PROJECTS

2019-20 SUMMER SCHOLARSHIPS

UNIVERSITY
OF WOLLONGONG
AUSTRALIA

FOR MORE INFORMATION

Please contact **smah-research@uow.edu.au** or +61 2 4239 2280

UOW.EDU.AU **#ThisIsUOW**

Contents

PROJECT 1: Antarctic climates through the lives of old-growth mosses 3

PROJECT 2: Tracking DNA replication in live bacterial cells 4

PROJECT 3: Characterising the raw materials of archaeological stone tools at Liang Bua, Indonesia 5

PROJECT 4: The exchange of water and carbon dioxide between the deep Earth and its surface 6

PROJECT 5: Understanding historical bushfire fuel moisture patterns in NSW 7

PROJECT 6: Unbiased identification of SOD1 interactors to reveal novel therapeutic targets for MND/ALS 8

PROJECT 7: Determining the carbon storage potential of endangered Swamp Oak Forests 9

PROJECT 8: Pyrotechnology: resolving the transformative effects of deliberate heating on rocks used in early human technologies 10

PROJECT 9: Build a fluorescence microscope to study DNA replication at the single-molecule level. 11

PROJECT 10: One Pot Cascade Reactions of Indigo to Complex Heterocycles – The Synthesis of Potential New Photooptical Molecules 12

IMPORTANT INFORMATION 13

PROJECT 1:

Antarctic climates through the lives of old-growth mosses

SUPERVISOR: DR MELINDA WATERMAN

CENTRE FOR SUSTAINABLE ECOSYSTEM SOLUTIONS

PROJECT DESCRIPTION

Mosses, the main flora in maritime and continental Antarctica, are hardy plants. In order to survive harsh environments, mosses use incredible resilience mechanisms including their ability to tolerate desiccation and damaging ultraviolet radiation. These remarkable tiny plants can also preserve a record of their environment in their cells and cell walls as they grow. Some individual living moss shoots can be up to 500 years old! Several mosses also accurately preserve a record of their immediate water environments through stable isotopes. Hence, 'moss cores' can be used as valuable proxies for local Antarctic climates.

In this project, you will work on long moss shoots or 'moss cores' collected from various sites around coastal Antarctica. You will be taught how to extract and purify cellulose in order to analyse the stable isotope signatures captured within. The data you collect can help provide a history of the region's changing climate and will collectively allow us to determine sites where mosses are at risk of drying and dying.

SPECIAL CONSIDERATIONS

This project is suitable for motivated 3rd or 4th year students interested in plant biochemistry. Preferred: experience in the laboratory working with pipettes!

LEARN MORE

Read more about mosses at risk of drying and dying: **theconversation.com/antarcticas-moss-forests-are-drying-and-dying-103751**

Visit Centre for Sustainable Ecosystem Solutions webpage at: **uow.edu.au/science-medicine-health/research/cses/**

Learn about Dr Melinda Waterman: **scholars.uow.edu.au/display/melinda_waterman**

UNIVERSITY OF WOLLONGONG AUSTRALIA

PROJECT 2:

Tracking DNA replication in live bacterial cells

SUPERVISOR: DR ANDREW ROBINSON

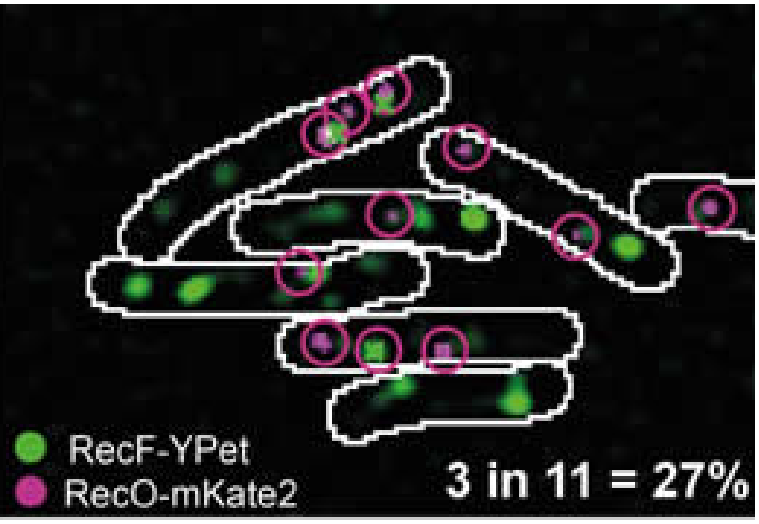
MOLECULAR HORIZONS

PROJECT DESCRIPTION

You will be working as part of a team of researchers who aim to better understand how bacteria copy and repair their DNA. This research is part of our strategy for dealing with antibiotic-resistant bacteria. By identifying weaknesses in bacterial DNA repair processes, we hope to develop new antibiotics that will allow us to kill drug-resistant organisms.

Your role will be to help us to better understand how bacteria copy their DNA under fast growth conditions. Bacteria need to copy their genome before they can divide. This normally takes about 40 minutes. But under fast-growth conditions some bacteria divide once every 20 minutes. You will study this using our custom-built laser-driven single-molecule fluorescence microscope. You will image the proteins that duplicate DNA in live bacterial cells. By studying and analysing the images, you will determine how many replication forks are present in cells growing at different rates.

This project will not only give you hands-on experience in cutting-edge microscopy techniques. You will also gain experience in handling bacterial cells, genetic manipulation, image processing and micro fluidics. As part of the group, you will also be exposed to new techniques for experimental evolution and the development of high-tech single-cell microfluidics.



SPECIAL CONSIDERATIONS

Single-molecule experiments can be fiddly to set up. You should be good with your hands! There may also be some very basic scripting involved. Nothing too scary, but it would be good if you know your way around a computer.

LEARN MORE

Visit Molecular Horizons webpage at:
uow.edu.au/research-and-innovation/our-research/research-institutes-and-facilities/molecular-horizons/

Learn about Dr Andrew Robinson:
scholars.uow.edu.au/display/andrew_robinson

UNIVERSITY OF WOLLONGONG AUSTRALIA

PROJECT 3:

Characterising the raw materials of archaeological stone tools at Liang Bua, Indonesia

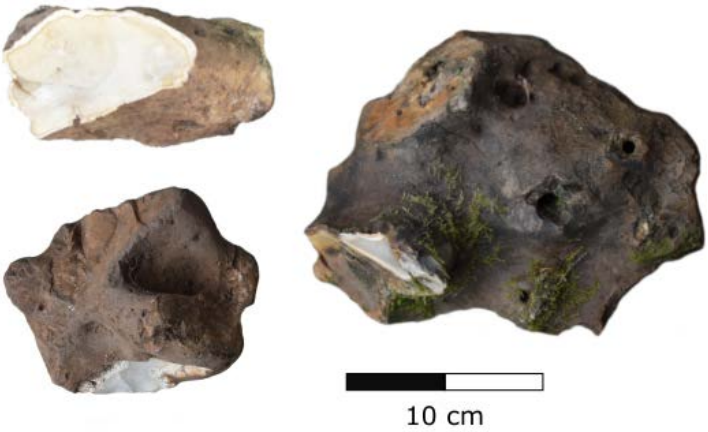
SUPERVISOR: DR SAM LIN

CENTRE FOR ARCHAEOLOGICAL SCIENCE

PROJECT DESCRIPTION

Archaeological stone tools are an important source of information for understanding the behaviours and technologies of our early human ancestors. Because stones are naturally variable, how early humans selected and used different stone types for tool making would have been influenced by the stone mechanical properties (e.g., ease of flaking, tool edge durability).

For this project, you will use a range of geological and mechanical techniques to help characterise the properties of stone raw materials used by *Homo floresiensis* (nicknamed the hobbit) and early modern humans at the site of Liang Bua in Flores, Indonesia. You will prepare samples of chert and silicified tuff collected from the surroundings of Liang Bua to describe their mineralogical and mechanical attributes, using petrographic analysis, X-ray florescence, scanning electron microscopy and fracture toughness testing. The results will help us better understand the physical qualities of these stone raw materials and how they may have influenced the stone tool technologies of early humans at Liang Bua.



SPECIAL CONSIDERATIONS

This project is suitable for 3rd or 4th-year students. A background in geology and petrology is strongly preferred. You should be comfortable working in a lab and willing to operate machinery (e.g., rock saw) by following safety guidelines.

LEARN MORE

Visit Centre for Archaeological Science webpage at: **cas.uow.edu.au/index.html**

Learn about Dr Sam Lim: **scholars.uow.edu.au/display/sam_lin**

UNIVERSITY OF WOLLONGONG AUSTRALIA

PROJECT 4:

The exchange of water and carbon dioxide between the deep Earth and its surface

SUPERVISOR: DR NICOLAS FLAMENT

GEOQUEST

PROJECT DESCRIPTION

Hydrogen, oxygen and carbon are three of the four most abundant chemical elements in the solar system. Together, they can form water or carbon dioxide which make life possible and influence temperatures at Earth's surface. Most of Earth's hydrogen, oxygen and carbon is found in rocks in the planet's deep interior. Water and carbon dioxide are released into Earth's atmosphere by volcanoes and re-introduced into the deep Earth at subduction zones. The deep water and deep carbon cycles influence the volume of Earth's oceans and climates over tens of million years.

In this project, you will use cutting-edge tectonic reconstructions to investigate how the assembly and dispersal of supercontinents has influenced the deep water and the deep carbon cycles over the past billion years. The project involves working with Dr Nicolas Flament, Dr Xianzhi Cao (postdoctoral fellow) and PhD candidate Alexander Young

Image source: flickr

SPECIAL CONSIDERATIONS

You will be working with cutting-edge global tectonic reconstructions spanning the last billion years. These are developed with the open-source, open-access software GPlates (gplates.org). You will be working with python scripts in the open-source, open-access Jupyter Notebook environment (jupyter.org), giving you the opportunity to improve your scripting skills with the support of trained researchers.

LEARN MORE

Visit the GeoQuEST webpage at:
uow.edu.au/science-medicine-health/research/geoquest/

Learn about Dr Nicolas Flament:
scholars.uow.edu.au/display/nicolas_flament

UNIVERSITY OF WOLLONGONG AUSTRALIA

PROJECT 5:

Understanding historical bushfire fuel moisture patterns in NSW

SUPERVISORS: DR HAMISH CLARKE & DR MEAGHAN JENKINS

CENTRE FOR ENVIRONMENTAL RISK MANAGEMENT OF BUSHFIRES (NSW BUSHFIRE RISK MANAGEMENT RESEARCH HUB)

PROJECT DESCRIPTION

Do you want a chance to combine world class research with real world impact? Do you want to develop data analysis skills while also undertaking field work in the region's stunning dry sclerophyll forests?

Australia is one of the world's most fire prone places and fuel moisture is a critical driver of bushfire risk. Although we know major fire seasons are associated with very dry fuels, we still don't understand what 'normal' fuel moisture patterns are, how they vary from year to year and how frequently dry patches join up, sending the landscape into an 'armed' state. In this project you will explore historical patterns of fuel moisture and connectivity and their links to fire activity in NSW, combining new datasets, novel modelling methodologies and fieldwork.

You will be working in the Centre for Environmental Risk Management of Bushfires, a diverse and highly productive group with a reputation as one of the world's leading wildfire research groups. You will also be part of the recently formed NSW Bushfire Risk Management Research Hub, a multimillion dollar initiative linking researchers across the country with fire managers to drive better on ground outcomes for NSW communities.

SPECIAL CONSIDERATIONS

You will have an ability to use data analysis software (e.g. R, ArcGIS) or a willingness to learn. You will be prepared to attend two days of field work with your supervisor and colleagues from the Centre. A tolerance for caffeine and/or donuts will be looked upon favourably.

LEARN MORE

Visit the Bushfire Hub Facebook page:
facebook.com/bushfirehub/

Learn about Dr Hamish Clarke and Dr Meaghan Jenkins:
scholars.uow.edu.au/display/hamish_clarke
scholars.uow.edu.au/display/meaghan_jenkins

UNIVERSITY OF WOLLONGONG AUSTRALIA

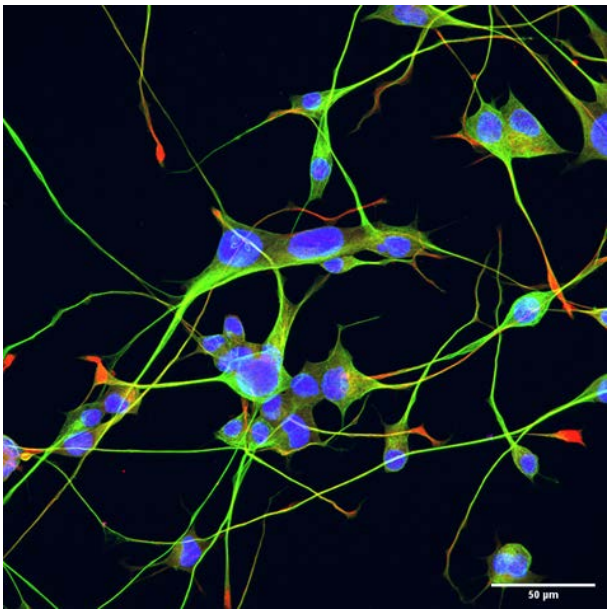
PROJECT 6:

Unbiased identification of SOD1 interactors to reveal novel therapeutic targets for MND/ALS

SUPERVISORS: DR YEE LIAN CHEW & PROF. JUSTIN YERBURY

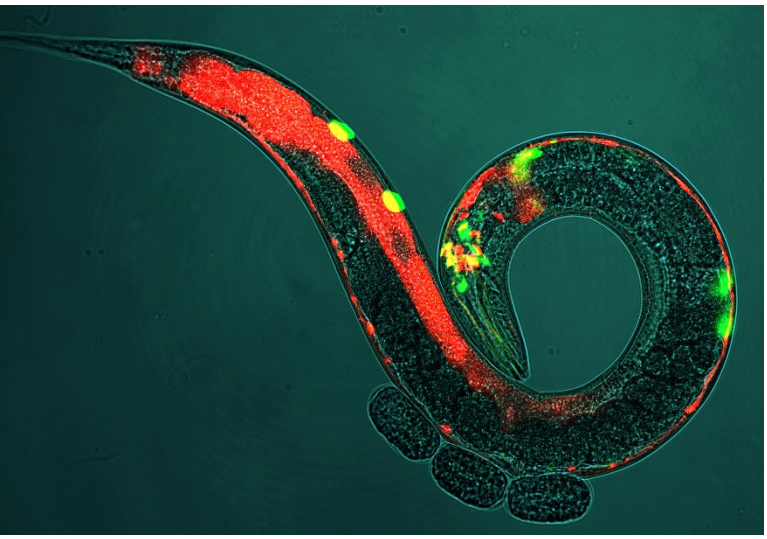
MOLECULAR HORIZONS

PROJECT DESCRIPTION



One of the key missing pieces in our understanding of Motor Neuron Disease/Amyotrophic Lateral Sclerosis is how the interaction between important molecules (such as SOD1, which is mutated in 20% of inherited ALS cases) contributes to disease progression. When dysfunctional, this network of interactions could lead to breakdown of critical cellular processes, resulting in motor neuron death. Previous work indicates that mutated SOD1 has a different profile of interactors. Uncovering these differences could inform our understanding of disease mechanisms, or even identify new drug targets for ALS.

This project will take an innovative experimental approach to identify SOD1 interactions in an unbiased manner using the cutting-edge tool TurboID. You will first generate data using a motor neuron-like cell culture system, and will then use this data to optimise experiments in a small animal model - the nematode (worm) *Caenorhabditis elegans*. The goal is to identify changes in the SOD1 profile of interactors when SOD1 is mutated, and during the process of ageing. Defining this would provide invaluable knowledge on how neurodegeneration is linked to SOD1 in MND/ALS.



SPECIAL CONSIDERATIONS

Must be comfortable working with a small animal model (no ethics required – it is a worm, but still an animal, and there will some worm smooshing involved). No field trips required.

LEARN MORE

Visit Molecular Horizons webpage at:
uow.edu.au/research-and-innovation/our-research/research-institutes-and-facilities/molecular-horizons/

Learn about Dr Yee Lien Chew and Prof Justin Yerbury:
scholars.uow.edu.au/display/yee_lian_chew
scholars.uow.edu.au/display/justin_yerbury

UNIVERSITY OF WOLLONGONG AUSTRALIA

PROJECT 7:

Determining the carbon storage potential of endangered Swamp Oak Forests

SUPERVISOR: DR JEFF KELLEWAY

GEOQUEST

PROJECT DESCRIPTION

Coastal wetlands are among the most effective ecosystems at naturally drawing greenhouse gases out of the atmosphere and may therefore play a role in fighting climate change. To date, research in this emerging field of 'blue carbon' has largely focussed on three ecosystems: mangrove forests, saltmarshes and seagrass meadows. You will be involved in one of the first projects to assess whether other coastal wetland types are also carbon storage powerhouses, with a focus on the endangered Swamp Oak Forests of coastal New South Wales.

You will be involved in field work campaigns to collect soil cores and characterise study sites. This will include vegetation and water monitoring, high precision GPS surveying, and potentially drone imagery and terrestrial laser scanner data collection. Back in the lab, you will then describe the stratigraphy of their soil cores and undertake a number of standard analytical procedures on them, before analysing and interpreting data under the guidance of the supervisor.

Field sites will be located within National Parks of the Sydney region, as well as within the picturesque Jervis Bay region. You'll get wet and muddy and help make a great contribution to the exciting field of 'blue carbon' science!

SPECIAL CONSIDERATIONS

This project will involve multiple field trips and is best suited to a student with an interest in environmental and earth sciences.

LEARN MORE

Visit the GeoQuEST webpage at:
uow.edu.au/science-medicine-health/research/geoquest/research-themes/coastal-marine/

Learn about Dr Jeff Kelleway:
scholars.uow.edu.au/display/jeffrey_kelleway

UNIVERSITY OF WOLLONGONG AUSTRALIA

PROJECT 8:

Pyrotechnology: resolving the transformative effects of deliberate heating on rocks used in early human technologies

SUPERVISORS: ASSOC. PROF. ALEX MACKAY & DR SAM LIM

CENTRE FOR ARCHAEOLOGICAL SCIENCE

PROJECT DESCRIPTION

Around 160 000 years ago our species learned that fire could change the properties of the rocks they used to make tools, a technique that subsequently became widespread. Yet we still don't understand the full adaptive value of heat treatment, largely because past studies have relied on uncontrolled processes of replication. In this project, you will use a range of techniques from archaeology and earth sciences to quantify the effects of heat treatment on tool production.

The project will involve shaping (cutting) pieces of rock obtained from around important archaeological sites, heating them in a furnace, inducing controlled fracture, and examining changes in their toughness, porosity and mineralogy. The results will help us better understand why and under what circumstances this aspect of the human technological repertoire evolved.

SPECIAL CONSIDERATIONS

Some aspects of this project will have mild physical demands (operating a brick saw).

LEARN MORE

Visit Centre for Archaeological Science webpage at:
cas.uow.edu.au/index.html

Learn about Assoc. Prof. Alex Mackay and Dr Sam Lim:
scholars.uow.edu.au/display/alex_mackay
scholars.uow.edu.au/display/sam_lin

UNIVERSITY OF WOLLONGONG AUSTRALIA

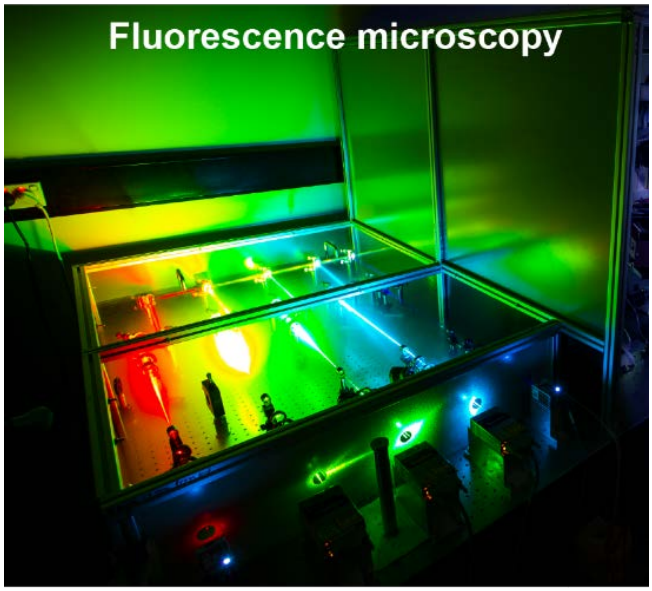
PROJECT 9:

Build a fluorescence microscope to study DNA replication at the single-molecule level.

SUPERVISORS: DIST. PROF. ANTOINE VAN OIJEN & DR LISANNE SPENKELINK

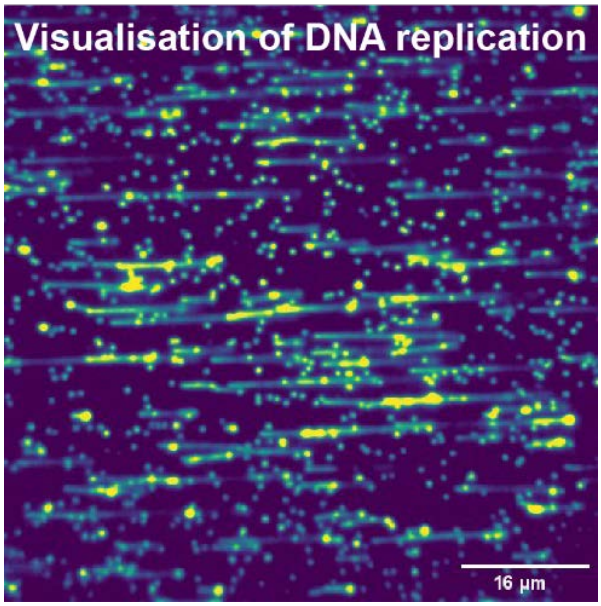
MOLECULAR HORIZONS

PROJECT DESCRIPTION



This project will involve the construction of a high-end, single-molecule fluorescence microscope, which you will use for the real-time visualisation of DNA replication. The microscope will be an integral part of the Molecular Horizons institute. This new institute is dedicated to illuminating how life works at a molecular level and solving some of the biggest health challenges facing the world. You will be involved in the design, assembly, and initial calibration of the microscope in the new Molecular Horizons building. During this time you will learn about laser optics, fluorescence microscopy, and single-molecule detections methods.

You will use this microscope to study the dynamics of individual proteins acting on DNA during DNA replication. DNA replication, or the copying of DNA, is a process that is fundamental to all life. Recent studies have shown that DNA replication proteins are much more dynamic than we previously thought! These dynamics could be crucial to understanding disease mechanisms. It is therefore important that we learn as much as we can about dynamics!



SPECIAL CONSIDERATIONS

Best suitable for 3rd or 4th-year students.

LEARN MORE

Visit Molecular Horizons webpage at:
uow.edu.au/research-and-innovation/our-research/research-institutes-and-facilities/molecular-horizons/

Learn about Dist. Prof. Antoine Van Oijen and Dr Lisanne Spenkelink:
scholars.uow.edu.au/display/antoine_van_oijen
scholars.uow.edu.au/display/lisanne_spenkelink

UNIVERSITY OF WOLLONGONG AUSTRALIA

PROJECT 10:

One Pot Cascade Reactions of Indigo to Complex Heterocycles – The Synthesis of Potential New Photooptical Molecule

SUPERVISOR: PROF PAUL KELLER

MOLECULAR HORIZONS

PROJECT DESCRIPTION

We recently reported the unprecedented one-pot cascade reaction of indigo with allyl bromides and propargyl bromides under basic conditions to yield a variety of new, complex heterocycles. These unexpected and exciting results opened up an entirely new area of synthetic chemistry of indigo, with the potential to produce larger and structurally more complex heterocycles in one-step from a very cheap and readily available starting material. Preliminary screening of these heterocycles revealed significantly potent antimalarial, anticancer and antimicrobial molecules, suitable for further development in medicinal chemistry projects. Importantly, these molecules also show interesting photophysical properties and that could be developed into the next generation of photooptical small molecules.

You will be building on these results targeting the synthesis of highly fluorescent derivatives that will be sent to our collaborators in Germany for the measurement of photophysical properties.

SPECIAL CONSIDERATIONS

Have completed second year organic chemistry (or equivalent)

LEARN MORE

Visit Molecular Horizons webpage at:
uow.edu.au/research-and-innovation/our-research/research-institutes-and-facilities/molecular-horizons/

Learn about Prof. Paul Keller:
scholars.uow.edu.au/display/paul_keller

UNIVERSITY OF WOLLONGONG AUSTRALIA

Important information

WHAT DO THE SCHOLARSHIPS OFFER?

- Free accommodation for the duration of the Scholarship (8 weeks). You will be located in modern, vibrant campus facilities centrally located in the heart of the seaside city of Wollongong.
- Return economy class airfares (or equivalent travel) to a maximum value of $500 plus an optional second airfare home for the Christmas break.
- $300 stipend per week for the duration of the Scholarship (8 weeks).
- Supervision by internationally renowned researchers in high-quality research facilities.
- Participation in exciting research projects designed to solve complex, real-world problems.

WHO CAN APPLY?

All applicants must meet the criteria below:

- Australian or New Zealand citizen or Australian Permanent Resident (international students studying in Australia or NZ are not eligible to apply).
- Currently enrolled full-time at an Australian or New Zealand university (UOW students are not eligible to apply).
- Currently studying a relevant undergraduate degree at second-year level or higher (first-year students are not eligible to apply), or a relevant honours degree, or the first year of an MRes degree (second year MRes students are not eligible to apply).
- Interested in future studies towards honours or higher research degrees.

SUMMER SCHOLAR KEY DATES

- **Applications open:** 22nd July 2019
- **Applications close:** 8th September 2019
- **Project commencement:** 25th November 2019
- **Christmas break:** 14th December – 5th January
- **Project completion:** 7th February 2020

WHAT SHOULD YOU INCLUDE WITH YOUR APPLICATION?

- Select 2 research projects in order of preference
- Complete the online application form.
- Attach your CV.
- Attach your current academic transcript.

GET IN CONTACT

SMAH Research Unit
Faculty of Science, Medicine and Health
Building 41.260
University of Wollongong
Wollongong, NSW 2522

P: 02 42392280
E: smah-research@uow.edu.au
W: uow.edu.au/science-medicine-health/research/summer-research-scholarships/

UNIVERSITY
OF WOLLONGONG
AUSTRALIA