2020

Annual Report

FORREST
RESEARCH
FOUNDATION

Contents

ELINOR OSTROM, THE 2009 NOBEL LAUREATE IN ECONOMICS SAID:

"A core goal of public policy should be to facilitate the development of institutions that bring out the best in humans."

DRS ANDREW FORREST AND NICOLA FORREST,
CO-CHAIRS OF THE MINDEROO FOUNDATION AND
GOVERNORS OF THE FORREST RESEARCH FOUNDATION

Foreword

Only two women have been awarded the Nobel Prize in Economics. One was Elinor Ostrom. Born of humble means in 1933, she knitted scarves for soldiers as a teenager. She put herself through university, graduating with eight dollars in her bank account. As an academic, she alienated and infuriated peers by interviewing "ordinary" people – unusual at the time – and collaborating with individuals outside her field.

"A core goal of public policy should be to facilitate the development of institutions that *bring out the best in humans*," she concluded in her Nobel speech in 2009, based on decades of study of multiple societies – contradicting 50 years of policy that assumed that all individuals are self-interested and need to be forced or "nudged" into compliance.

The other woman to win a Nobel Prize in Economics was Esther Duflo, in 2019. Duflo's research tests the effectiveness of social policy on poverty, and allows governments to design better policies – ones that actually work. Like Ostrom, she conducted extensive fieldwork in a range of systems, venturing into multiple fields, including health, education, financial inclusion and the environment.

Great research is inclusive, impactful and innovative. It requires minds that refuse to be boxed in by traditional boundaries, it requires collaboration and a desire to change the world, and it requires vision. Yet many aspects of academia remain inward-looking and insular – as the writer H.G. Wells lamented in 1932, when he wrote that "there is not a single Professor of Foresight in the world."

Almost a century on, our system of research continues to exhibit structural flaws – often recognising individual esteem and citations, rather than successful, real-world problem-solving as part of a group, or the *application* of that knowledge. Those who step outside of traditional boundaries risk being dismissed by their peers as radical, unconventional or mercenary.

There are exceptions of course. Most obviously, the global scientific effort to produce rapid diagnostic tests and COVID-19 vaccines has involved unparalleled co-operation between researchers in different disciplines, between universities, governments and businesses, between scientists and practitioners, and between nations. But, in general, radical approaches that incentivise impact and cross-talk remain rare in academia.

We created Forrest Research Foundation in 2014 to support new ways of doing research. We seek researchers with an exceptional vision of the future and the skills needed to get there. Forrest scholars and fellows are fearlessly creative in how they solve problems, and refuse to be constrained within their own disciplines – drawing on industry, government and civil society.

As Elinor Ostrom, Esther Duflo and all of the world's great researchers through history have demonstrated – this is not a radical approach. It is simply the only one that works. As you read this report, we encourage you to think differently, and imagine a different future – and the role you can play in achieving it.

Nicola and Andrew Forrest

Message from the Chair

2020 was a year which attracted many epithets—'unprecedented' being perhaps the most frequently used. The constraints on international and interstate movement of people created challenges for the Foundation. But as Professor Paul Johnson, the Warden of the Foundation reports, our program to recruit new Scholars and Fellows continued at pace. There were 406 applications for Post-doctoral Fellowships from around the world, which is an all-time record for the Foundation.

The challenges of 2020 yielded an opportunity with the creation of the Prospect Fellowship scheme. The scheme provides support for up to 20 outstanding, early-career researchers in Australia and New Zealand. Out of 106 Prospect Fellowship applications, 12 Prospect Fellows were appointed at UWA, Curtin and Murdoch universities. They cover 10 different fields of research. There were also 6 PhD Scholars appointed out of 165 applications and distributed across UWA, Curtin, Murdoch and ECU. They join 30 current PhD scholars who work across 18 different fields of research. 6 Post-doctoral Fellows were appointed out of 411 Fellowship applications made in 2019, and they join 10 current Fellows who conduct research at UWA, Curtin and Murdoch universities in 13 different fields. While all this was going on, the construction of the second Forrest building began in April and, at the time of writing this overview, is close to completion.

The performance of the Foundation in 2020 is testament to the enduring impact of the vision of its philanthropic founders, Andrew and Nicola Forrest. The fruits of their contribution are seen in the work of the Scholars and Fellows described in the pages that follow in this Report.

The Foundation comprises a Board of Governors, which I have the honour to chair. They consist of the Vice-Chancellors of all the Western Australian universities, Andrew and Nicola Forrest and external appointees. One of our number, Michael Chaney, who was closely involved as Chancellor of UWA with the establishment of the Foundation, retired from the Board and from the chairmanship of its Finance Committee.

The Foundation owes him a great debt of gratitude for his work. Professor Deborah Terry, who was a Governor by virtue of her office as Vice-Chancellor of Curtin University, also left the Board upon assuming her new office as Vice-Chancellor of the University of Queensland. Again, we thank her for her contribution and wish her well in her new role. Professor Dawn Freshwater, who was a Governor by virtue of her office as Vice-Chancellor of UWA, left in March to take up her role as Vice-Chancellor of The University of Auckland. We thank her for her contribution and welcome her successor the new Vice-Chancellor of UWA, Professor Amit Chakma.

As appears from the pages that follow, our Scholars and Fellows come from many different parts of the globe, demonstrating that the Foundation has a global reach in accordance with the vision of its Founders. It is our intention that the global reach be expanded and supported by the reputation of Forrest Hall based, most importantly, on the experience of those who come there. It is a critical part of the ethos of Forrest Hall that it is a home away from home for Scholars and Fellows, providing opportunities for intellectual cross-fertilisation and collaboration. The Foundation also seeks to create an intellectually rich environment with symposia and seminars involving the participation of Scholars and Fellows and others visiting from elsewhere. It also seeks to support scholars by showing them ways of enhancing their networks, their research and publishing opportunities, and future employment opportunities.

The Foundation, with the support of the Forrests and cooperatively with their Minderoo Foundation, looks forward to increasing its reach and its impact in the years ahead. My thanks to the Board for their contribution to the work of the Foundation, to the Warden, Professor Paul Johnson, and to the Secretary of the Board, Ms Rochelle Gunn.

The Hon Robert French AC
Chair

Our Values

We will:

- set ourselves ambitious targets
- strive to be the very best we can be
- surprise ourselves and others with what we achieve
- demonstrate integrity, inclusiveness, humility and generosity in work and in life
- support, encourage and respect each other
- make a positive impact on the world around us

"We want to do our part to eradicate hunger, conquer disease, protect the planet, develop new technologies, extend human knowledge and live wisely."

Warden's Report

The COVID pandemic derailed many of the Foundation's plans for 2020. The Visiting Fellows program came to an abrupt halt in late March when Australia closed its borders to international travellers.

The Forrest Hall program of academic meetings and seminars went into abeyance for six months and resumed only gradually in the final quarter of the year as rules in Western Australia about meetings and social distancing were relaxed. The research progress of many Forrest Scholars and Fellows was curtailed by the closure of laboratories and other university facilities for several months and the cancellation of large numbers of national and international conferences and symposia. Most seriously, a number of current and commencing Scholars and Fellows who were overseas when Australia's international travel ban was implemented were unable to travel to Perth to undertake their research – their personal and professional lives have been left in limbo.

Despite these difficult circumstances, and despite the waves of despondency and financial pain that swept across the higher education landscape, the Foundation pushed ahead with its program to recruit new Fellows and Scholars. The 2020 Post-doctoral Fellowship competition received a record number of applications (411) from around the world. Applicants were no doubt influenced by Western Australia's remarkable record in effectively eradicating community transmission of COVID, and also by the global contraction in research funding resulting from the financial impact of the pandemic on universities.

The Foundation responded to this reduction in research opportunities by creating a new Prospect Fellowship scheme specifically designed to provide support for 20 outstanding early-career researchers in Australia and New Zealand whose career prospects had been diminished by the COVID pandemic. The Foundation also pressed ahead with its infrastructure plans, commencing construction of the second Forrest Hall building in April, with completion expected before the end of 2021.

The Forrest Research Foundation continues to look to the future, knowing that the research and innovation we support today will provide the responses and solutions to the problems humanity will face in the future. We want to do our part to eradicate hunger, conquer disease, protect the planet, develop new technologies, extend human knowledge and live wisely. The way we do that is set out in a core part of this 2020 Annual Report in which Forrest Scholars and Fellows explain how their research is making a difference.

Professor Paul Johnson
Warden

Forrest Research Foundation's response to COVID-19

The abrupt implementation around the world of travel restrictions and lockdowns in March 2020 had an immediate impact on the employment opportunities available to early-career researchers.

Recent PhD graduates in Australia suddenly found they could no longer take up the international post-doctoral positions they had secured because they could not leave the country. Furthermore, the significant financial impact on Australian universities caused by the closure of the country's border to international travellers, including international students, led to the suspension or withdrawal of many domestic post-doctoral research positions.

The Foundation's Governors responded rapidly to this crisis, allocating an additional $3 million to launch a new short-term post-doctoral fellowship scheme – **Prospect Fellowships** – for 20 recent PhD Australian and New Zealand graduates. Prospect Fellowships, which can be held at any of Western Australia's five universities, and which provide salary for 18 months together with a professional and personal development program, are intended to keep some of the very best recent PhD graduates engaged in path-breaking research until research opportunities and funding in the university sector begin to normalise in 2022. The first 12 Prospect Fellows were appointed in October 2020, with a further 8 to be appointed in early 2021.

The Foundation also supported the work of Forrest Fellow **Dr Julie Ji** who, with colleagues in the School of Psychological Sciences at UWA and with additional support from the Minderoo Foundation, undertook a rapid large-scale survey of the psychological and behavioural implications of self-isolation and quarantine: the COVID-19 CARE Study (https://www.thecarestudy.com/reports).

This study showed the negative mental health impact of self-isolation and quarantine was far greater for people with an existing mental health condition, and for people who were quarantining in a hotel or other quarantine facility rather than in their own home. It also revealed a surprising number of positive response to self-isolation – the 'silver linings' of spending more time at home, of having more time for hobbies and other activities, and the opportunity to learn and use new technologies to stay connected with others.

Our Aims

Through our research we want to:

Eradicate hunger

Conquer disease

Protect the planet

Develop new technologies

Extend human knowledge

Live wisely

A GLOBAL SCHOLARSHIP AND FELLOWSHIP PROGRAM...

Scholars and fellows come from around the world


POLAND
JAPAN
CHINA
VIETNAM
INDIA
SRI LANKA
BANGLADESH
ETHIOPIA
SINGAPORE
MAURITIUS
AUSTRALIA
NEW ZEALAND

Research:
making a difference

Despite the tragedies of the global COVID-19 pandemic – the hundreds of thousands of lives lost, the economies blighted, the education of a generation of schoolchildren disrupted – there were, in 2020, some remarkable achievements.

←
Giovanni Polverino

Research seldom involves a simple transition from problem to solution.

Bio-medical scientists created vaccines in the space of 12 months, rather than the usual 10-15 years. Government economists designed and rolled out job support packages of unprecedented scale at rocket-like speed. Epidemiologists and public health experts rapidly worked out how the virus was spreading and how it could be contained.

Psychologists developed strategies to help people mitigate the mental health impact of prolonged isolation and lock-down. Historians looked back to previous pandemics to identify what control measures had and had not worked. Politicians – some of them, at least – took tough evidence-based decisions that may have cost them votes, but which saved lives.

None of this could have been achieved without knowledge and expertise created and accumulated by researchers and practitioners over previous years and decades. The rapid development of mRNA vaccines for COVID-19 is the culmination of more than three decades of basic research, much of which appeared at the time to be unsuccessful or, at best, impractical. The income support programs have drawn on extensive theoretical and practical research by economists since the 1930s on the micro- and macro-economic impact of wage subsidies and transfer payments. The public health response to the pandemic – including travel restrictions, social distancing and the wearing of face masks – draws on the knowledge of disease transmission that epidemiologists have built over many years studying the progression of infectious diseases. And so on with each rapid response that societies around the world have had to make to the COVID pandemic. At this time of acute need, we have come to rely on the effort and advances, large and small, made by countless researchers over many years which provide us with the knowledge to navigate our way through the pandemic. It makes us recognise that research really matters, because the knowledge that research produces makes a difference, sometimes the difference between living and dying.

It is not always apparent, even to the researchers involved, how today's research will affect the lives of people tomorrow. When the German physicist Heinrich Hertz transmitted the world's first deliberately-created electro-magnetic wave across a distance of 12 metres, he viewed it as "of no use whatsoever... this is just an experiment". Yet that experiment lay the foundation for all subsequent radio, TV and wi-fi communication. When x-ray crystallographer Rosalind Franklin produced the first images of DNA in 1952, she was pursuing an intellectual quest for knowledge of fundamental molecular structures, but her research was one of the building blocks on which the huge edifice of modern genomics is based.

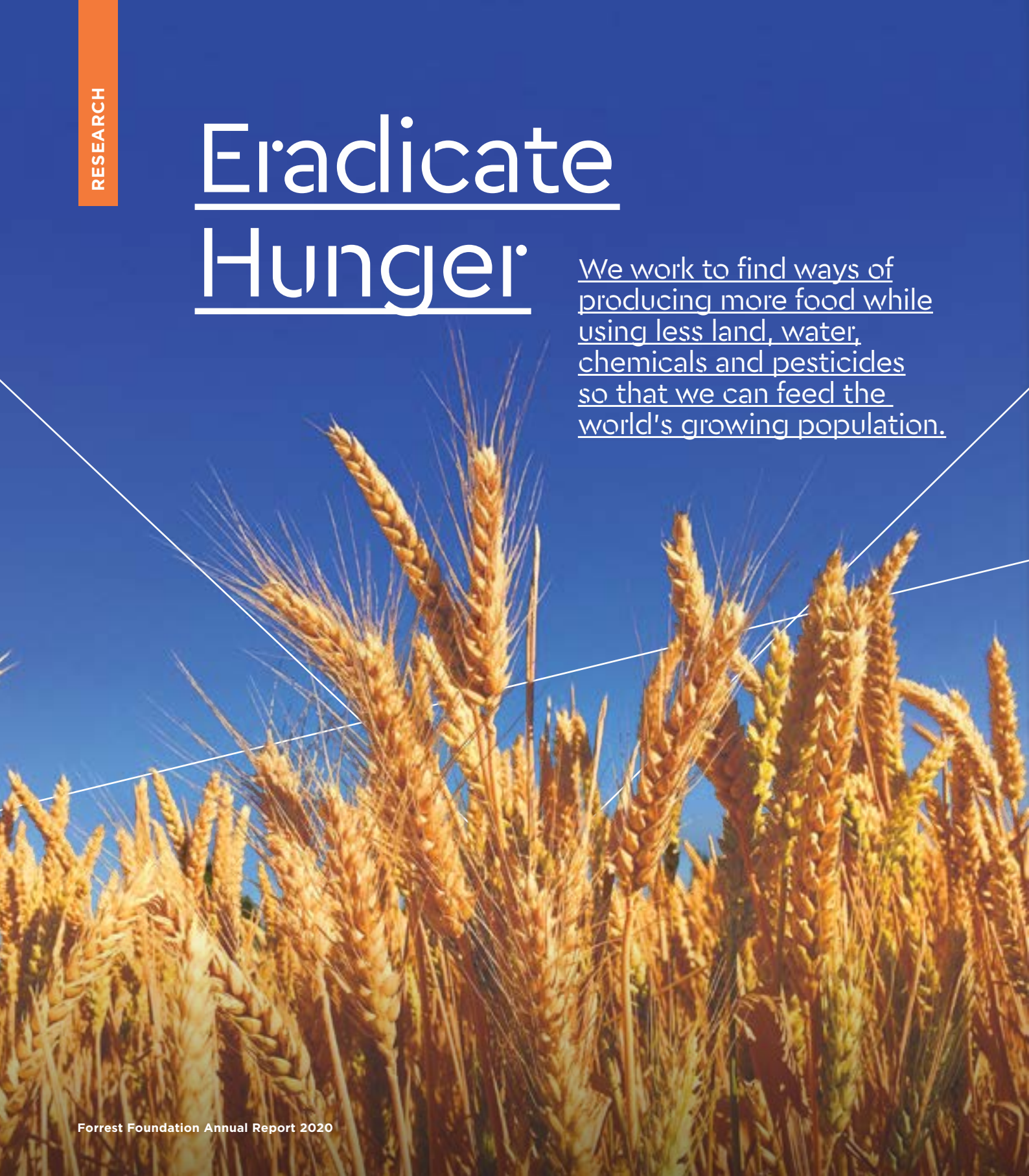
Research seldom involves a simple transition from problem to solution. The path to discovery and understanding is long and winding, sometimes doubling back on itself, sometimes completely blocked. Researchers need the determination to commence the journey, the resilience to cope with reversals, and the creativity and imagination to find new ways forward when progress can no longer be made on the old routes. And throughout all this, researchers need to keep their eyes focused on the horizon, because the goal is to look beyond what is currently known.

At the Forrest Research Foundation we create opportunities for the world's brightest and most imaginative early-career researchers to pursue that path of discovery and understanding. Forrest PhD Scholarships and Post-doctoral Fellowships support work in all disciplines and in both basic and applied research, but in all cases the intention is to have an impact and make a difference. COVID has forced many people around the world to narrow their vision and hunker down, so at the Forrest Research Foundation we believe it has never been more important to look to the future, and embrace the possibilities that can be created by new ideas and new knowledge. We want to eradicate hunger, conquer disease, protect the planet, develop new technologies, extend the boundaries of human knowledge, and live wisely, and this is how, little by little, step by step, we are making a difference.

RESEARCH

Eradicate Hunger

We work to find ways of producing more food while using less land, water, chemicals and pesticides so that we can feed the world's growing population.



←
Melissa Askew
on Unsplash

SAMALKA WIJEWEERA (UWA)

Soil salinity is a major constraint on agricultural production. It causes large yield losses in many important crops including wheat which is a major staple. Many previous studies have been conducted to identify salt-tolerant plant variants, but we still don't fully understand the biochemical processes by which some plants develop their salt tolerance. By examining the proteins and RNA of tolerant and non-tolerant wheat varieties I will identify the biochemical processes involved in salinity tolerance. This research will improve fundamental knowledge of the effect of salinity on the establishment of vital cellular functions in wheat and the study will be extended to improve salinity tolerance and bring significant benefits to global wheat production.

XUYEN LE (UWA)

The world population without doubt will increase in the future; however, the decline in agricultural land and resources is inevitable due to the forces of nature. Technology, especially safely applied gene technology, is the answer to this challenge – feeding the burgeoning world. The law of conservation of energy applies to all things, even plants. Energy can neither be created nor destroyed; energy can only be transferred or changed from one form to another. Plants take energy from the environment and convert it into fruits, flowers, seeds, chemical releases or just heat. In my research, plant genetics is studied to deduce the molecular mechanism of using this energy. This knowledge can be exploited so that plant energy is optimised towards growth and yield rather than being wasted.

DR KATE LOUDON (MURDOCH)

The application of new technology and better use of production data is needed to increase the quantity and quality of agricultural outputs. The ability of Australian beef producers to select suitable cattle for market is currently limited by imprecise and subjective live animal assessment. This leads to variable performance and impacts the ability of cattle to meet beef market specifications. A key component of beef carcass trading in Australia is fat depth; overfat cattle are unwanted by industry as excess fat represents wasted on-farm nutritional inputs, as well as increased processing costs, whereas underfat cattle represent poor performance. This project aims to test and deploy prototype technologies to objectively measure fat depth and infuse successful systems into the beef supply chain to enhance production and enable the true value of the animal to be traded.

← Duanghorn Wiriya on Unsplash

DR SAM LYMBERY (UWA)

Invasive pests pose a catastrophic threat to the natural environment and human prosperity. Answering this threat in a sustainable and environmentally friendly way poses an enormous challenge to science and innovation. Introduced ant species are one of the most pervasive of these pests, draining the economy of billions of dollars, dominating native species, threatening human health and infrastructure, and decimating natural ecosystems. As with many pest species, current efforts to eradicate invasive ants based on pesticide application have proven inefficient and inflict unacceptable costs on the natural environment. My research will use cutting-edge evolutionary biology theory to manipulate the behaviour and social structure of invasive ants, changing the competitive landscape and allowing native species to restore ecosystem balance.

KRISTINA HEIDRICH (UWA)

The human population is growing at an unprecedented speed and with it the need for food. The fishing industry provides a major dietary-component for more than 3 billion people worldwide and employs over 50 million. Fishing however, represents a dominant threat to ocean biodiversity and can lead to unsustainable fishing practices including increased illegal and unreported fishing if unrestrained. My research aims to fill current data and transparency gaps in the fisheries statistics for tuna, billfish and shark species. This big data project focuses on reconstructing and analysing catches and fishing effort over the past 70 years to better inform policy recommendations for a sustainable management of global tuna fisheries; crucial to the conservation of marine ecosystems and optimal resource utilisation for global food supply.

Our PhD scholarships

Number of scholars **36**

31% MALE
69% FEMALE

Distribution across universities

72% UWA
16% CURTIN
6% MURDOCH
6% ECU

Number of scholarship applications in 2019

165

60% MALE
40% FEMALE

SUCCESS RATE

3.6%

FIELDS OF RESEARCH

Archaeology
Bio-engineering
Biological science
Chemistry
Design
Ecology
Economics
Engineering
Epigenetics
Mathematics
Medical science
Neuroscience
Oceanography
Physics
Physiology
Plant science
Population health
Radio-astronomy

SUBJECT AREA OF APPLICATIONS

26% Social sciences and humanities
25% Biological science and ecology
23% Engineering and technology
20% Medical and life sciences
6% Natural sciences

Using this data we can inform the plant breeding process to speed up breeding in order to feed a growing population in a changing climate.

DR PHILIPP BAYER (UWA)

Climate change has started. There are now more bushfires, more droughts, higher average temperatures, and more hot spells in Australia and the world. The United Nations set the target of no undernourished people by 2030, but we are on track to have 150 million more undernourished people in 2030 than we have now. We need to improve and speed up breeding novel plant cultivars to feed a growing world under climate change. My research uses large amounts of genomic sequencing data of various crops to find genomic regions of interest to plant breeders and farmers. This data helps me to track the accidental and intentional impact of breeding in plant genomes and to find new variants and genes not used in plant breeding. Using this data we can inform the plant breeding process to speed up breeding in order to feed a growing population in a changing climate.

MONICA DANILEVICZ (UWA)

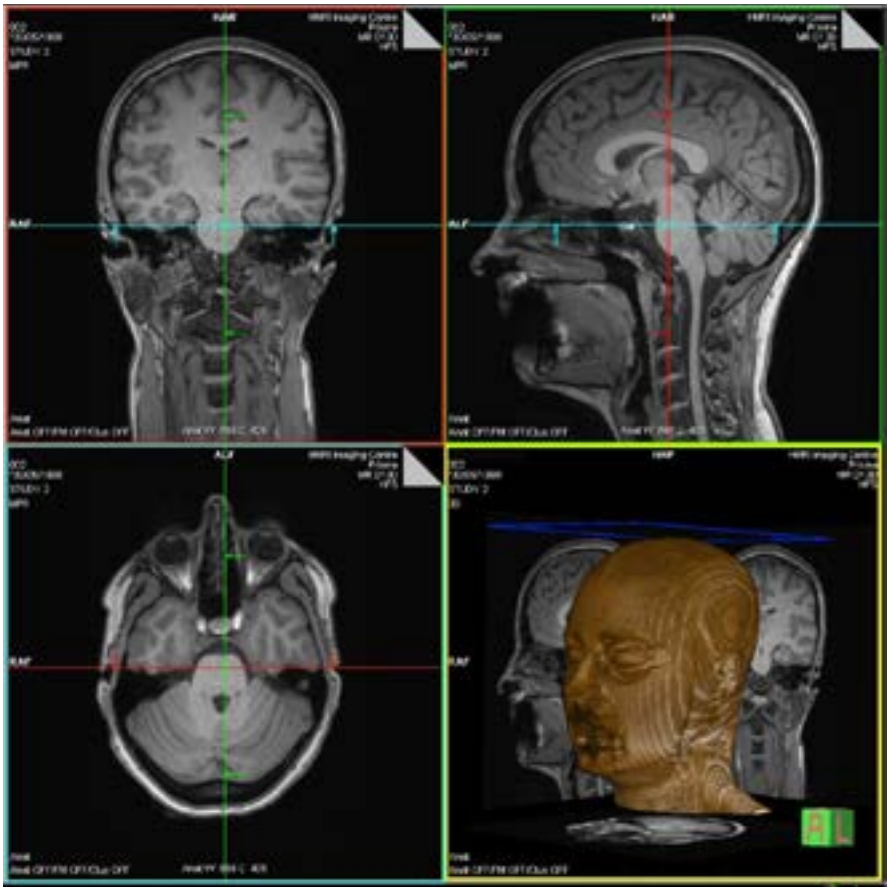
With an increasing global population and climate change impacting food security across many nations, there is an urgent need to improve crop productivity and develop better adapted cultivars. Working with crop breeding companies, I am developing tools to accelerate crop improvement. My research applies multispectral images collected by unmanned aerial vehicles (UAV) to monitor crop performance. These flights gather massive volumes of image data throughout plant development, and this is used to train machine learning models to provide yield predictions for these plants. This application of machine learning supports the breeding of advanced crops which will support future food security.

→
Diana Polekhino
on Unsplash

Conquer Disease

We combine our knowledge of physiology and medicine with the latest scientific advances to find new ways to tackle disease and improve human health.

The goal of these new treatments is to both improve survival, and also to reduce side effects for kids with brain cancer.



DR JESSICA BUCK
(UWA/TELETHON KIDS INSTITUTE)

Brain cancer kills more Australian children than any other disease. Despite this, very little research focuses on children's cancers, and new treatments are desperately needed. My research uses my unique training in both neuroscience and cancer to tackle the challenges of childhood brain cancer research. In particular, since radiotherapy is an important part of treatment for childhood brain cancer, I work to find new combinations of medicines that increase the effectiveness of radiotherapy. The goal of these new treatments is to both improve survival, and also to reduce side effects for kids with brain cancer. My goal is to help all kids grow up happy, healthy, and free from cancer.

← Jessica Buck

BHEDITA SEEWOO (UWA)

Depression is a common mental health condition affecting about 1 in 7 Australians at some point in their lifetime. For many people, antidepressants play a priceless role in relieving symptoms, but up to one-third of adults experience treatment-resistant depression and the standard medications provide little to no relief. Brain stimulation can be an effective non-drug therapy which targets the brain directly to help reverse symptoms of depression. It acts on different pathways from antidepressants, but these pathways are not fully understood. My research focuses on studying the mechanisms of brain stimulation in animal models using similar techniques as in human studies (e.g. MRI). An improved basic understanding of the mechanism will help tailor personalised treatment protocols to suit particular individuals and therefore increase the therapeutic efficacy of this treatment.

AKILA BALACHANDRAN (MURDOCH)

Cancer is one of the leading causes of death worldwide. Despite recent advances in the field of medicine and technology, treatments for certain cancers are still not effective. Conventional cancer treatments such as chemotherapy and radiotherapy have side effects. These therapies cannot distinguish between cancer and normal cells and hence kill all the cells. In order to minimise the side effects and improve therapeutic response, therapies that target specific cancer cells are gaining importance. My research is focused on developing antisense oligonucleotides for cancer cell targeted treatment. Antisense oligonucleotides, which are referred to as synthetic DNA/RNA, are man-made chemicals that can modify cancer cells' growth and survival. By doing this, we aim to develop novel cancer therapies and increase the efficiency of existing therapies.

DAWID MAKOSA (UWA)

Ageing is a natural process leading to organismal decline by inducing progressive biological, physiological, and behavioural changes. Among these, age-related cognitive decline, characterised by impairment of memory, perception, attention or problem solving abilities, is probably one of the most alarming changes as it directly relates to who we are and strongly impacts the quality of life. My research focuses on studying the molecular mechanisms underlying cognitive decline. This is a central and unresolved question in the field of ageing research as such knowledge would pave the way towards innovative treatments to preserve and/or restore cognitive function in the elderly. It is especially important for the developing countries experiencing population ageing, as novel therapies have the potential to alleviate projected economic costs.

JESSICA MURRAY (CURTIN)

Cutaneous malignant melanoma is one of the most commonly diagnosed cancers in Australia. This is a particularly aggressive type of cancer because tumour cells can rapidly spread to different tissues and organs in the body, leading to poor patient prognosis. In recent years, medical advances in the treatment of malignant melanoma have been fundamental to improving patient outcomes. Still, a large proportion of melanomas either do not respond to these treatments or eventually become resistant, leading to continued tumour growth and spread throughout the body. To identify potential new therapeutic targets, an improved understanding of the fundamental biology of melanoma is important. My research explores i) how melanoma invades through the skin, an early step in the development of metastasis, and ii) the biology of a less well understood form of tumour spreading termed extravascular migratory metastasis, which occurs in melanoma and other cancers, and is associated with poor prognosis.

GLADYMAR PÉREZ CHACÓN (CURTIN/TELETHON KIDS INSTITUTE)

The game-changing role of vaccines and global vaccination programmes is indisputable. From the elimination of smallpox in 1980, to the hope offered by vaccines in the COVID-19 pandemic, vaccines remain as one of the most successful public health interventions. But much more could be done. Knowing that vaccines train the immune system to recognise what certain germs look like, my research looks at whether a first dose of a type of whooping-cough vaccine (known as “whole-cell pertussis vaccine”) might also help prevent food allergy, by training the immune system to detect the difference between germs that are harmful and things that are not harmful, like food. This pivotal work will provide the foundations to confirm whether in the current Australian context, where 1 in 10 infants are diagnosed with food allergy by their first birthday, whole-cell pertussis vaccine may offer additional protective benefits that could be used to combat the rise in food allergy.

MARISA DUONG (UWA)

Duchenne muscular dystrophy is a genetic disease that affects one in every 3500 boys worldwide, and its devastating physical effects are visually evident. What is not so obvious is how the excessive inflammation that accompanies this disease affects the shapes and functions of the proteins in our muscles and blood. My PhD research aimed to pinpoint which proteins are affected and where they are changed in Duchenne muscular dystrophy muscle and blood tissues. By understanding what is happening to our body at the tiny scales, we can better evaluate which treatments are effective in tackling muscular dystrophies and many other diseases with chronic inflammation.

Our postdoctoral fellowships

Number of fellows **16**

69% MALE
31% FEMALE

Distribution across universities:

63% UWA
25% CURTIN
12% MURDOCH

Number of fellowship applications in 2019

411

63% MALE
37% FEMALE

SUCCESS RATE

1.5%

FIELDS OF RESEARCH

Bioinformatics
Chemistry
Computer science
Earth science
Evolutionary biology
Marine physics
Materials science
Medical science
Philosophy
Physical chemistry
Psychology
Radio-astronomy
Space science

SUBJECT AREA OF APPLICATIONS

35% Social sciences and humanities
27% Engineering and technology
17% Natural sciences
15% Biological science and ecology
6% Medical and life sciences

→
Kit Prendergast

DR RACHAEL ZEMEK (UWA/TELETHON KIDS INSTITUTE)

A key step in treating solid cancers is surgical removal. It is crucial to remove all cancer for the best outcome, but this is not always feasible. Chemotherapy is given to try prevent relapse, but is not always successful and can cause long-term side effects. With the discovery that your own immune system can be reprogrammed to kill cancer cells comes the realisation that surgery does not simply remove the cancer, but also initiates an immune response. Despite surgery being used since ancient Egyptian times, we know very little about how the immune response after surgery interacts with cancer. My research will investigate this interaction and find ways to reprogram the surgery-induced immune response to kill remaining cancer cells.

DR GEORGIA HAY (CURTIN)

Now more than ever (i.e. in light of COVID-19), understanding how to design and facilitate interdisciplinary collaboration and creativity in healthcare teams is critical. Yet, decades of research in organisational psychology highlights the fact that when groups of diverse individuals try to work together on complex problems they face many challenges (e.g. fragmentation, a lack of psychological safety, miscommunication, conflict). Research is urgently needed on the cognitive, motivational, and psychosocial factors that contribute to effective interdisciplinary collaboration in healthcare teams. My research project aims to identify the factors that contribute to the effectiveness of a specific group of 'extreme knowledge teams': panels of interdisciplinary medical specialists in Undiagnosed Diseases Programs, who use genetic testing and creative brainstorming to find answers for highly complex and undiagnosed patients.

DR LUCY FURFARO (UWA)

With viruses being in the headlines for all the wrong reasons, we may forget that not all viruses are bad. Viruses are among the most abundant entities on the planet and viruses that specifically infect bacteria – known as bacteriophages or phages - are no exception. Phages are able to kill bacteria and are considered the enemy of our enemy. In nature, they play a key role in maintaining numbers of bacteria. My research is focused on understanding our exposure to bacteria and viruses before birth to begin to unlock what health implications this has. Infection during pregnancy can have devastating outcomes and being born too early is the leading cause of death and disability in children under 5 years old. This research aims to understand if phages are present and whether they may protect us from bacterial infection prior to and after birth.

Protect the Planet

We aim to ensure that our children, and their children, can marvel at a natural world that is as beautiful, bountiful and diverse as the one we enjoy today.

DR CHONG WEI (CURTIN)

Our oceans are getting noisier every year, which is posing threats to the animals living there. These marine animals rely on sound for all major life functions. However, it is really difficult to know the impact of noise on most animal species because they are inaccessible for live testing. My research develops non-invasive and rapid methods that construct animal hearing models based on imaging scans of collected specimens. The model helps us know what animals can hear and how the noise impacts them. The developed database will be a critical asset to global researchers and managers, and will, for example, help us better understand and respond to the phenomenon of the mass stranding of whales. The benefits are far-reaching, from Australia to the world, from science to industry, government and environmental managers, globally.

MATT HEYDENRYCH (UWA)

We live in an age of unprecedented environmental destruction. A key step in reducing our impact is understanding and monitoring our natural world and the animals which inhabit it. They form a vital part of our planet and the human experience, and my research is focused upon their preservation. I am developing genetic and epigenetic tools that allow for low cost, high speed assessments of animal populations, which can determine age, sex, and sexual maturity. These tools will give conservationists and environmental managers large amounts of key information about animal populations. This can be utilised for biosecurity applications, sustainable resource and fisheries management, and for endangered species biomonitoring, leading eventually to a world where our presence is not associated with the loss of biodiversity.

CELINA BURKHOLZ (UWA)

Kelp forests are declining worldwide due to rising seawater temperatures and more extreme weather events driven by climate change. These forests, however, are crucial for the protection of our coastlines, carbon uptake, and provision of food and shelter for important fisheries. But different kelp populations decline at varying rates, with some appearing to be less affected by a changing climate. My research aims to identify the difference between stronger and weaker kelp individuals, by testing their resilience in laboratory and field-based experiments. These results can help predict future scenarios and provide critical information for new restoration techniques. The goal is to use these strong individuals as donor plants, plant young kelp back onto degrading reefs, help kelp forests become more resilient, and thereby protect the health and diversity of our oceans.

EMILY HOFFMANN (UWA)

Our global biodiversity is unique, incredibly complex, and ultimately provides the processes and services that sustain our very existence. Yet, our biodiversity is in drastic decline as a result of human activities. My research focuses on the conservation of amphibians – the group of vertebrates currently most threatened with extinction. I want to better understand the causes behind population declines, and how species are impacted by current and future pressures such as climate change. By understanding how species are impacted, we can both manage the threats and work towards preventing extinctions. Further, this will help us comprehend how we are impacting our planet and allow us to make changes and live in a world where humans and a rich and productive biodiversity can coexist.

DR GIOVANNI POLVERINO (UWA)

Invasive species and pollution are major threats to our economy and biodiversity, especially in freshwater environments. One aspect of my research pioneers the use of bioinspired robots to artificially manipulate the behaviour of highly invasive fish, challenging their capacity to reproduce and survive, and thereby protecting Australian wildlife. Another aspect of my research investigates the dramatic effects that water pollution by antidepressants (Prozac) have on fish, reducing differences in the behaviour of individuals and compromising the resilience of fish populations around the world. Overall, my work reveals with great precision the vulnerabilities of invasive and native animals, and provides the fundamental knowledge to inform new strategies for restoring Australia's freshwater ecosystems.

DR KIT PRENDERGAST (CURTIN)

Most of us have heard about the importance of bees for food production, but bees are important for so much more – they are crucial components of biodiversity, and as pollinators of wildflowers, they give biodiversity hotspots like Western Australia its local 'flavour'. And whilst most of us have heard about bees, it's typically been the European honeybee – *Apis mellifera* – an introduced species. My research involved discovering the biodiversity of our native bees, and how we can better conserve them. I looked at: how honeybees interact with native bees, finding that native bees with high niche overlap are most vulnerable to competition; whether residential gardens can replace native vegetation remnants as habitat (they can't – we must preserve our urban bushland); and what factors are associated with thriving native bee communities (large proportions of preferred wildflowers).

We explore the potential to find new ways of making and using the molecules, materials and machines that support our modern way of life.

Develop New Technologies

DR JACOB MARTIN (CURTIN)

Rapid decarbonisation is required to avert the most extreme impacts of climate heating. Hydrogen is a non-polluting alternative fuel, however, the transportation and storage of hydrogen remains a challenge because of the high pressures involved. In my research, I am developing new carbon materials that hydrogen can stick to, lowering the pressure in storage tanks and improving safety during transportation. Recent work has shown that flexing the sponge-like structure of certain carbon materials can greatly increase their capacity to hold hydrogen. I use supercomputers to model and test this flexing before the materials are made in the lab, greatly speeding up material development. These insights will be coupled with experimental work to engineer a hydrogen sponge that could enable the hydrogen economy in Western Australia and the world.

MANOU ROSENBERG (UWA)

The way we generate and consume electricity is changing and with it the requirements that the electricity network must meet. Traditionally, electricity networks consist of centralised generation and a system connecting all consumers to the supply sources. With more renewable energy sources being utilised the traditional network layout may no longer be optimal or feasible. Especially in remote areas this leads to specific challenges but also offers the opportunity to redefine the way electricity is distributed. Knowing the electricity loads and locations in a rural area, we want to be able to plan an optimised electricity network infrastructure. In my research I am using advanced mathematics and artificial intelligence techniques to help develop and evaluate methods that are able to improve the network planning process and support the shift to renewable energy sources.

DR DAVID GOZZARD (UWA/ICRAR)

Light can carry a lot more information than radio waves, thousands of times more. This means laser communications can send much more data than radio transmissions, and measurements made using lasers are the most precise. I am developing technologies for satellites to connect with the ground via laser links through the turbulent and shimmering atmosphere, freeing them from the limitations and bottlenecks of radio transmissions. These laser links will lead to a huge range of technological advances including faster download of huge quantities of satellite data, more accurate GPS navigation, and the most precise fundamental physics and applied science experiments ever performed.

Our Prospect fellowships

Our rapid response to the research funding crisis caused by COVID-19

Number of Prospect Fellows **12**

42% MALE
58% FEMALE

Distribution across universities

75% UWA
17% CURTIN
8% MURDOCH

Number of Prospect Fellowship applications in 2020

106

58% MALE
42% FEMALE

SUCCESS RATE

11.3%

FIELDS OF RESEARCH

Bio-medicine
Engineering
Evolutionary biology
Linguistics
Mathematics
Physics
Psychology
Sociology
Visual Arts
Veterinary Science

APPLICATIONS BY RESEARCH AREA

31% Physical and mental health
23% Environment and natural resources
13% Agriculture food and nutrition
12% Frontier technologies
11% Indian Ocean
10% Arts and Culture

JINCHENG WANG (ECU)

In order to live more sustainably we need to lower the environmental and economic impact of production processes and adopt new ways of synthesising and re-using materials. Current multi-step manufacturing processes consume large amounts of metal and energy inputs and generate large amounts of waste. Innovative metal additive manufacturing (3D-printing) techniques can manufacture finished parts with complex structures and desired properties in just one process. The main aim of my research is to find ways of applying additive manufacturing techniques to existing and new titanium alloys for biomedical and industrial applications. In particular, I aim to improve the scientific understanding of the interrelation between alloy compositions, processes, structures, defects, and properties of 3D-printed parts.

ASJA KROEGER (UWA)

From the production of plastics to the synthesis of pharmaceuticals - around 90% of today's industrial chemical processes are driven by catalysts and the products of chemical catalysis are indispensable to our day-to-day lives. Not surprisingly, there is an ongoing quest for new catalysts and improvements to current processes. Many of the catalysts used in current industrial applications are based on rare and expensive transition metals which pose a risk to the environment and users. My research aims to propose new avenues for catalysis using only organic materials based on insights from computational models into the chemical interactions driving reactivity.

DR PETER KRAUS (CURTIN)

Computational design of materials is a promising avenue for the development of semiconductors, with applications in solar cells, sensors, or catalysts. Instead of synthesizing a large amount of novel candidate materials, computational tools can already be used as a screening method, reducing development costs and time requirements. However, such screening requires accurate predictions of electrical conductivity, which is a difficult target for computational modelling. My work focuses on developing new tools and selecting appropriate computational methods, allowing us to model various aspects of materials, with the goal of formulating a systematic way of predicting the real-world conductivity.

DR MARCUS KORB (UWA)

The consumption of noble metals, such as gold, platinum and palladium increases steadily, due to their high demand in modern electronic devices. Since most chemical processes also rely on these catalytically active metals, prices of chemical commodity and fine-chemicals will be impacted in the near future. My research focuses on the development of new iron-based complexes, which can replace the existing catalysts based on noble metals. Contrary to toxic noble metals, iron as one of the most abundant metals is biocompatible. I especially focus on the design of the metal's surrounding organic framework, which is the most decisive factor to tune the activity of the final catalyst.

MINGXIN YE (UWA)

Titanium is widely used in the fabrication of artificial hip, knee and other implants, and has been thought to be safe with a high success rate. However, in some cases, there have been reports of complications due to hypersensitivity as these implants are subject to corrosion and wear. My research aims to develop strong, non-toxic, ceramic implants that facilitate bone growth. This will allow implants to be integrated into bone in a manner that imitates natural healing processes.

MASNUN NAHER (UWA)

Over the past century, silicon has been the dominant material for all electronic devices such as diodes, switches, rectifiers, transistors and integrated circuits. The fundamental limitation with the miniaturisation of silicon-based electronic devices creates growing interest in alternative materials and design, particularly in the field of molecular electronics. Molecular electronics uses individual molecules on electrode platforms to mimic the properties of conventional devices. However, integration of multiple devices into a truly molecular integrated circuit is challenging. As chemists, we are very good at making molecules with functions we want, so my research is mainly based on designing and synthesising molecular wires with different functionalities to explore molecular structure-property relationships. This will ultimately help us design robust molecular junctions that will form the building blocks of a new industry based on molecular electronics.

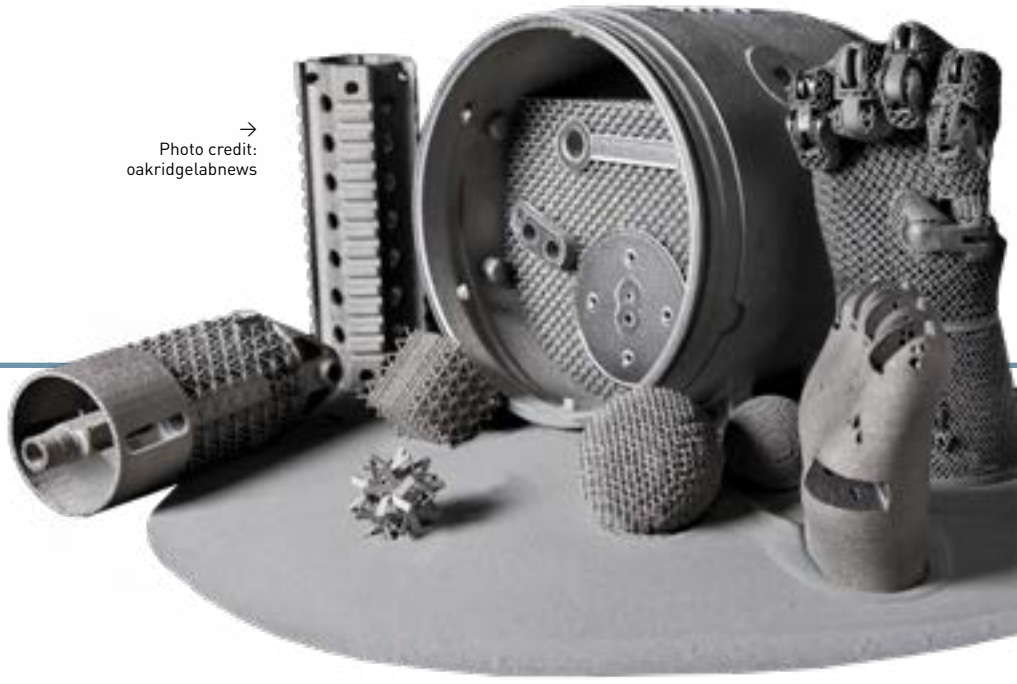


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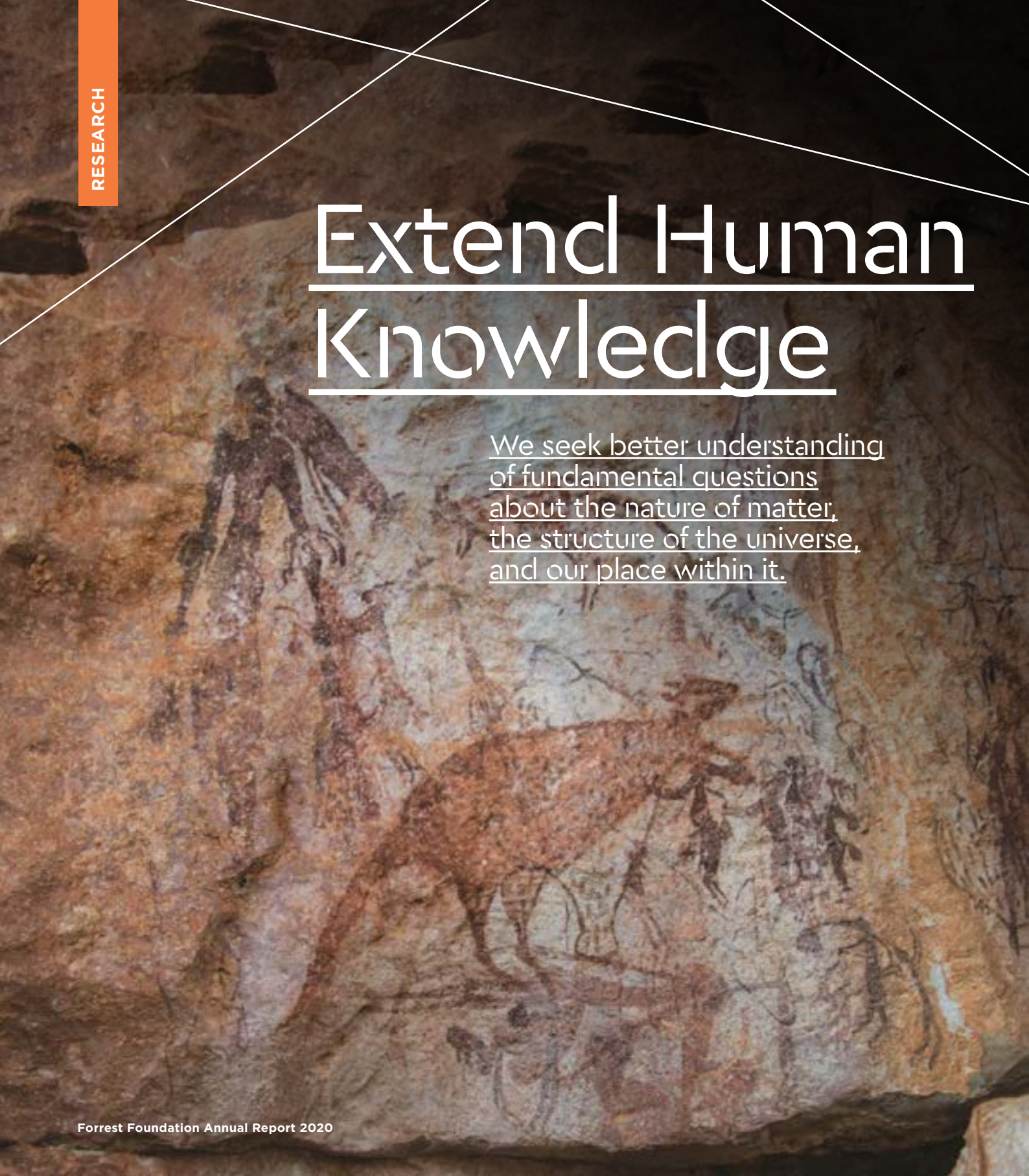
Photo credit:
oakridgelabnews

DR ARMAN SIAHVASHI (UWA)

In today's world as the population grows the demand for energy increases. On the other hand climate change is becoming one of the biggest threats that modern humans have ever faced. Hydrogen as a clean fuel can significantly help meet this energy demand and mitigate the global warming issues. My research helps advance the science necessary to remove some of the constraints on our ability to access, reliably produce and export our hydrogen endowment. Essentially, the constraints arise from inadequate fundamental knowledge of a cost-effective, safe, scalable and predictable hydrogen system. My research produces a model and a software package that can help scientists and industry experts to better understand and improve the design safety and substantially reduce the costs associated with hydrogen production, liquefaction and storage systems.

In order to live more sustainably we need to lower the environmental and economic impact of production processes and adopt new ways of synthesising and re-using materials.



Extend Human Knowledge

We seek better understanding of fundamental questions about the nature of matter, the structure of the universe, and our place within it.

←
Motta, Porr and Veth
(2020:146)

ANA MOTTA
(UWA)

We live in a world that heavily relies on animal products and bi-products for human subsistence. As a consequence, ecosystems are being depleted and animal species are extinguishing at an unprecedented pace. However, the domination of humans over other species is not shared across all humans. For example, Indigenous populations have been caretakers of their environment for many millennia and have established significant relationships with other non-human beings. Animals have always been part of our life, since the beginning of the human species more than 5 million years ago. I study how Indigenous populations in the Kimberley, Australia, relate to animals through rock art. Reflecting upon how humans related to animals in the past and how these relationships changed through time is relevant for understanding how we relate to animals in the present.

LIAM SCARLETT
(CURTIN)

Atomic and molecular collisions are ubiquitous throughout the universe. In the field of quantum collision physics our goal is to calculate the probabilities associated with each of the different processes which can take place between reacting particles. My PhD has been focused on modelling reactions between electrons and molecular hydrogen, with the aim of producing the most comprehensive set of collision data ever assembled. These reactions play an important role in governing the dynamics of low-temperature plasmas in a wide variety of applications, from developing nuclear fusion technology to modelling stellar formation. Through a collaboration we have formed with the Max-Planck Institute of Plasma Physics in Germany, my research is being used in the development of plasma diagnostic tools for the International Thermonuclear Experimental Reactor (ITER) project.

NICHOLAS LAWLER
(UWA)

Despite tremendous advances in our understanding of how our biology is affected by interactions with the environment, there are many areas where current knowledge remains limited. I am particularly interested in improving our awareness of how energetic stimuli effect the growth, development and DNA of cells in our bodies. I explore two forms of stimuli, electrical pulses and millimetre wave light, via techniques such as next-generation genetic sequencing. My research develops an understanding of the interactions of millimetre waves with DNA and the implications for our cells, the role of electrical signals in the development and function of our brains, and works towards the goal of realising potential therapeutic applications.

← John Moeses
Bauan on Unsplash

HARRISON CADDY (UWA)

In space, no one can *see* you scream – because an increasing number of astronauts that spend long durations in space develop a vision disorder called space associated neuro-ocular syndrome (SANS). Currently it is unclear as to why vision degrades in space, and with the advent of planned missions to the Moon and Mars on the near horizon, there is an increasing need to better understand this phenomenon, and how to stop it. My research involves the use of computational fluid dynamics to build simulations of blood flow within the eye, with the goal to identify mechanical markers associated with blood vessel damage and consequently, the signs and symptoms of SANS development.

DR BEN MCALLISTER (UWA)

I am an experimental physicist developing technology for the "second quantum revolution". Quantum mechanics describes the laws of nature on very small scales – like those of individual particles. The first quantum revolution occurred during the 20th century, when we developed an understanding of the behaviour of particles on small scales, which led much of the technology we use today. Without quantum mechanics we would not have understood the counter-intuitive microscopic nature of materials, and would not have been able to develop, for example, microprocessors which power computers. The second quantum revolution refers to the coming shift in technology where, rather than simply understanding particles on small scales, we are able to engineer and exploit their many strange properties to gain advantages over traditional devices. I am developing tools called GHz single photon counters, and novel superconducting materials for applications in quantum technologies such as quantum computers.

ADAM WDOWIAK (UWA)

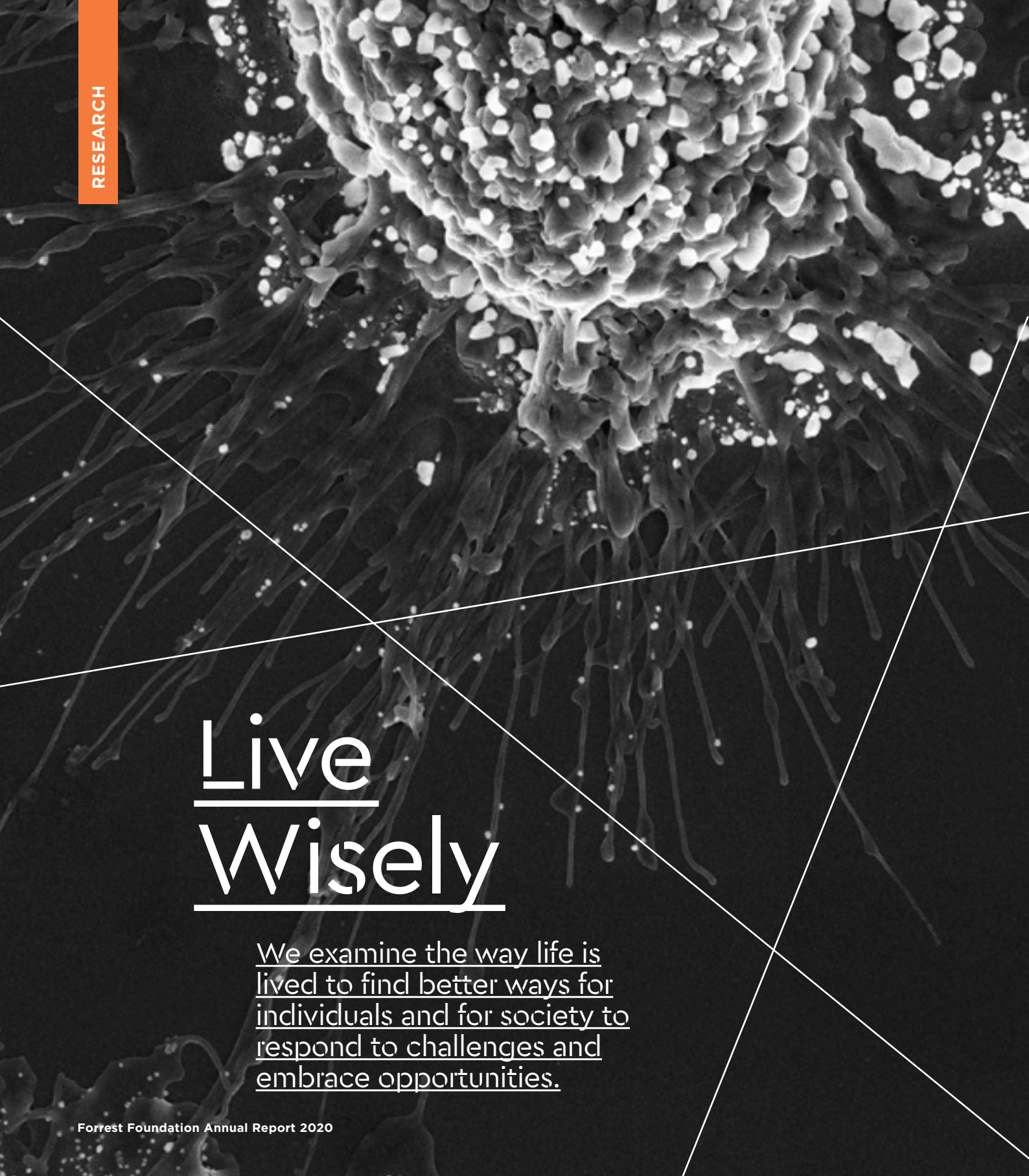
Triangulenes, a novel class of human-designed molecules, are one example of beauty hidden within a molecular structure. As a synthetic chemist, I am drawn to substances and materials with useful properties. However, I believe that the future of synthesis lies in design, where we can break free from copying nature. Triangulenes have a great potential to be very useful in many applications, and their structural beauty allows them to be easily modified to suit a given application. My research focuses on finding efficient and clean ways to make these compounds, such that we can thoroughly investigate their properties.

TYRONE O'DOHERTY (CURTIN)

Black holes are among the most mysterious objects in the Universe. Stellar-mass black holes are those born from the deaths of the most massive stars. Theoretical simulations suggest that there should be around 100 million black holes wandering around our Galaxy. However, to date, we know of less than 100, since we can only detect black holes through light emitted by their interactions with other stars as they orbit each other in binary stellar systems. My research uses a new technique to discover non-interacting (invisible) black holes in binaries through analysis of the orbits of their visible companion stars. Uncovering this new population will help inform our models of black hole formation rate, stellar lifecycles, and more broadly, Galactic evolution theory.

SEAN LI (UWA)

Understanding the molecular structure of complex organic materials is central to the development of new chemical products, for example pharmaceuticals and pesticides. Mass spectrometry is an analytical technique that is uniquely able to identify the structure of even nanograms of a particular compound within a complex mixture. However, this is a slow and laborious process, because it requires expert analysis of large quantities of data, originating from each molecule in the mixture. For my PhD, I aim to devise an automated methodological framework to rapidly identify the molecular structure of organic compounds purely from data obtained with mass spectrometry. An automated approach of this sort will allow complex mixtures – for example plant extracts or insect pheromones – to be rapidly and readily screened for interesting or useful compounds, thereby directly supporting advances in both basic and applied research.



Live Wisely

We examine the way life is lived to find better ways for individuals and for society to respond to challenges and embrace opportunities.

←
Andrea Rassell

DR JULIE JI (UWA)

Imagine a world where invisible forces have control over our feelings and behaviours – this sounds like science fiction, yet this is the lived reality of human beings every single day. While six decades of research has investigated how distortion in our internal mental landscape (i.e. the internal monologues and mental pictures and movie clips that form our stream of consciousness) powerfully shapes our emotions and perception of reality, we are only beginning to directly examine how it drives our behaviour. My research uses correlational and experimental methods in the laboratory and the real-world to investigate how biases in "mental evidence" relating to the future influence judgement, motivation and behaviour, in the context of depression, self-injury, and health behaviours. My research has the potential to reveal presently unknown behavioural levers at the cognitive level, thereby informing novel pathways to treatment innovation and empowering individuals to have more control over themselves.

GRACE GOH (UWA)

It is often said that our body has an internal clock that controls our biological rhythms. But referring to a singular "clock" is something of a misnomer; in reality, timekeeping genes are found in almost every cell in the body. Our various body clocks have to tick to the same rhythm to maintain health, but in a world where light, food, and mental stimulation are available 24/7, our body clocks have never been more out-of-sync. The goal of my research is to figure out what keeps clocks ticking in sync (body temperature and meal timing are key players) and how they influence health and longevity (stronger rhythms = longer lifespan). With this information, we can eventually learn how to minimise body clock dysfunction when lifestyle disruption (shift work, fly-in-fly-out) is inevitable.

CLAIRE DOLL (UWA)

Parks provide social, physical and mental health, and ecosystem benefits to communities, but often require substantial amounts of water to stay green year-round. With climate change and a growing population, water is becoming more scarce around the world, increasing the challenge of sustainably managing water resources. In response, parks are being designed to include more native, drought-resistant vegetation. Yet whether and to what extent the public benefits from parks that are less water intensive remains uncertain. My research uses survey tools and administrative data to understand public preferences for different park designs. I am estimating the dollar value of parks generally, and more specifically from park watering, to perform benefit-cost analyses that will help local governments make evidence-based decisions as they adapt to climate change conditions.

←
Luis Villasmil
on Unsplash

DR CATRIONA STEVENS (UWA)

My research seeks to understand migrants working in Australian aged care from their own perspectives, why they migrated to Australia, how they came to find employment in the sector, and what they imagine their future careers to be. The Royal Commission into Aged Care Quality and Safety clearly identified workforce issues as a significant challenge facing the sector. Key recommendations include finding new approaches to attract and retain staff, professionalising the workforce, and developing new visa pathways to meet a looming labour shortfall through international recruitment. My project responds to these concerns. I aim to empower migrant aged care staff in their work by hearing and heeding the stories they tell. In addition, the project will contribute to policy and practice in the sector, supporting our diverse aged care workforce to improve quality of life for older Australians, including those living at home and in residential facilities.

DR MICHAEL WILSON (CURTIN)

Most people will experience being over-worked or work-related stress at some stage in their careers, which if left unaddressed, can lead to fatigue, poorer mental health, and costly workplace errors. We know a lot about the general features of work that can undermine or support mental health and wellbeing, but we don't yet understand how work stress accumulates or how resilient individuals draw upon protective resources over time. To gain these insights, my research focuses on developing predictive models that can describe patterns of data collected from workers intensively over time. Ultimately, my approach will support the development of individually personalised workplace interventions, and methods that can proactively detect and prevent work stressors from accumulating to long-term health problems.

DR SHANNON ALGAR (UWA)

Animal welfare is relevant to commercial and private animal owners, legislators, protection groups and, crucially consumers, who are increasingly demanding greater visibility of appropriate animal welfare. Meat and Livestock Australia estimates ignoring welfare issues will cost the industry $4 billion over the next decade. Typically, animal welfare is monitored and reported at a group level and data analysis in this space is reactive. Both of these norms are increasingly being recognised as inadequate. My research with the Forrest Foundation seeks to use modern mathematics to analyse the physiological parameters (such as temperature and heart rate) of individual animals and predict changes in that individual's health allowing for proactive intervention.

DR ANDREA RASSELL (UWA)

Can you imagine what a nanobot looks, feels, and sounds like? If you can, chances are you are drawing this scene from science fiction or speculative art, because anything on the nanoscale is too small for us to sense with sight, touch or hearing. As a media artist, I aim to engage the public with nanomedical technologies. I want to extend our understanding of how these technologies might assert social and political power on our communities, and to create interactive and multisensory media artworks that challenge our notions of what nanomedical technology is. This research is important because it will draw the public into conversations around these emerging technologies. It will also carve out new opportunities for further research by charting the opportunities and challenges for the cultural industries in their presentation of nanotechnologies to the public.

DR FRANCESCO DE TONI (UWA)

My research investigates how Australians name and express their emotions when talking about health and illness. Emotions are a fundamental component of our mental, physical and social wellbeing. Through language, we can share our emotional experiences of health and illness. By understanding emotion language health professionals can provide person-centred care and communicate with patients in an empathetic manner. The goal of my research is to understand how linguistic models of emotional expression about health are used in public discourse (e.g. online) and in health-care settings (e.g. in medical consultations) in Australia and how emotional communication affects health care outcomes. The results of my research will assist in developing strategies and resources to enhance health-care professionals' communication skills and public-health communication. They will also provide insight into how we can apply emotion-language detection technology to health care.

RESEARCHER PROFILE
MASNUN NAHER

Overcoming giant obstacles to help create the building blocks of next generation electronics

For Masnun Naher, the road to a career in science has been more difficult than that of many of the people she has come to know as a Forrest Research Foundation Scholar.

"Gender discrimination is one of the major problems in third world countries and in Bangladesh it begins at birth," the softly-spoken young Bangladeshi scientist says.

"Young girls, teenagers and women suffer equally and each has to face many difficult situations involving gender-related issues if they want to be successful."

One of the most densely populated nations in the world, Bangladesh – a small south-east Asian country lying on the Bay of Bengal and bordered by India to the west, north and east and Myanmar to the south-east – boasts areas of stunning natural beauty.

But at only two-thirds the size of the Australian state of Victoria, the country is also home to more than 161 million people (compared to a comparatively lean six and a half million in Victoria).

The rapid and unplanned urbanisation has led to widespread pollution, over-crowding and poverty.

While recent sustained economic growth is seeing some turnaround, for women it is still an environment where deeply-rooted socio-cultural constraints and a lack of work opportunities can be obstacles to success.

This is especially true, Masnun explains, for women choosing the path of higher education, something the 31-year-old says she set her heart on from a young age.

"My favourite subjects at school were chemistry and maths – I realised early on that maths was something I was good at," recalls the eldest of four siblings who grew up in the small town of Brahmanbaria in eastern Bangladesh.

"From my father's side of the family, I was the first to go to university although my mother's side of the family were highly educated. My parents really wanted to send us to a different town or city to study so that we would have greater opportunities," she says.

Continuing on her path

Tragically in 2007, the year after she began her Bachelor of Science at Shahjalal University of Science and Technology (SUST) in Sylhet, Masnun lost her father.

"As the eldest daughter, I had to take on a lot of extra responsibilities," she says. "I got very strong from that time, there were financial difficulties and I was travelling a lot, back and forth to home."

But, she persevered, completing not only her undergraduate degree with distinction but also a Master of Science in Chemistry where she scored 3.98 out of a possible 4.00 – outstanding results which saw her offered a faculty position in the Department of Chemistry at The Shahjalal University of Science & Technology (SUST).

"Gender discrimination is one of the major problems in third world countries and in Bangladesh it begins at birth."

As one of the country's first science and technology-based universities, SUST is one of Bangladesh's leading institutions, but even this prestigious place of learning didn't come without its challenges.

"For instance, when I started working in a research laboratory during my undergraduate research, I was the only female among 11 students," Masnun says.

"I had to go through some serious difficulties including not being able to work in the evening because the streets aren't safe for women after twilight in our country. This and other issues made the completion of my research work difficult.

"Also, in a country where quality education and sufficient research facilities are lacking and outdated economic systems and technology are typical problems, there is a lack of physical infrastructure and a digital divide compared with the developed world."

For example, she says, not having any access to an NMR spectrometer, mass spectrometer and X-ray crystallography caused serious problems in her chemistry research.

But the young scholar wasn't deterred and before taking up her Forrest Scholarship in 2018 to complete a PhD in the School of Molecular Sciences at UWA, she published five research articles in ISI listed journals, and achieved a competitive research grant from the SUST Research Centre.

A whole new world

Masnun says her Forrest Scholarship and life in Australia opened up a world of possibilities, bringing her dream – to use molecular electronics to help develop next generation technology – a lot closer.

"Imagine a world in which electronic technology can be made available not only to the advanced nations of the world, but to everyone," she says. "The basic science in this area is advancing at great pace, but less is being done to migrate the science to achievable device structures.

"I've developed new methods for synthesising and studying the electronic properties of different kinds of organic, organometallic and coordination molecular wires.

"My synthesised molecules show unique electronic functions, not possible with conventional equipment. These will be lower cost and have lower power consumption than current technology, providing the platform for a whole new phase of electronics."

Masnun's ground-breaking projects build on single molecule chemistry, concentrating on how it might be possible to go from single molecules to minute molecular films (about $5nm^2$) and using electrodes to 'sandwich' the molecular films.

"This would allow us move from developmental research, towards a tangible technology that allows active molecular components to be integrated into devices," she smiles.

Another key element of Masnun's research is that it seeks to move away from the rare and expensive toxic metals of electronic substrates and STM (electrode) tips, to alternative electrode materials, especially carbon and even graphene.

"This result will be a significant reduction of electronic waste," she explains. "Reducing toxicity will make it far easier to integrate into wearable electronics, and reduce the strain of electronic devices on the environment.

"Ultimately, it will also lower the cost of manufacturing to make electronics more available not only to the rich but to the masses."

A turning tide

Her career dreams may be big but Masnun is also determined to get everything she can out of life.

Since 2018, she's worked as a teaching assistant for first and third year undergraduate students at UWA and also co-supervises junior students from her group and is involved in science related volunteering work.

She loves spending time with her friends at Forrest Hall, watching movies and sharing walks and seeking out spicy food ("there's not enough of it here!") and says missing her family and her pets is made more bearable with regular Skype calls.

As for the future? With a 2019 World Bank report *Voices to Choices: Bangladesh's Journey in Women's Economic Empowerment*, finding Bangladeshi women still have limited choices, control and decision-making power over their employment, finances and economic assets but the country could become prosperous more quickly if more women got work with higher-quality and higher-paid jobs. Masnun says the time has come.

"Women are now showing their desire to contribute to the development of my country," she reveals. "As a student from a developing country, the Forrest Scholarship is helping me to contribute to the economic development of Bangladesh and above all I hope that my achievements will play a significant role in national development as well."

RESEARCHER PROFILE
LIAM SCARLETT

Forrest Scholar Liam's electron-molecule collision modelling 'great step forward' in largest nuclear fusion experiment the world has ever seen

Put Liam Scarlett to the 'pub test' and ask him to summarise his area of research in 30 seconds and no problem. That's despite his field of theoretical physics being one of the most intellectually demanding in science.

"I use supercomputers and quantum mechanics to study atomic and molecular collisions," the 28-year-old Forrest Scholar says simply.

"We work on the theory side of the reactions that take place when subatomic particles and molecules collide with each other – we model the reactions and predict the outcomes."

He might make it sound easy, but during his PhD Liam has successfully advanced the field of molecular collision physics by devising new theoretical methods, developing massively-parallel computer codes and using Western Australia's Pawsey supercomputing facilities to perform large-scale scattering simulations.

As part of that work, he's developed a new computational method known as vibronic close-coupling for modelling collisions of electrons and positrons with diatomic molecules.

The method is based on the first principles of quantum mechanics and doesn't apply the approximations utilised in previous research, which allows Liam to perform the most accurate calculations in the world for molecular collisions.

Quite an achievement for the Fremantle-born scientist who admits he was far more interested in music than science at secondary school!

I was late to physics and to discovering science at all

"We are a musical family," Liam smiles. "Both my parents are recreational musicians, and Mum is a piano teacher. You could say I had a bit of a winding journey to discovering physics."

That 'long and winding road' (to borrow from Paul McCartney) started with a year studying music at the Western Australian Academy of Performing Arts, or WAAPA, after secondary school at South Fremantle Senior High School (now Fremantle College) followed by a period studying psychology at Murdoch University.

"It was during my psychology degree that my interest in science began," he recalls. "I'd started reading Richard Dawkins and watching Carl Sagan documentaries and, in a similar way that they've inspired many people before me, I was intrigued.

"As part of my psychology degree I had to do a mandatory course in mathematics. To my surprise I was quite capable, which gave me the confidence to pursue my interest in physics."

Signing up for a Bachelor of Science and then Honours in Physics at Curtin University in 2014, Liam says in one of those synchronistic life changing moments, he was also introduced to a research group that would change his future.

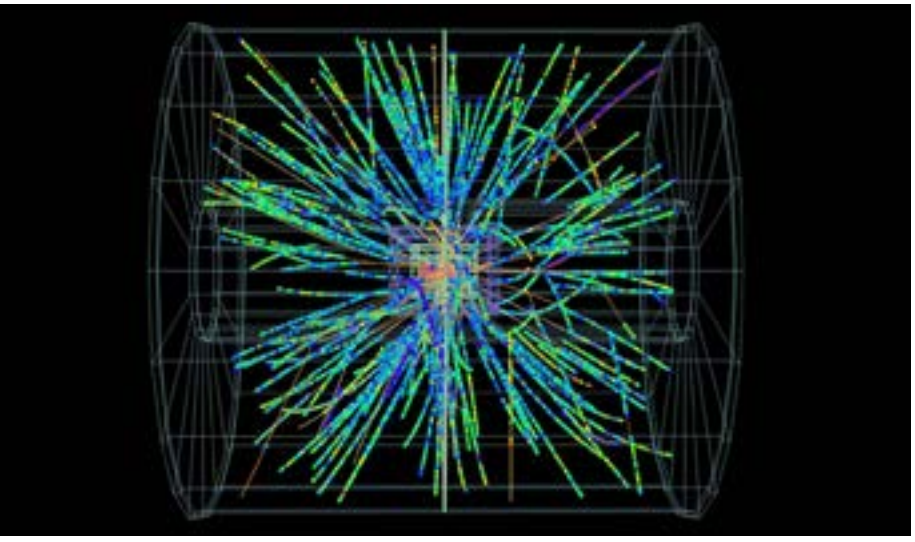


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Photo credit:
CERN

The molecular collisions he models are fundamental processes that play a major role in a diverse range of fields including energy production, medicine and astrophysics.

Directed by world-leader in the field of atomic collision theory Professor Igor Bray, the Theoretical Physics Group is internationally known for its work on electrons, positrons, photons, and heavy particles scattering from atoms, ions and molecules, as well as laser and atom-surface interactions.

"I owe everything to this research group, they've been incredibly supportive and have provided me with great mentorship," Liam says. "They've been leading the field for the past three decades, they've published papers that are older than I am!"

Atomic and Molecular Collisions and becoming a Forrest Scholar

At the end of 2017, and with "zero expectation of success", Liam received another major boost to his career when he was awarded a Forrest Research Foundation Scholarship, designed to support outstanding domestic and international students as they complete their PhDs.

"I applied and didn't think I'd get it and then I did – it's been completely life changing," he says. "It's allowed me to live at Forrest Hall and it's been fantastic having access to all the resources the scholarship provides to conduct our research. I feel incredibly lucky."

And for the future? So far, Liam's calculations have produced data for over 58,000 possible reactions in electron collisions with molecules of hydrogen and its isotopes, the most comprehensive and accurate dataset of its kind ever produced.

He's designed an online database (mccc-db.org) to make those results freely available to scientists worldwide, and with the support of the Forrest Research Foundation has promoted the research in numerous national and international forums.

The molecular collisions he models are fundamental processes that play a major role in a diverse range of fields including energy production, medicine and astrophysics. But the area he's most excited about is nuclear

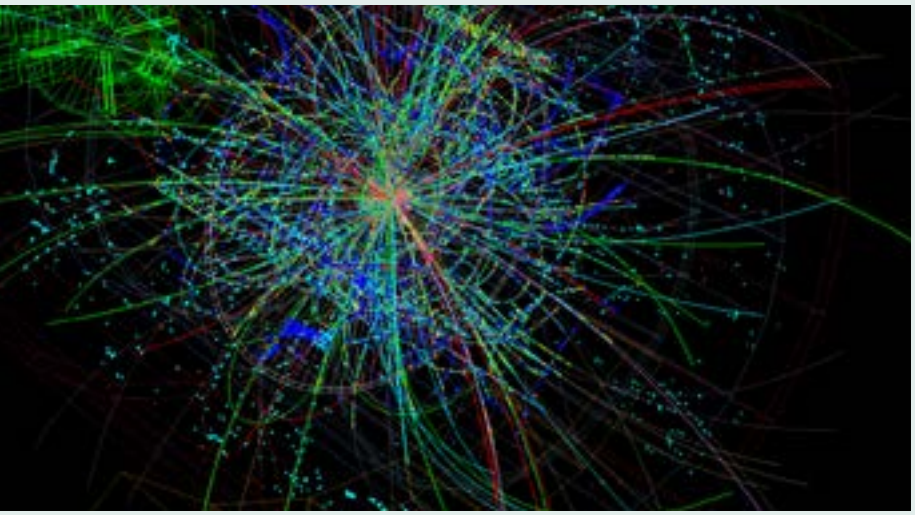

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Photo credit:
CERN

fusion, and his research into electron-molecule collisions is already being used in one of the largest scientific projects in the world, the €20 billion International Thermonuclear Experimental Reactor (ITER) in France.

"Our calculations are being used to construct models for the plasmas which will be present in the ITER fusion reactor," he explains. "These models will be used to perform vital diagnostics and improve the performance of the heating and waste-removal systems in the reactor."

Scientists at the Max-Planck Institute for Plasma Physics (IPP) described the modelling made possible by Liam's research as "a great step forward that we were awaiting for many years". The collaboration between the IPP and WA will result in the world's first ever complete collisional-radiative model for molecular species in fusion plasmas.

Pretty good going for a young man who wasn't even sure he liked science back in secondary school.

The future and a strumming guitar

All thoughts now are on the ITER experiment. "Once it's completed, it will be the largest magnetic-confinement nuclear fusion experiment in the world," Liam says. "Fusion reactors will be able to provide a safe and virtually limitless source of energy with no long-lived radioactive waste or carbon emissions.

"It's a much safer alternative to the fission reaction utilised in present-day nuclear power where, as everyone knows, there've been some very famous examples of runaway chain reactions. One of the benefits of the fusion process is that runaway chain reactions are impossible, making it much safer."

Liam says with more than 20 countries contributing, the ultimate aim is to demonstrate the feasibility of nuclear fusion energy, paving the way for the next generation of fusion reactors to be used for power production.

But he says, while COVID-19 has meant much more time working from home alongside partner Katie and the couple's cat Priscilla, he's also conscious that life can't be 100 per cent numbers and calculations.

"Yes, I spend a lot of my time working on physics, but that's not to say we don't love stepping outside and taking some meandering walks along the river. And very occasionally I do pick up my guitar and strum a few tunes."

That early love of music, it seems, hasn't completely disappeared.

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Financial Update

2020 saw further growth of the Foundation's activities which, despite the COVID-19 pandemic, resulted in an increase in the number of PhD scholars and post-doctoral fellows.

Further donation income of $6.5 million was received from Minderoo Foundation; the cumulative donation received as at 31 December 2020 was $80.5 million.

Forrest Hall revenue was below budget due to lockdown and travel restrictions limiting the number of short-stay visitors and delaying the arrival of some scholars and fellows. Forrest Hall expenses and Foundation operating costs were also below budget for the same reason.

Investment income at 31 December reflects the mark-to-market revaluation of the investment corpus. 2020 was a turbulent year in financial markets; substantial declines in asset values in the first quarter were largely recovered in the latter part of the year, and the university's long-term investment pool produced a return of 5.69 per cent.

The total carrying value of the foundation financial assets as at 31 December 2020 was $62 million, of which 96 per cent is invested in the long-term pool. The total carrying value of property, plant and equipment as at 31 December 2020 was $28 million.

Income Statement
for the period ended 31 December 2020

	2019 Actual	2020 Budget	2020 Actual
	$	$	$
INCOME			
Funds from Forrest Foundation **(a)**	13,000,000	6,500,000	6,500,000
Forrest Hall – Student Accommodation Rental **(b)**	451,113	704,555	651,904
Forrest Hall – Short-stay Rental **(b)**	555,856	406,460	136,592
Forrest Hall – Parking **(b)**	6,490	-	350
Investments Income **(c)**	6,858,618	3,443,465	3,085,522
Other	187,789	-	219,760
TOTAL INCOME	**21,059,866**	**11,054,480**	**10,594,127**
EXPENDITURE			
Forrest Research Scholarships **(d)**	497,165	641,740	599,202
Forrest Foundation Fellowships **(d)**	609,174	1,034,239	1,295,462
Salaries	311,883	350,724	357,889
Marketing	3,154	73,000	10,296
Operating Costs	252,163	252,500	142,180
Forrest Hall – Expenses **(b)**	456,057	499,957	354,980
TOTAL EXPENDITURE	**2,129,595**	**2,852,159**	**2,760,009**
OPERATING RESULT BEFORE DEPRECIATION	18,930,271	8,202,321	7,834,119
Depreciation expense	852,987	848,078	840,870
OPERATING RESULT AFTER DEPRECIATION	**18,077,284**	**7,354,243**	**6,993,248**

Notes

a) The 2018 $6.5m donation instalment from the Minderoo Foundation was received in February 2019 and the 2019 instalment was received in December 2019.
b) The Forrest Hall operating model has adopted a 'whole of life' approach to managing the building. 45 per cent of the income flows to manage the facility and pay all associated operating costs. The residual income available to the Foundation is allocated to a building sinking fund.
c) Represents actual investment return earned. For the year ended 31 December 2020, the long term pool returned 5.69 % and the short term pool returned 3.61%
d) The variance to budget is driven by the timing of cash flows. The budget is phased on a straight line basis whilst the actual expenditure is impacted by the staggered commencement of the fellows and scholars.

Statement of Financial Position as at 31 December 2020

	2019	2020
	$	$
ASSETS		
Current assets		
Cash and cash equivalents	2,112,312	2,515,733
TOTAL CURRENT ASSETS	2,112,312	2,515,733
NON-CURRENT ASSETS		
Other financial assets	52,762,574	60,132,799
Property, plant and equipment **(a)**	29,080,516	28,300,119
TOTAL NON-CURRENT ASSETS	81,843,090	88,432,918
TOTAL ASSETS	**83,955,402**	**90,948,650**
EQUITY		
Reserves **(b)**	885,460	1,379,798
Retained earnings	83,069,942	89,568,852
TOTAL EQUITY	**83,955,402**	**90,948,650**

Notes

a) Depreciation is based on a 2% reducing balance for buildings and 5% straight line for fixtures and fittings
b) The reserves represent 55% of Forrest Hall total revenue set aside to cover future capital maintenance

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