



UNIVERSITY  
OF WOLLONGONG  
AUSTRALIA

# Molecular Horizons

Understanding life,  
one molecule at a time

# U O W





# World-class research

The molecular life sciences are at the forefront of scientific discovery, unlocking the cell's innermost secrets and developing new ways to detect and attack disease and other disorders. If cancer is to be cured, new classes of antibiotics developed, and Alzheimer's disease reversed, chemists and biologists will most likely work together powering these breakthroughs.

The University of Wollongong's new world-class research institute, Molecular Horizons, is dedicated to precisely that - **illuminating how life works at a molecular level to solve some of the biggest health challenges facing the world.**

The study of the tiny, complex structures that define life requires revolutionary technology. The new Paul Wellings Building is home to world-class research facilities, providing researchers with the tools to visualise the processes of life; from single molecules to whole organisms, using X-ray crystallography, electron microscopy, fluorescence microscopy and flow cytometry. The building's centrepiece is a facility with Australia's most powerful biological microscope, the Titan Krios cryo-electron microscope.

Leveraging the unique vantage point from the top of the new facility, an observation platform with state-of-the-art sensing equipment is used to track molecular changes in our atmosphere and better understand climate change.

The new Paul Wellings Building brings together molecular research across length scales, from the smallest to the biggest. It demonstrates the University's commitment to impact-driven research and translating that research into real-world applications, improving our communities' health and well-being.

# An integrated research precinct

The Molecular Horizons Institute brings together the University of Wollongong's intellectual strongholds in physical chemistry, biological chemistry and synthetic chemistry, and cell, molecular and whole-organism biology. With the Paul Wellings Building as a focal point, Molecular Horizons researchers are located in several facilities across the University's Science precinct, together with the Illawarra Health and Medical Research Institute (IHMRI). The Paul Wellings Building is also located close to undergraduate and postgraduate teaching facilities, providing unique experiences for students to be involved in research throughout their educational journey.



**PROFESSOR ANTOINE VAN OIJEN**

**Distinguished Professor  
Director, Molecular Horizons,  
University of Wollongong**

Professor Antoine van Oijen led research groups at Harvard Medical School and Groningen University (the Netherlands) before moving to the University of Wollongong in 2015 as an Australian Research Council Laureate Fellow. His research revolves around the development and use of single-molecule biophysical tools to study complex biological systems. As inaugural Director of Molecular Horizons, Professor van Oijen aims to create a research ecosystem that brings together scientists from biology, chemistry, physics and medicine and that uses molecular visualisation approaches as a key driver for medical discovery.

**“The molecular life sciences are focused on understanding proteins, the little machines inside our cells that are the foundation of life. The field is going through a revolution. We finally have the technology to visualise those proteins and use the resulting insights to develop new treatments and therapies to combat disease.”**





#### OUR VISION

**Create, discover, inspire - from molecule to mechanism to cure.**

Seeing is believing: Molecular Horizons will be a global leader in visualising biological processes on an unprecedented scale to advance understanding of health disorders and translate this knowledge into diagnostics, therapies and cures.

#### OUR MISSION

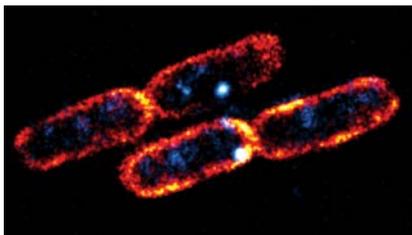
**Empower curiosity-driven research on the molecular mechanisms of disease through collaboration, technology and ingenuity.**

By bringing together exceptional multidisciplinary scientific teams around powerful microscopy and visualisation technology, Molecular Horizons aims to combat the health challenges of the 21st century and transform understanding of disease - one molecule at a time. This approach will place Molecular Horizons at the forefront of scientific discovery for developing unprecedented ways to effectively visualise, diagnose, treat and prevent health disorders. Molecular Horizons partners with industry, government, community and national and international collaborators to cultivate highly integrated research programs that deliver outcomes of increased scale, scope and unparalleled impact. Underpinned by strong cultural pillars of collegiality, diversity, equality, creativity and innovation, we will translate basic molecular understanding into real-world applications, while training and inspiring future generations of interdisciplinary life scientists.

# Research themes

Molecular Horizons comprises a growing team of interdisciplinary and talented researchers whose research sits within four key research themes.

## ANTIMICROBIAL RESISTANCE



Antibiotics have allowed what some might call the greatest revolution in modern medicine, saving millions of lives every year. However, the rapid rise in resistance of bacterial infections against these miracle drugs presents a significant health threat. By integrating academic disciplines and working with stakeholders in the health, pharma, biotech, and agriculture sector, we aim to develop new and effective solutions.

## CANCER THERAPEUTICS

Molecular Horizons' basic cancer research and drug development grouping works on understanding the biological processes underlying cancer progression and develops cancer prevention methods, detection

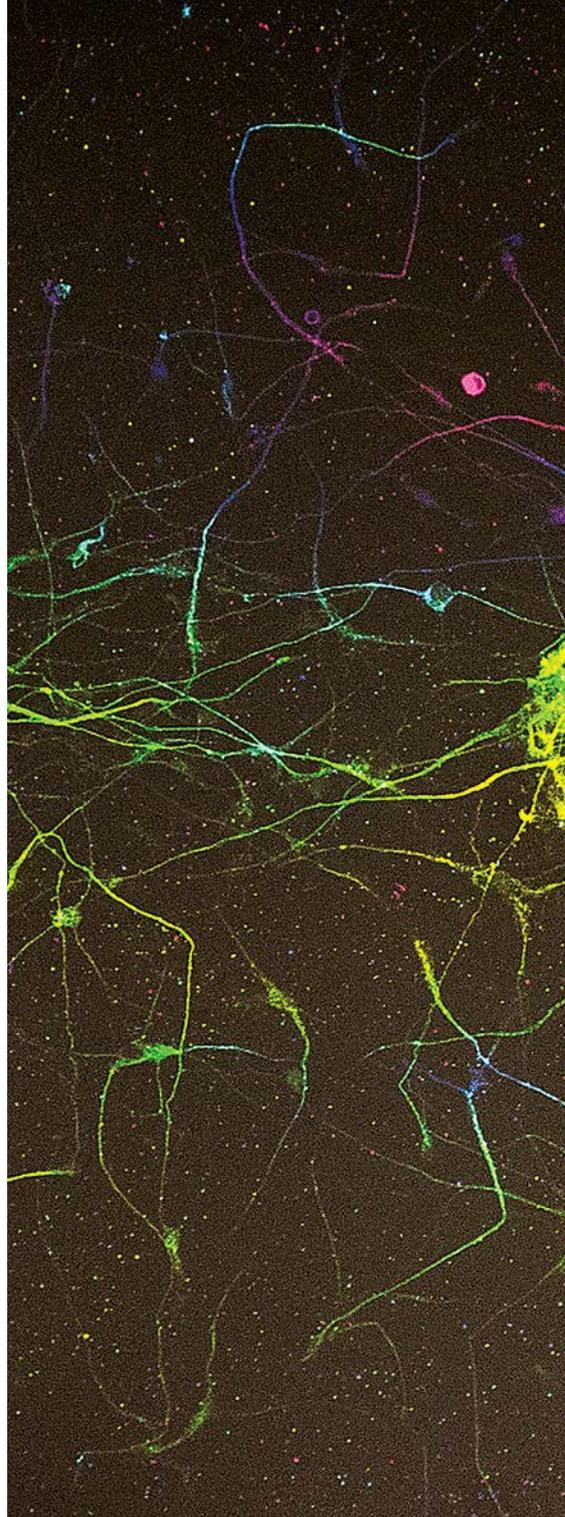
and treatment. They use a range of cell and molecular biology techniques, medicinal chemistry and preclinical animal models to meet the demand for novel anti-cancer drug testing and research leading to a range of innovative cancer treatment options.

## MOLECULAR NEUROSCIENCES

Our researchers aim to identify new ways to prevent and treat schizophrenia, obesity, and obesity-related colon cancer through a combination of approaches. A key strategy is to study the pathological mechanisms of disease using human brain tissue, animal models and cell culture. Results from these studies are translated into novel pharmacological and dietary interventions for human diseases.

## PROTEIN-AGGREGATION RELATED DISEASES

In a healthy cell, the production and degradation of proteins are integrated with processes that ensure the proper folding of these proteins and the prevention of unfolded proteins aggregating. Misregulation of this balance can lead to diseases such as Parkinson's Disease, Motor Neuron Disease and Alzheimer's. Our researchers investigate the molecular mechanisms of protein aggregation and work on the next generation of therapies against these diseases.



# Disciplines

## **STRUCTURAL BIOLOGY**

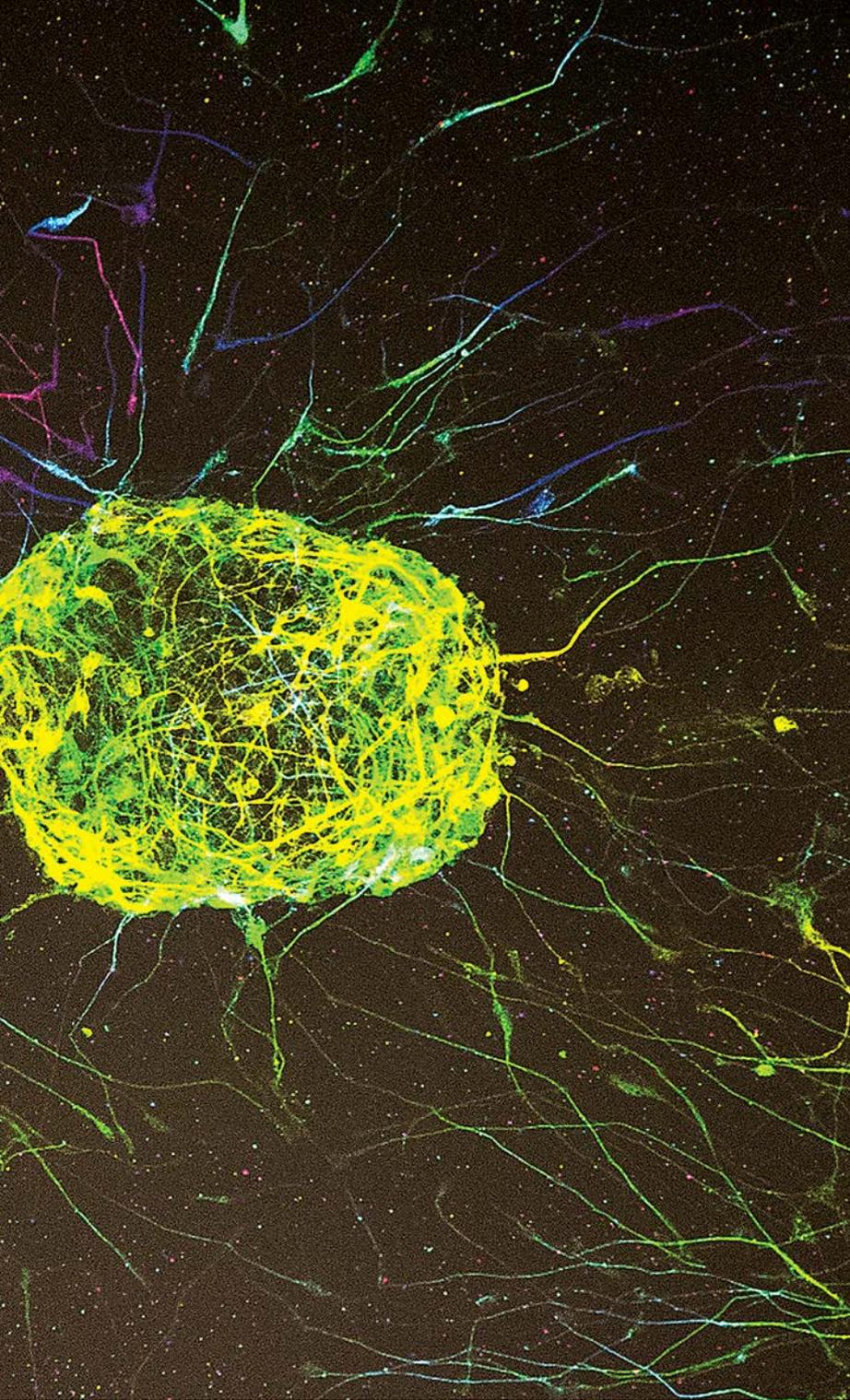
Understanding the molecular mechanism of disease requires detailed knowledge of the structure of the relevant biological macromolecules. Our researchers employ experimental approaches such as X-ray crystallography and cryo-electron microscopy and combine them with computational approaches to unravel protein structures and better understand their function.

## **MEDICINAL CHEMISTRY AND SYNTHESIS**

Medicinal Chemistry covers all elements of the development of new medicines for human use, including the isolation of new medicinal agents from natural sources, the design and synthesis of new drugs, and understanding the cause of diseases at the molecular level.

## **MOLECULAR CELL BIOLOGY**

To understand the operating principles that support life, a diverse array of molecular and cellular approaches are applied. By integrating biochemistry, molecular biology and cellular biology with advanced imaging and analysis technology, our researchers seek a mechanistic understanding of the molecular and cellular pathways related to disease.



MOLECULAR HORIZONS - UNDERSTANDING LIFE, ONE MOLECULE AT A TIME



# Researchers in focus



**ASSOCIATE PROFESSOR  
DANIELLE SKROPETA**

Associate Professor Danielle Skropeta is one of the Deputy Directors of the Molecular Horizons Institute. Professor Skropeta's research focuses on medicinal chemistry, enzyme inhibitors and anti-cancer agents. An advocate for women in STEM, Professor Skropeta has been a tremendous mentor for early and mid-career researchers throughout her own career.



**PROFESSOR JUSTIN YERBURY**

Professor Justin Yerbury is recognised internationally as a true pioneer in his field. Despite the challenges of living with Motor Neurone Disease MND, he has been unstinting in his efforts to find a cure for the disease. Professor Yerbury's work takes a cell and molecular biology approach to understanding protein homeostasis in neurodegeneration and disease, with a particular interest in motor neurone disease.



**DR NATALIE MATOSIN**

Dr Natalie Matosin leads a research group at Molecular Horizons focusing on neurobiology and genetics of mental illnesses including PTSD, depression, bipolar disorder, and schizophrenia. Dr Matosin's research focuses on the contribution of stress and trauma to the development of mental illness.



**DR LISANNE SPENKELINK**

Dr Lisanne Spenkellink is an early-career researcher at the Molecular Horizons Institute. She moved to UOW from the Netherlands in 2015. Working as an Associate Research Fellow, she develops fluorescence-imaging tools to visualise the dynamics of single molecules in complex biological systems. Using these tools she studies DNA replication – the process of the copying of DNA. She has revealed new interactions and unexpected molecular pathways that changed our fundamental understanding of DNA replication.

# Global collaboration

Molecular Horizons attracts top calibre scientists from around the world and puts the University of Wollongong at the forefront of a science field that is in the midst of a revolution, positioning the University as a global research hub for single-molecule and cell visualisation.

Molecular Horizons partners with numerous research institutes and organisations to promote and foster collaborative research networks at a national and global level, including the Australian Nuclear Science and Technology Organisation (ANSTO), the Commonwealth Scientific and Industrial Research Organisation (CSIRO), many of the key Australian Universities, and several leading international institutions (Cambridge University, Harvard University, and many others). Our partnerships also foster key relationships with business, such as biotechnology and pharmaceutical companies who collaborate with us to commercialise new discoveries or use our high-tech facilities.

## PROFESSOR MICHAEL M. COX

**Evelyn M. Mercer Professor in Biochemistry,  
University of Wisconsin-Madison, USA**

World-leading microbiologist and co-author of  
Lehninger Principles of Biochemistry



“The Molecular Horizons Institute and the technology available in the new Paul Wellings Building plays a key role in our research. Funded by the US National Institutes of Health, Molecular Horizons researchers work with us on understanding how bacteria copy and repair their DNA. Understanding these processes is important to combat the increasing problem of antibiotic resistance and requires the interdisciplinary approaches and cutting-edge visualisation technology present in Molecular Horizons. Our collaborators are outstanding and every aspect of the work is rewarding.”

# UOW's Health and Wellbeing strategy

The creation of the Molecular Horizons Institute and the Paul Wellings Building forms part of the University of Wollongong's Health and Wellbeing strategy.

With a commitment to delivering innovative and quality healthcare, the University's Health and Wellbeing Strategy aims to address global and regional health challenges by capitalising on our expertise in medical research, research application and education, and our focus on high impact science. The strategy aims to harness and build upon the collective talent across the University and partners to deliver world-class health and medical research, education, research translation and health outcomes, both physical and mental.

The Health and Wellbeing Strategy is focused on six key initiatives with a local, national and global outlook. The initiatives span the creation of a world-class health precinct in the Illawarra, to strategies to address local mental health and wellbeing, aged care living and regional medical training, to the world-class Molecular Horizons Institute.

**PROFESSOR JENNIFER L. MARTIN AC**

**Deputy Vice-Chancellor (Research and Innovation),  
University of Wollongong**

**“Molecular Horizons stands out not just in its beautiful architecture, but also in its vision: to produce high-impact research that changes the way we understand our world, and to directly benefit our society and the health of our communities.**

**Importantly, Molecular Horizons contributes to the other pillar of a research-intensive university - delivering high-quality teaching and training. I am excited to see the opportunities that Molecular Horizons provides to our students and our early-career researchers as they embark on their educational and career journeys.”**



# Building a dream

The \$80 million Paul Wellings Building is at the forefront of scientific discovery. Creating a physical environment that would allow the highly sensitive microscopes to perform at their best was a design and architectural challenge tackled by architectural firms Jacobs and Denton Corker Marshall.

The building houses some of the most advanced pieces of scientific equipment globally, which are so sensitive that they need to be completely isolated from all forms of vibrations and electromagnetic fields.

## DESIGNING ONE OF THE MOST COMPLEX BUILDINGS IN THE WORLD

- The Paul Wellings Building was designed and built around highly sensitive microscopes and various research and laboratory requirements. It is the first multi-storey building of its kind to use glass fibre reinforced polymer in a suspended ferrous-free slab to ensure the highly sensitive microscopes' functionality.
- It is the first building of its kind globally, with builders Richard Crookes Construction and their consultancy teams having to adopt overseas building code and overlay it on the respective Australian standards to incorporate the required cutting-edge construction technology. It is a similar process to building foundations in an earthquake zone, topped with multiple layers of non-magnetic stainless steel and polymer. The aim was to create an area of complete isolation from vibration and electromagnetic fields known as "The Zone of Influence" around the microscopes.

- Over a million plastic cable ties were installed by hand to join the glass fibre segments before the pouring of concrete within the building foundations.
- State-of-the-art non-ferrous shielding was installed in and around the electron microscope suites to help eliminate electromagnetic interference; protecting the consistency of research results and machine performance.
- In line with the 'Science on Display' aspects of the building, specially designed structural glass elements have been used, allowing natural light into the lab spaces and giving passers-by an insight into the research being undertaken.
- During construction, up to 220 tradespeople were onsite each day, with 83 per cent of the building workforce being local tradespeople.

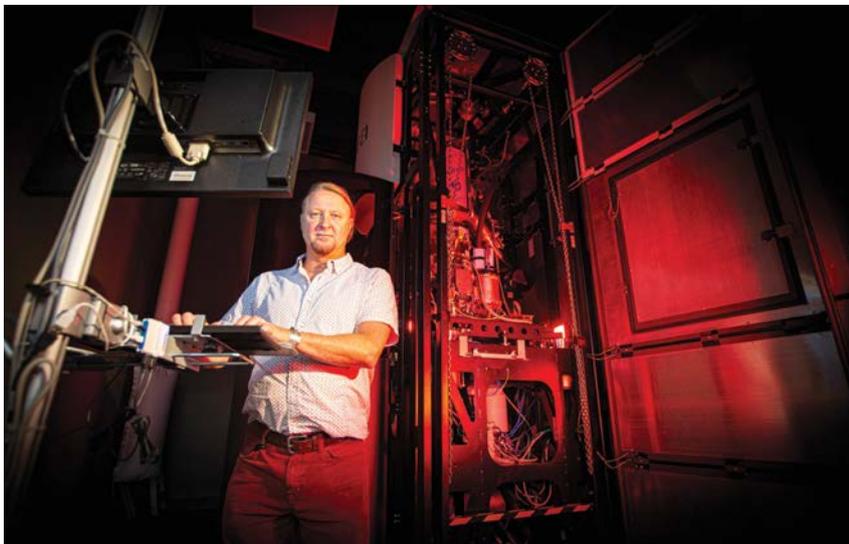
## AWARD WINNING DESIGN

The extraordinary nature of the building design and construction was recognised in the 2020 Master Builders Association (MBA) NSW Awards, where it received the 'Excellence in Construction' Award for Tertiary Buildings (\$50M - \$100M) and the 'Excellence in Construction' Award for Innovation - Construction Technique/ Equipment.





# Facilities



## CRYOGENIC ELECTRON MICROSCOPY FACILITY

The Cryogenic Electron Microscopy facility is home to a world-class team of technical staff and researchers providing cutting-edge equipment access. The facility currently houses a Thermo Fisher Titan Krios, a Talos Arctica, a Tecnai T-12, and a Mark IV Vitrobot, as well as a suite of ancillary equipment. Visiting researchers from around the world enjoy access to high-performance computing infrastructure on some of the world's most powerful computational systems. A specialist team provides end-to-end training on instrument operation, data acquisition, and data processing and visualisation.

## TITAN KRIOS: REVOLUTIONARY TECHNOLOGY

The centrepiece of the new Paul Wellings Building is the Thermo Fisher Titan Krios cryo-electron microscope. The Titan Krios is the most powerful high-resolution electron microscope in medical research, enabling three-dimensional visualisations of biomolecules such as proteins. This microscope works by firing a stream of high-energy electrons through a frozen sample, generating multiple two-dimensional images of molecules, visualising their nano-sized loops and chains.



Standing at three metres tall, this one-tonne microscope enables scientists to see with unprecedented accuracy and speed what previous generations of microscopes could not reveal. By combining electron microscopy with tools that show how proteins move and interact through time, scientists at Molecular Horizons can get a better understanding of how proteins and cells behave and interact at the molecular level, which is critical to developing new ways to detect and fight disease.



#### FLOW CYTOMETRY AND FLUORESCENCE MICROSCOPY

The Fluorescence Analysis Facility is situated in the Paul Wellings Building and offers high-end instrumentation in fluorescence microscopy, flow cytometry and mass photometry. The facility's technical support team specialises in support for cell and molecular analysis across a broad range of both biological and environmental applications. With 11 high-end fluorescence microscopes (confocal, super-resolution, high-throughput imaging) and six multi-parameter flow cytometers (including a cell sorter), the facility enables high-quality research throughout the University of Wollongong and the wider region.

#### MASS AND NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY

Situated in Building 18 (Chemistry), equipment facilities are available to Molecular Horizons researchers providing access to nuclear magnetic resonance (NMR - 400 and 500 MHz) and mass spectrometry (including nano-ESI, Orbitrap) methods. All facilities are supported by highly trained personnel, working closely with researchers and students on research design, sample preparation, data acquisition and data analysis.

#### CENTRE FOR ATMOSPHERIC CHEMISTRY

The Paul Wellings Building is also the new home of the University's Centre for Atmospheric Chemistry. The building is designed specifically to allow for the Centre's atmosphere and air quality measuring instruments to be positioned on the rooftop platform with a clear view to the horizon. The view to the ocean all-year-round means researchers can now measure as soon as the sun comes up, allowing more sensitive measurements. The Centre is working with a wide range of partners, including NASA and ANSTO, and research ranges from monitoring the air quality in Wollongong and its surroundings to measuring carbon dioxide and its effect on the Earth's climate.

## Contact us

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