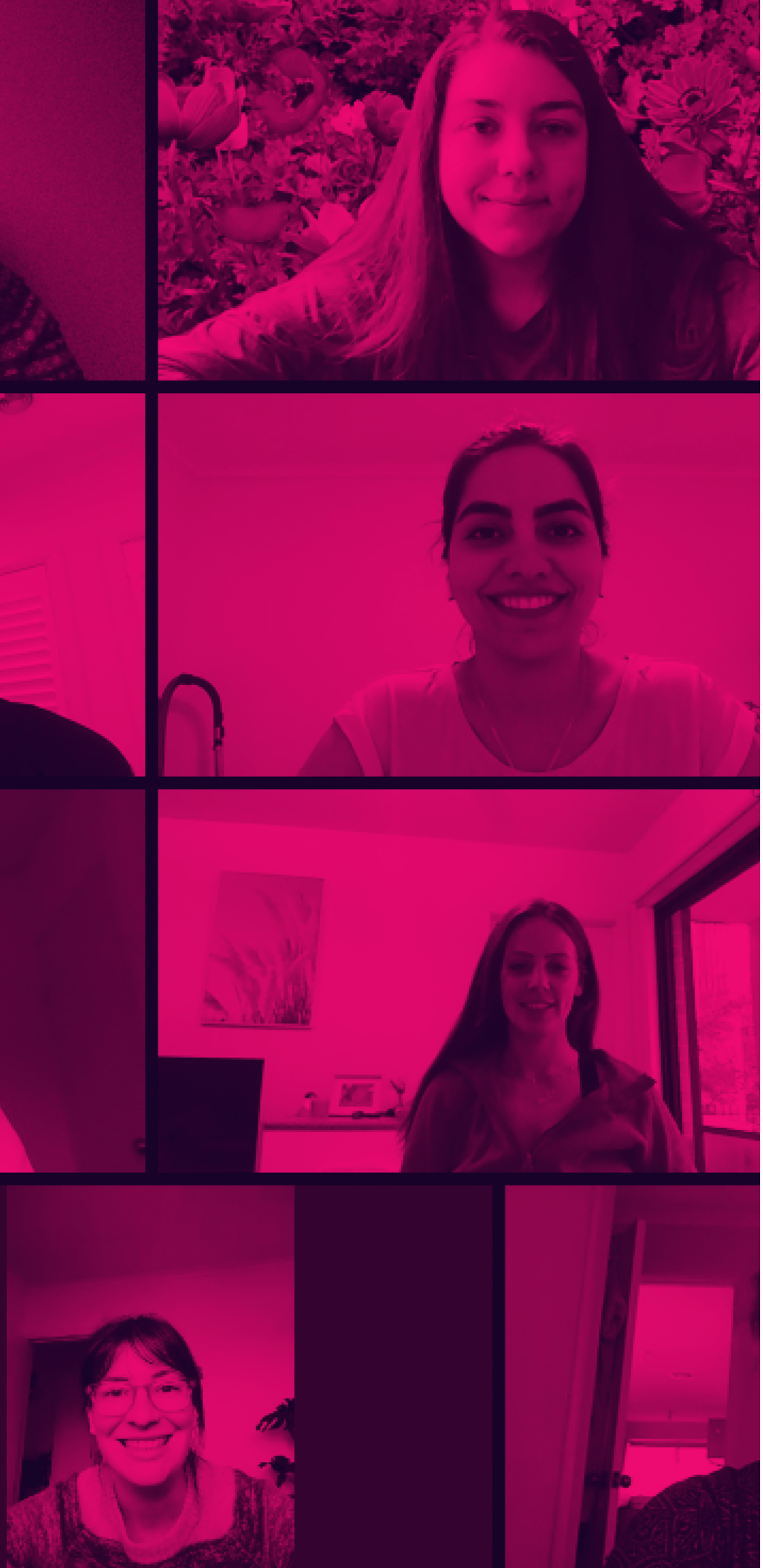
HUDSON
INSTITUTE OF MEDICAL RESEARCH

ANNUAL REPORT 2020

2020 changed how we work but not why



Cover image: Willow O'Brien.
See pages 24-25 for full story.

About us

A global bioscience medical research leader, Hudson Institute strives to improve human health through groundbreaking medical research discoveries and the translation of these into real-world impact.

Our scientists and clinicians are experts in five areas of unmet medical need

- Inflammation
- Reproductive health and pregnancy
- Infant and child health
- Cancer
- Hormones and health

Our reputation as an institution of excellence attracts leading scientists, clinicians and graduate students from around the world in pursuit of one mission – to collaborate to improve human health globally.

Our more than 400 scientists are solving some of the most complex problems in human disease.

Clinical experience based on patient need informs our research enquiry, and our close ties with medical staff and industry supports the translation of our discoveries into new preventative approaches, therapies and devices for patients.

Our Institute is named after endocrinologist Professor Bryan Hudson AO, the Founding Director of Prince Henry's Institute and Inaugural Chair of the Department of Medicine at Monash University.

Our major themes

Inflammation

Reproductive health and pregnancy

Infant and child health

Cancer

Our Precinct

Hudson Institute is located within a major scientific research and medical innovation cluster in Melbourne's south-eastern corridor.

With our precinct partners, Monash Health and Monash University, we deliver outstanding healthcare, education and world-class research.

National Employment and Innovation Cluster

The Victorian Government has identified the Monash Precinct, including Hudson Institute, as a National Employment and Innovation Cluster (NEIC). It is investing in the Precinct to support its growing role in the Victorian economy, including the post-COVID-19 recovery, with international education, research, health, medical technology, pharmaceuticals, science, business services, manufacturing and IT sectors providing highly skilled jobs close to where people live.

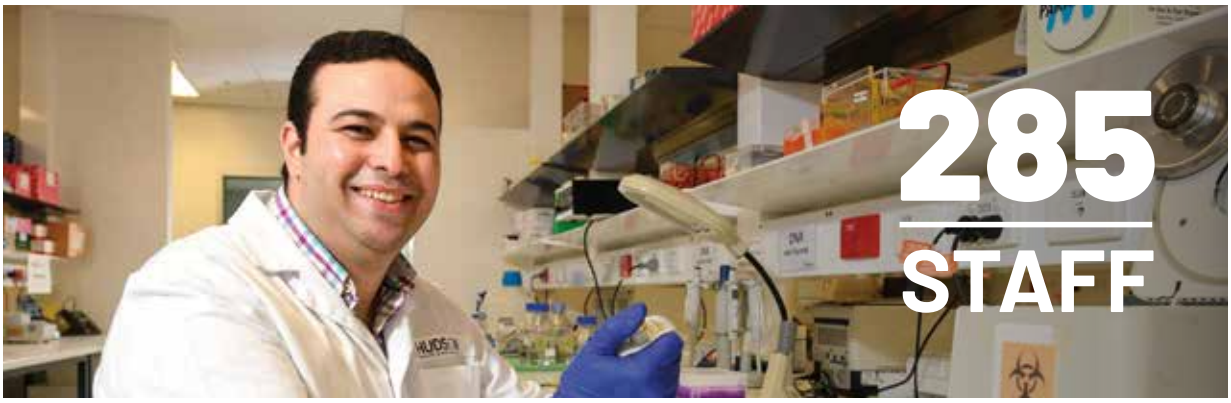
HUDSON INSTITUTE OF MEDICAL RESEARCH

MONASH University

Monash Health

Monash Children's Hospital

At a glance

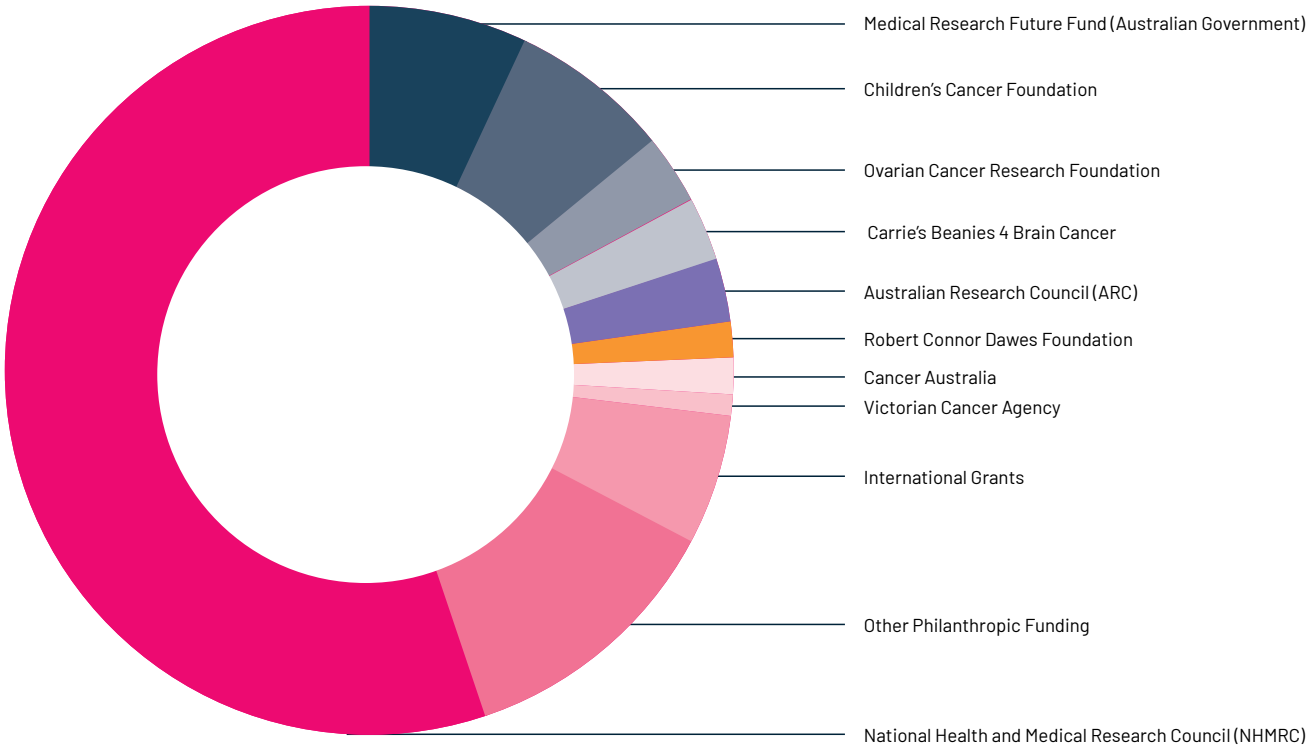

285
STAFF


158
STUDENTS


45
RESEARCH
GROUPS


285
RESEARCH
PUBLICATIONS

Research outputs



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National Health and Medical Research Council (NHMRC)	16,441,367
Medical Research Future Fund (Australian Government)	2,137,782
Children's Cancer Foundation	2,076,033
Ovarian Cancer Research Foundation	882,331
Australian Research Council (ARC)	826,458
Carrie's Beanies 4 Brain Cancer	822,253
Robert Connor Dawes Foundation	488,386
Cancer Australia	468,000
Victorian Cancer Agency	300,000
Other Philanthropic Funding	
The Kids' Cancer Project	256,368
Eva and Les Erdi Charitable Foundation	200,000
Perpetual Trustees	173,953
Cerebral Palsy Alliance	142,171
Cancer Council Victoria	138,975
Science and Industry Endowment Fund	120,026
The CASS Foundation	116,000
Rebecca L Cooper Foundation	100,000
Other grant funding	1,376,282
TOTAL	**3,623,775**
International Grants	
Department of Defense (USA)	1,215,233
Kenneth Rainin Foundation	153,654
Other international grants	318,042
TOTAL	**1,686,929**

Publications

In 2020, Hudson Institute's researchers published extensively in international peer-reviewed journals.

Publication type	2018	2019	2020
Original research articles	206	203	210
Reviews	50	52	41
Editorials and commentaries	17	16	26
Books and book chapters	27	12	8

Director's report

Communicating the importance of medical research to the general public can be challenging. However, in 2020, medical research became front and centre of people's lives. As the scale and devastation of the COVID-19 pandemic emerged, scientists, governments, investors and pharmaceutical companies acted with unprecedented speed to develop and deliver a safe and effective vaccine.

It's important to remember that this 'rapid' response was built on decades of painstaking research and technology development, the result of long-term support for fundamental discovery science and health and medical research.

Hudson Institute was part of the global effort to help find answers to the growing toll from COVID-19. Our world-leading inflammation researchers – the largest group in Australia – were sought-after experts in the fight against severe COVID-19 inflammation. Our scientists were called on by the media and government to advise on how the immune system was driving life-threatening inflammation during COVID-19, and to provide clarity around what treatments would likely work, in an environment where misinformation was rife.

"Our world-leading inflammation researchers – the largest group in Australia – were sought-after experts in the fight against severe COVID-19 inflammation."

We worked with commercial partner, Noxopharm, to test the anti-inflammatory properties of its approved cancer drug, Veyonda. This resulted in the drug moving into clinical trials for COVID-19 in Europe, to determine whether Veyonda could halt the potentially fatal inflammatory cascade caused by the immune system's response to viral infection. The results of these trials will be known in 2021.

Our experts studying influenza redirected their work to include COVID-19, a move which will not only benefit the global community now but in future viral pandemics.

However, the COVID-19 pandemic also highlighted that the Institute lacks the infrastructure to respond effectively to highly infectious disease outbreaks caused by pathogens that require high-containment facilities. In fact, the fast-growing south-east corridor of Melbourne is currently without the PC3 laboratories required for this highly sensitive research.

To address this directly, we have proposed to establish a National Centre for Inflammation Research to house our more than 120 inflammation researchers. In 2020, the Victorian Government generously supported our vision for this new facility by providing $1 million in the 2020 budget to further develop the business case. Additional State and Federal government and philanthropic funding is being sought to complete the project, which is expected to attract significant international commercial investment.

COVID-19 also took its toll on the health and well-being of our staff and students. Like employees everywhere, our exceptional people juggled working from home, home schooling, caring responsibilities and endured separation from loved ones. Despite this, our researchers still made major advances in 2020 against all our areas of important research, underpinned by our dedicated support staff. I wish to thank all our staff and students for their perseverance and resilience throughout 2020, helping the Institute to navigate its way safely through the global crisis.

We remain as grateful as ever for the unwavering support of our community despite the difficult economic environment. This includes all our generous donors – individuals and organisations – such as the Ovarian Cancer Research Foundation, Children's Cancer Foundation, Carrie's Beanies 4 Brain Cancer and the Robert Connor Dawes Foundation, among many others.

I extend my warmest gratitude to our Board of Directors, especially Chair Dr Bob Edgar, for the support and guidance they have generously offered in one of our most challenging years. We look forward with optimism to 2021.

Professor Elizabeth Hartland
Director and CEO

Chair's report

The year 2020 brought its challenges but also some rewards. In particular, in a year when many organisations struggled due to the economic impact of COVID-19, the Institute maintained a stable financial position. We owe this to the quality of research by our talented, dedicated scientists and the grants they were able to attract, to our hardworking Business and Commercialisation department, and to the generous support of our loyal donors and philanthropic organisations.

The Institute's success in commercialising the advances uncovered through our fundamental research was notable. There was a 10 per cent increase in the value of our commercial agreements which rose to $5.4 million. This included a significant agreement with Morningside Ventures to commercialise an ovarian cancer treatment – an exciting development that provides hope to women with this devastating disease.

Revenue for the year was $54 million, up from $49 million in 2019. This included $34 million from the Australian Government, $8 million from philanthropic grants and $3 million from the Victorian Government. Other highlights included $4 million from the National Health and Medical Research Council (NHMRC) for 'Ideas Grants' supporting microbiome, immunity and differences of sex development research.

Our Institute is currently pursuing plans to create a National Centre for Inflammation Research based on our reputation for research excellence in this area, which is so central to worldwide health. The Centre will be housed in a proposed new building based at Hudson Institute that will meet the needs of more than 120 inflammation researchers – the largest group of inflammation experts in Australia.

Critically the building will also compensate for a large loss of leased research space - some that has already been lost and more that will be lost to Hudson Institute in the next few years.

The proposal has attracted $1 million in initial funding from the Victorian Government, with further funds sought from the Federal Government and philanthropy. The building will include facilities to manufacture cell therapeutics, provide increased capacity for clinical trials and much-needed PC3 containment laboratories to study infectious diseases and multi-drug resistant bacteria.

The Board is extremely appreciative of the leadership provided by our Director and CEO, Professor Elizabeth Hartland, and the exceptional efforts of Hudson Institute's research team. We look forward to working with the Institute and the community in 2021 on the next exciting chapter when we focus on developing the NCIR, a world-class hub where our researchers will discover new ways to treat severe and chronic inflammation that underpins many fatal diseases worldwide.

My sincere thanks to my fellow Board members for their support throughout the past year.

Dr Bob Edgar AM
Board Chair

2020 at a glance

$54M
Revenue

$34M
Australian government funding

$8M
Philanthropic grants

$3M
Victorian government funding

L-R: Rob Merriel, Kate Mackin and Carmela Monger

BUSINESS DEVELOPMENT AND COMMERCIALISATION

Hudson Institute builds on commercial success

2020 represented a strong and successful year for business development and commercialisation. While COVID-19 impacted other traditional revenue streams, our Institute grew its commercial success, boosting income through commercial agreements.

The value of these agreements rose from $4.5 million in 2019 to $5.4 million in 2020 – a 10 per cent increase. Four patents protecting our discoveries were granted in Australia, China and the US, while two PCT applications were filed.

Business development oversaw a 25 per cent increase in agreements and contracts managed in 2020 compared to 2019 with commercial activity a key driver of the expanded workload.

Two start-up companies were funded by venture capital, while one is seeking investment funding or an industry partner.

Key achievements included commercialising an ovarian cancer treatment discovery with Morningside Ventures; establishing a new company, Pharmorage, with industry pharmaceutical company Noxopharm (ASX:NOX); and entering into a research services agreement with Invion (ASX:IVX) to evaluate the company's cancer treatment therapeutic, Photosoft™.

The business development and commercialisation team ensure the Institute's research discoveries reach patients. Working with academic, industry and government partners, research is protected, commercialised and developed for future use. Partnerships are forged with global pharmaceutical, clinical and venture capital organisations to progress research from early stages to clinical trials and ultimately to patients.

Key milestones

Medical Research Commercialisation Fund (MRCF)

Hudson Institute continued as an active member of the Medical Research Commercialisation Fund (MRCF), the largest life science investment fund in Australia and New Zealand. MRCF is a unique collaboration between major

Hudson Institute is recognised worldwide for its inflammation, infection and immunity research. Since 2017, we have been proudly collaborating with Hudson Institute through its exciting research and innovative projects.

Gerald Chan, Morningside Ventures CEO

Australian superannuation funds, the Australian and New Zealand governments, Australian state governments and more than 50 leading medical research institutes and research hospitals. A successfully funded project continued throughout 2020 while researchers pitched another project to MRCF for funding.

Hudson Institute Investment Holdings (HIIH)

HIIH was established on 16 June 2020 to streamline and enhance the Institute's commercialisation capacity. The company will hold equity on behalf of the Institute in spin-off companies and hold units issued from venture capital trusts as part of our MRCF membership. In 2021, the Institute is investigating how to utilise HIIH to attract investment funding for intellectual property.

Morningside Ventures

A research partnership between Hudson Institute and international venture capital group, Morningside Ventures, achieved a key milestone that has led to a multi-million-dollar investment in a start-up company, Epsila Bio, focusing on development of a therapeutic candidate to treat metastatic ovarian cancer.

Noxopharm Limited (ASX:NOX)

A partnership between Hudson Institute and Noxopharm has led to the formation of a new Australian drug development company, Pharmorage Pty Ltd. Pharmorage will be developing treatments for life-threatening inflammation together with Hudson Institute and Australian National University. The development comes after Hudson Institute scientist Associate Professor Michael Gantier discovered how Noxopharm's drug Veyonda – a late-stage prostate cancer drug – acts on the STING pathway that is implicated in inflammation.

Invion Limited (ASX:IVX)

Hudson Institute entered into a Research and Development Alliance Agreement with Invion Limited to provide key scientific assessment of Invion's cancer treatment technology, Photosoft™.

The collaboration will initially focus on the treatment of ovarian cancer, with a view to expanding research and development projects into other forms of cancer. Photosoft™ is a next generation Photo Dynamic Therapy (PDT) that uses a laser light activation method based on short, pulsating 'near infrared' (NIR) wavelengths. PDT technology uses non-toxic photosensitisers and visible light in combination with oxygen to produce cytotoxic-reactive oxygen to kill malignant cancer cells and stimulate the immune system. PDT causes acute inflammation, expression of heat-shock proteins, and invasion and infiltration of a tumour by leukocytes.

Lateral Pharma P/L

Lateral Pharma, an Australian biotechnology company, worked with Hudson Institute throughout 2020 on preclinical development of a novel therapy for respiratory diseases, including Influenza A. Associate Professor Michelle Tate is leading the collaboration on behalf of the Institute. Lateral Pharma recently signed a new research agreement extending the project throughout 2021.

Discussions continue with other potential investors to drive a range of Hudson Institute projects.

NATIONAL CENTRE FOR INFLAMMATION RESEARCH

State-of-the-art response to a world health crisis

The COVID-19 pandemic that has gripped the world since 2020 is a lesson in the dangerous and often fatal effects of inflammation that follow infection. But did you know more than half of all deaths worldwide are also caused by conditions linked to inflammation? That's why we're proposing to establish a world-leading National Centre for Inflammation Research (NCIR) at Hudson Institute.

Inflammation underpins hundreds of health issues across the human lifespan. It's behind more than half of all premature deaths worldwide – along with incalculable pain and suffering, debilitating illness and disability.

The state-of-the-art centre will cement Victoria as a global leader in medical research and enhance the state's capability and capacity to respond rapidly to current and future health challenges, including pandemics.

Acute inflammation of the lungs and heart, associated with COVID-19, can lead to sepsis, multi-organ failure and, to date, is responsible for the deaths of more than two million people.

"There is immense potential for medical innovation targeting the body's inflammatory responses," Hudson Institute Director and CEO Professor Elizabeth Hartland said.

"If we can short circuit the pathways that lead to severe and chronic inflammation, we can have a real impact on major human diseases like sepsis, cancer, endometriosis and other inflammation-related conditions. We're calling for a national focus on this area to accelerate much-needed progress," Prof Hartland said.

The centre was kickstarted with $1 million in funding from the Victorian Government, announced in October 2020 by the Hon Jaala Pulford, Minister for Innovation, Medical Research and the Digital Economy. This funding is being used to assist with detailed planning to establish the NCIR at Hudson Institute, co-located with Monash Medical Centre in Clayton, as well as providing critical seed funding to accelerate inflammation research.

Hudson Institute is home to the largest group of inflammation researchers in Australia. Scientists at the new NCIR will investigate cell and gene therapies, immunotherapies and the microbiome to treat chronic and dangerous inflammation during infection, cancer or chronic diseases.

The facility will include much-needed PC3 containment laboratories – the only PC3 laboratories in the Monash Precinct – enabling scientists to study the inflammatory response to life-threatening hospital or community-acquired infections, such as multi-drug resistant bacteria and infectious disease outbreaks.

More than 950 jobs will be created throughout the project, including 300 highly skilled jobs for researchers, scientists and clinician researchers, and a further 650 construction-related jobs throughout the building phase. With funds already invested in the planning and design phase, this initiative is ready to launch in 2021, with construction scheduled to begin in October 2021 (subject to funding).

Further State and Federal government and philanthropic funding will be sought to complete the project, which is expected to attract significant international commercial investment.

Why inflammation research?

Inflammation is how our body fights infections, injuries and toxins. It's a natural part of healing – a protective response to infection or tissue injury and the crucial first step in activating the full immune response. However, when chronic or unchecked, inflammation can lead to a wide range of life-threatening and debilitating conditions. Chronic, persistent inflammation is implicated in the ever-growing burden of disease from cancer, strokes and diabetes; as well as heart, lung, kidney and liver disease, endometriosis and infertility, lupus, pneumonia, and infectious diseases including COVID-19.

Hudson Institute leads the world in inflammation research, with a team of more than 120 scientists in this area. The number of these scientists has more than doubled since 2018, and their breakthrough research is being translated into best practice healthcare in Victoria, across Australia and around the world. Our pioneering inflammation-based treatments were the basis of clinical trials with COVID-19 patients in Europe.

NCIR in numbers

450
Scientists and support staff

120
Inflammation researchers

950
New jobs created

650
Immediate construction jobs

300
Permanent highly skilled jobs

Ovarian cancer survivor Vali Creus with daughters Alexis and Kaia

Research impact

L-R: Arwaf Alharbi, Associate Professor Michael Gantier, Tomalika Ullah and Sumaiah Al Asmari

Inflammation researchers tackle COVID-19

Hudson Institute is home to Australia's largest group of inflammation researchers, who, along with the world's scientific community, pivoted rapidly in early 2020 in response to the COVID-19 outbreak.

Inflammation and COVID-19

To understand our research in this space, it's essential to understand the difference between good and bad inflammation.

Inflammation is a normal, protective reaction to infection – and a critical first step in activating the body's full immune response. However, if uncontrolled, inflammation can lead to a range of debilitating and life-threatening conditions – acute respiratory syndromes, sepsis, chronic obstructive pulmonary disease, inflammatory bowel disease, lupus, pneumonia, endometriosis, infertility, and even cancer.

The life-threatening acute respiratory distress syndrome (ARDS) in severe COVID-19 cases results from hyper-inflammation driven by an over-active immune response, similar to that seen during other SARS, MERS and avian influenza outbreaks. The effect on our aged and immune-compromised communities has been devastating. Restricting this inflammation could help save lives and is a crucial part of any pandemic response, along with vaccine development and delivery.

COVID-19 treatment discovery in clinical trials

Associate Professor Michael Gantier

Working in collaboration with Australian ASX-listed biotech firm Noxopharm, A/Prof Michael Gantier investigated the effects of the company's end-stage prostate cancer treatment, Veyonda, on immune responses.

The discovery was clear. Laboratory studies by A/Prof Gantier's team indicated the drug's potent anti-inflammatory activity. Idronoxil, the active component in Veyonda, blocked the production of several pro-inflammatory proteins, known as 'cytokines'. These proteins are involved in the 'cytokine storm' or hyper-inflammation that leads to ARDS and death from COVID-19.

Noxopharm and A/Prof Gantier suggested that idronoxil may have potential beneficial effects on COVID-19 patients, by limiting the severity of the infection and any potential long-term impacts.

The first clinical trial of Veyonda in COVID-19 patients started in October in patients with severe disease. The trial involved patients in hospitals in Moldova, which was at the time experiencing high rates of SARS-CoV-2 infection and hospitalisation. Following encouraging results in the first 40 patients, the trial is now being expanded to a larger cohort. Full results are expected mid-2021.

"In critical COVID-19 patients, the progression from ARDS to death directly relates to out-of-control inflammation from damaged tissues," A/Prof Gantier said. "This progression is slow (over a week), allowing a window of opportunity to prevent the inflammatory storm and protect these patients." It's this window of opportunity that was tested in clinical trials when delivering the treatment to patients.

"

Hudson Institute combines world-class discovery science with a focus on facilitating commercial activity. Our experience working with their researchers and commercial team has shown the Institute to be an excellent partner.

Graham Kelly, Noxopharm CEO and Chairman

L-R: Associate Professor Michelle Tate, Associate Professor Ashley Mansell

L-R: Nicole Campbell, Dr Sam Forster, Professor Paul Hertzog and Tamblyn Thomason

Inflammation and infectious diseases

Associate Professor Michelle Tate, Associate Professor Ashley Mansell

COVID-19 has similar characteristics to severe Influenza A virus (IAV) infections, including the damaging lung inflammation that causes acute respiratory distress syndrome (ARDS). A/Prof Ashley Mansell and A/Prof Michelle Tate are collectively using their knowledge of severe inflammation from IAV studies to repurpose and develop potential drugs to treat COVID-19. The team has been sought out by international biotech companies due to their specialist expertise.

"The impact of the COVID-19 pandemic has been devastating for human health and the economy," said A/Prof Tate.

"Unfortunately, this is not the last pandemic we are likely to see. We desperately need new drugs that limit the damaging inflammation during severe viral infections.

"I think there are a lot of lessons we can learn from the current pandemic, to better prepare us for the next."

A/Prof Mansell said: "Inflammation is involved in nearly every disease known to humankind and yet we understand very little about how, why and where this occurs and what causes it. If we understand the how and why, we can try and target it to reduce disease."

How we are tackling acute inflammation

- Identifying which molecular mechanisms induce SARS CoV-2 hyperinflammation and disease
- Developing and testing new and repurposed anti-inflammatory compounds to treat ARDS in COVID-19.

Innate immunity, the microbiome and genomics – a multi-pronged approach to studying COVID-19 infection

Professor Paul Hertzog, Dr Sam Forster, Professor Marcel Nold, Associate Professor Claudia Nold, Professor Phil Bardin, Professor Jim Buttery and Dr Ben Rogers

A research project studying the innate – initial – immune response of COVID-19 patients admitted to Monash Health is continuing. It involves our world-leading immunity, microbiome and paediatric immunology researchers – Prof Paul Hertzog, Dr Sam Forster, Prof Marcel Nold and A/Prof Claudia Nold.

The study is comparing the status of the immune response and microbiome composition over the course of COVID-19 infection, correlating this with disease severity and outcomes including recovery or intensive care. The idea is to examine whether there is something different about the microbiome of those who have an extreme reaction to the virus and how this correlates with patients' age.

Meanwhile, genomic sequencing of patients will investigate any genetic predisposition to the virus.

30,130	910	172M	3.7M	1.5B
COVID-19 cases in Australia	Deaths in Australia	COVID-19 cases globally	Deaths globally	Vaccinations

Figures accurate as at June 4, 2021. Source: WHO

Saving lives with cell therapies

Cell therapy research by Associate Professor Rebecca Lim is revealing how cells from the amniotic sac can reverse life-threatening conditions.

Human amniotic epithelial cells (hAECs) are from the amniotic sac that surrounds a baby during pregnancy. They have stem cell-like properties and can grow into many cell types. Importantly, they have potent effects on inflammation and tissue damage.

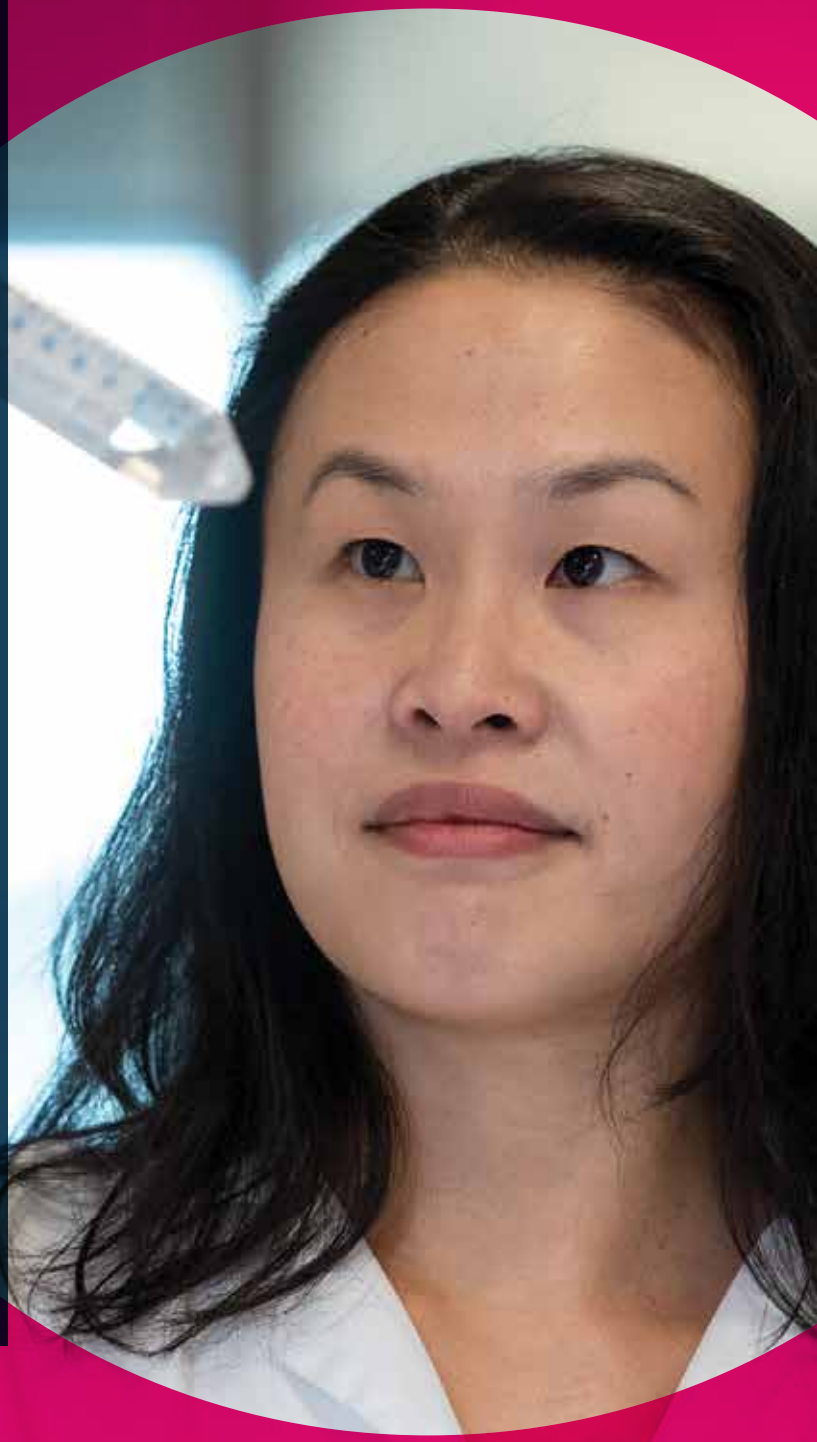
Patients who will benefit include extremely premature babies with the lung disease bronchopulmonary dysplasia (BPD), which can cause cerebral palsy; and adults with acute stroke, chronic liver disease and Crohn's disease.

hAECs are game-changing because these cells offer a simple treatment – they don't need to be matched to the patient's blood or tissue type and can be delivered intravenously in about an hour.

The long-term goal is to develop a treatment for premature babies, accessible in hospitals around the world, to increase survival rates and prevent long-term complications for vulnerable infants.

Collaborators Monash Children's Hospital, Monash University, Royal Women's Hospital

Funders Fielding Foundation, Hugh Rogers Foundation, NHMRC, Jack Brockhoff Foundation



Associate Professor Rebecca Lim

Male fertility under the microscope

Inflammation underpinning medical conditions and disease is spread across the lifespan. Now we are learning more about how it can affect male fertility, thanks to Professor Kate Loveland and her team.

Inflammation and male fertility

Infection in the male reproductive tract may lead to reduced fertility in men. Understanding how this happens was a key goal of research examining immune cells in the healthy adult testis, to learn how these cells may function differently in response to disease-causing bacteria.

It is hoped the new information will lead to improved monitoring and treatment of male fertility issues.

The study examined macrophages, specialised immune cells that are both essential for normal organ function and also among the first to detect and destroy harmful organisms like bacteria. However, macrophages can also promote inflammation, releasing signals that impair sperm production. Immune cells are important for maintaining a healthy environment for sperm production, but these cells' activity must also be held in check to ensure maturing sperm are not recognised as foreign.

The researchers also discovered new information about the influence of activin A, a key protein signal of central importance to reproductive health. Testes with higher-than-normal activin A levels had a higher proportion of macrophages likely to be involved in inflammation, placing sperm production in peril. This highlights the potential for men's fertility to be reduced both during and after an infection.

Researchers Sivanjah Indumathy, Prof Kate Loveland, Prof Mark Hedger

Collaborators Monash University; Justus-Liebig University, Germany; Ohana Biosciences, USA; Burnet Institute

Funders Ideas Grant and Fellowship, Victorian State Government Operational Infrastructure Scheme, German Research Council, Monash University

Professor Kate Loveland

Male fertility and testicular cancer

Male fertility problems and testicular cancer are both on the rise. Research led by Prof Loveland documented for the first time the importance of a key signalling pathway, crucial for embryonic development, to male fertility and testis cancer. The pathway, called WNT signalling, plays an active role during sperm development and is also present in precursor germline cells (cells involved in egg, sperm and embryo development) that turn into tumour cells. The discovery has important implications for boosting male fertility and for treating men with testicular cancer, especially those who experience a relapse and poor prognosis. It provides a potential new target for treatment.

Researchers Prof Kate Loveland

Collaborators Monash University, University of Copenhagen, Denmark

Funder NHMRC

Could male fertility problems begin in the womb?

Two published studies by Prof Loveland's team are providing evidence this could be the case. One study found that a male fetus exposed to abnormally high levels of a growth factor (activin A), present during pregnancy, directly affected a male baby's sperm cell development and could lead to infertility and testicular cancer later in life.

Activin A levels may be elevated in some pregnant women who take certain medications such as selective serotonin reuptake inhibitors (SSRIs), have infections, or suffer from conditions such as pre-eclampsia. "With rates of infertility and testicular cancer increasing around the world, the more information we have, the better chance we will have for developing treatments or minimising risk due to exposures during pregnancy," Prof Loveland said.

Researchers Dr Sarah Moody, Prof Kate Loveland, A//Prof Patrick Western

Funders NHMRC Ideas Grant and Fellowship, Victorian State Government Operational Infrastructure Scheme, Australian Government RTP Scholarship, Japan Society for the Promotion of Science

When testes first develop

The same activin A growth factor was linked to steroid production in the testes growing in the womb, showing the protein is necessary for normal testosterone production. Activin A was shown to promote synthesis of two enzymes crucial for the final steps of testosterone synthesis. The absence of activin A resulted in an abnormal steroid environment during a window of development when the program of masculinisation is initiated in male offspring. "Events that alter activin A levels, which can occur due to different physiological conditions of pregnancy or the mother's exposure to certain medications, may explain why some boys and men have impaired reproductive health," Prof Loveland said.

Researchers Penny Whiley, Prof Kate Loveland, Dr Liza O'Donnell

Collaborators Prof David Handelsman (ANZAC Institute, Sydney), Prof Kristian Almstrup (Copenhagen University Hospital)

Funders NHMRC Ideas Grant and Fellowship, Victorian State Government Operational Infrastructure Scheme

Quick facts

- Infertility affects **one in 20** men
- Testicular cancer is the second most common cancer in men aged **18–39**
- The incidence of testicular cancer is rising worldwide at **two per cent per year**, for unknown reasons
- Some **95 per cent** of men under 40 who get testicular germ cell (reproductive) tumours can be 'cured' with surgery and chemotherapy, but the prognosis is poor for men who relapse
- While recovery rates from testicular cancer are excellent, it can still have lifelong consequences.

L-R: Dr Caitlin Filby, Professor Caroline Gargett and Dr Fiona Cousins

Your endometriosis questions answered

Hudson Institute researchers Professor Caroline Gargett, Dr Caitlin Filby and Dr Fiona Cousins are investigating the potential causes of endometriosis. If we can understand more about how endometriosis emerges and develops, this could lead to the development of less invasive diagnostic tests and more effective treatments.

What is endometriosis?

Endometriosis or 'endo' is a debilitating, chronic inflammatory condition where tissue fragments with similar properties to the womb lining attach to other organs and grow into lesions outside the uterus. Initially, these lesions are still responsive to female reproductive hormones that trigger menstruation and may bleed during a woman's period, causing inflammation.

The condition can cause chronic pelvic pain, bowel and bladder dysfunction, back pain, heavy menstrual bleeding, nausea, pain during sex, and infertility. There is no cure. Treatments include hormonal-based therapies and surgery to remove lesions to reduce pain and improve fertility. But much better treatments are needed.

There are three main types of endometriosis lesions: endometriomas on the ovaries; deep infiltrating endometriosis (DIE) lesions between the bowel and vagina; and superficial lesions, which grow on the surface of organs and the peritoneum.

What causes endometriosis?

This is the key question facing endometriosis researchers today. Our team is working on the hypothesis that endometriosis is caused by retrograde menstruation – where menstrual fluid containing cells that initiate endometriosis flows backward through the uterus, out of the fallopian tubes and into the pelvic cavity. These cells somehow evade the immune system, attach to organs, and form lesions.

What does your research involve?

We believe there are two types of endometrial stem cells shed during menstruation that could be forming lesions following retrograde menstruation into the pelvic cavity. The ability for stem cells to grow and proliferate are qualities that enable the endometrium – the lining of the uterus – to renew each month after shedding during the menstrual cycle.

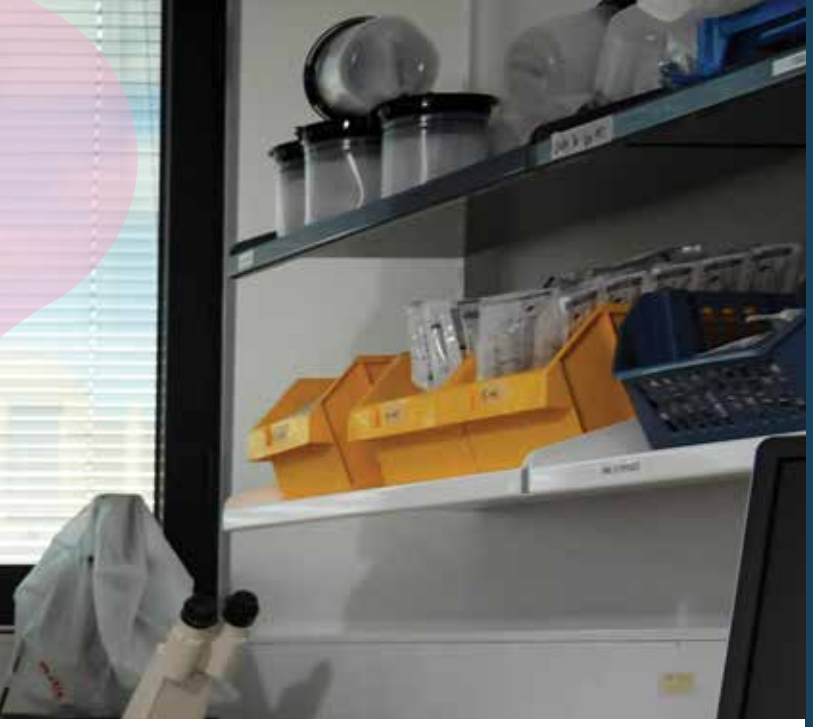
176M
Affected worldwide (1 in 9)

10 years
How long a diagnosis can take

A$9.7B
Annual cost for Australia

£8.5B
Annual cost for UK

US$53.8B
Annual cost for US



You may wonder then why all women don't have endometriosis? We believe the answers might be in the DNA of women's endometrial cells. We are working in collaboration with Professor Grant Montgomery from the University of Queensland to investigate how variations in the DNA sequence (genomics) that give rise to endometriosis risk genes could be giving these stem cells an advantage to grow into lesions. The role of inflammation and the immune system is also important in allowing lesions to survive. This work is funded by a $3 million grant from the US Department of Defense.

There is an urgent need to improve the lives of women with endometriosis. To achieve this, we need to understand which cells form the lesions, how they spread to other organs, and what factors govern their ability to survive and invade other tissues. This will enable us to develop new therapies that will hopefully prevent endometriosis, saving women from the debilitating pain and discomfort caused by this condition.

"This is a disease affecting young women in the prime of their life. It prevents them from reaching their full potential – personally, professionally, financially. We desperately need new ways to diagnose and treat endo. We want to give the millions of women with endometriosis their quality of life back."

Prof Caroline Gargett

Collaborators Prof Grant Montgomery, University of Queensland; Prof Luk Rombauts, Monash IVF

Funders US Department of Defense, NHMRC

Case study: Gabrielle Jackson

Gabrielle Jackson is Associate News Editor, Guardian Australia and the author of *Pain and Prejudice - A call to arms for women and their bodies*. Chronic pain has tainted her life since age 14. This is her story.

I had incredibly painful periods from about the age of 14, involving back and leg pain, nausea and diarrhoea. No one ever suggested this was unusual. I also had periodic bouts of intense fatigue and was diagnosed with chronic fatigue syndrome at 16.

I was eventually diagnosed with endo at 23, but only after insisting on a referral to a gynaecologist. My GP previously told me that some women get bad period pain and I should learn to put up with it.

Endometriosis and the associated symptoms have had a severe impact on my life. I had extended periods off school and work, and sometimes worked part-time just to cope. Worst of all, I lived a life where I believed I was a hypochondriac – a weak and flaky person who couldn't cope with life. I have missed countless opportunities because of the pain and fatigue associated with endometriosis. I resent not being given the full picture of the disease from the earliest stages of diagnosis. It is not just about period pain and fertility. Learning the full symptomology of endo and its impacts has helped me to improve my life and manage my symptoms. Until 2015, I had no idea that the back, leg and hip pain, headaches, fatigue and nausea were all common endometriosis symptoms. I cannot overstate the importance of understanding the chronic pain aspect of endo.

I had laparoscopic excision surgery in 2001, and again in 2016. That has helped both times with period pain and the worst of the nausea, vomiting and diarrhoea. Pelvic physiotherapy is critical in managing the muscle pain, which is the cause of some of my worst pain. Finding a doctor who treated the whole body and understood the disease was life-changing. I take daily amitriptyline, which has helped me sleep properly for the first time in 20 years, and the Qlaira contraceptive pill. Daily exercise, a careful diet, good sleep and massage really help. And not overdoing it.

Ultimately, I want research that will help us live a better quality of life. I hope more research and education will help doctors treat women and other people with endo better, recognising endo as a multisystem disease and treat it as such. I hope research can unlock the mystery of chronic pain to help not only endo sufferers, but others with overlapping chronic pain conditions too.

L-R: Associate Professor Claudia Nold, Professor Marcel Nold, baby Willow and Christy and Brendan O'Brien

A mystery solved

Necrotising enterocolitis, or NEC, is a potentially fatal condition in premature babies. It can trigger massive inflammation, causing parts of the small and large intestines to die, leading to widespread infection and multi-organ failure.

It's hard to diagnose, surgery is common but comes with a high fatality rate, and there is no therapeutic treatment. Babies can only be offered basic support, including fluids and antibiotics. NEC can also have long-term impacts on the developing brain of those babies who survive.

However, research led by Professor Marcel Nold and Associate Professor Claudia Nold is offering fresh hope to these vulnerable children. An international discovery published in *Nature Communications* shed new light on how NEC develops, discovered possible treatment targets and identified the potential for new or existing drugs to treat the condition, for the first time.

"By the time we know a baby has NEC, the infant is often already in a critical condition with sepsis (widespread bacterial infection) and sometimes life-threatening multi-organ failure. A targeted treatment is urgently needed – but no such treatment exists," said Prof Nold (Department of Paediatrics at Monash University; Hudson Institute; and Neonatologist at Monash Newborn, Monash Children's Hospital).

A/Prof Nold (Hudson Institute) said, "Neonatologists do a fantastic job keeping extremely premature babies alive, but the increase in the number of survivors comes at the price of a rising incidence of severe diseases, including necrotising enterocolitis. NEC is a looming spectre that haunts neonatal intensive care units and strikes unpredictably.

"By substantially advancing scientific knowledge about NEC, our team's work has made this terrible disease easier to understand, handing scientists and clinicians the tools to propel drug development," she said.

Life-saving discovery

The researchers found levels of an anti-inflammatory protein, IL-37, were lower in samples from babies with NEC. Further studies in preclinical models then showed IL-37, when given as a supplement, was protective against NEC.

"Our data suggests that supplementing babies who have or are at risk of developing NEC with an IL-37 therapeutic may prevent or treat the condition," Prof Nold said.

The research also identified a range of cytokines, small molecules that regulate immune function. One responsible for triggering inflammation, IL-36, was elevated in babies with NEC. IL-36 is a pro-inflammatory cytokine that is

Hope for babies like Willow

Willow O'Brien was born at 24 weeks and six days, weighing a tiny 630 grams. Her parents, Christy and Brendan, knew that necrotising enterocolitis (NEC), an inflammatory disease attacking the bowel, was common in extremely premature babies. After spiking a fever in her first three weeks of life, NEC was raised as a potential cause. "Hearing the word NEC was pretty scary. We knew about NEC and that it had a high risk of mortality," Brendan said. Without any way to diagnose the condition for certain, little Willow had several rounds of surgery as her condition fluctuated to check whether there was any damage to the bowel, which was thankfully intact.

Brendan said the world-leading research by Prof Nold and A/Prof Nold was "revolutionary".

"To be able to detect whether NEC is occurring, then being able to interfere with that inflammatory cascade to prevent the condition from developing is amazing," he said.

Willow finally went home after 143 days in neonatal intensive care at Monash Health. She continues to thrive.

also involved in a skin condition, psoriasis, for which a range of medications is already available. Prof Nold said work would begin to investigate whether psoriasis drugs were suitable NEC treatments.

"Despite decades of research, NEC remains a major challenge in the neonatal intensive care unit because of its insidious onset, rapid progression and the absence of an effective therapy," Prof Nold said. "This renders neonatologists powerless to treat what still is for many babies a deadly disease and for survivors a severely disabling condition," he said.

"We suggest that IL-37 and other strategies could provide our tiniest patients with a much-needed therapy to shield them from NEC."

Funders National Health and Medical Research Council, ANZ Trustees Medical Research & Technology in Victoria Program, The Marian & E.H. Flack Trust, Fielding Foundation, Future Leader Fellowship from the National Heart Foundation of Australia, Monash University, Australian Government Research Training Program Scholarships by the German Research Foundation

Quick facts

- NEC affects between **one and three in 1000** live births
- **Up to a third** (between 20–30 per cent) of babies with NEC die – a number that has changed little over the past 50 years
- NEC is one of the most common causes of death in premature babies between days **15 and 60** of life
- Of NEC-afflicted infants, **20–30 per cent** need surgery – and up to **65 per cent** of these babies don't survive
- Babies born full-term but with congenital heart disease are also at risk of NEC
- Babies who survive NEC are at increased risk of poor long-term physiological and neurodevelopmental growth.

Leane Flynn, second from left, is an ambassador for the Ovarian Cancer Research Foundation. She has ovarian cancer and patients like herself may benefit from a treatment like this in future. She is pictured here with her daughters, L-R: Anabel, Laura and Amelia.

Ovarian cancer treatment hope

Ovarian cancer is a silent killer. It is often asymptomatic and goes undetected until the advanced stages, when the cancer is widespread.

Ovarian cancer therefore has the lowest female cancer survival rate. Only 45 per cent of women diagnosed live for five years. There have been only a few new treatment options for the past 30 years.

"There's a huge unmet need for treatments for women who have ovarian cancer," said inflammation researcher Professor Paul Hertzog, who led the discovery of a protein in the female reproductive tract that could hold the key to a new treatment for late-stage ovarian cancer.

Prof Hertzog's laboratory in 2004 discovered interferon epsilon – part of the immune system's protective inflammatory response – shielded against infection in the female reproductive tract.

Prof Hertzog's team then showed in clinical studies that it protects against infection and cancer. The promising findings led to a multi-million-dollar investment in the research by international venture capital fund Morningside Ventures, resulting in a spin-out company, Epsila Bio, Inc, established in partnership with Hudson Institute to develop these discoveries into a therapy.

The investment will progress the research from the laboratory into clinical trials.

Key finding

The discovery of a protein – interferon espsilon – in the female reproductory tract could hold the key to a new treatment for late stage ovarian cancer.

How does the treatment work?

Metastatic ovarian cancer often spreads to the peritoneum, which encases abdominal organs including the uterus, bladder, intestines and diaphragm. Current treatment for ovarian cancer that has spread to the peritoneum involves what is called 'debulking' surgery – removing metastatic cancer deposits in the abdomen – followed by chemotherapy. Unfortunately, ovarian cancers often develop resistance to chemotherapy, severely limiting options for subsequent treatment.

Prof Hertzog, who is the Head of the Centre for Innate Immunity and Infectious Disease and the Institute's Associate Director, said the new therapeutic candidate to

be developed by Epsila Bio has been shown to limit cancer growth, particularly in the peritoneum. "This is where it seems to be most effective," Prof Hertzog said.

"We think it has a two-pronged action – boosting the immune response to the cancer, as well as directly slowing down the growth of cancer cells, both processes independent of chemoresistance," he said.

"This new treatment could be groundbreaking for women who have developed chemotherapy resistance and who are in the late stages of cancer," Prof Hertzog said.

Human clinical trials are targeted to begin within two years.

What is interferon epsilon?

Interferons are the immune system's first line of defence against infections. Prof Hertzog's laboratory in 2004 discovered interferon epsilon – a type of protein known as a cytokine – which regulates the immune system in the female reproductive tract. The team showed that it can protect against infection, in part by recruiting and activating immune cells. Further investigations revealed interferon epsilon activates these immune cells in a similar way to provide a protective inflammatory response to ovarian cancer.

Quick facts

- Ovarian cancer is the most lethal gynaecological cancer
- About **1800** women are diagnosed and **1000** die from it in Australia every year
- Symptoms can be non-existent or vague, mimicking common female complaints including cramps, bloating, feeling full or needing to urinate more often.

Professor Paul Hertzog

News in brief

Pelvic organ prolapse treatment

A team led by Dr Shayanti Mukherjee has previously designed new degradable meshes using nanotechnology for pelvic organ prolapse (POP), a debilitating condition where the pelvic floor muscles become damaged. The team observed the meshes – Nanomesh – worked better when implanted with mesenchymal stem cells derived from the endometrium (eMSCs).

In 2020, a further study investigated the foreign body response to Nanomesh when combined with eMSCs and found that there was better tissue integration and more blood vessels in and around the meshes after six weeks. The research provides a significant understanding of how the body deals with meshes once they are implanted, and how the foreign body response can be modulated using nanotechnology and stem cell therapy.

For meshes to perform well, the foreign body response to implantation must be controlled and, eventually, promote the formation of new tissue and blood vessels. Dr Mukherjee is also using silver-based perovskite particles and a process called electrospinning to engineer human tissue implants.

Silver-based perovskite particles – commonly used in solar cells production – were added to a polymer solution and spun using high voltages to produce ultra-fine mesh from nanofibrous strings, which mimic the nano-architecture of our body's own tissues. The result is a 95 per cent porous mesh that provides a favourable platform for human cells to anchor to and grow, a crucial requirement for implants.

The study showed that perovskites have anti-microbial properties, without toxic side effects to human cells and can be used as additives to engineer human tissue implants.

Dr Shayanti Mukherjee

Associate Professor Graeme Polglase

Cord clamping discovery

Newborn babies who need resuscitating at birth could benefit from CPR while their umbilical cord is still attached, according to new research led by Associate Professor Graeme Polglase. The discovery could change the way these babies are treated worldwide. Current practice recommends that babies requiring cardiopulmonary resuscitation (CPR) at birth, including respiratory support, chest compressions and adrenaline administration, undergo immediate umbilical cord clamping.

The new discovery found delaying cord clamping for up to 10 minutes after CPR may reduce brain injury. The finding was in preclinical models and is yet to be verified in newborns. Clamping the umbilical cord too early may increase the risk of brain injury in babies that need substantial help to survive at birth.

Associate Professor Ashley Mansell and Dr Dan Gough

Inflammation discovery

A Hudson Institute study has discovered the key to how cells turn on inflammation to fight infection, providing the knowledge to potentially reduce or stop destructive inflammation. The study co-authored by Associate Professor Ashley Mansell and Dr Dan Gough found that a protein called STAT3 plays a critical role in communicating signals from surface sensors on the cell – macrophages – to the cell's engine room – the mitochondria – following exposure to a foreign invader. This signal reprograms the mitochondria to kick-start energy production necessary for an inflammatory response. While inflammatory responses are key to fighting infection, if unchecked it is an underlying component of many diseases including heart, lung, brain and infectious diseases, cancer, diabetes and chronic kidney, liver, autoimmune diseases, as well as 2020's unwelcome surprise, COVID-19. This discovery has implications for the treatment of diseases caused by rampant or excessive inflammation.

Dr Edward Giles

Crohn's disease and future health

Crohn's disease is an incurable inflammatory bowel disease (IBD) affecting more than 60,000 Australians, including children. A large international study of children with Crohn's, involving Dr Edward Giles, found it was possible to predict whether the condition would return after surgery, by studying the findings at their initial gastroscopy – a camera test routine in children, but not adults, with IBD.

The study showed the benefits of gastroscopy for diagnosis, which can give a better picture of how widespread the damage is to the bowel. This could have implications for gaining a deeper understanding of adult patients, as well as children, before surgery.

Dr Giles said the study could help predict outcomes for children with Crohn's disease, helping decide when surgery is appropriate, and which patients need closer monitoring after surgery for potential relapses.

Dr Jason Cain

Personalised cancer treatments closer

In a world-first discovery, Hudson Institute cancer researchers have found two potential genetic markers that could be used to provide more personalised cancer treatments to some patients.

Researchers led by Dr Jason Cain found that changes in two genes, TP53 and RB1, played a role in activating a developmental pathway called Hedgehog signalling, which is implicated in a wide range of cancers.

These two genes could act as genetic biomarkers in tumours that are likely to respond to cancer treatment drugs, known as Hedgehog inhibitor therapies. Many of these drugs are in clinical trials, with a small number approved to treat specific cancer types. The discovery has significant implications for learning which patients, and which tumours, are likely to respond to an emerging cancer therapy.

PhD student Tayla Penny

Cord blood for brain injury

In a world-first, our research has shown that multiple doses of umbilical cord blood (UCB), rather than a single treatment, could help improve brain injury in babies starved of oxygen during pregnancy or birth. UCB therapy has the potential to improve poor motor and cognitive outcomes in children with cerebral palsy, a condition that affects one in 700 babies in Australia and impacts muscle tone, movement and motor skills.

The study, led by first author PhD student Tayla Penny, found that giving multiple doses of umbilical cord blood stem cells could improve behavioural outcomes, and, most importantly, may also reduce long-term physical injury to the brain.

The research in preclinical models could help pave the way for clinical trials in babies.

Thank you to our supporters

We are grateful for the gifts received from individuals, trusts, foundations and organisations during the year.

We also acknowledge the support of the Victorian State Government through the Operational Infrastructure Support Program and the Australian Government.

Funding bodies

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Cancer Australia
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Carrie's Beanies 4 Brain Cancer Foundation
CDH Australia
Cell Care Australia
Cerebral Palsy Alliance
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Mr Neville Marriott
Mr Greg Shalit and Dr Miriam Faine
Professor Julian Smith
Estate of the late Ian John Wolstenholme
Estate of the late Judith Ann Fisher
Metafit Australia

Dr Sarah Meachem's children Olive and Will with letters written to scientists by Malvern Primary School students.

PHILANTHROPY

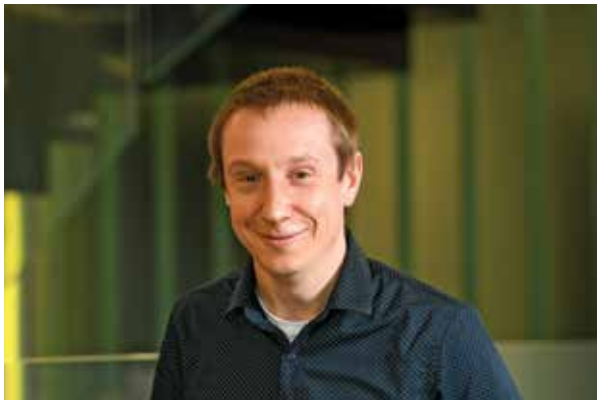
An enduring legacy

The Ron Evans AM Fellowship was established in memory of AFL great Ron Evans AM, who passed away from bowel cancer in 2007. In the years following, his family dedicated their time to raising funds for medical research to find a cure for bowel cancer, a disease that claims the lives of 5375 Australians each year – the second largest cause of cancer deaths.

Dr Marius Dannappel and Dr Madara Ratnadiwakara were this year awarded the Ron Evans AM Fellowship to progress treatments for bowel cancer.

The two researchers will work on a collaborative project to discover new molecular therapies for bowel cancer, particularly metastatic disease. Dr Dannappel is a bowel inflammation and cancer scientist and Dr Ratnadiwakara is a cancer genetics researcher with a special interest in RNA regulation in bowel cancer.

"The Fellowship presents a fantastic opportunity to combine our expertise and present critical data needed for biomarkers and therapies targeting bowel cancer," Dr Ratnadiwakara said.



Dr Marius Dannappel

Dr Dannappel is a third-year postdoctoral research fellow in the Cancer Genetics and Functional Genomics Research group. He has a longstanding interest in bowel inflammation and cancer.

Over the past five years, Dr Dannappel has published his work on mechanisms of bowel inflammation in prestigious scientific journals, including *Immunity, Molecular Cell and Nature* (first author). More recently, Dr Dannappel has cultured bowel cancer organoids derived directly from bowel cancer patients. Dr Dannappel's expertise in intestinal organoid biology will be essential for testing new targets developed at Hudson Institute in clinically relevant models of bowel cancer.

Dr Madara Ratnadiwakara

Dr Ratnadiwakara is a fourth-year postdoctoral research fellow in the Functional RNAomics Research group. Her background is in cancer genetics, with a current interest in understanding RNA regulation in bowel cancer.

Over the past five years, she has published five papers in top journals including highly cited first author papers in *eLife* and *Seminars in Cell and Developmental Biology*. Dr Ratnadiwakara's expertise in different aspects of RNA and cancer cell biology will be critical for the project.

"

It was such a shock losing Ron, and I sometimes wonder what would have happened if different treatments existed when he got cancer. Since Ron's passing, our family has helped raise more than $1 million for cancer research at Hudson Institute. By providing funding to find a cure or better treatment, we hope others may not have to go through what we did.

Mrs Andrea Evans, Founder, The Ron Evans AM Fellowship

TRUSTS AND FOUNDATIONS

Our loyal supporters

Hudson Institute is grateful for the ongoing support of our generous trusts and foundations who form part of our wider community, connecting our Institute and scientists with patients who inform our research.

L-R: Dr Amy Wilson and Dr Maree Bilandzic

Ovarian Cancer Research Foundation

The Ovarian Cancer Research Foundation (OCRF) provides funding for our researchers including Dr Andrew Stephens, Dr Maree Bilandzic, Dr Amy Wilson, Dr Joseph Kang and Rhiannon Dudley. Our scientists cherish getting involved with their supporter communities through fundraising campaigns. In 2020 our ovarian cancer researchers – Dr Maree Bilandzic, Dr Amy Wilson, Maria Petraki and Bashirah Basri – enthusiastically donned frocks for OCRF's Frocktober campaign, posting photos and key facts on Instagram to raise awareness of this insidious disease.

Carrie Bickmore. Photo courtesy Carrie's Beanies 4 Brain Cancer

Carrie's Beanies 4 Brain Cancer

Carrie's Beanies 4 Brain Cancer has supported brain cancer projects at Hudson Institute since 2018. Two current early-stage clinical trials investigating new treatments for brain cancer are: the AIM-BRAIN Project, also supported by the Robert Connor Dawes Foundation, for a national roll-out of a previous pilot program to provide more targeted therapy; a Phase I clinical trial of a therapy for recurrent medulloblastoma brain tumours, and a Phase I/Ib trial of a treatment for paediatric brain and solid tumours. Several projects are co-funded by the Federal Government's Medical Research Future Fund (MRFF) including the Australian Brain Cancer Mission.

L-R: CCF CEO Jeff Darmanian and A/Prof Ron Firestein

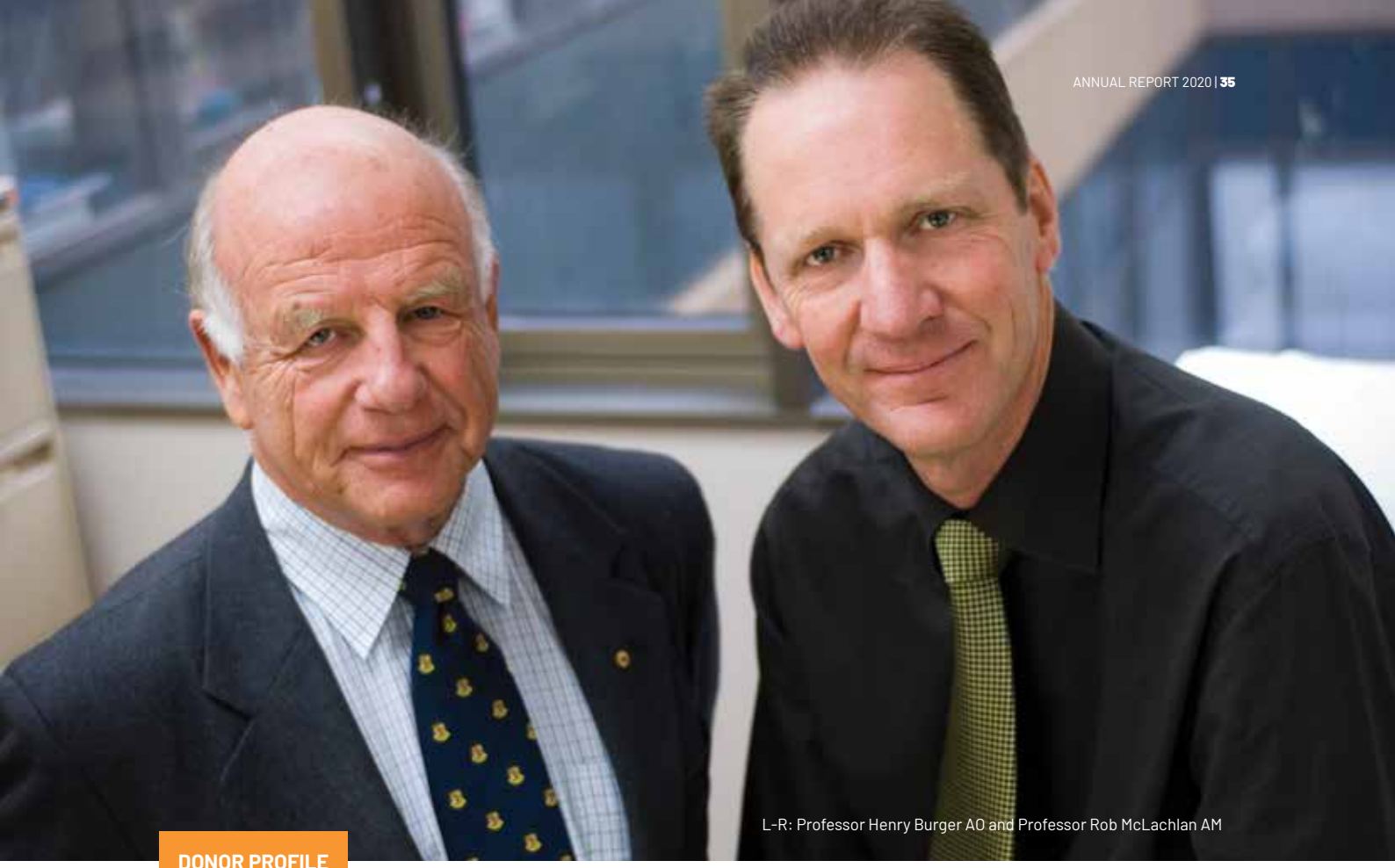
Children's Cancer Foundation

The Hudson Monash Paediatric Precision Medicine program is a cross-institutional discovery and translational research program for paediatric cancers, generously funded by the Children's Cancer Foundation (CCF). The program has established one of the largest global repositories of childhood cancer models. State-of-the-art functional genomic and multi-dimensional profiling technologies are used to develop the next generation of precision oncology therapeutic targets for paediatric tumours of greatest unmet medical need. CCF also supports our biobank operations (with the Australian Lions Childhood Cancer Research Foundation), clinical research fellowships for paediatric oncologists (with MyRoom Foundation), Paediatric Precision Oncology PhD scholarships, and our annual Childhood Cancer Research Symposium.

Dr Gabrielle Bradshaw, Alfie Chivers Research Fellow

Robert Connor Dawes Foundation

The Robert Connor Dawes Foundation is supporting the Alfie Chivers CRISPR project in paediatric high-grade gliomas (pHGG) – the leading cause of cancer-related death in children. Led by A/Prof Ron Firestein, this program includes an international team of paediatric cancer researchers, molecular pathologists, bioinformaticians, materials scientists and functional genomics specialists, working with the latest technology to understand the genomic characteristics of these gliomas. The RCD Foundation also supports the Gideon Gratzer PhD Scholarship and our annual Childhood Cancer Research Symposium.



L-R: Professor Henry Burger AO and Professor Rob McLachlan AM

DONOR PROFILE

Former director generously continues to support Hudson Institute

Professor Henry Burger AO, Emeritus Director and Distinguished Scientist, Hudson Institute, led Prince Henry's Institute, the precursor to Hudson Institute, from 1969 until 1998.

In 2018, Prof Burger kindly indicated his wish to make a financial contribution to the work of the Centre of Endocrinology and Metabolism, the field of research he dedicated his career to both as a scientist and clinician.

The Henry G Burger Clinical Endocrinology Research Fellowship was established to support emerging leaders in clinical endocrinology research through a two-year postdoctoral fellowship. The inaugural Fellowship is supporting Dr Anne Trinh, who is working with Associate Professor Frances Milat and her team optimising musculoskeletal health across a spectrum of chronic disease.

"Establishing a career in science, and securing funding for a chosen area of research, can be challenging," Prof Burger said. "Many top young scientists need all the support they can get through the critical phases of their research. As a former director of the Institute, I wanted to continue to help young scientists establish their careers and pursue their research. I'm proud to support up-and-coming researchers through this fellowship."

Prof Burger was the preeminent Australian academic endocrinologist who, in collaboration with Professor David de Kretser, led the team that discovered the hormone 'inhibin'. In 1971, in conjunction with the late Dr Jean Hailes, he initiated Australia's first menopause clinic. He has received numerous awards and honours, and trained several generations of endocrinologists. In 1993 he was appointed an Officer in the Order of Australia and in the same year became a fellow of the Australian Academy of Science.

Hudson Institute is sincerely grateful for the ongoing contribution Prof Burger provides to the Institute and its young researchers. The generosity of philanthropists like Prof Burger and other individuals and organisations who support fellowships like these ensures our life-saving and transformative research can continue to benefit patients for many years to come.

Historical photo of Prof Henry Burger, AO, pictured, right

BEQUESTS

A Gift in a Will supports stem cell research

We were humbled in 2020 to receive a Gift in the Will of Ian John Wolstenholme, which specified a desire to support stem cell research at Hudson Institute.

The estate now supports the work of Associate Professor Patrick Western, who leads the Germ Cell Development and Epigenetics Group. A/Prof Western's lab studies epigenetic regulation of stem and germ cells to understand inherited causes of diseases.

"Stem cells and epigenetics have stimulated broad interest and excitement in the medical, research and wider communities based on their uses in modelling 'diseases in a dish', and their potential for cell therapies and new treatment in patients," A/Prof Western said.

Epigenetics regulates how DNA is organised in each cell so that the correct genes are switched on or off. This allows stem cells to make and repair specialised tissues in the body. Epigenetics also provides a memory for each cell, influencing the long-term function of cells in an individual, and the information inherited by children from their parents.

Using preclinical models, A/Prof Western's lab is exploring how epigenetics regulates the ability of stem cells and germ cells (sperm and eggs) to support formation of specialised cell types and properly make specific tissues such as brain and bone, and how some of this information is passed by sperm and eggs from parents to their children.

Understanding these processes is critical for determining how altered epigenetic states affect the potential uses of stem cells in research and medicine. Research like that undertaken by A/Prof Western's laboratory benefits greatly from the foresight and vision of those like Ian, who are kind enough to consider a gift to Hudson Institute in their will.

As you can imagine, such fundamental research is necessary to ensure that therapies used in patients are effective, safe and ethical.

Associate Professor Patrick Western

Our people

L-R: Dr Erin McGillick, Dr Beth Allison and Belinda Pelle

L-R: Penny Whiley and Ellen Menkhorst

Hudson Ally Network established to support LGBT+ community

Hudson Institute proudly launched its LGBT+ Ally Network in 2020. The initiative to create a supportive and welcoming environment for LGBT+ people at the Institute was instigated by researchers Dr Erin McGillick and Dr Beth Allison, who sit on the Equity and Diversity Committee. Rainbow pins were created with a special LGBT+ Hudson Institute logo and distributed for staff and students to wear and show their support as allies. Dr McGillick said it was a proud moment launching the Hudson Institute LGBT+ Ally Network. "We have been heartened to see the support from our community wearing their rainbow pins," said Dr McGillick.

Hudson Institute recognised as Healthy Workplace

In a first-of-its-kind achievement, Hudson Institute received Victorian Government recognition under its Healthy Workplaces Achievement Program. The program centres around five health areas: healthy eating, physical activity, mental health and wellbeing, smoking, and alcohol and other drugs. Each health area has a set of targets for workplaces to achieve accreditation, which results in widespread healthy changes. The Institute's Culture and Engagement Committee rallied to introduce new wellbeing initiatives during the challenging COVID-19 period, including a physical activity challenge on Strava, and MasterChef and talent competitions.

Our students

Future leaders selected for industry mentoring

Ten Hudson Institute PhD students have been selected for the first time to participate in the high-level mentoring program, Industry Mentoring Network in STEM (IMNIS).

Led by the Australian Academy of Technology and Engineering, IMNIS provides Australia's future STEM leaders with the opportunity to engage with industry, extend their professional network, strengthen their skills and get advice from an influential industry mentor. Student mentees will gain a better understanding of how industry works and learn about career opportunities in other professional sectors.

L-R: Tomalikah Ullah, Mary Mansilla, Abbey Yee Choo, Rama Ravinthiran, Sigrid Petautschnig, Mehri Barabadi, Quinton Luong, Hsin Yee Tee, Alice West, Ingrid Dudink

Awards

$2.2 million MRFF grant to tackle rare ovarian cancer

Women with a rare and potentially aggressive form of ovarian cancer will benefit from a grant awarded to Dr Simon Chu to continue ground-breaking research into new treatments and diagnostics.

Led by Hudson Institute, a collaboration to combat ovarian granulosa cell tumours (GCT) received $2,218,870 from the Medical Research Future Fund (MRFF) Emerging Priorities and Consumer Driven Research Initiative.

Dr Chu's Hormone Cancer Therapeutics team at Hudson Institute works with collaborators to improve outcomes for women with hormonally active GCT – a rare subset of ovarian cancer.

Dr Chu says the grant will allow the team to build on progress already made in understanding and fighting GCT, which accounts for five to 10 per cent of ovarian cancers and can occur at any age.

A small percentage of those with GCT have an aggressive juvenile version. A $10,000 donation from Rare Ovarian Cancer Inc. enabled the group to kickstart a world-first study into juvenile GCT, but the new money will enable it to do so much more.

Dr Chu is looking forward to analysing real-world data of Survivor Sisters, a global Facebook group of women with rare ovarian cancer whose members share details of their treatment journey. It provides unique access to a large cohort.

Partnerships with the Ovarian Cancer Research Foundation, Victorian Cancer Agency, Monash Partners Comprehensive Cancer Consortium, and the Granulosa Cell Tumor Research Foundation for PhD scholarship and travel bursaries will take the total to around $2.5 million.

Dr Simon Chu

Dr Mohamed Saad

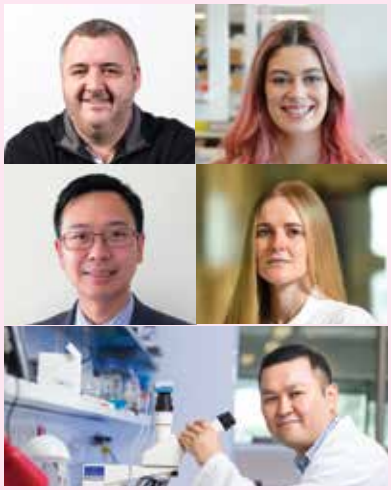
Lung cancer research fellowship

Dr Mohamed Saad was awarded a Cancer Council Victoria (CCV) Postdoctoral Cancer Research Fellowship to inform the design of better treatment approaches in lung cancer.

Dr Saad was awarded $77,950 for his one-year research project to delve into how an enzyme promotes lung cancer. The enzyme has been identified by his team as a therapeutic target for lung cancer.

His team's research has demonstrated that the enzyme promotes lung cancer by activating inflammatory signalling pathways. Inhibiting the enzyme's activity resulted in greater suppression of tumours compared to blocking the inflammatory pathways.

The Postdoctoral Fellowships are offered by CCV to provide Victorian scientists who have recently completed a PhD with support for up to one year of research, based on their thesis work – a natural progression of the project.



L-R: Dr Daniel Garama, Dr Amy Wilson, Dr Jimmy Shen, Dr Fiona Cousins and Dr Joohyung Lee

CASS Foundation grant awardees

Five Hudson Institute researchers have been awarded one-year grants totalling almost $300,000 from the CASS Foundation to advance research into cancers, Parkinson's disease, endometriosis, and an underlying cause of high blood pressure known as 'primary aldosteronism'.

The awardees were Dr Daniel Garama who is investigating mitochondrial-driven cancers, Dr Amy Wilson who is researching deadly ovarian cancer 'leader' cells, Dr Jimmy Shen who is studying primary aldosteronism, Dr Fiona Cousins who focuses on a naturally occurring cytokine to potentially treat endometriosis, and Dr Joohyung Lee who is studying Parkinson's disease.

The CASS Foundation is a private philanthropic foundation that supports short-term, 'proof of concept' Victorian medicine and science research projects in promising topic areas, which have the potential to attract longer-term funding and contribute to better practice and delivery of services.

Alice West

Inaugural Daniel Wilson Metafit PhD Scholarship

An incredible effort to raise funds for stomach cancer research in memory of Metafit Australia founder Daniel Wilson has resulted in an inaugural scholarship. The first recipient is Alice West, who will have her research costs fully covered over her three to four-year stomach cancer research, after more than $37,000 was raised in six months in Daniel's name.

Daniel introduced the high-intensity interval training workout Metafit to Australia in 2013. In March 2019 Daniel was diagnosed with stage 3 stomach cancer, and he died just two months later, aged 37. Daniel was public about his diagnosis and bravely shared his story in the hope that it would inspire and support others. It is hoped the fundraising for the scholarship will continue.

PhD student Sharmony Kelly

Sir John Monash Medal

Research investigating ways to prevent brain injury in newborns earned Hudson Institute and Monash University PhD student Sharmony Kelly the Sir John Monash Medal for outstanding academic achievement in biomedical science.

The medal is awarded annually to a Bachelor of Science or Bachelor of Science (Honours) graduate who demonstrates an excellent academic record and significant commitment to advancing the University goals of social justice, human rights and a sustainable environment.

Sharmony received the medal for her Honours degree completed in 2019 at Monash University. Her project focused on reducing brain injury caused by inflammation in late preterm newborns. There is no cure or prevention for these newborns who suffer from brain injury, and it's vital that a suitable therapy is found to protect the brains of our youngest population.

Dr Gina Kusuma

Rebecca L Cooper Foundation Grant

Dr Gina Kusuma has been awarded a two-year Rebecca L Cooper Medical Research Foundation Project Grant to investigate therapeutics to aid blood vessel regeneration in the aged population. Dr Kusuma was awarded $100,000 over her two-year project in the Geriatrics category.

Her research will harness factors released by stem cells, to formulate 'cell-free therapeutics' and use this emerging form of regenerative medicine to improve treatment options and patients' health. This will be a game changer, enabling deployment of regenerative medicine for this urgent unmet medical need across the community.

The 2020 Project Grants were designed to encourage early career researchers to take ownership of a discrete research project, providing a stepping stone towards independence. In 2020, 172 applications were received with a 20 per cent success rate.

Graduates of 2020

Congratulations to our Postgraduate and Honours students who graduated in 2020

Doctor of Philosophy

Dr Christine Bui

Interventional immunology for cardiopulmonary diseases of the neonate

A/Prof Claudia Nold, Prof Marcel Nold

Dr Yan Yee (Kyra) Chan

Ventilation-induced brain injury in preterm neonates: mechanisms and potential therapies

A/Prof Graeme Polglase, Suzie Miller, Dr Vanesa Stojanovska

Dr Yogeswari Chandran

Characterisation of the putative cysteine protease effectors, OspD2 and OspD3, from Shigella species

Prof Elizabeth Hartland, Dr Jaclyn Pearson, Dr Cristina Giogha

Dr Charlotte Shengnan Chen

Therapeutic targeting of OLIG2 in high grade glioma

Dr Sameer Greenall, Professor Terrance Johns

Dr Michelle Chonwerawong

The factors involved in stomach B cell lymphoma associated with Helicobacter pylori infection

Prof Richard Ferrero, Dr Jonathan Ferrand

Dr Brittany Croft

Investigating SOX9 regulation and FGF9 variants in disorders of sex development

Prof Vincent Harley, Prof Andrew Sinclair, Dr Daniel Bird, Dr Rajini Sreenivasan

Dr Chamira Dilanka Fernando

Post translational modifications and interactome of STAT3

Dr Daniel Gough, Dr Daniel Garama

Dr Monica Goney

Physiology and therapeutic potential of inhibin

Prof Craig Harrison, Dr Kelly Walton, Prof Peter Stanton

Dr Aleks Guanizo

The role of STAT3 in MYC-driven tumourigenesis

Dr Daniel Gough, Dr Jason Cain

Dr Ishmael Miguel Inocencio

Investigating pre and post-natal therapies in the altered cardiovascular system of fetal growth restricted lambs

A/Prof Graeme Polglase, Dr Beth Allison, Prof Stuart Hooper AM

Dr Aidan Kashyap

Improving the transition to newborn life for babies with congenital diaphragmatic hernia.

Prof Stuart Hooper AM, A/Prof Ryan Hodges, Dr Kelly Crossley, Dr Philip Dekoninck

Dr Anastasia Christine Kauerhof

Involvement of Activin A in the development of chronic testicular inflammation and fibrosis

Dr Monika Fijak, Prof Mark Hedger, Prof Kate Loveland

Dr Amanpreet Kaur

Designing a tissue-selective steroidal mineralocorticoid receptor antagonist for the treatment of chronic heart failure

Prof Jonathan Baell, A/Prof Morag Young, Dr Prashant Mujumdar

Dr Pengfei Li

Amoebae as a host for Legionella replication

Prof Elizabeth Hartland, Dr Nichollas Scott, Dr Shivani Pasricha

Dr Diana Micati

Snail transcription factors in testis health and pathologies

Prof Kate Loveland, Prof Helen Abud

Dr Sarah Moody

Investigating the effects of activin A and TGF beta superfamily ligands on the fetal male germline

Prof Kate Loveland, A/Prof Patrick Western

Dr Gregory Ong

Mechanisms and effects of mineralocorticoid receptor signalling in macrophages

A/Prof Morag Young, Prof Peter Fuller

Dr Kelsee Shepherd

Prone positioning in NICU: Effects on cerebral and cardiovascular physiology

Prof Flora Wong, Prof Rosemary Horne, Dr Stephanie Yiallourou

Dr Eleanor Thong

Optimising bone and reproductive health in individuals with type 1 diabetes

A/Prof Fran Milat, Prof Helena Teede

Dr Anne Trinh

The optimisation of bone health in chronic neurological conditions

A/Prof Fran Milat, Prof Peter Fuller, Prof Peter Ebeling AO

Dr Raissa Wibawa

Legionella pneumophila: from amoeba to macrophage metabolism

Prof Elizabeth Hartland, Dr Shivani Pasricha

Dr Amy Wilson

Improving in vivo detection methods and immunotherapies for epithelial ovarian cancer Prof Magdalena Plebanski, Dr Andrew Stephens, A/Prof Mark Wright, Dr Kirsty Wilson

Master of Biomedical Science

Mrs Shahrzad Zamanitaghizadeh Rabe

Novel role for macrophage migration inhibitory factor in the regulation of inflammation

Dr Nicole De Weerd, Prof Paul Hertzog, Prof Eric Morand

Bachelor of Biomedical Science (Honours)

Ms Ihara Shazia Andjumain

Ms Janet Alappadan

Ms Shaye Game

Mr Sahampath Hettiarachchi

Mr Yang (Ryan) Huang

Mr Naveen Kumar

Ms Marie Lee

Ms Shanilka Leitan

Mr Harrison Long

Ms Constance Malliaris

Miss Ottilia Manyonga

Ms Alexandra McAllan

Ms Fang (Elisabeth) Wang

Ms Vera Wang

Ms Sharon Weearsingha

Bachelor of Medical Science (Honours)

Ms Madison Andrew

Ms Bimal Gayathri

Ms Melissa Bruerton

Ms Sarah Butler

Ms Lara Calligaro

Ms Suwandi Dewapura

Ms Anaysa Diandra

Ms Alissa Heng

Ms Christy Sibirani

Ms Lila van Breugel

Ms Amber Wang

Mr James Widdop

Ms Teresa Weng

Ms Tegan White

Ms Lok (Vanessa) Yiu

Bachelor of Science (Honours)

Ms Alexandra Bergen

Ms Nooshin Davarifard

Ms Sara Di Simone

Ms Brittany Doran

Ms Tyra Fraser

Ms Grace Morgan

Ms Thuy-Vy Nguyen

Ms Beth Piscopo

Ms Charmaine Rock

Ms Jyothi Varkey

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The directors of Hudson Institute of Medical Research Board, 31 December 2020

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Resigned: August 2020

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Associate Professor
Ron Firestein

Centre for Endocrinology and Metabolism
Professor Peter Fuller

Centre for Innate Immunity and Infectious Diseases
Professor Paul Hertzog

Centre for Reproductive Health
Professor Kate Loveland

The Ritchie Centre
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Ms Ann Scott

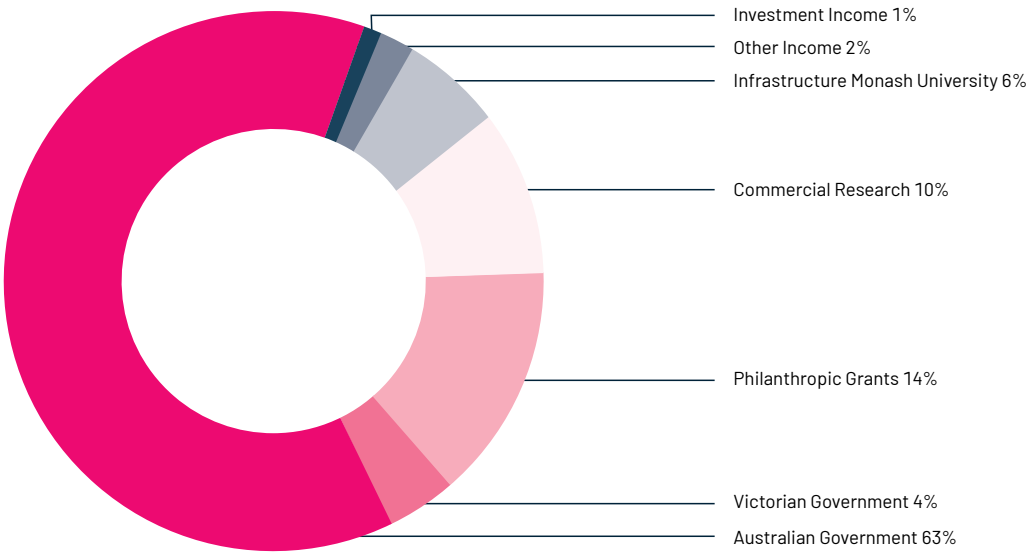
SCIENTIFIC SUPPORT GROUP

Finance
Commercialisation and IP
Research Office

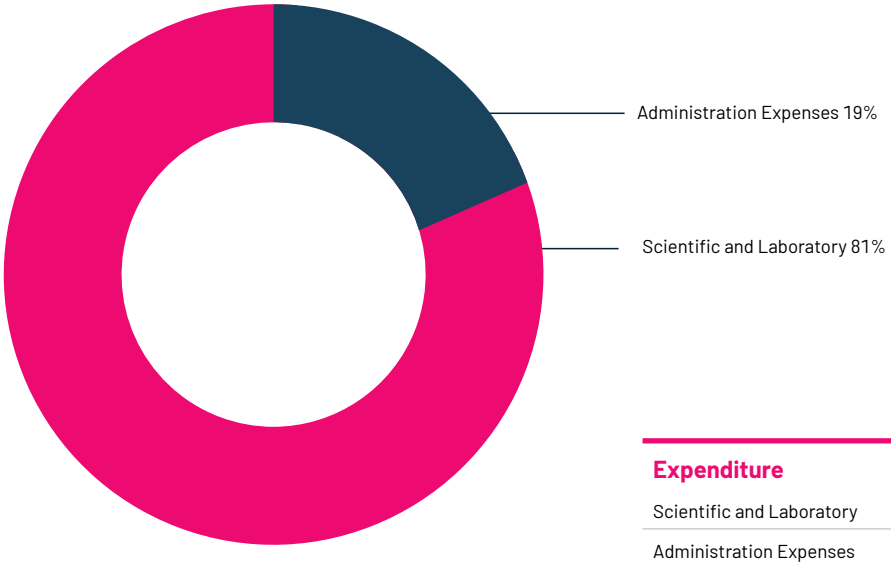
Human Resources
LATS
Platforms
Purchasing

Communications
Strategic Committees

Financial snapshot



Revenue	2020 ($)	2019 ($)	2018 ($)
Australian Government	33,717,571	28,408,235	27,875,344
Philanthropic Grants	7,672,830	8,168,395	6,957,795
Commercial Research	5,374,502	3,984,044	3,547,176
Victorian Government	2,419,514	3,172,168	3,336,283
Infrastructure Monash University	3,207,348	3,616,999	3,198,626
Other Income	1,084,855	1,485,615	2,122,605
Investment Income	400,587	586,932	625,873
Total	**53,877,208**	**49,432,388**	**47,663,699**



Expenditure	2020 ($)	2019 ($)	2018 ($)
Scientific and Laboratory	42,856,176	40,238,073	38,950,957
Administration Expenses	9,807,793	9,058,817	8,806,847
Total	**52,663,969**	**49,296,890**	**47,757,804**

2020 Publications

Book Chapters

1 Abidi JH, Harris J, Deen NS (2020) Co-immunoprecipitation of macrophage migration inhibitory factor. In *Macrophage Migration Inhibitory Factor*. 1st Edn. Harris J, Morand EF, eds. *Methods in Molecular Biology*. Springer US. Vol 2080, pp 115-122.

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Journal Articles

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