not constrained by tradition – by thinking in a whole new way, we uncover a completely new approach to solving problems. Together, we can stop imagining what might be possible and advance the health and wellbeing of the world around us.

Exploring the molecular to examine the building blocks of life develops an understanding of the what, how and whys of natures. Our scientists harness this knowledge to develop innovative solutions to the problems that plague us every day.

In supporting our research, you will unleash the expertise of our world-leading capability in:

- Venoms and toxins as therapeutics
- Natural products
- Drug discovery
- Antibiotics against superbugs
- Biomarker development
- Bio-insecticides
- Solar Biotechnology
- Bioinformatics
- Genomic technologies

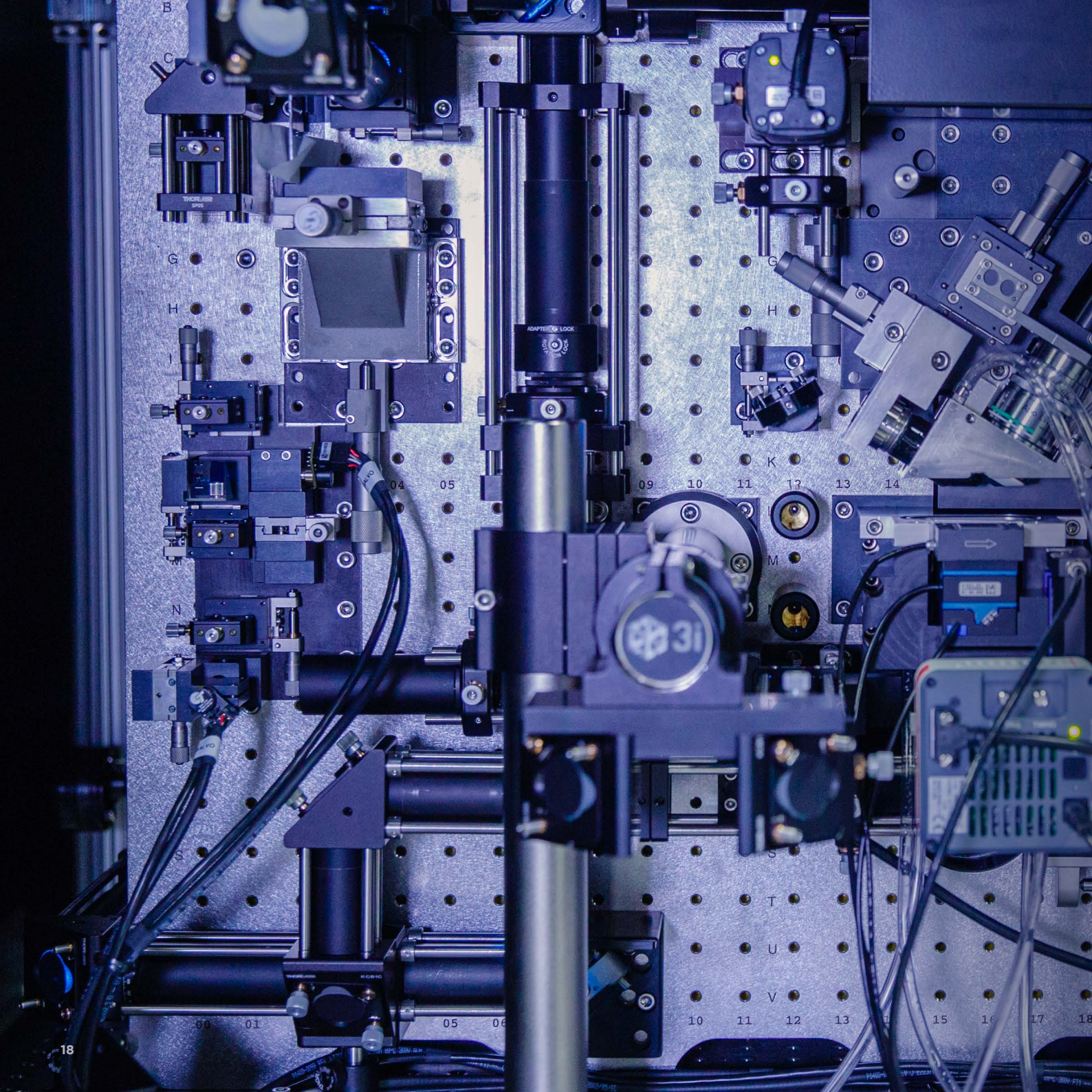
Our scientists' imaginations spark revolutionary ideas with the potential to create innovative solutions for the world's most perplexing challenges. Yet these revolutionary ideas are considered too risky to gain support from government grant schemes or commercial investment. Philanthropists understand the riskiness and enormous up-side of funding the big, bold transformational ideas.

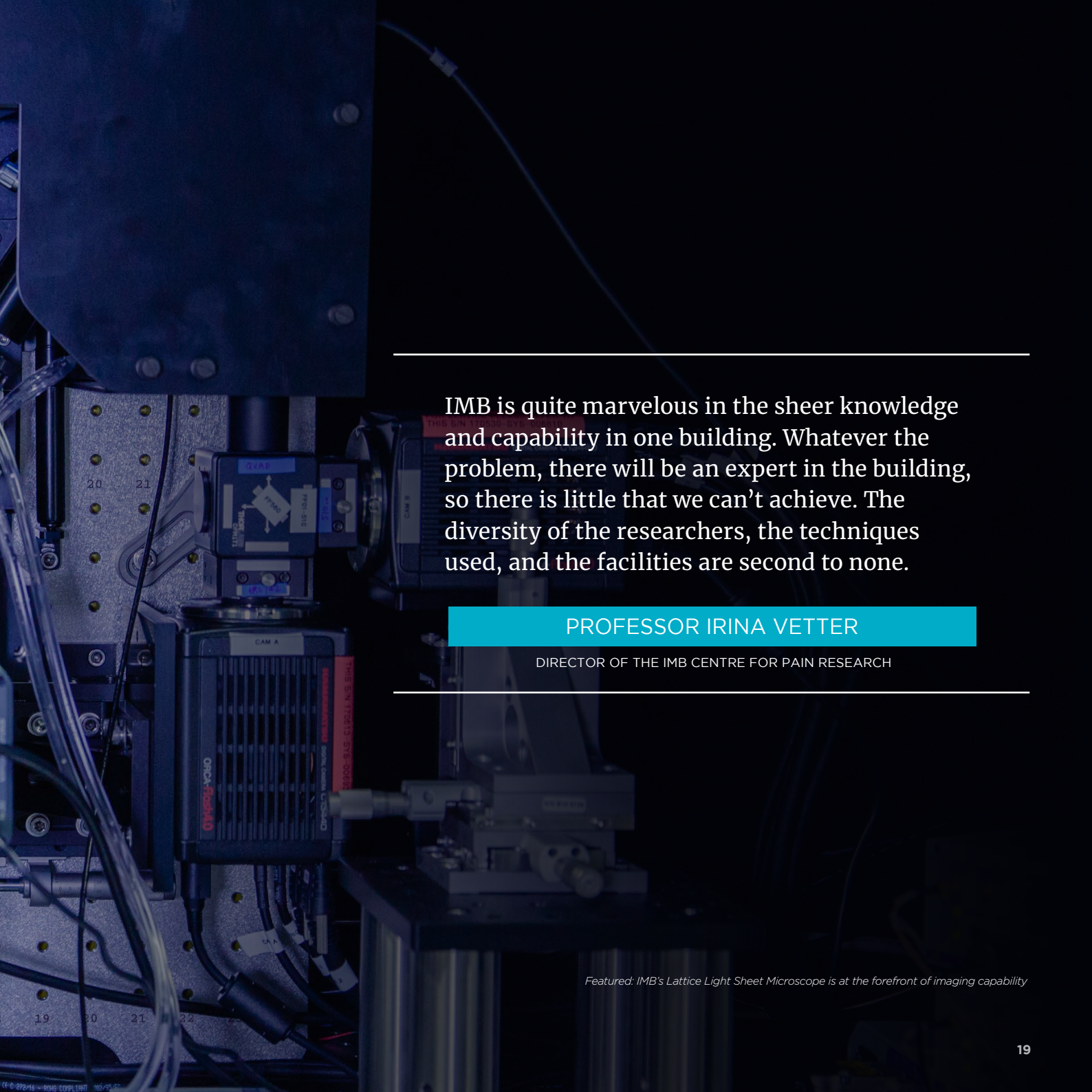
"I believe in innovation and that the way you get innovation is you fund research and you learn the basic facts." Bill Gates

Let's turn imagination into reality

IMB researchers of all levels of experience compete for Ignite Innovation Awards by pitching their revolutionary ideas to an expert panel of peers and representatives of the IMB Advisory Board Translation Sub-Committee. The awards provide seed funding to kick-start research and provide the critical evidence required for a successful grant application or pitch for commercial investment.

We invite you to establish a prestigious named award.





IMB is quite marvelous in the sheer knowledge and capability in one building. Whatever the problem, there will be an expert in the building, so there is little that we can't achieve. The diversity of the researchers, the techniques used, and the facilities are second to none.

PROFESSOR IRINA VETTER

DIRECTOR OF THE IMB CENTRE FOR PAIN RESEARCH

Featured: IMB's Lattice Light Sheet Microscope is at the forefront of imaging capability

Enable life-saving research to impact the health of ageing populations globally

Life-changing research requires significant funding. Large and small, with every donation you help researchers to get closer to finding a prevention, a treatment or a cure.

Your investment could provide

$50,000

Invest in IMB's Ignite Innovation Fund to provide researchers with the financial capacity to pursue blue sky ideas through to commercialisation. Innovative science with translational outcomes will bring better preventions, diagnostics and cures to patients sooner.

$300,000

Establish an IMB Ageing research fellowship to support efforts to investigate the underlying factors of degenerative diseases and realise biomedical solutions to market for people to live healthier and longer lives globally. Foster the next generation of research leaders and enhance UQ's vision to forge strategic partnerships with industry and clinicians internationally and sustain the highest quality of research.

$1,500,000

Make a capacity-building investment to IMB's virtual Cardiac Research Centre. Combined, stroke and cardiac disease are responsible for over a third of deaths worldwide. This investment will empower the world leading researchers at IMB to realise new critical therapies through the commercial pipeline to support longer and more enriched lives globally.

$5,000,000

Endow UQ's Chair in Inflammation and Disease Research with a philanthropic investment that will ensure we continue to attract and retain the brightest and most innovative scientific investigators from across the globe to deliver on our ambition to translate the inflammation disease discoveries from the lab to clinical trials to make a lasting impact for an ageing population.

$20,000,000

Create a lasting legacy by investing in IMB's Centre for Pain Research, enabling scientific excellence to endure in perpetuity at the Centre for future generations. A significant research strength within the institute, the Centre has already identified an entirely new class of pain medicine, developed potential new drugs sourced from animal venoms and uncovered the underlying mechanisms of pain. This investment will ensure that our researchers are strategically poised to translate innovative pain therapies from the bench to the bedside faster.

Together, our greatest days lie ahead. To discuss your investment in the minds of IMB for a healthier future, contact Kamyra Laurenson by email: k.laurenson@uq.edu.au or phone: +61 7 3346 2222.

Featured: Professor Irina Vetter, Director, IMB's Centre for Pain Research

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CREATE CHANGE