



Australian  
National  
University

SCIENCE, HEALTH  
& MEDICINE

A N U

ANU Colleges of  
Science  
Health & Medicine

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Our academics produce  
**research that  
changes lives,  
and life as we  
know it.**

Collecting rock samples from among the red dust of Central Australia.

Scanning the night sky under cover of darkness at Siding Spring Observatory.

Sitting with patients in the doctor's office.

At a lab bench, and in front of the classroom.

You'll find our researchers at the forefront of scientific practice and discovery, wherever it may be.

Befitting the Australian National University's place among the top 20 universities on the planet, our academics produce research that changes lives, and life as we know it. We are committed to solving problems through big picture and applied scientific research, to improving health outcomes for people around the world, and to the sustainable, secure and equitable use of global resources.

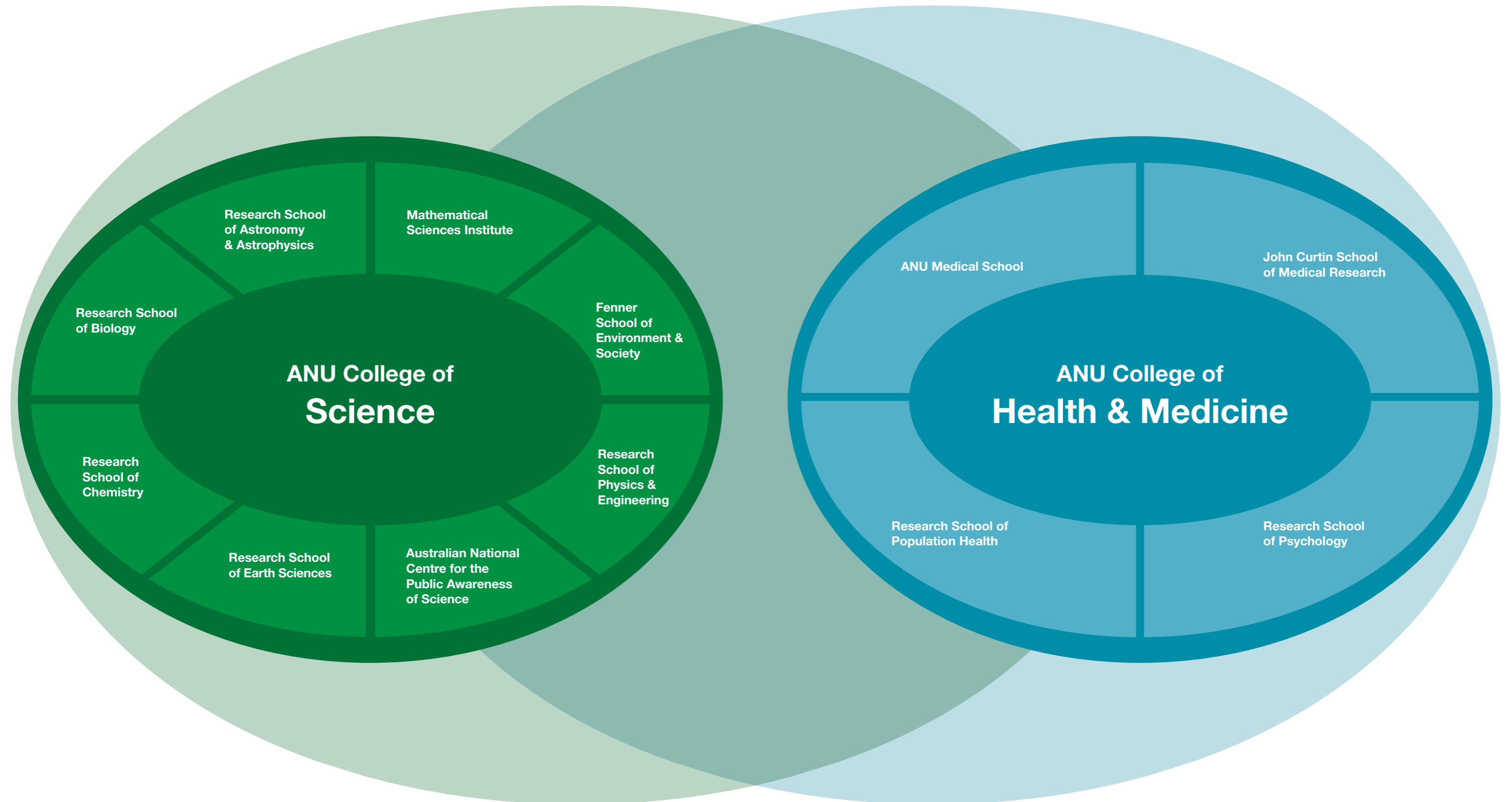
Our students learn from these world-class researchers, as do Australia's policy-makers, with our expertise and influence extending to our Canberra neighbours—leaders in government and industry—and beyond.

We are proud of our standing, our history and our achievements. In the past 70 years we have produced four Nobel Laureates, some of Australia's most pre-eminent scientists and thousands of graduates with a world-class education in science, environment, medicine and health.

But nothing excites us quite as much as our future, beginning now.

# How we work together

Research and teaching in science, environment, medicine and health at ANU is delivered by two colleges, linked by joint administration and interdisciplinary programs.



# Strong international connections

North America

5177

Europe

8870

UK

2606

Asia

3266

South America

984

Africa

405

Oceania

594

From working with Indonesian government and technical agencies on understanding earthquakes, to forming a joint Australian-Chinese research centre for personalised immunology, to consulting with multinational oil and gas companies on a multimillion-dollar high-tech start-up, we bring Australian knowledge, research and innovation to the world stage.

Alongside our collaborative research, we also have education partnerships with leading institutions around the world, including a dual PhD program with the Chinese Academy of Sciences, and a joint undergraduate and Master's degree program with the National University of Singapore.

Graphic: The size of the green circles indicates the number of ANU science, medicine and health publication collaborations by region, 2010-2017



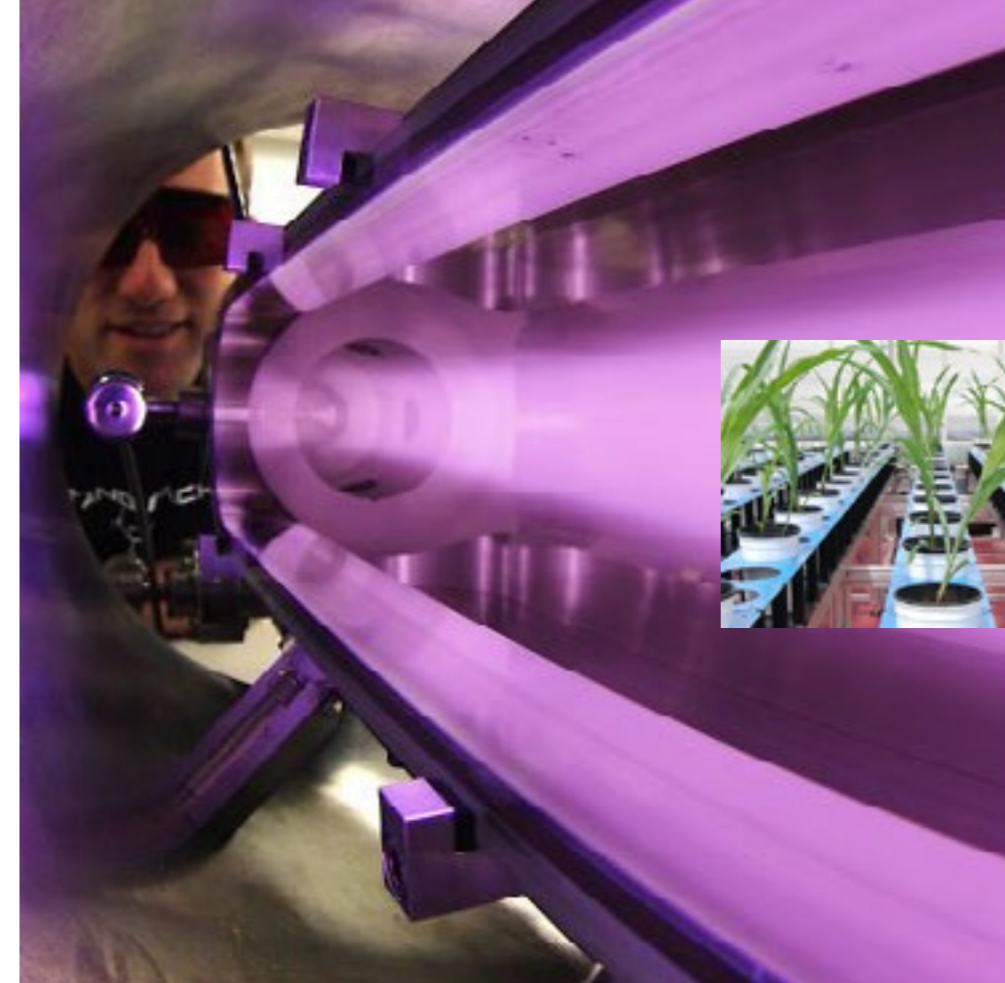
▲ Our new \$240-million science precinct on the ANU campus has state-of-the-art biological and chemical research laboratories, as well as a teaching hub.



▲ The Sensitive High Resolution Ion Microprobe (SHRIMP) for analysing geological materials was designed and developed at ANU.



▲ The ANU Siding Spring Observatory in north-west New South Wales is Australia's premier optical and infrared observatory, housing the state-of-the-art SkyMapper telescope.



◀ The Australian Plasma Fusion Research Facility is a uniquely versatile resource for developing fusion energy.



◀ The Australian Plant Phenomics Facility at ANU is the only place in the world that provides high-calibre public sector access to infrastructure and expertise on crop performance.



▲ The Australian Phenomics Facility at ANU specialises in mouse models of human disease and is one of Australia's foremost genomics and bioinformatics capabilities.

# World-class facilities



◀ ANU is home to the fastest super computer in the southern hemisphere at the \$50-million National Computational Infrastructure.

▶ The \$30-million Advanced Instrumentation and Technology Centre at our Mount Stromlo Observatory is a world-class facility for developing space instruments.



▶ Our Heavy Ion Accelerator Facility is the one of the largest in the world, supporting Australia's only experimental nuclear physics program.



▶ In partnership with the ACT Government and CSIRO, we are working to improve biodiversity at the "outdoor laboratories" of Mulligans Flat and Goorooyaroo Nature Reserves in the Canberra Nature Park.



▶ We have a ten per cent share in the Giant Magellan Telescope under construction in Chile. When completed, it will be the world's most powerful telescope.



▲ The 348-hectare ANU Kioloa Coastal Campus on the south coast of New South Wales is one of Australia's premier field stations, used for research and fieldwork training.



▲ Our partnership with the Mulloon Institute has allowed ANU students and researchers to study ecological farming principles at Mulloon Creek Natural Farms in Bungendore, NSW for the past 20 years.

# Our alumni have global impact in science and beyond.



## Motivator

**Robert Wiblin: BSc 2012, BEc (Hons) 2012**

Executive Director of the Centre for Effective Altruism in Oxford, a leading organisation in the philanthropic sector, and a member of the World Economic Forum's Global Shapers Community.



## Trailblazer

**Professor Mary O'Kane: PhD (Physics) 1982**

NSW Chief Scientist and Engineer, and pioneer in the field of automatic speech recognition. She is also a senior figure in research policy and higher education in Australia.



## Leader

**Jane Halton AO PSM: BA (Hons) (Psychology) 1982**

Former Secretary of the Australian Department of Finance and one of the most senior female public servants in Australian history. She is also a Fellow at the ANU Crawford School of Public Policy.



## Inventor

**Professor Paul Sanberg: PhD (Behavioural Biology) 1981, DSc (Neuroscience) 1998**

Neuroscientist and inventor with over 100 patents, a number of which have been licensed. He is the author of 14 books and President of the American National Academy of Inventors.



## Entrepreneurs

**Phillip Williamson: BSc (Hons) 1988 and Michelle Melbourne BSc 1991**

Founders of software company Intelledox, a *BRW* "Fast 100" company. They have attracted more than one million users around the world to their document digitisation software product, Infiniti.



## Activist

**Rosie Sheb'a: BSc (Hons) 2010**

Founder of Sustainable Menstruation Australia, which advocates for greater awareness of the environmental, social, and financial impact of menstruation.



## CEO

**Dr Cheong Choong Kong: MSc 1966, PhD (Mathematics) 1968, HonDSc 2002**

Dr Cheong was named by *Fortune* as "Asia's Businessman of the Year" during his time as CEO of Singapore Airlines. He is also a prominent community leader and distinguished mathematician.

# We are dedicated to providing unparalleled excellence in research-led education.

Over half of the University's Australian Awards for University Teaching in the last five years have been awarded to educators from science, health and medicine, reflecting our innovative and resource-rich teaching and learning environment.

Our highly collaborative and intensive research culture means that our students are provided with a world-class education from high-calibre academics who, in turn, are offered opportunities for development and are recognised for their successes.



**Professor Joe Hope**

ANU Research School of Physics and Engineering

Winner of the Vice-Chancellor's Award for Teaching Excellence

For his theoretical physics course, Professor Hope adopted blended learning techniques to "flip" his classroom, replacing all of his lectures with hand-developed online materials, allowing the three hours of lecture time to be spent on student activities and small-group and individual instruction.



**Distinguished Professor Chennupati Jagadish AC**

ANU Research School of Physics and Engineering

Winner of the Companion of the Order of Australia for eminent service to physics, engineering and education.

Distinguished Professor Jagadish is the recipient of more awards than we could list. During his 25 years at ANU, he has mentored 40 PhD students and 44 post-doctoral research fellows, and has created an endowment to support students from the developing world to undertake research at ANU.



**Associate Professor Katrina Anderson**

ANU Medical School

Winner of the Teaching Excellence Award at the Australian Awards for University Teaching

Associate Professor Anderson teaches across the ANU Medical School curriculum and is a national leader in the vertical integration of medical teaching and clinical supervisor training, focusing specifically on communication skills, self-care and reflective practice — lifelong skills that are applicable to all students and doctors.



**Professor Malcolm Sambridge, Dr Michelle Salmon and Dr Natalie Balfour**

ANU Research School of Earth Sciences

Winners of *The Australian* Innovation Challenge for Education

Professor Sambridge, Dr Salmon and Dr Balfour developed the Australian Seismometers in Schools Network, which installed 40 seismometers in schools around the country with financial support from the National Collaborative Infrastructure Strategy. The participating schools are able to view seismic waves recorded from local and distant earthquakes, and share research-quality data with the seismological community.



"We often meet students who want to be astronauts and engineers but few who want to be Earth scientists. The big question is how do we attract these students to the Earth sciences? To start with, we can educate students that Earth science is not just about exploration and rocks and that there is a diverse market of jobs that involve training in Earth science; even some astronauts and engineers are trained in the Earth sciences."



## UNDERGRADUATE STUDIES

# Our undergraduate students are destined to make the discoveries that will define Australia's future.

At ANU, we give our students the right start, with access to world-leading scientists and researchers. And with Australia's best student to staff ratio of 11:1, it's no wonder they leave as the most employable graduates in the country.

A range of undergraduate study programs are available.

### Single degrees

Our suite of bachelor degrees covers the breadth of scientific endeavour from astronomy to zoology and everything in between. Students are able to choose a specialised degree program—in medical science, psychology or forestry, for example—or pursue their broad scientific interests with a Bachelor of Science. An advanced Bachelor of Science is also available to high-achieving students as a pathway to Honours.

### Double degrees

Our flexible double degree program allows students to combine two degrees, creating their own unique undergraduate experience. Science students are free to combine their program with complementary degrees outside of science, such as law, philosophy, arts, music or engineering, for a well-rounded and marketable education.

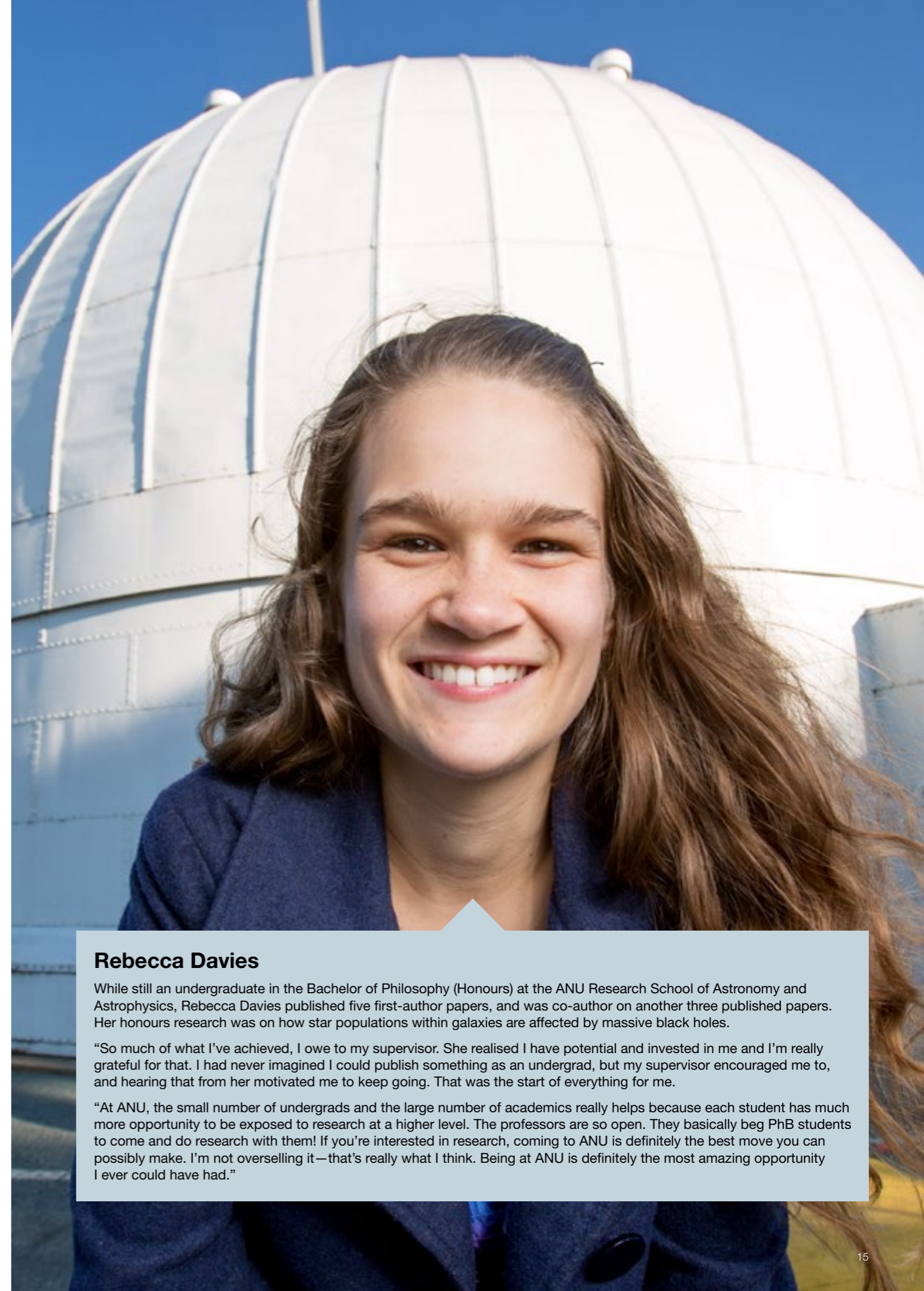
In partnership with the University of Canberra, we also offer a vertical double degree, the Bachelor of Science/Master of Teaching, allowing ANU science students to fast-track their entry into the teaching profession.

### PhB program

For intellectually ambitious students we offer the prestigious Bachelor of Philosophy (Honours) program in science. The PhB allows students to explore their interests, develop their research skills and be mentored by leading academics through individually-tailored advanced studies.

### Areas of study

- > Astronomy and astrophysics
- > Biology
- > Chemistry
- > Earth and marine sciences
- > Environment and sustainability
- > Mathematics
- > Medical and health sciences
- > Physics
- > Psychology
- > Science communication



### Rebecca Davies

While still an undergraduate in the Bachelor of Philosophy (Honours) at the ANU Research School of Astronomy and Astrophysics, Rebecca Davies published five first-author papers, and was co-author on another three published papers. Her honours research was on how star populations within galaxies are affected by massive black holes.

“So much of what I’ve achieved, I owe to my supervisor. She realised I have potential and invested in me and I’m really grateful for that. I had never imagined I could publish something as an undergrad, but my supervisor encouraged me to, and hearing that from her motivated me to keep going. That was the start of everything for me.

“At ANU, the small number of undergrads and the large number of academics really helps because each student has much more opportunity to be exposed to research at a higher level. The professors are so open. They basically beg PhB students to come and do research with them! If you’re interested in research, coming to ANU is definitely the best move you can possibly make. I’m not overselling it—that’s really what I think. Being at ANU is definitely the most amazing opportunity I ever could have had.”

# Our postgraduate coursework students are innovative, creative and take risks.

The intensive research culture in science, health and medicine at ANU, combined with a relatively small student population, gives our postgraduate coursework students the opportunity to work closely with leading researchers on work with real world implications.

### Tom Shaw, Master of Neuroscience (Advanced)

"I've just started my research project, using neuroimaging to look at whether poor cardiovascular health affects a loss of myelin in the brain, and vice versa. In the future I'd like to go into research on Alzheimer's or abnormal brain functioning.

"I moved to Canberra because of ANU. Looking at these amazing facilities, and the research that's going on here, it's definitely been worth it."



We offer a number of internationally recognised postgraduate coursework programs, with many also available as advanced programs.

#### Astronomy and astrophysics

Astronomy and astrophysics students have access to one of the highest concentrations of experts in the field, as well as to some of the world's best observing facilities. Graduates of the program are found in many of the world's major astronomical centres.

- > Master of Astronomy and Astrophysics (Advanced)

#### Biology

The biological research community in Canberra is unique in Australia, combining world-leading expertise and facilities with a broad spectrum of topics including evolution, ecology and genetics, biomedical and biochemical research, and plant science.

- > Master of Biological Sciences
- > Master of Biotechnology
- > Master of Science in Biological Sciences
- > Master of Science in Quantitative Biology and Bioinformatics

#### Earth, marine and planetary sciences

Graduate students have access to one of the highest concentrations of Earth sciences experts in Australia, as well as some of the world's most advanced and innovative equipment. The proximity of Geoscience Australia and CSIRO adds to students' research potential.

- > Master of Earth Sciences (Advanced)

#### Environment and sustainability

Drawing on our expertise in the management, science and policy of environmental issues and resource use in Australia, our graduate programs in environment and sustainability have strong links to government, industry and community groups.

- > Master of Energy Change
- > Master of Environment
- > Master of Environmental Science
- > Master of Forestry

#### Mathematical and computational sciences

Our graduate program prepares students for further study of mathematical sciences or upgrades their quantitative skills in areas such as the biological sciences and computational science. These areas are rapidly becoming more reliant on advanced techniques from the mathematical sciences.

- > Master of Mathematical Sciences (Advanced)

#### Medical and health sciences

Graduate students learn from our active researchers. We have more than 200 scientists at work in the life sciences, 100 research staff working in neuroscience, and one of the most research-intensive schools of ANU—the Research School of Population Health.

- > Master of Neuroscience
- > Master of Public Health

#### Medicine

The Doctor of Medicine and Surgery is a comprehensive four-year degree for students looking to enter medicine. It aims to produce graduates who are committed to compassionate, ethical health care and the expansion of medical knowledge through research.

- > Doctor of Medicine and Surgery

#### Psychology

Our popular Master program provides students with postgraduate clinical training to practise in a range of clinical settings such as hospitals, community health centres and private practice, while giving them a strong foundation for life-long professional learning.

- > Master of Clinical Psychology
- > PhD (Clinical Psychology)

#### Physics

Our graduate program gives students the unique opportunity to study both the fundamentals and applications of nuclear science, including studies in materials analysis, dating techniques, nuclear medicine and nuclear energy and provides access to state-of-the-art equipment.

- > Master of Nuclear Science

#### Science communication

Our graduate programs in science communication are internationally well-regarded qualifications, and are unique in the world. Our education experiences are hosted at Questacon and ANU, based on cutting-edge research in science communication.

- > Master of Science Communication Outreach
- > Master of Science Communication

# We offer the opportunity to work with world-class academics in world-class facilities.

There are almost 1,000 students enrolled in our postgraduate research programs in science, environment, medicine and health, including the Doctor of Philosophy (PhD), Master of Philosophy (MPhil) and professional doctorates, across a wide range of discipline areas. This number represents almost half of all postgraduate research students on the ANU campus, making the science, environment, medicine and health student body a vibrant and dynamic community.

We are well connected internationally through our alliances with top universities in the world and our students regularly travel and work with research groups that are at the forefront of emerging research.

## Research areas

- > **Astronomy and astrophysics**
- > **Biomedical science and biochemistry**
- > **Chemistry**
- > **Culture, health and medicine**
- > **Earth, marine and planetary sciences**
- > **Environment and resource management**
- > **Epidemiology and population health**
- > **Evolution, ecology and genetics**
- > **Mathematical and computational sciences**
- > **Medical science and neuroscience**
- > **Physics**
- > **Plant sciences**
- > **Psychology**
- > **Science communication**



## Pengxiang Hu

Pengxiang Hu completed her PhD as a joint student of the Institute of Geology and Geophysics, Chinese Academy of Sciences and the ANU Research School of Earth Sciences, thanks to the close partnership between the Paleomagnetism Lab at the Chinese Academy of Sciences and the Black Mountain Environmental Magnetism Lab at ANU. Her thesis looked at how past climate conditions, such as rainfall and temperature, influence the magnetic properties of soils developed in a past geological age.

“ANU has an amazing academic atmosphere and advanced scientific instruments. The top scientists in environmental magnetism are also located here. Not only was I able to collaborate with them on academic papers, they also helped me to adjust to the new culture in Australia.

“I love the teaching style here, which is lively, concise and easy to understand. It’s a relaxing and warm environment, where students are always free to ask questions at any time. A lot of academic and social seminars are also organised at the University, in which the latest developments in science, along with valuable experiences, are shared.

“I’ve been offered a position as a Research Fellow at ANU, which I’m very excited about. I love Canberra and ANU, and would like to work and live here as long as possible.”

# Telescopic view on history

Professor Susan Scott from the ANU Research School of Physics and Engineering was working at home late one night, when she received an extraordinary message from LIGO, the Laser Interferometer Gravitational-Wave Observatory in the USA.

Professor Scott is not unfamiliar with the extraordinary: ANU was a key player in the ground-breaking research which saw LIGO detect gravitational waves resulting from a black hole collision. But this message was different. She read it again to be sure.

Making its way through space and time, via the rippling of gravitational waves, LIGO appeared to have recorded the collision of two neutron stars, 130 million light years away, for the first time ever.

The SkyMapper and 2.3-metre telescopes at the ANU Siding Spring Observatory in northern NSW were immediately alerted and set to scan for the resulting light signal. SkyMapper then became one of the first telescopes in the world to confirm it.

“We saw the light from a fireball blasting out from the neutron star collision into space in the hours and days afterwards,” says Dr Christian Wolf from the ANU Research School of Astronomy and Astrophysics.

“We saw the light from a fireball blasting out from the neutron star collision.”

“When I saw the colours I realised this was unlike anything we’d seen before.”

“SkyMapper was the first telescope to report the colour of the fireball, which indicates its temperature was about 6,000 degrees Celsius - roughly the surface temperature of the Sun.”

Constructed and operated by ANU, SkyMapper is a state-of-the-art, wide-field survey telescope. This is not its first entry into the history books.

In 2014, ANU astronomers used early data taken with SkyMapper to discover the oldest known star in the Universe. In 2017, they released the most comprehensive map of the southern sky ever produced, also thanks to the telescope.

For SkyMapper, Dr Wolf says, “this is only the beginning”.

The ANU Research School of Astronomy and Astrophysics operates Australia’s largest optical observatory, has access to the world’s largest optical telescopes, and is leading Australian participation in the next-generation Giant Magellan Telescope.

School staff and students have made major contributions to astronomy, mapping the structure and formation of the Milky Way, discovering planets orbiting other stars, measuring the dark matter both within our Galaxy and in the wider Universe, and discovering the accelerating expansion of the Universe.

Our astronomers are members of the national academies of science in Australia, the USA and the UK, and include winners of the Prime Minister’s Prize for Science and the Nobel Prize. The Advanced Instrumentation and Technology Centre at the School designs, builds and tests world-leading instrumentation for astronomy and space science. We also have an innovative and expanding education and training program for undergraduate and postgraduate students.

# X marks the conservation hotspot

What do a platypus, a lemur, an armadillo and a South American mouse-like marsupial called, fantastically, the monito del monte all have in common?

The answer is: they don't have very much in common at all, not only with each other, but with anything. They are unique species with very few close relatives, making them important targets for conservation according to a study from the ANU Research School of Biology.

Using maps of about 4,700 land mammals' habitats, and information on how species are related to each other, ANU researchers have identified the most important places across the world for protecting mammal diversity.

"Scientists have often focused on the number of species in a protected area, but studies like this one consider the degree to which the family tree of life is well represented," biologist Dr Dan Rosauer says.

"This study seeks to protect all land mammals, but it gives top priority to species with no close relatives, because if they were lost there would be nothing like them left."

Dr Rosauer says targeting conservation efforts in areas that provided the most benefit was critical, because resources—particularly land and money—were limited.

**"This study gives top priority to species with no close relatives."**

"Habitat loss is a major threat to the world's mammal species," Dr Rosauer says. "Over 1000 mammal species are already threatened."

"This is the first time that anyone has mapped these priority areas for conserving the diversity of mammal evolution along with minimum target areas for habitat protection.

"People are already working on these challenges, but by using this cutting-edge genetic information we can make far better decisions, protecting much more of the diversity of the mammal tree of life through better use of limited resources.

"By targeting areas with these really unique species, you would also protect a lot of other species too."

The ANU Research School of Biology is internationally recognised for its high-impact research in plant sciences, evolutionary biology, ecology, genetics, quantitative biology, parasitology and biotechnology. It is home to more than 60 academics, including several who are members of learned academies, including the Australian Academy of Sciences, the Australian Academy of Medical and Health Sciences, the Royal Society, and the US National Academy of Sciences.

Our researchers work on issues of global importance, including food security in both Australia and the developing world, new treatments for cancer and type 2 diabetes, fighting malaria drug resistance, climate change and biodiversity, and conservation biology.

The School houses two ARC Centres of Excellence, and two ANU/CSIRO Centres: The Centre for Biodiversity Analysis and the Centre for Genomics, Bioinformatics and Metabolomics. It has state-of-the-art facilities for a wide range of research projects.



# Fighting bacteria with funky peptides

When you have experienced the transforming effect of antibiotics at a time when you're feeling your absolute worst, it's not something you forget.

Particularly the next time you're feeling a whole new level of absolute worst, and your doctor won't hand you the antibiotics you're certain you need.

But we are now paying the price for swapping *get better soon* with *get better right now*.

The *Medical Journal of Australia* has predicted that by 2050, deaths from currently treatable infections will overtake all cancer deaths, due to the over-prescription of antibiotics.

"When I was a kid, I would go to the doctor and come home with a big bottle of pills," Dr Lara Malins, a Research Fellow from the ANU Research School of Chemistry, remembers.

Fast forward to 2015, and Dr Malins has another, related, memory: hearing the World Health Organization put out a call to action on antibiotic resistance.

"I saw I had the training and skills to be helpful in this fight, because one of the under-explored areas of combatting antibiotic resistance is to develop new drugs that have new modes of action and can potentially outsmart resistant bacteria."

Dr Malins is a chemical biologist, meaning her research applies the methodology of chemistry towards molecules of biological interest, in her case, proteins and peptides.

"I saw I had the training and skills to be helpful in this fight."

"My goal is to use synthetic methods to understand the biological role of peptides and proteins and also to exploit their inherent biological activity to develop new antibiotic therapies," she explains.

"I'm looking at a particular type of peptides called 'lantibiotics'.

"We haven't really seen their therapeutic potential realised yet because we have trouble making them in the lab. They're a bit funky and have a variety of unnatural linkages that exist in nature, but that we don't yet know how to replicate.

"If we can find new strategies to make them in the lab to explore their antibacterial and antibiotic activity, it would be a huge step forward in this fight against antibiotic resistance."

The ANU Research School of Chemistry has an enviable reputation as a powerhouse of chemical research within Australia, attracting the best chemists from around the country and overseas. Supported by world-class equipment and laboratories, our scientists conduct pioneering research across the breadth of chemistry.

All of our researchers are involved in our undergraduate teaching program and supervising graduate students. Half of our 150 PhD students have travelled internationally to study with us.

Our research has had widespread international impact across the chemistry research community and has been applied within the agricultural, pharmaceutical and polymer industries.





## CLINICAL RESEARCH

# Working together for weight loss

In the modern version of the Hippocratic Oath, physicians are reminded that “warmth, sympathy, and understanding may outweigh the surgeon’s knife or the chemist’s drug.”

Dr Liz Sturgiss has gone further than Hippocrates. She has worked out what warmth, sympathy and understanding actually weigh: five to eight kilograms.

Dr Sturgiss from the ANU Medical School has led a pilot study which found GPs with good patient relationships are well-placed on the health frontline to help patients manage their weight.

“GPs and patients with warm and respectful relationships, shared goals and good agreement on what to do to achieve those goals got the best results,” says Dr Sturgiss.

Her team—which includes GPs, nurses and psychologists—developed a toolkit that guides GPs and their patients through an evidence-based weight management program.

Part of the toolkit measures the effectiveness of a relationship between a GP and patient to manage weight problems.

“More and more patients are coming to GPs with obesity problems, and we want to give GPs the tools to assist their patients. The current guidelines for obesity patients are to refer them to a dietician. However, this doesn’t work for everyone.”

**“We want to give GPs the tools to assist their patients.”**

Dr Mel Deery, whose practice in Canberra was involved in the pilot study, says the research helped the practice to treat weight and obesity problems.

“Through the research project we helped a number of patients lose five to eight kilograms, which is a significant amount, and we’re continuing to use these strategies with patients. This work is vital as obesity is a major public health problem that can lead to heart disease, stroke, arthritis and many mental health problems,” Dr Deery says.

Dr Sturgiss says the research team would use the pilot study results to conduct a randomised control trial, which could inform public policy on health and guidelines in GP clinics across Australia.

The ANU Medical School is dedicated to producing doctors equipped to meet tomorrow’s national and global health challenges.

Our world-class program offers students a personal, supportive environment to develop the skills necessary to deliver quality, effective, compassionate care. Our partnerships with ACT Health and Calvary Health Care, together with our Indigenous, GP and community partners and rural healthcare programs ensure our students graduate well-prepared to improve health outcomes for the people they will serve, as well as upholding the standing of ANU as a leading contributor to national health policy and medical research.

# Rocky start solves a mystery

Researchers from the ANU Research School of Earth Sciences have solved the mystery of how the first animals appeared on Earth, a pivotal moment without which we would not exist.

And the answer was found in rocks from central Australia.

“We crushed these rocks to powder and extracted molecules of ancient organisms from them,” says Associate Professor Jochen Brocks.

“These molecules tell us that 650 million years ago, there was a revolution of ecosystems. It was the rise of algae.”

Not only does The Rise Of Algae sound like a great name for a horror movie, it also triggered a chain of events which saw oceans transition from being dominated by bacteria to a world inhabited by more complex life.

“Before all of this happened, there was a dramatic event 50 million years earlier called Snowball Earth,” he says.

“The Earth was frozen over for 50 million years. Huge glaciers ground entire mountain ranges to powder that released nutrients, and when the snow melted during an extreme global heating event, rivers washed torrents of nutrients into the ocean.”

Dr Brocks said the extremely high levels of nutrients in the ocean, and cooling of global temperatures to more hospitable levels, created the perfect conditions for the rapid spread of algae.

“650 million years ago, there was a revolution of ecosystems.”

“These large and nutritious organisms at the base of the food web provided the burst of energy required for the evolution of complex ecosystems, where increasingly large and complex animals, including humans, could thrive on Earth,” Dr Brocks concludes.

Co-lead researcher Dr Amber Jarrett discovered the ancient sedimentary rocks from central Australia that related directly to the period just after the melting of Snowball Earth.

“In these rocks we discovered striking signals of molecular fossils,” says Dr Jarrett, an ANU Research School of Earth Sciences PhD graduate.

“We immediately knew that we had made the ground-breaking discovery that Snowball Earth was directly involved in the evolution of large and complex life.”

The ANU Research School of Earth Sciences is Australia’s leading academic research institution for Earth sciences and ranked 9th in the world for Earth and Marine Science (QS World Rankings by Subject 2018). Our focus is on understanding our evolving Earth and developing solutions to pressing national and global challenges, ranging from understanding the origins of the Earth, to addressing the discovery and extraction of resources in the 21st century, and predicting the course of future environmental change.

We are home to 60 world-class scientists who are supported by cutting-edge research facilities, and who are committed to training and educating the next generation of researcher leaders and geoscientists.





# How the water runs

During the drought that dominated Australian life at the start of the 21st Century, Dr Virginia Marshall noticed something was missing.

“In all the media and national dialogue about the drought, no-one was talking about how this issue was affecting Aboriginal people,” she remembers. She decided to change that.

Dr Marshall is now the ANU Inaugural Indigenous Postdoctoral Fellow, a role which sits between the Fenner School of Environment and Society and the School of Regulation and Global Governance (RegNet).

Her research draws upon the strengths in science and regulation of both schools, as she investigates how Aboriginal water rights can be recognised not merely as a stakeholder interest in the National Water Initiative, but as a pillar within it.

“We need to introduce having a value for Aboriginal water rights, in the law, in the science of water, economic value and a cultural value too,” she explains.

“At Fenner we talk about ‘water’, but to the Aboriginal people, ‘water’ has far more depth of meaning, going back to Aboriginal language.

“There’s a whole different range of understandings coming from where the Aboriginal people live. There’s where the water flows from, the headwaters, or the water that comes up through the desert, the jila, all incorporated into Aboriginal language.

“We need a paradigm shift for Aboriginal water rights.”

“In Australia we have all these artificial borders which designate states and towns, but underneath that we’ve got tens of thousands of years of Aboriginal understanding of the land. It’s far greater and far older than any European system we have now.

“In our system of national water policy and state laws and local government laws, we need to come back and look at Indigenous water knowledge to understand how the water runs, and why we have problems with western water management.

“We need to have the first peoples’ extensive knowledge and relationship with the land and water in the National Water Initiative, which is the blueprint of Australia’s water resources.”

The ANU Fenner School of Environment and Society is a rare place, one where economists and hydrologists, historians and ecologists, foresters, geographers, political scientists and climatologists work together on the big environmental challenges and opportunities facing the world.

Ranked in the top 25 globally for environmental sciences (QS World Rankings by Subject 2018), and with over 60 academic staff, more than 100 PhD scholars and a comprehensive coursework programme, we are a leading centre for integrated environmental research and training. Through links to other ANU schools, external research organisations and the wider policy community, we bring a powerful array of skills and perspectives to bear on issues such as biodiversity, water, energy, drought, climate change, urbanisation and wildfires.



# The explosive impact of maths

This is a story about an unusual white dwarf which devours its neighbour and then explodes.

This is also a story about how maths can take you places you might not expect, such as into the furthest reaches of the Galaxy.

It starts when Professor Lilia Ferrario from the ANU Mathematical Sciences Institute became interested in a star which was traveling extremely rapidly compared to the other stars in the Galaxy.

Working with researchers from around the world, Professor Ferrario used mathematical modelling to determine the characteristics of the star, including its mass, temperature, chemical composition and its trajectory in the Galaxy.

Their conclusion was that this small star is actually a piece of shrapnel from a huge explosion that happened millions of years ago.

Professor Ferrario says the explosion was a supernova event in a binary system where a super-dense white dwarf, a dead star that has run out of nuclear fuel, sucked mass away from its giant star companion.

So this small star might help to answer one of the Universe's big mysteries: what triggers supernovae explosions.

"This discovery gives weight to a theory that a white dwarf star devours material from its giant star companion until the white dwarf explodes as a supernova.

**"This small star might help to answer one of the Universe's big mysteries."**

"The mass that accumulated on the white dwarf caused a thermonuclear runaway and a violent explosion that destroyed the binary system," she explains.

White dwarfs, left to their own devices, would never explode, Professor Ferrario says. There are two theories on how they do.

"One suggests that two white dwarfs merge to form a single ultra-massive white dwarf, while the other theory envisages a white dwarf growing in mass by devouring material from its companion star," she says, with this discovery supporting the latter.

"In both cases, when the white dwarf becomes 1.4 times as massive as the Sun, a thermonuclear explosion is ignited leading to a partial or total disruption of the white dwarf."

And total disruption of the idea that maths is something which begins and ends on the blackboard.

The ANU Mathematical Sciences Institute is ranked number one in Australia for maths teaching and research (QS World Rankings by Subject 2018). We host some of the best mathematicians in Australia, currently including 15 fellows of the Australian Academy of Sciences, two fellows of the Royal Society, ten recipients of the Australian Mathematical Society Medal and three ARC Laureate Fellows. The Institute offers researchers up-to-date computing facilities including access to the National Computational Infrastructure supercomputer.

We fulfil both a national and international role as a "research institute" in the mathematical sciences, working cooperatively with the Australian Mathematical Sciences Institute (AMSI) and international centres such as the French National Centre for Scientific Research (CNRS), Fujitsu Laboratories of Europe, The Mathematical Sciences Center at Tsinghua University (MSC) and the Pacific Institute for the Mathematical Sciences (PIMS).

# When neurons go wrong

“And actually, it worked!”

An excited grin comes over Dr Nathalie Dehorter’s face as she says these words, the significance of which would resonate with anyone who’s ever undertaken research.

But the significance is even greater when you consider the potential impact of Dr Dehorter’s findings.

“I was looking at Parkinson’s Disease, working on detecting early signs of neuronal impairment. We found that some specific neurons were displaying aberrant oscillations really early on, and well before the first motor symptoms appear.

“What we proposed was to block such aberrant oscillations with specific drugs and”—cue grin—“actually it worked! It worked on our mouse models in vitro and in trials on patients, it improved their motor symptoms by 30 percent.”

Dr Dehorter, who undertook this research in France and the UK, has come to the John Curtin School of Medical Research (JCSMR) at ANU to apply the same concept to the research of other neurodevelopmental disorders.

“Neuronal activity is clearly different in an autistic brain, but we lack information about how neurons change their activity. We know genes and environmental factors are involved, but the mechanisms underlying the adaptation of neuronal activity, and all the steps from the starting point to the behavioural outcomes, are what we need to work out.

“This will open the path to novel therapeutic strategies.”

“It’s really interesting because detecting the molecules involved in early impairment of neuronal activity will open the path to novel therapeutic strategies. We could target new genes which may be really important for the treatment of these diseases.”

Dr Dehorter says she chose JCSMR for her research because of the facilities, particularly the Australian Phenomics Facility, the multidisciplinary approach, and the opportunities for internal collaboration.

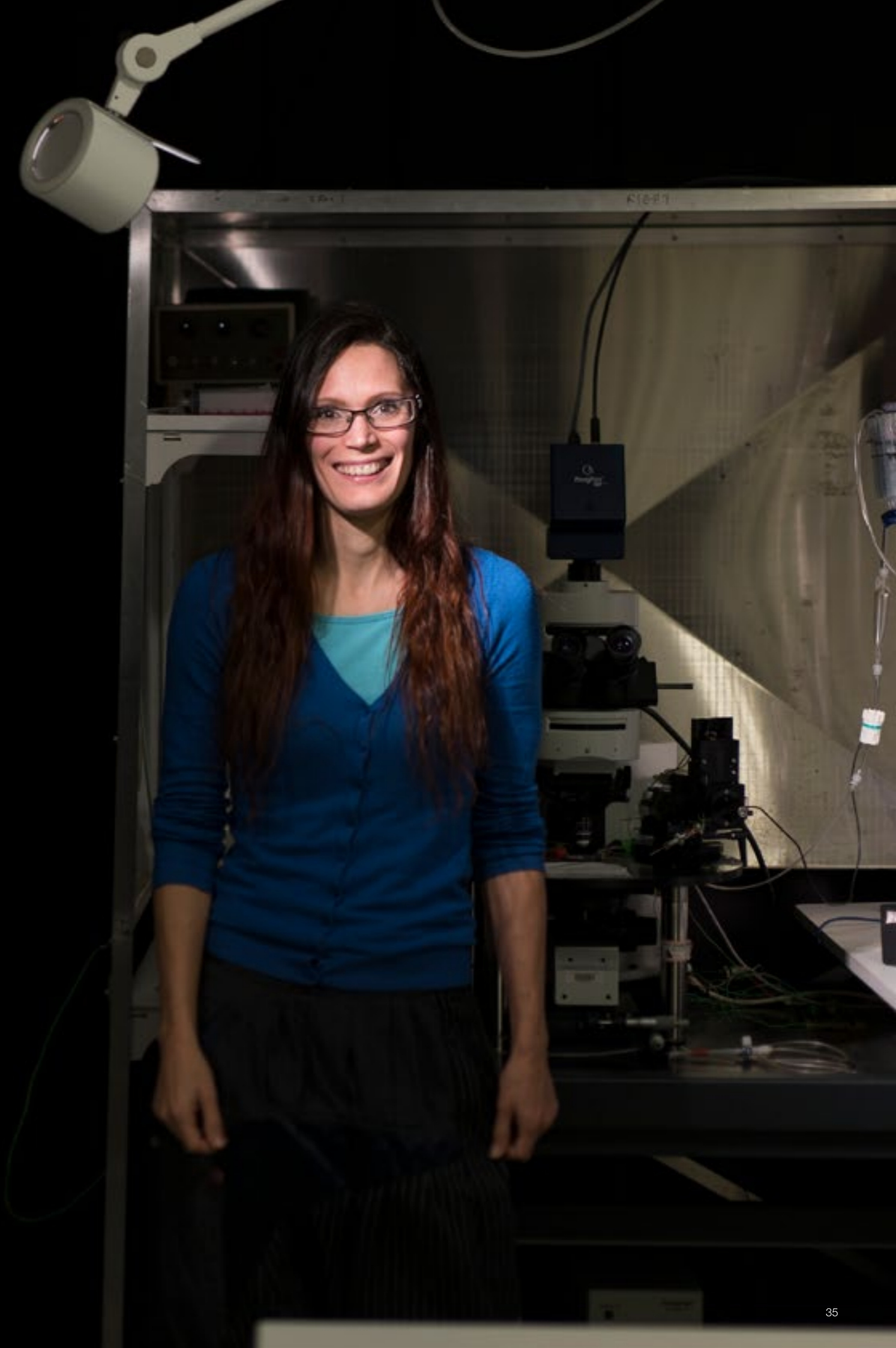
Her research students work alongside her, benefiting from the same environment.

They also get to work on research which could make a real difference.

“That really motivates me, the outcomes. I’m driven by the hope we can add a piece to the puzzle.”

The John Curtin School of Medical Research at ANU was established in 1948 as Australia’s national medical research institute. We excel in multidisciplinary, translational medical research in fields including immunology, cancer, genomics and neuroscience.

Three of our former researchers have received Nobel Prizes in Physiology or Medicine for work conducted here, while our current researchers include three fellows of the Australian Academy of Health and Medical Sciences and three fellows of the Australian Academy of Science.



# Crystal-clear future for quantum computing

It's been predicted that by 2040, we will not have the capability to power all of the world's computers. This is why the effort to build a quantum computer—which overcomes the limitations of energy efficiency—has been called the “space race of the 21st Century”.

And physicists from ANU are getting ready for take-off.

Scientists working at the Centre for Quantum Computation and Communication Technology (CQC2T) at the ANU Research School of Physics and Engineering have found a new way to store quantum data long enough to share the information around a next-generation internet which promises to be impervious to hacking.

Lead researcher Associate Professor Matthew Sellars says the improved storage is an important part of a viable quantum internet.

“Our work will allow us to build a global network to connect quantum computers.”

Dr Rose Ahlefeldt, also from CQC2T, says quantum memory allows scientists to buffer and synchronise quantum information, operations necessary for long-range and ultra-secure encrypted communications.

“At the moment researchers are using memories that don't work at the right wavelength, and have to employ a complicated conversion process to and from the communications wavelength.”

“It feels great to know that our approach was the right one.”

“This can be inefficient, and means they have to do three very difficult things instead of just one.”

To improve on these inefficiencies, the ANU team used erbium, a rare earth element, in a crystal. Erbium has unique quantum properties and operates in the same bandwidth as existing fibre optic networks, eliminating the need for a conversion process.

This increased the storage time of telecom-compatible quantum memory by 10,000 times compared to previous efforts.

“We have shown that an erbium-doped crystal is the perfect material to form the building blocks of a quantum internet that will unlock the full potential of future quantum computers,” Associate Professor Sellars said.

“We had this idea 10 years ago, but many of our peers told us that such a simple idea couldn't work. Seeing this result, it feels great to know that our approach was the right one.”

The ANU Research School of Physics and Engineering constitutes Australia's largest university-based research activity incorporating major national facilities, national networks, a significant technical manufacturing and prototyping capability, as well as a highly innovative undergraduate teaching program. The School is home to a vibrant and highly collegial community of postgraduate research students, professional and academic staff, all of whom form our greatest asset.

We are among the leaders in many fields of research with major activity in nonlinear and quantum optics and quantum systems engineering, soft and hard condensed matter physics, III-V semiconductor physics, nano-engineered and meso-scale materials, nuclear physics, novel imaging technologies, plasma science and gravitational wave detection.

We strive to balance our fundamental physical approach with seeking new applications via broad industry engagement, and consequently the School has created some of University's largest international spin-out companies.

# Working together for Indigenous health

Thanks to partnerships with Aboriginal and Torres Strait Islander individuals, communities, and organisations, researchers from the ANU Research School of Population Health have been able to provide important policy-relevant evidence for improving Indigenous health.

The research findings from the National Centre for Epidemiology and Population Health will inform programs and policy on preventing obesity and reducing smoking.

Dr Katie Thurber's research looked at factors promoting the maintenance of healthy weight across the childhood years.

"We know that many Aboriginal and Torres Strait Islander families across Australia—in remote, regional, and urban settings—face barriers to accessing healthy foods," she says.

"Therefore, efforts to reduce junk food consumption need to occur alongside efforts to increase the affordability, availability, and acceptability of healthy foods."

Latest national figures show obesity rates are 60 per cent higher for Aboriginal and Torres Strait Islander adults compared to non-Indigenous adults.

Dr Thurber, together with Associate Professor Ray Lovett, also conducted the first comprehensive assessment of the tobacco epidemic among Aboriginal and Torres Strait Islander peoples.

**"We need a continued, comprehensive approach."**

They found there have been substantial reductions in smoking over the past 20 years, particularly in the last decade. While this will lead to thousands of premature deaths averted, smoking-related deaths among Aboriginal and Torres Strait Islander peoples are likely to continue to rise and peak over the next decade. This is because of the lag between smoking and the onset of some smoking-related diseases, such as lung cancer.

"We need a continued, comprehensive approach to tobacco control," Associate Professor Lovett says.

"The incorporation of Indigenous leadership, long-term investment and the provision of culturally appropriate materials and activities is critical to further reducing smoking."

At the ANU Research School of Population Health, we are committed to training the next generation of researchers and population health practitioners, who will improve the population's mental and physical health through discovery, education and the translation of research into effective health policy and practice.

ANU is the only Australian university rated well above world standard for public health and health service research in all three of the Excellence in Research for Australia evaluations (2010, 2012 and 2015). Our work spans the full range of population health research, including non-communicable disease epidemiology, infectious disease surveillance and outbreak investigation, global health, health services research, social and cultural determinants of health, environmental health, healthy ageing and mental health.



# The fact of the matter

In our “post-truth” world, where Senator Pauline Hanson isn’t racist, climate change doesn’t exist and President Donald Trump’s inauguration was attended by record crowds, do facts really matter?

Professor Michael Platow from the ANU Research School of Psychology says they do, more than ever.

“What you have in the racism debate, as in the climate change debate, is that both sides have their own facts,” he says.

“The point is that facts themselves are social constructions. We’re in an era where the common frame of reference for judging what is a fact and what is not, is disintegrating.

“We need to reconstruct a shared perspective of what are facts. We need a shared set of values and norms to allow us to move forward.”

Professor Platow is hoping his research into understanding and reducing prejudice—part of the biggest ever study on the subject—will help do exactly this.

The research study, called the Prejudice Census, asks people to act as “citizen scientists”, recording any experiences with prejudice that they may encounter in their daily lives.

“The Prejudice Census will allow us build a better understanding of exactly what people think prejudice is in the first place,” Professor Platow says.

“We need to reconstruct a shared perspective of what are facts.”

“What we need is an analysis of what people believe to be prejudice and how and why these beliefs are changed and maintained.”

Influential public figures like Trump, Hanson and the climate change-deniers have only increased the urgency and importance of this research, which is being funded by an ARC Discovery grant.

“Our leaders have reset the norms of what is appropriate,” Professor Platow says.

“By our leaders expressing these views, they are setting the norms and showing that it’s OK to say these things.”

The ANU Research School of Psychology is ranked in the world’s top 50 (QS World University Rankings by Subject 2018). We conduct world class research into behaviour, emotions, social interaction, perception, the brain and the thinking mind. Our research strengths in stereotyping, prejudice, discrimination, ethnocentrism, social influence and leadership have been built over several decades.

Our research has been applied in areas as diverse as wellbeing, the management of chronic illness, understanding and treating mental health, the psychology of justice and fairness, ageing, learning and development, social cohesion, climate change attitudes, human resources and organisational performance.

We collaborate with governments, foundations and service providers, as well as leading researchers across the world.



# Us and science: it's complicated

There's not many things you could get 90 per cent of Australians to agree upon, but when it comes to the positive impact of science, we're almost all on the same page.

Ninety per cent of respondents to the Australian Beliefs and Attitudes Towards Science Survey said they think science has made life easier.

Dr Rod Lamberts from the Australian National Centre for the Public Awareness of Science at ANU conducted the survey and says it reveals that "overall, Australians are very pro-science."

"Most of us think the benefits of science have outweighed the harmful effects and science has made our lives easier.

"Plus, as a society, we are generally quite highly engaged with science-related issues. The majority of people are having some kind of science-related conversations regularly."

More than 90 per cent of people surveyed used technology at least a few times a week, and more than 80 per cent of people needed maths skills, and more than half used science skills in their jobs.

Despite these findings, Dr Lamberts says, the survey also showed "our attitudes to science and its outputs are far from straightforward."

Despite valuing science, nearly half of the respondents said they felt it has changed our way of life too quickly.

**"Most of us think the benefits of science have outweighed the harmful effects."**

"Many of us are also against genetically modified foods and food grown with pesticides, fracking and nuclear energy, and many people are also suspicious about the potential of bioengineering."

Dr Lamberts says he thinks this complicated relationship between Australians and science is "encouraging".

"This is a good thing in a modern society. The fact that we can applaud what science does well, but are still prepared to question what we don't like or understand is a sign of a healthy democratic relationship with science, scientists and science funding."

The results are also validating for science communicators like Dr Lamberts: the more informed people felt about science, the more likely they were to be positive about it.

The Australian National Centre for the Public Awareness of Science at ANU was the first science communication centre in Australia and is now the most diverse of its kind in the world.

We are global leaders in our field, developing methods to encourage informed decisions about the big scientific issues.

We are an accredited Centre for the Australian National Commission for UNESCO, and boast partnerships with the Alan Alda Centre for Science Communication at Stony Brook University in New York and Shell Australia amongst many others.

SCIENCE, MEDICINE AND HEALTH  
AT A GLANCE

4

NOBEL PRIZE  
WINNERS

3,067

UNDERGRAD STUDENTS

741

ACADEMIC STAFF

23,772

ALUMNI

12

AUSTRALIAN RESEARCH  
COUNCIL (ARC)  
LAUREATE FELLOWS\*\*

1,047

POSTGRADUATE RESEARCH  
STUDENTS

313

TECHNICAL STAFF AND  
RESEARCH OFFICERS

32%

UNDERGRADUATES  
CONTINUING TO  
FURTHER STUDY\*

\$344m

TOTAL ANNUAL INCOME

992

POSTGRADUATE  
COURSEWORK STUDENTS

965

VISITING FELLOWS AND  
HONORARY ADJUNCTS

\$75k

POSTGRADUATE  
FULL-TIME STARTING  
SALARY\*

1,407

ACTIVE RESEARCH  
GRANTS

27%

PERCENTAGE OF  
INTERNATIONAL STUDENTS

11:1

STUDENT TO TEACHING  
STAFF RATIO

19%

FULL-TIME EMPLOYED  
GRADUATES IN HIGHER  
EDUCATION\*

\*Graduate Outcomes Survey 2016 \*\* Since 2010



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