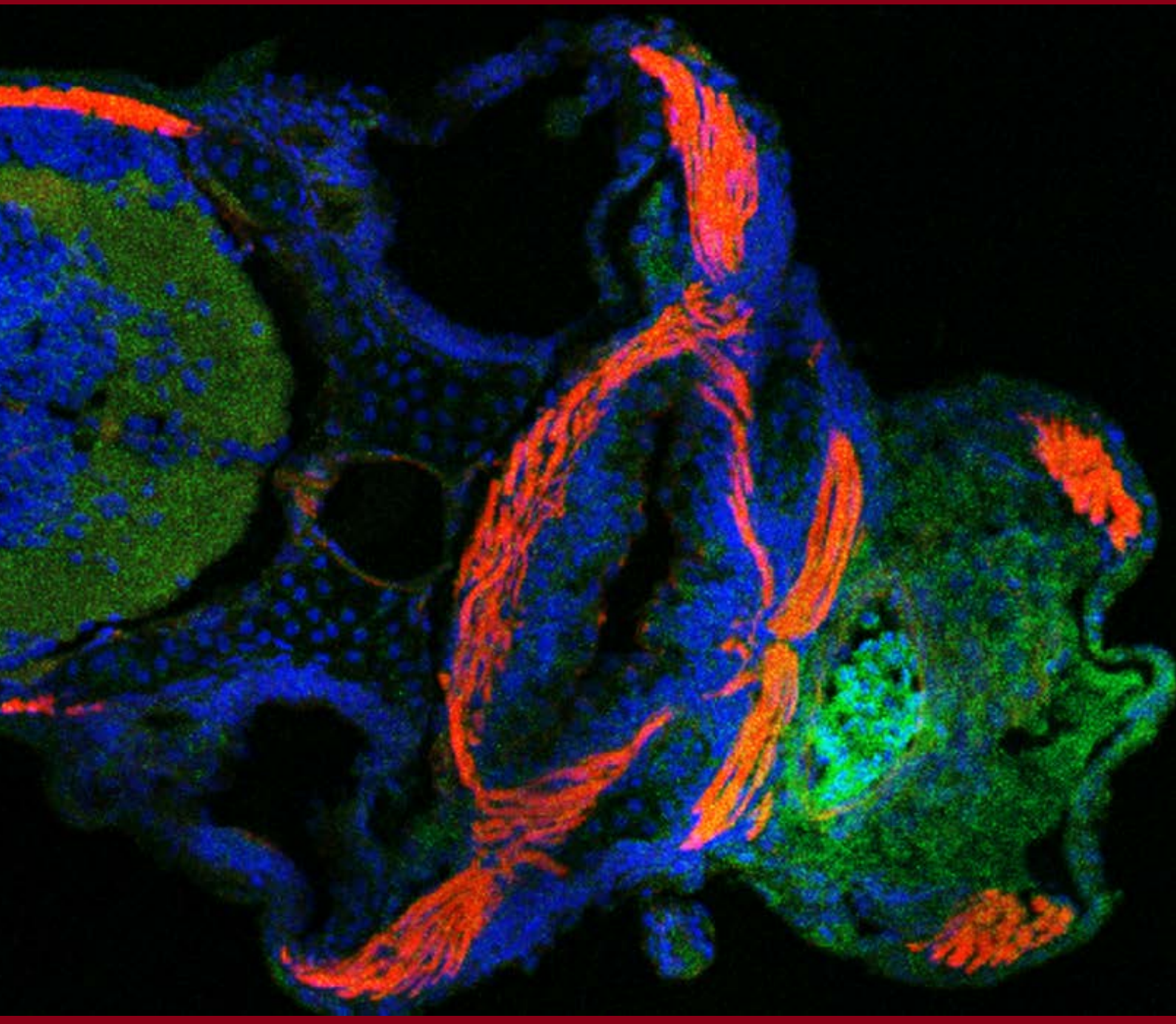
LA TROBE
UNIVERSITY • AUSTRALIA

Department of Microbiology, Anatomy, Physiology and Pharmacology

School of Agriculture, Biomedicine and Environment

Scientists at the forefront of knowledge into how biomolecules, cells, organ systems, disease and the environment interact to form functioning organisms (i.e. viruses, bacteria, animals, humans, etc.)



latrobe.edu.au/school-agriculture-biomedicine-and-environment

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Cover Photo:
Expression of fibronectin in the anterior region of a zebrafish larva (Photo Credit: Nishanthi Mathiyalagan)

About the School of Agriculture, Biomedicine and Environment

The School of Agriculture, Biomedicine and Environment is one of the largest in the University, with more than 170 continuing and fixed term staff across multiple campuses. Over the last three years the School has seen significant growth in both research and teaching revenue. Staff in the School currently generate a significant proportion of the University's teaching revenue and research income, and supervise more than 270 higher degree research students. The School is responsible for 7 undergraduate degree courses at the main Bundoora campus in Melbourne, and our regional campus at Albury-Wodonga. It is a leader in teaching innovation and student satisfaction within the university.

The School undertakes teaching and research across a broad range of disciplines, including: Agriculture, Botany, Soil Science, Animal Science, Plant Science, Ecology, Environmental Geoscience, Evolution and Genetics, Conservation Biology, Zoology, Neurobiology, Microbiology, Physiology, Pathophysiology, Pharmacology and Anatomy, Biochemistry, Chemistry and Cardiovascular Physiology. The School is a major contributor to research strengths in both the Biological and Agricultural Sciences, achieving the highest possible rating '5 - well above world standing' from the Australian Research Council in the fields of Ecology, Zoology, Plant Biology, Physiology, Microbiology, Biochemistry and Cell Biology, Crop and Pasture Production, Genetics, Soil Science, and Veterinary Science, and rated as '4 - above world standing' in Ecological Applications.

The 5 departments in the School are:

- Animal, Plant and Soil Sciences
- Baker Department of Cardiovascular Research, Translation and Implementation
- Biochemistry and Chemistry
- Environment and Genetics
- Microbiology, Anatomy, Pharmacology and Physiology

The School of Agriculture, Biomedicine and Environment research environment is dynamic and growing, and includes these major research centres:

- La Trobe Institute of Sustainable Agriculture and Food (LISAF)
- ARC ITRH (Industry Transformation Research Hub) for Medicinal Agriculture
- ARC CoE (Centre of Excellence) Plant Energy Biology
- Centre for Livestock Interactions with Pathogens (CLiP)

- Centre for Cardiovascular Biology and Disease (collaboration with the Baker Heart and Diabetes Institute)
- Research Centre for Extracellular Vesicles
- Centre Research Biomedical and Environment Sensor Technology (BEST)
- Research Centre for Molecular Cancer Prevention
- La Trobe Institute for Molecular Science
- Research Centre for Future Landscapes (collaboration with the Arthur Rylah Institute of DELWP)
- Centre for Freshwater Ecosystems (formerly the Murray-Darling Freshwater Research Centre)
- Research Centre for Applied Alpine Ecology

- Mallee Regional Innovation Centre (MRIC)(a joint venture with The University of Melbourne)

Professor Shaun Collin
Dean, School of Agriculture, Biomedicine and Environment, Co-Director of AgriBio

Department of Microbiology, Anatomy, Physiology and Pharmacology

The Department of Microbiology, Anatomy, Physiology and Pharmacology is one of the largest academic departments at La Trobe University. The Department consists of more than 60 continuing and fixed-term academic staff, including one Tracey Banivanua Mar Fellow, one ARC Future Fellow, one ARC DECRA Fellow, and one NHMRC/National Heart Foundation ECR Fellow. Professor Grant Drummond serves the role of Head of Department.

We teach >3000 undergraduate students enrolled across 32 subjects. We take great pride in providing a friendly and supportive environment, taking particular care to ensure a positive experience for undergraduate students.

We teach into La Trobe's undergraduate Science, Biomedicine and Allied Health ` and offer fully online subjects through Open Universities Australia. A number of our teaching staff have been recognised as Fellows/Senior Fellows of the UK's Higher Education Academy, and have received university and national awards for innovation and excellence in curriculum design and delivery.

Our Department produces graduates who are ready to take up a diverse range of job opportunities, with potential careers in government departments and agencies, hospitals, community health centres, rehabilitation centres, pharmaceutical and biotech companies, private health-care organisations and research centres.

The Department has a dynamic Higher Degree by Research (HDR) program that reflects the disciplinary interests of the staff. We are currently training 75 PhD and Masters students and 30 Honours (4th year Research) students from Australia and overseas.

Research carried out in the Department is world leading and focusses on some of today's biggest challenges in health and the environment. Staff and postgraduate students research the structure, function and environment of microbes, animals and humans in health and disease. Our breadth of expertise and co-location in world-class facilities create opportunities for new discoveries in cardiovascular biology and disease, neuroscience, developmental biology, musculoskeletal function, host-pathogen interactions and microbial ecology. Through this research, members of the Department are key contributors to La Trobe's new Research Themes of:

- Understanding and preventing disease
- A healthy, safe and equitable life course for everyone
- Production of quality foods and medicines
- Protection and restoration of vulnerable ecosystems

The Department's research activities also underpinned La Trobe University's ratings of '5 – well above world standard' in the latest round of Excellence in Research Australia (ERA) in the disciplinary areas of Physiology, Microbiology and Cardiovascular Medicine. The Department also contributed to similarly high ratings in the areas of Neuroscience and Soil Science.

The Department's research environment is dynamic and growing, and includes close relationships with world-renowned medical research institutes such as the Baker Heart and Diabetes Institute and the Howard Florey Institute of Neuroscience. We also have research partnerships with state, federal and non-government agencies, and are home to a major Research Centre:

- The Centre for Cardiovascular Biology and Disease Research

Research Centre

Centre for Cardiovascular Biology and Disease Research (collaboration with the Baker Heart and Diabetes Institute)

Centre for Cardiovascular Biology and Disease Research

Cardiovascular disease refers to chronic diseases involving the heart and/or blood vessels, often leading to heart attack, stroke, heart failure and kidney disease. Cardiovascular disease is also a major cause of dementia.

In Australia, 4 million people suffer from cardiovascular disease, costing the economy $5 billion annually. Alarmingly, cardiovascular disease claims more than 40,000 Australian lives per year, with the highest death rates amongst Aboriginal and Torres Strait Islander peoples, socioeconomically disadvantaged groups, and those living in remote and regional areas. It is for these reasons that cardiovascular disease is recognised as a National Health Priority area by the Australian Government.

There is an urgent need for more research and greater public awareness to address the enormous health and economic impacts of cardiovascular disease.

The Centre for Cardiovascular Biology and Disease Research was established in 2018 by Professors Chris Sobey and Grant Drummond. In just five years, the Centre has attracted more than $13 million in research funding and is now home to more than 75 research staff and students, making it one of the largest cardiovascular research groups in Australia.

Our researchers utilise leading animal, organoid and cell culture models, and cutting-edge technologies including mouse genetics, physiology, immunology, single cell and spatial transcriptomics, proteomics, microbiomics and molecular imaging. This enables translation of discoveries into novel diagnostics, preventions and treatments for cardiovascular disease.

Our experimental findings on cell therapy in stroke have recently been translated into Phase I and Phase II clinical trials.

Our Centre is located in the heart of Melbourne's northern suburbs, serving a community that is disproportionately impacted by the devastating consequences of cardiovascular disease and stroke. Our researchers work closely with the local community through public awareness campaigns, high school education programs, and partnerships with local government, health care providers and industries. The Centre also seeks input from members of the local community for strategic decision making, research planning and dissemination of findings.

Co-Directors:
Profs Chris Sobey and Grant Drummond.

Research Divisions and leaders:
Cardiac Cellular Systems
(Associate Professor Alex Pinto)

Cardiac Disease Mechanisms
(Dr James Bell)

Cardiorenal Disease
(Dr Brooke Huuskes)

Cardiovascular Physiology
(Associate Professor Colleen Thomas)

Cerebrovascular Disease
(Dr Michael De Silva)

Diabetes Development and Prevention
(Associate Professor Hayder Al Aubaidy)

Dying Cell Communication and Clearance
(Dr Amy Baxter)

Hypertension and Diabetes
(co-led by Associate Professor Antony Vinh & Dr Maria Jelinic)

Immunometabolism and Macrophage Biology
(Dr Katrina Binger)

Microbial Genetics and Interactions
(Associate Professor Steve Petrovski)

Molecular Proteomics
(Dr David Greening)

Stroke and Brain Inflammation
(Dr Helena Kim)

Vascular Dementia
(Professor Garrie Arumugam)

Vascular Therapeutics and Regeneration
(Dr Kazuhide Shaun Okuda)

Strategic Partners:
Australian Cardiovascular Alliance,
Baker Heart and Diabetes Institute,
CAD Frontiers, and
Beluga Foundation.

Research Groups

Anatomical Sciences and Higher Education Research Group

Anatomy ('to cut up') is the study of the structure of an entity.

Therefore, Human Anatomy concerns itself with the study of how the human body is structured.

It is often said that there is nothing new to discover about the human body.

For hundreds of years, it was believed that we know how many muscles and bones and organs we have.

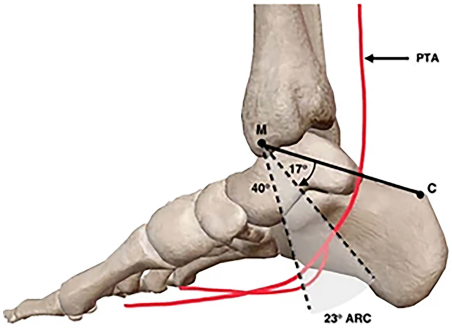
Therefore, there must not be much more to study!

However, anatomical research continues to make new discoveries about the human body, such as identifying new structures previously unknown (e.g. there are actually five muscles forming the 'quadriceps femoris' group, and there are lymphatics in the brain when previously it was thought there were none).

These new findings are helping to improve medical interventions such as surgical techniques, as well as the functional and clinical understandings contributing to health and disease and injury management.

Additionally, studying Human Anatomy is considered one of the most challenging topics in a science degree.

Helping students develop meaningful ways to study and apply their anatomical knowledge is essential.



Anatomical education has evolved significantly since the days of the didactic 'sage on a stage' lecture.

Although students think they learn more by watching a good lecturer up on stage, they ultimately understand less when compared to those engaged in active learning activities.

Our research group is interested in both anatomical science research (focused on better understanding the anatomical relationships in the body and their clinical applications) and developing and evaluating better ways to teach and learn anatomy.

In combination, these areas of focus ensure that students are being taught the most current anatomical information and are also being taught using evidence-based, contemporary teaching and learning methods.

Group Head:
Assoc Prof Aaron McDonald

Group Members:
Dr Laura Whitburn;
Dr Heath McGowan

Students:
Ms Melby Tentrisanna;
Ms Bridget Marchese;
Mr Shane Cassar

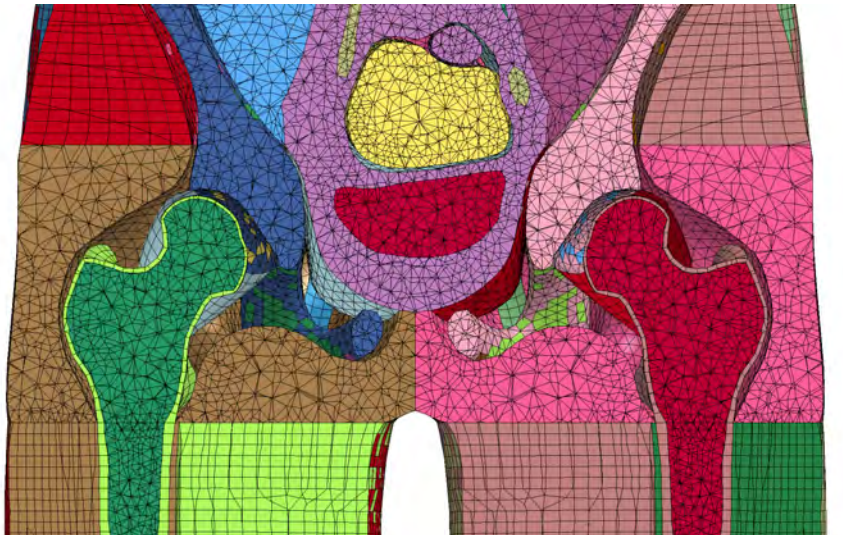
Fields of Study:
Gross anatomy; topographical anatomy; higher education research in human anatomy.

Capabilities and Techniques:
Human dissection; MicroScribe; ultrasound; qualitative and quantitative analysis; digital educational technologies; curriculum development; student-teacher co-creation; peer-peer learning.

Translational Opportunities:
Education; curriculum development; human dissection; sports and exercise science; medical research.

Anthropometry and Impact Biomechanics Laboratory

The application of human topographic anatomy to various disciplines is the main focus of this laboratory. The multidisciplinary approach of combining anatomical and biomechanical techniques to investigate injury prevention strategies has constituted the majority of work to date. Research has concentrated on hip fracture prevention, particularly the role of the gluteal muscles as an energy absorption medium when using energy shunting type hip protectors. Anthropometric studies have quantified variations in pelvic bony and soft tissue anatomy to improve the design of hip protectors and other prosthetic devices. This laboratory has a number of existing local and national collaborations including the Victorian Institute of Forensic Medicine (VIFM), The Forensic Engineering Society of Australia (FESA), The University of Melbourne (Body Donor Program) and the University of New South Wales (Transport and Road Safety Research Centre).



THUMS pedestrian fracture baseline
(Photo credit: UNSW, Transport and Road Safety Research Centre)

Anatomical and biomechanical basis of hip protector design

Hip fracture is a major cause of death and disability among older persons. Anatomical and biomechanical design considerations for shunting-type hip-protectors is being studied by this laboratory. Hip protectors are protective devices worn over the hip region to protect against injury during a fall by redistributing kinetic energy to adjacent anatomical structures. To date work has involved Computed Tomography and dissection techniques to create a three-dimensional map of human gluteal muscle thickness. This serves to aid in anatomically designed hip protecting devices. Biomechanical work involved developing a new method to measure material properties of skeletal muscle under fall conditions (dynamic impact) by impacting muscles in the in-situ state, substituting ovine for human specimens. Finite Element Modelling (FEM) are being used to evaluate the body's response to hip-protector function. These models are virtual computer-generated representations of real-world structures built with many elements, very much like a Lego model is built with many bricks. Each element can be assigned specific material properties, the net effect allows kinematic data to be attained from simulations of an impact to the model. The Total HUman Model for Safety (THUMS) was developed for use in the automotive industry for crash evaluation. This laboratory has worked to modify and use it to study fall related injuries in older people.

Anthropometric assessment of skeletal dimensions for prosthetic devices

Skeletal anthropometic studies enable the design of prosthetic devices and improve their fit to patients. Using the VIFM CT scan database, measurement of skeletal dimensions were used with mathematical models to estimate a key measurement required to fit prosthetic legs. This work was completed in collaboration with Assoc. Prof. Michael Dillon, Prosthetics and Orthotics, La Trobe University.

Forensic anatomical assessment of Egyptian mummies

This laboratory collaborates with the Victorian Institute of Forensic Medicine, to conduct forensic anatomical evaluations. Recently an intracranial review and gender determination of juvenile Egyptian mummies was undertaken using computed tomography 3D imaging. Collaboration with Dr Janet Davies, Victorian Institute of Forensic Medicine and Dr John H Taylor of the British Museum.

Review of La Trobe University's skeletal material for Aboriginal remains

In 2018 an audit reviewed all of the human skeletal material in the Department of Physiology, Anatomy and Microbiology to assess possession of Aboriginal remains. Ongoing assessment is performed on any newly donated human skeletal remains to ensure Aboriginal remains are repatriated.

Lab Head: Dr Richard Fernandez.

Fields of Study:
Topographic anatomy; anthropometry; injury prevention; impact biomechanics; forensic applications of anatomy.

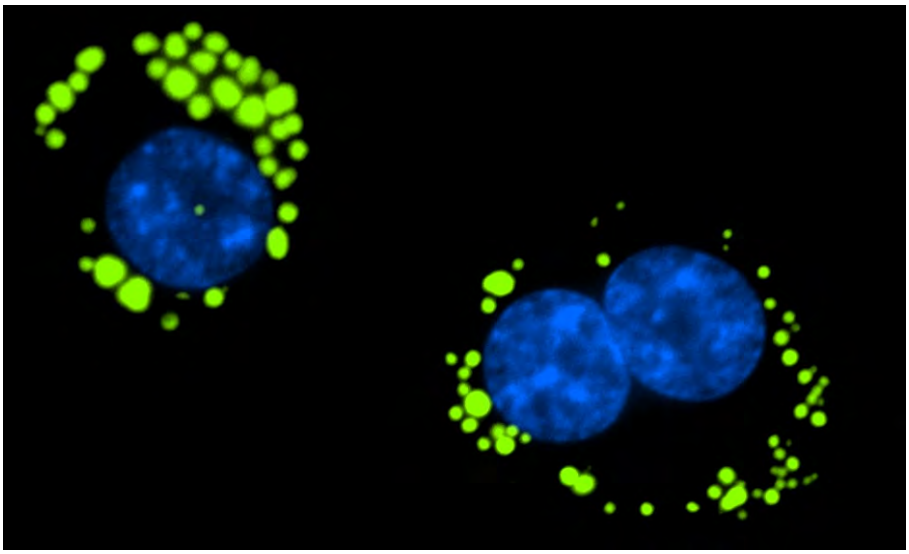
Capabilities and Techniques:
Human anatomical dissection; Computed Tomography scanning; anthropometric evaluation; Finite Element Modelling; Dynamic impact testing of biological tissue.

Antiviral Innate Immunity and Viral Genomics Group

Viruses infect all living organisms. Our laboratory studies both viruses of animals and humans to unravel the role of novel host and viral proteins in the control of viral infection, with a goal towards development of novel strategies to combat viral infection in both humans and animals. Our group uses advanced imaging, molecular, and genomic techniques to perform research across 4 main themes.

Detection of novel and emerging viruses (Helbig and Sarker Group)
Understanding the diversity of viruses in our environment has been limited by our ability to detect them. Since the advent of more sensitive next generation sequencing approaches, many new viruses have been described. Along with external partners we focus on three main areas of viral discovery:(1) detection of viral pathogens involved in new wildlife diseases; (2) analysis of viromes; and (3) detection and sequencing of new bacteriophages that target specific antibiotic resistant bacterial pathogens in animals. We investigate the development of new therapeutics and vaccines for animals and inform government of wild 'pest' risks to Australian livestock.

Host Induction of an efficient antiviral response
When a virus infects a cell, the host cell has sentinel receptors to detect foreign viral material. Receptor activation triggers a cascade of signaling pathways resulting in the upregulation of interferons, the main antiviral cytokines, which further upregulate thousands of antiviral gene products. Limited drugs are available to treat viral infections, and many significant viral infections have no treatments other than supportive care. We study molecular mechanisms that underpin the ability of a host cell to upregulate the most effective antiviral response. We focus on multiple viral pathogens across many animal and human models to uncover novel pathways and host proteins that will assist in developing next generation anti-viral drug treatments for multiple viruses.



Macrophage lipid droplets. (Photo credit: Karla Helbig)

Control of viral pathogens
Viral pathogen control is solely restricted to vaccines in the veterinary sector, with vaccines and a small handful of drugs available for the treatment of some viral infections in humans. In collaboration with the Beddoe Group (APSS) we work on developing new vaccines and tools to run vaccine trials for the veterinary sector. We focus on solutions for viral pathogens in small aquatic animals, where they do not have an adaptive immune system, and rely on innate immunity to control viral pathogens. We use our host induction research to develop new immune priming strategies to target viral pathogens in the aquatic livestock industry.

Understanding structure and function of viral protein (Sarker Group)
In-depth understanding of the structure and function of important viral proteins is crucial for development of potential anti-viral drugs or vaccines to successfully resolve viral diseases. Our research uses new technologies to uncover viral protein atomic structures. This enables a deeper understanding of viral protein functions to develop new anti-viral drugs or vaccines of benefit to threatened animal species vital for sustainable ecosystems.

Lab Head: Assoc Prof Karla Helbig.

Lab members: Ms Monique Smith; Ms Ebony Monson; Mr Keaton Crosse; Mr Jose Huaman-Torres; Ms Stephanie Lynch; Ms Jacinta Agius; Mr Jay Laws.

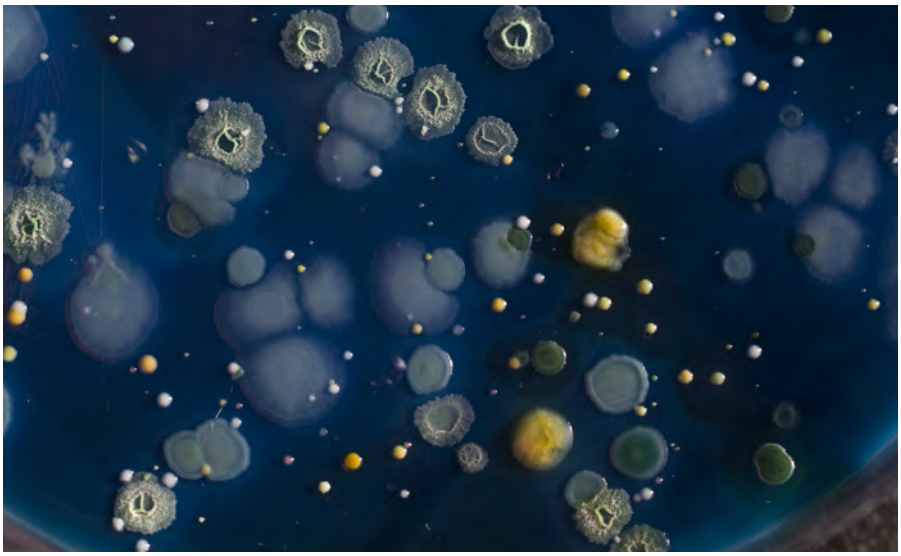
Fields of Study:
Virology; Innate Immunology; Structural biology; Viral metagenomics; Veterinary pathogens.

Capabilities and Techniques:
Microscopy: transmission electron, confocal, super resolution, light, fixed, live, static & movies; X-ray crystallography; Cell & virus culture & propagation; Primary cell culture; animal husbandry (mice/silkworms/ abalone); Viral delivery of genetic material; CRISPR/ cas; proteomics/lipidomics; bacterial & phage infection silkworm models; Protein expression & purification; Next generation sequencing; General molecular biology.

Translational Opportunities:
Viral animal pathogen detection; targeted drug development and management; bacteriophage solutions for antibiotic resistant infections in animals.

Applied and Environmental Microbiology Group

Our research investigates a diverse range of microbiomes associated with soil, human and ecosystem health. We have in-house Illumina Next-Generation sequencing facilities and develop custom bioinformatic pipelines for structural and functional community analysis. We have custom made equipment for the study of anaerobic microorganisms including electroactive bacteria, gut and soil microbes. We collaborate with medical, soil science and ecology researchers as well as NGOs, corporate partners, landholders, national and international partners. We lead the microbial branch of the La Trobe Applied Microbiomes project (LAMP) and pioneer the use of functional traits in microbiome research.



Culturing diverse microorganisms (Photo credit: Gene Drendel)

Pioneering trait ecology in microbiome analysis

From soil to human health, there is an urgent need to predict how changes to microbial community structure impact community function. We pioneer the use of functional traits to study microbial communities and how they impact environment functions. Traits go beyond looking at 'who' is present in a community, to understanding 'how is the community behaving', leading to identifiable opportunities for 'engineering' these communities for beneficial outcomes in health, disease and environmental research.

The human microbiota in infant health

The human microbiota contains trillions of microbial cells with most present in the gut. Branched chain fatty acids (BCFA) in breast milk influence normal human microbiota development, infant gut epithelial cells, and the immune system. Preterm infants and those mainly fed on formula often lack BCFAs. We isolate bacteria producing BCFAs to study their impact on human microbiota and gut health. Our research may lead to new infant formulas for optimal infant gut and microbiota development.

The microbiome in health and disease

The human microbiome, performs vital health functions that influence immunity, synthesis of essential molecules, and even our mood. Interactions between the microbiome, genetics and physiology are complex. We collaborate with clinicians, neurobiologists and physiologists to study the microbiome's role in Parkinson's disease, Autism and other disorders.

Promoting ecosystem health from the ground up

Agricultural and natural ecosystems rely on soil microorganisms to drive key ecosystem functions. For example, microorganisms are gatekeepers of the carbon cycle, both creating and removing carbon from soil systems. We study how the ecology of a microbial community governs these key ecosystem services, the wider implication for ecosystem function and interactions with climate. The answers to these questions have far reaching implications for the role of soil health in ecosystem restoration and sustainable farming and climate change mitigation.

Applied electromicrobiology

The developing field of electro-microbiology investigates bacteria with novel electrical properties including the ability to transfer electrons between each other and onto stable surfaces such as electrodes. We use microbial fuel cells (MFCs) and plant MFCs to study these electroactive microbes and key roles they play in corrosion in bioremediation processes.

Rare and extreme microbiomes

We study microbial survival in extreme environments to understand the role of microbes in biogeochemical cycling, primary production and as mediators and mitigators of climate change.

Lab Heads: Dr Jennifer Wood & Prof Ashley Franks.
Lab Members: Dr Anya Shindler (senior researcher); Dr Sean Bay (DECRA fellow); Mr Gene Drendel; Ms Sarah Knowler; Mr Joshua Vido; Mr Luke Bosnar; Ms Berenice Della Porta; Ms Edden Subejano; Ms Marissa Blunden; Mr Luke Florence

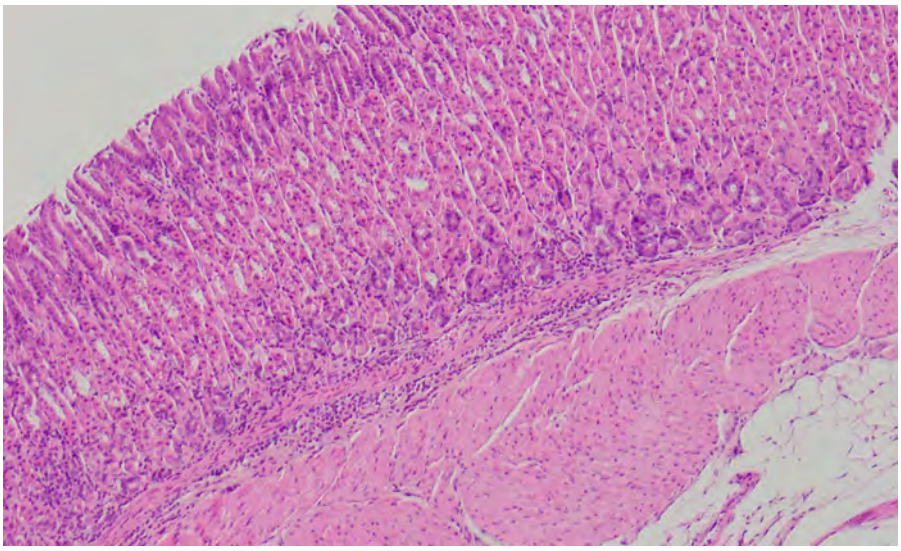
Fields of Study:
Microbiology; Ecology; Health; Bioremediation; Soil Science.

Capabilities and Techniques:
Next-generation sequencing, quantitative PCR; Anaerobic microbiology (gassing station & anaerobic chamber); Electro-microbiology; Trace gas analysis; multivariate statistics; bioinformatics.

Translational Opportunities:
Early detection/alleviation of human disease phenotypes (in Parkinson's Disease & Autism); improved sustainable agricultural land management practices; holistic ecosystem conservation and monitoring; soil contaminants bioremediation.

Bacterial Pathogenesis Group

Our body has about 39 trillion bacteria and everyday we encounter more bacteria, some of which cause disease. Our lab focuses on two fundamental questions: How do bacteria and their products interact with and cause disease in humans, and how does the host detect and respond to bacterial pathogens and their products resulting in immunity? Our facilities enable the detailed examination of host-pathogen interactions mediated by bacteria and their products. Our research, funded by Victorian, National and International agencies, involves national and international collaborators. We use cutting edge microbiology, immunology, and imaging techniques to study the cellular and molecular mechanisms of host-pathogen interactions.



Gastritis in response to *H. pylori* infection (Photo credit: Maria Liaskos)

Bacterial membrane vesicles (BMVs)

Bacterial membrane vesicles (BMVs) are spherical, bi-layered membrane nanostructures (20 to 300 nm in size) that are naturally produced by all bacteria as part of their normal growth. BMVs contain many of the components present within their parent bacterium in a non-replicative form, including lipopolysaccharide, toxins, DNA, proteins and enzymes. Our team studies the complex mechanisms used by bacteria to produce BMVs and regulate their cargo composition, in addition to determining how BMVs mediate disease in the host. We aim to understand the roles of BMVs in bacterial survival, promoting disease and enabling horizontal gene transfer within and between bacterial species. We are also developing methods to refine the use of BMVs as vaccines, and as nano-delivery molecules to deliver biological material into target cells.

Immune responses to the human gastric pathogen *Helicobacter pylori*

H. pylori is a bacterium that infects more than 3 billion people worldwide, causing lifelong infections resulting in gastritis, gastric ulcers and cancer. The mechanisms used by *H. pylori* to manipulate the immune system to mount an ineffective and chronic inflammatory response, and to survive remains unknown. Our team in collaboration with national and international clinicians and researchers focuses on identifying the mechanisms used by *H. pylori* to enable lifelong colonisation and disease. We use molecular, microbiology and immunology techniques, (animal models, human clinical samples and advanced immunological assays) to characterise immune responses to *H. pylori* and to identify targets to prevent *H. pylori* mediated disease.

Detection of bacteria by innate immune receptors

Host surface and cytoplasmic innate immune receptors detect bacterial pathogens and initiate an immune response. The host immune receptor nucleotide oligomerisation domain-1 (NOD1) detects a peptidoglycan motif present in all Gram-negative bacteria, resulting in an immune response. How NOD1 controls immune signalling and bacterial disease remains unknown. Our team studies how Gram-negative bacterial peptidoglycan is detected by NOD1 in order to identify methods to limit NOD1-mediated inflammation and disease in humans.

Microbiome and BMVs

We analyse BMVs produced by the human microbiota to understand their contribution to maintaining immunity and gut health.

Lab Head: Assoc Prof Maria Liaskos (publishing as Maria Kaparakis-Liaskos).

Lab Members:
Dr Natalie Bitto; Ms Ella Johnston; Ms Lauren Zavan; Mr William Gilmore; Ms Kalara Jayawardene; Ms Sarah Signorello.

Fields of Study:
Microbiology; Host-pathogen interactions; Innate Immunity; Cell biology; Immunology.

Capabilities and Techniques:
Bacterial/eukaryotic extracellular vesicles purification & characterisation; innate and adaptive immune responses to bacterial pathogens; microbiology; molecular microbiology; cell culture; live cell imaging; confocal & transmission electron microscopy; infection/vaccination animal models; flow cytometry.

Translational Opportunities:
Bacterial/eukaryotic vesicles; bacterial disease & animal models; Vaccine design/ delivery; development of biological nanocarriers; bacterial pathogenesis; characterisation & modulation of innate/ adaptive immune responses; protein expression; antimicrobial resistance mechanisms; horizontal gene transfer; microbiota immunological/biological functions.

Cardiac Disease Mechanisms group

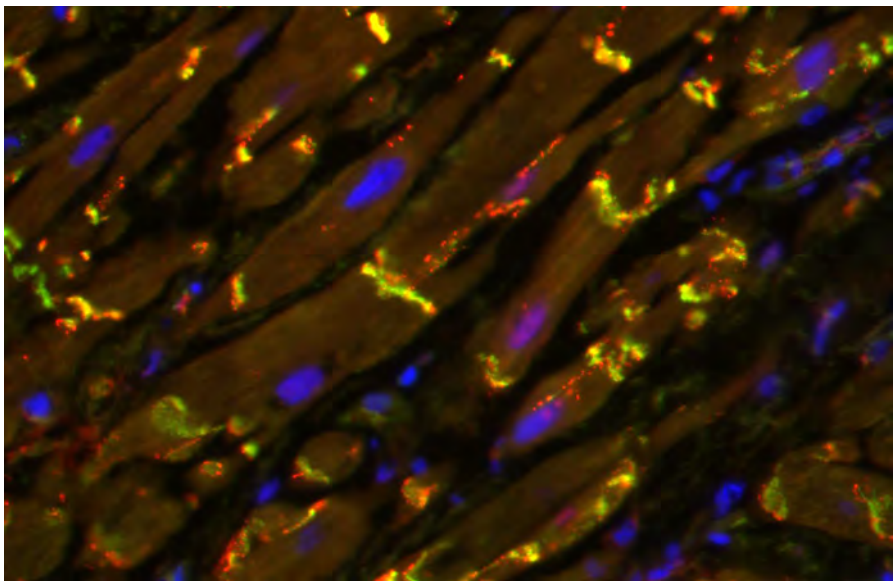
The Cardiac Disease Mechanisms Laboratory seeks to understand the cellular and molecular mechanisms driving diseases in the heart in a bid to identify new candidate targets for future therapies. One in five of all deaths in Australia are due to heart disease – a devastating public health and economic burden that will continue to escalate with an increasingly aged and obese population. This new research group within the Department has extensive expertise in in vivo, in vitro and molecular methodologies, with a focus on examining the underlying causes and pathological consequences of irregular heart rhythms (arrhythmias), heart attacks (myocardial infarction) and chronic heart failure.

'Heart fat' emerging as a critical mediator of heart disease

Increased body fat (especially visceral tummy fat) is known to be an important contributor to the development of heart disease, releasing factors into the blood that travel to the heart and disrupt function. Up until recently though, the role of the fat immediately surrounding the heart has been largely overlooked. This 'heart fat' increases markedly in obesity, with aging, and in post-menopausal women – all important risk factors for heart disease. Heart fat is increasingly thought to be critical to the development of irregular heart rhythms and relaxation abnormalities that represent a primary component of cardiac demise.

Inter-cellular communication between heart fat and muscle cells drive irregular heart rhythms

We have very recently shown that heart fat exerts a unique, detrimental influence on the surrounding heart muscle. Our findings show that the very close proximity between the fat and muscle cells within the heart greatly increases the potential influence of this local fat on heart function. We have taken the first steps in identifying the factors released from the heart fat, and look to establish how these modulate the function of neighbouring heart muscle cells in a manner that increases their vulnerability to potentially fatal irregular heart rhythms.



Cell-to-cell communication proteins in human cardiomyocytes (Photo credit: Jim Bell)

Relaxation abnormalities in fatty hearts?

We are also taking the field in a new direction, by investigating a very recently described clinical link between heart fat and the capacity of the heart to relax. An inability of the heart to relax properly disrupts its capacity to fill with blood, and is an emerging global health issue with no effective therapies available. Building on our growing understanding of the factors released from heart fat that influence heart rhythmicity, we seek to also identify how these may drive relaxation abnormalities that eventuate in heart failure and death.

Our research capacity is supported by ongoing pre-clinical/clinical collaborations developed both locally (University of Melbourne, Baker Heart Institute) and internationally (University of Birmingham, UK).

Lab Head: Dr Jim Bell.

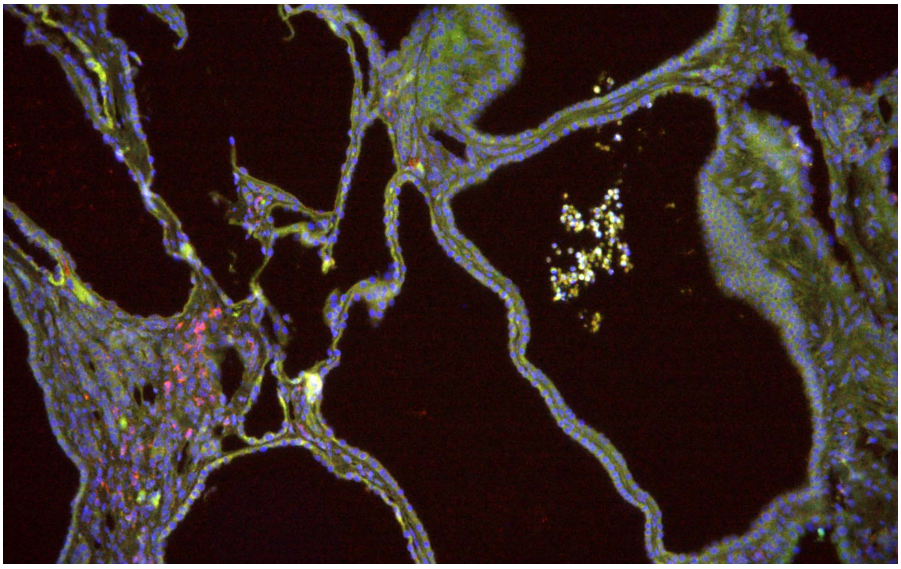
Fields of Study:
Cardiac arrhythmias; Heart failure; Adipose tissue; Intercellular signalling; Sex steroids.

Capabilities and Techniques:
Human cardiac tissue collection & rodent models of obesity; isolated heart & cardiomyocyte contractility; electrophysiology & conduction mapping; protein biochemistry; fibrosis/adipose infiltration quantification.

Translational Opportunities:
This research will identify novel molecular targets that advance preventative therapies for aged and obese populations at risk of developing heart disease.

Cardiorenal Disease Research Group

Kidney disease affects around 12% of the population and places a huge burden on the individual suffering the disease. The only option for patients is dialysis or transplantation. Dialysis is life limiting and there is a sever organ shortage meaning long wait times for those in need. Devastatingly, people with kidney failure often die of a cardiovascular event before even getting a lifesaving transplant. Imagine a world where we can completely reverse the effects of kidney disease. That is the goal of the Cardiorenal Disease Research Group, to unravel the mysteries of chronic kidney disease and find new ways to stop the progression of this disease, and even regenerate the kidney. Further, we are using qualitative research methods to understand how transplant recipient experience the public health system and also investigate how to increase the number of organ and tissue donors in Australia.



Macrophage staining in polycystic kidney disease. (Photo credit: J. Gasperoni)

Does the immune system contribute to polycystic kidney disease progression?
Polycystic kidney disease (PKD) is a genetic condition affecting up to 1in 400 people worldwide. This inherited condition comes in two forms: Autosomal Dominant (ADPKD) and Autosomal Recessive (ARPKD). Patients with PKD grow large fluid filled cysts on their kidneys which causes several side effects due to the crucial role that the kidneys have in maintaining body homeostasis. Namely, the cyst grow so big that they destroy the kidney tissue, eventually leading to complete kidney failure. One major side effect of PKD that patients have high blood pressure.
Using both zebrafish and rodent models of, we aim to understand how the immune system contributes to disease development, progression and high blood pressure. By identifying the molecular pathways involved in disease progression we may be able to design therapies to stop disease early in its progression.

Can Zebrafish be used to screen for new drugs to treat kidney disease?
Zebrafish develop cystic changes in a way that is similar in humans. This gives us the unique opportunity to screen new compounds that may be beneficial in stopping or slowing the progression of PKD development. Zebrafish embryos are transparent and develop outside the body, so we can use sophisticated microscopy techniques to monitor their development in real time.

Why do cells dye in human kidney disease?
We use new technology called tubules on a chip (TOAC) to understand the crosstalk between cells of the kidney and the immune system.
In this cell culture technique, we take cells from human kidneys, which have been surgically removed from patients with kidney cancers or PKD, and grow epithelial cells in one chamber, endothelial cells in another. We then add immune cells and culture everything under physiological flow, meaning that this culture method closely represents what occurs in the human kidney. Using Bulk RNA sequencing, we can determine the cellular changes that occur under different conditions, giving us insight into the cellular changes associated with disease progression.

How has telehealth changed the way care is delivered to kidney transplant patients?
This qualitative study will expand on our recent work that looked into how kidney transplant recipients feel about using technology in their post-transplant care. The results of this previous study was used to lobby for government changes into telehealth services across Australia. Now, we want to gain insight into the physicians point of view and determine if the mode of healthcare delivery affects patient outcomes.

Lab Head: Dr Brooke Huuskes

Lab members: Jemma Gasperoni, Emily Major, Sean Barton, Hojjatullah Nasirie, Cahal Freestone

Fields of Study:
Kidney disease, Hypertension, Genetics, Public Health, Patient-centered

Capabilities and Techniques:
Animal models of kidney disease (including rodents and zebrafish), molecular biology techniques, human cell culture, live-cell imaging, histopathology, immunohistochemistry, confocal microscopy, renal function, qualitative data collection

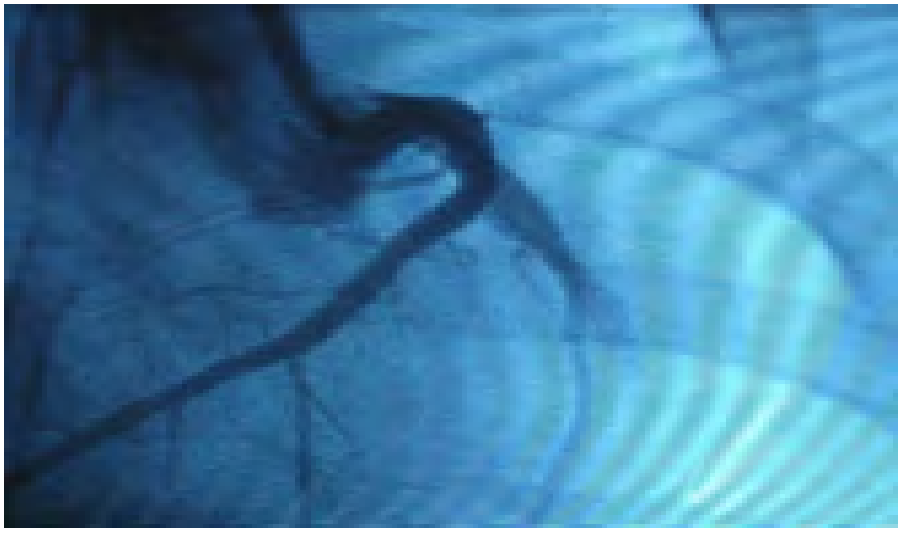
Translational Opportunities:
Understanding the mechanisms involved in kidney disease allows us the opportunity to identify new therapies for kidney disease. Through qualitative research, there is opportunity to impact current practices in government processes and policy.

Cardiovascular Physiology Group

Our collaborative clinical research involves local, national and international partners. Our laboratory-based coronary heart disease and heart failure research features an integrated approach of simultaneously monitoring blood pressure, heart rate and blood flow via indwelling or wireless monitors for long time periods. We conduct Proof-of-concept small animal model studies to screen and assess new interventions/drugs, and use large animal models, with similar anatomy and physiology to humans, to translate discoveries into clinical therapies.

Myocardial Ischemia-Reperfusion Injury
Heart attack patient survival depends on the amount of heart muscle damaged. The most effective treatment is to re-establish blood flow in the blocked artery which saves heart tissue, but also causes cell death. This is called ischemia-reperfusion (IR) injury and there are no drugs to prevent it. Along with collaborators, we developed a highly potent flavonol drug which significantly reduces myocardial IR injury and has multiple beneficial actions (antioxidant; inflammatory; ability to stimulate pro-survival kinase pathways in heart cells). We are developing a non-invasive intervention to reduce cardiac IR injury called remote ischaemic preconditioning (RIPC). This consists of multiple episodes of brief blood loss to a limb to stop prolonged blood loss in the heart. We developed a large animal RIPC model to study cardioprotection mechanisms and have assessed zinc homeostasis impairment in cardiac IR injury.

Microbiome & Cardiometabolic disease
Links exist between inflammation and disruption of gut microbial communities in cardiometabolic disease. In chronic low-grade inflammation diabetes, levels of anti-inflammatory protein Annexin-A1 (AnxA1) are reduced. We study AnxA1 deficiency effects on gut microbiome in diabetic mice. With clinicians, we are assessing gut bacteria composition changes after mini-gastric bypass surgery, and potential links to reversing obesity and diabetes.



Using contrast dye to evaluate coronary blood flow (Photo credit: Colleen Thomas)

Healthy Diet and Lifestyle for the Prevention and Management of Cardiovascular Disease
We study flavonols in plant-based polyphenols to see if healthy diet patterns improve CVD outcomes. We study plant-rich Mediterranean diets for heart disease-fighting properties and are trialling diet modifications to improve anti-inflammatory potential, including the clinical importance of polyphenol intake. We have developed and validated a CARDIO-MED survey tool food frequency questionnaire to assess diet quality and MedDiet adherence of Australian cardiology patients. We are assessing effects of legume and olive oil consumption in diabetes and heart disease, as well as diet and cognitive impairment risks in India.

Cardio-Renal Syndrome (CRS)
CRS occurs when the failure of the kidney or heart worsens the function of the other, leading to the failure of both. We are studying how to reverse uremic-toxin-induced vascular dysfunction.

Lab Head: Assoc Prof Colleen Thomas.

Lab member: Ms Urja Amin.

Fields of Study:
Cardiovascular Diseases; Public Health; Medical Biotechnology; Nutrition; Clinical Sciences.

Capabilities and Techniques:
Myocardial IR/RIPC animal models; Integrative Cardiovascular Monitoring; Blood flow/Haemodynamics (telemetry; chronic indwelling catheters, blood flow probes, electrocardiography); Biochemistry/Molecular Biology; Clinical trial design & management; Anthropometry; Body composition - absorptiometry; Continuous glucose monitoring; Accelerometers for physical activity and Dietary assessment analyses; Dietary Inflammatory Index.

Translational Opportunities:
Gastrointestinal microbiome-specific obesity therapies; Highly potent flavonol application in stroke survivors; Hospital menu planning; Remote limb conditioning strategy (ambulances/sports rehab); Diabetic cognitive impairment screening; Digital/mobile delivery MedDiet intervention.

Cerebrovascular Disease Group

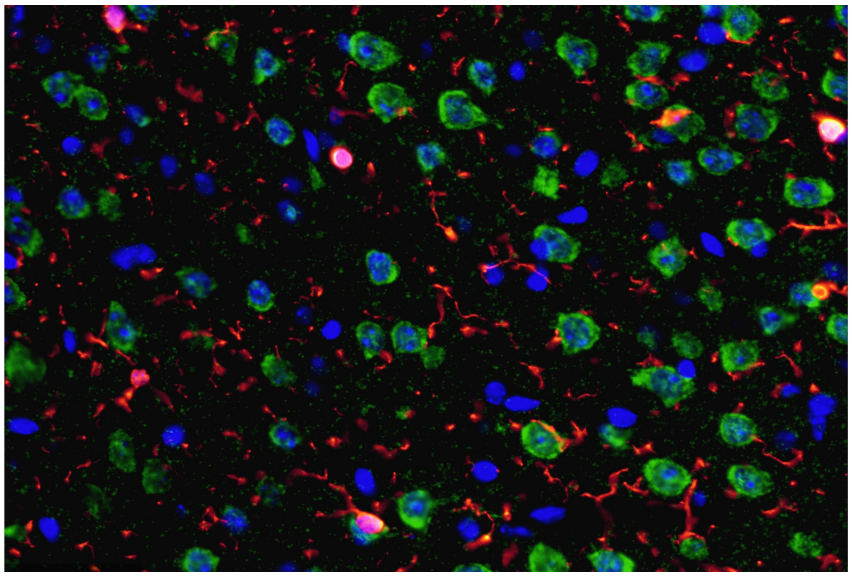
Cerebrovascular diseases (stroke, dementias) are a major health concern in Australia and throughout the world. The brain is and its circulation are particularly sensitive to disease. Cardiovascular diseases disrupt the function of cerebral arteries which leads to a dysregulation of cerebral blood flow. This may lead to altered blood flow to the brain which may starve neurons of the continuous supply of oxygen and other nutrients essential for their function. Insufficient delivery of oxygen and nutrients to the brain is a major factor in neuronal dysfunction and may contribute to the development of cognitive impairment (e.g. loss of memory). Our research focuses on the effects on cardiovascular diseases (e.g. hypertension, ischaemic stroke, metabolic syndrome) on the brain and its circulation. We utilise animal models of disease as well as state of the art imaging, molecular and behavioural testing techniques to determine the impact of disease on the brain and identify potential targets for therapy.

Targeting estrogen signalling to reduce dementia risk

It was recently reported that postmenopausal women with hypertension to have the greatest reduction in brain health between ages 60-80. This decline is greater than in groups regarded as "unhealthier" (e.g. males with multiple cardiovascular diseases). Loss of protection by estrogen after menopause is a likely contributor. We have shown that activation of the G protein-coupled estrogen receptor (GPER) is protective in cardiovascular disease models, including hypertension and stroke. Importantly, selective activation of GPER avoids unwanted effects that result from activation of classical estrogen receptors. In this project we will study menopause-accelerated brain atrophy and cognitive decline in female mice with hypertension and if these changes to brain health can be prevented by pharmacological targeting of GPER.

Comorbidities and stroke

Stroke patients are typically older and have one or more cardiometabolic diseases. Despite this, most preclinical research is performed in young, healthy animals.



Staining for neurons and microglia in the prefrontal cortex. (Photo credit: Tarunpreet Rajput)

This has likely contributed to the failure to translate drugs identified in preclinical studies to clinical use. Hypertension is the major risk factor for stroke and we recently found that hypertension worsens memory after stroke. The combination of hypertension and stroke altered the transcriptomic profile of the brain, with changes to genes associated with neuroinflammation and neuronal function. This project aims to understand how hypertension, or other cardiometabolic diseases, worsens stroke outcomes.

Human amniotic epithelial cells and cognitive function

Cardiovascular diseases are known to promote brain injury and may therefore, result in impairment of cognition. The complex mechanisms that underly these diseases mean that a single therapeutic agent is unlikely to be effective. Human amnion epithelial cells (hAECs) have many properties (eg. anti-inflammatory, antifibrotic, regenerative and immunologically inert) that make them attractive candidates for a cell-based therapy for disease. This project will determine whether hAECs can treat cardiovascular disease-induced brain injury and cognitive impairment.

Lab Head: Dr Michael De Silva.

Lab members:
Mr. David Wong Zhang; Mr. Mehdi Zia; Ms. Tarunpreet Rajput; Ms. Elizabeth Fernandes.

Fields of Study:
Dementia, stroke, vascular function, brain injury, behaviour.

Capabilities and Techniques:
Animal models of hypertension and stroke; flow cytometry; histopathology; immunohistochemistry; confocal microscopy; genomic sequencing; mouse behavioural/cognitive testing; oxidative stress & inflammation assessment; vascular reactivity/compliance.

Translational Opportunities:
New drug targets: Pre-clinical dementia/ stroke.

Developmental Genetics Group

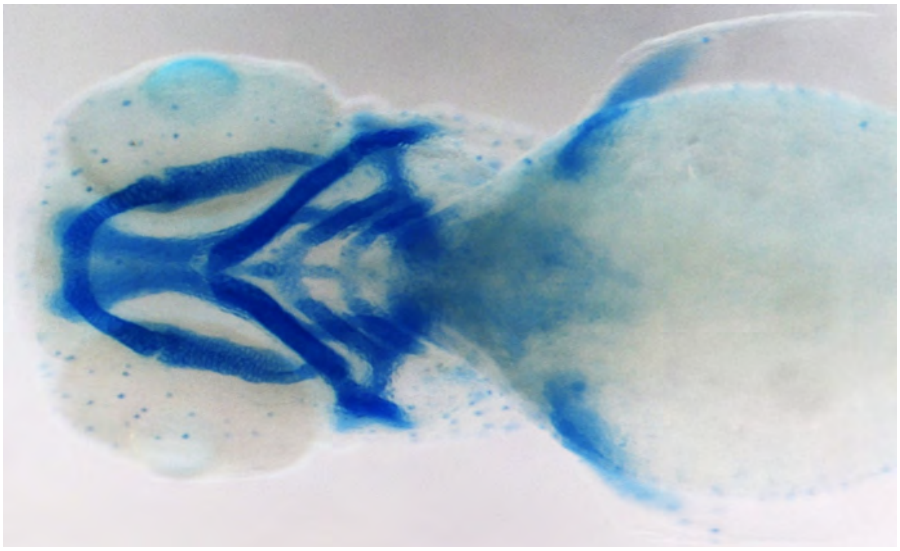
Understanding the cellular behaviours, particularly in the craniofacial region and neural tube, and the molecular pathways by which these behaviours are regulated, forms the cornerstone of understanding embryonic development. Using genetically-modified mouse and zebrafish models, our group identify critical genetic networks that underpin formation of the head (brain, skull and jaws) and epithelia of the body. We focus on the roles played by key conserved transcription factors Grhl3 and PLAG1 in regulating organ formation and behaviour in vertebrates. Our group also aims to identify supplements that may overcome the severity and/or incidence of birth defects due to genetic deficiency.

Novel genetic pathways in skull, jaw and epithelial formation

Congenital anomalies affecting the formation of the head, skull and jaws (craniofacial defects), are mainly caused by genetic mutations. We focus on the Grainyhead like (Grhl) genes, a key family that regulates craniofacial formation in flies, zebrafish, mice and humans. We developed mouse and zebrafish models with impaired Grhl function, that identify new genetic pathways affecting skull, hard palate and lower jaw formation. Our animal models also identify the role these genes play in establishment and maintenance of healthy epithelia and ensuring correct organ function.

Environmental factors that affect embryonic development

Environmental factors (smoking, alcohol intake and bacterial/viral infection) can cause human birth defects. Supplements (folic acid, magnesium, zinc, vitamin B and iodine) reduce birth defect severity. We use zebrafish embryos and mouse palate explants to identify ways to reduce epithelial and craniofacial defects incidence and severity. We also study the effects of prolonged agricultural organophosphate insecticides exposure on adult behaviour and embryonic development.



Craniofacial skeleton in a zebrafish (Photo credit: Seb Dworkin)

Establishing zebrafish models of human craniofacial defects

Using both germline deletion and transient knockdown approaches, we establish zebrafish lines to model structural human craniofacial skeleton birth defects. By identifying genes that are known to cause birth defects in humans and inhibiting or inactivating the respective zebrafish orthologues of these genes, we study how and why mutations in these genes lead to defects.

Animal models of neurocognitive and behavioural disorders

Using time-lapse microscopy, animal tracking software and mouse and zebrafish behavioural analyses, we study how genetic compromise during embryogenesis can lead to subsequent learning, memory and behavioural issues in later life. Using mouse models deficient for two genes – PLAG1 and Grhl3 - we study the habenula brain region that acts as a "handbrake" to guard against socially-inappropriate or overt risk-taking behaviours. Understanding how this neural center is established and maintained at the genetic level may lead to new therapies.

Lab Head: Assoc Prof Seb Dworkin.

Lab members:
Ms Jemma Gasperoni; Mr Jarrad Fuller; Ms. Emma Parks; Mr. Zachary Di Pastena.

Fields of Study:
Embryology; Genetics; Craniofacial Biology; Neurodevelopment; Animal models of disease.

Capabilities and Techniques:
Zebrafish model system; confocal and fluorescent microscopy; in-situ hybridisation; cartilage & bone staining; PCR & DNA/RNA molecular biology techniques; micro-injection; immunohistochemistry and basic histology; genetically-defined models (mouse, zebrafish) and mouse palate cultures.

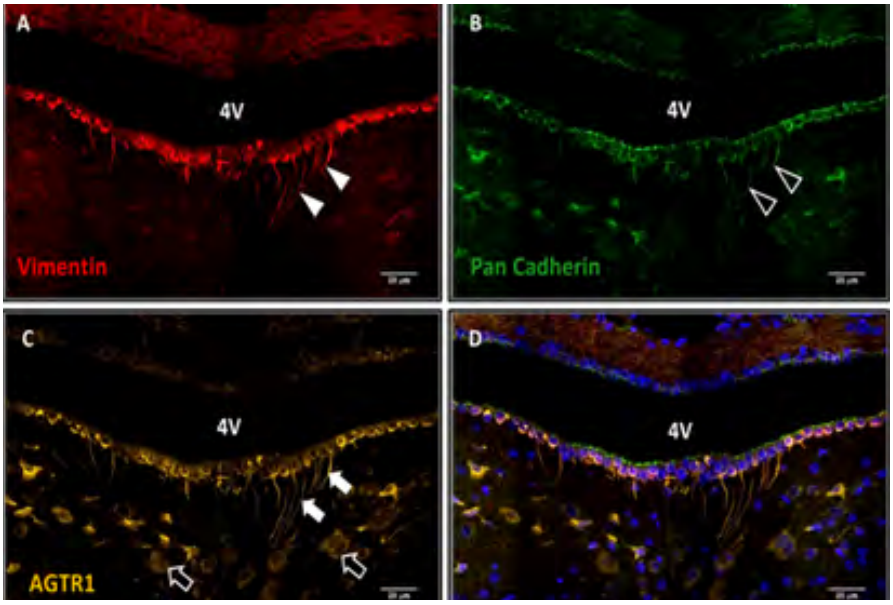
Translational Opportunities:
Genetic counselling; Gene mutation identification for pre- and peri-natal healthcare to ameliorate craniofacial defects and behavioural disorders.

Diabetes Development and Prevention Group

The Diabetes Development and Prevention research group is involved in broad range of research activities which includes experimental, clinical trials and community-based research. The primary aim of our group is to explore risk factors which increases the incidence of diabetes and identifies measures that can be undertaken to prevent the development of this disease and thereby reducing the development of cardiovascular complications. The group uses innovative high-performance clinical and analytical techniques to assess the levels & activity of enzymes, hormones and trace elements in various biological samples in both animal model and human model. The research group has established collaborations with local, national, and international research teams aiming for better prevention and early management of diabetes mellitus and related co-morbidities. The group is also investigating barriers pertaining to diabetes management and wellbeing in people from Culturally And Linguistically Diverse (CALD) communities living with type 2 diabetes Australia. The lab has three main research foci:

The antioxidant, anti-inflammation and hypoglycaemic effects of selected nutraceutical supplements
This research project aims to investigate the effects of a series of nutraceutical supplements (including citrus bioflavonoids and phytosterols) on the levels of oxidative stress, inflammation and glycaemic index in prediabetes and type 2 diabetes mellitus. This project involves research collaboration from local (Professor Grant Drummond, Associate Professor Colleen Thomas, Dr Maria Jelinic), national (Dr Glenn Jacobson – University of Tasmania, Professor Catherine Itsiopoulos – Murdoch University) and international (Dr Lynne Chepulis – Waikato University, NZ).

Indicators of poor glycaemic control
This project aims to highlight the interplay of several biochemical markers associated with poor diabetes outcome which may precipitate the development of diabetes complications including cardiovascular disease. In collaboration with research staff from Charles Sturt University and Khalifa University, UAE, the research team introduced the oxidative stress and inflammation assessment as a routine clinical test of diabetes screening program in rural areas.



Immunofluorescence labeling of vimentin (A), pan cadherin (B), AGTR1 (C) and combined (D) in coronal sections of rat brain (Photo credit: Hayder Al-Aubaidy)

Improve diabetes management in developing countries
This research project focuses on improving the current measures used in early detection and management of type 2 diabetes in developing countries. It has established collaboration with several clinicians and medical researchers from international universities in both Iraq and India to look for better ways to increase awareness of the risks of diabetes and its complications, through early diagnosis of prediabetes and type 2 diabetes mellitus. These research project involves – Dr Jency Thomas, Dr Sabrina Gupta (Local), Dr Ramesh M (JSS university, India), Associate Professor Amani Alhazmi (King Khalid University, Saudi Arabia) & Dr Clarice Tang (Victoria University, Australia).

Lab Head:
Assoc Prof Hayder Al-Aubaidy.

Lab members: Dr Jency Thomas; Dr Sabrina Gupta; Dr Dina Jamil; Ms. Deniz Heydarian; Mr Rahul Puvvada; Mr Anwar Althubyani; Ms. Chandana Deekshith; Mr Abdulsatar Jamal; Mr Jad El-Rassi.

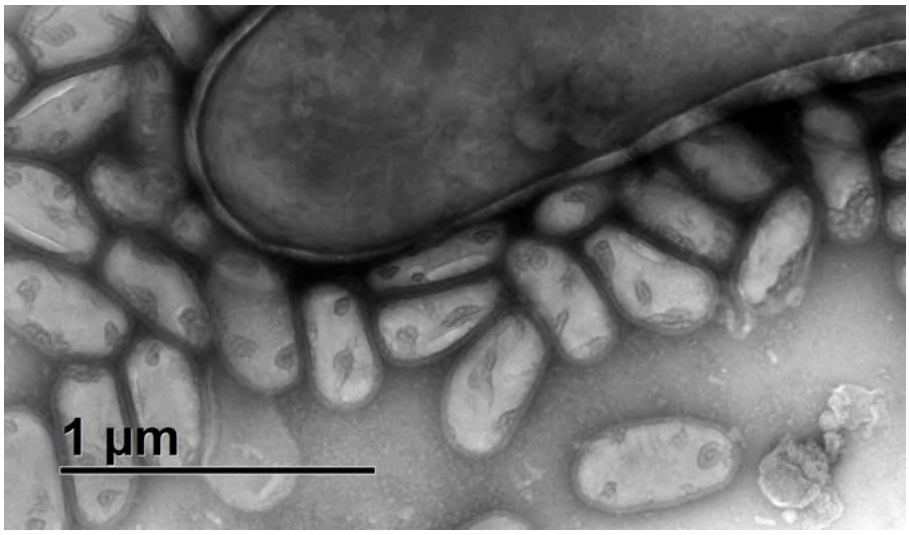
Fields of Study:
Diabetes Mellitus; Cardiovascular Disease Prevention, Diagnosis and Early Management; Nutrition; Public Health; Clinical Sciences.

Capabilities and Techniques:
Ultra-Performance Liquid Chromatography-Mass Spectrophotometry; Enzyme Linked Immunosorbent Assay; Fluorometry; Molecular Biology; Epigenetics; Immunohistochemistry, Semi-structured interviews, Qualitative and Quantitative data analysis.

Translational Opportunities:
Ultra-Performance Liquid Chromatography-Mass Spectrophotometry, Enzyme Linked Immunosorbent Assay, Fluorometry, Molecular Biology and Epigenetics. Quantitative and Qualitative research methodologies, Semi structured interviews, Randomised Control Trials (RCTs) & Community engagement.

Environmental Microbial Genetics Group

We study horizontal gene transfer (HGT) and genome sequencing, which is the mechanism of gene-swapping between bacteria of unrelated species. HGT provides opportunities for bacterial evolution over long and short timespans. HGT has contributed to antimicrobial-resistance amongst diverse, clinically significant, bacterial species, a situation that now threatens the usefulness of antimicrobials in the treatment of bacterial infections. We study plasmids, transposons and bacteriophages which are vital components of HGT. Our research group uses molecular genetic techniques, transmission electron microscopy, next generation sequencing, microbiological techniques and CRISPR/cas9 gene editing. We also have state of the art equipment, e.g. Illumina MiSeq, Nanopore sequencing facility, bioprocessing fermenter and other equipment to perform genetic analysis.



Transmission Electron Microscope Image of *Mycolasynbacter amalyticus* infecting *Gordonia pseudoamarae* (Photo credit: Steve Petrovski)

Bacterial horizontal gene transfer in *Pseudomonas aeruginosa*

Bacteria are evolving and are becoming resistant to antibiotics. Understanding how bacteria gain resistance can enable us to control the spread of resistance. *Pseudomonas aeruginosa* is a bacterium that thrives in environments including in humans where it can be part of the normal flora or an opportunistic pathogen that causes serious infections. *Pseudomonas* infection treatment is challenging because it is naturally resistant to antimicrobial agents and can carry plasmids that confer antibiotic resistance. We focus on the genetic elements in *P.* aeruginosa that contribute to the spread of antimicrobial resistance, particularly broad-host-range plasmids which are transmissible between diverse types of Gram-negative bacteria and serve as vehicles for HGT. We study the distribution and evolutionary relationships of these elements as well as the mechanistic basis of their mobility. Our aim is to prevent or limit the spread of antibiotic resistance and our research could also lead to new molecular biology tools that genetically manipulate bacteria.

Population dynamics and biocontrol of wastewater foams

Activated sludge processes remove excess nutrients from wastewater prior to release into other water bodies (oceans and/or lakes) but often fail due to microbiological foams. The brown scum surface foam in aeration tanks contains Candididatus '*Microthrix parvicella*' or "Mycolata" bacteria. We apply lytic bacteriophages directly to activated sludge plants to reduce the bacterial cell numbers below the foaming threshold. We have isolated >100 mycolata bacteriophages and have shown that we are able to control them. We also study bacteriophage interactions to identify their population dynamics.

Treating bacterial infections with phage therapy in humans and animals

With antibiotic resistance, alternative ways such as Phage therapy are needed to control serious bacterial infections. We are collaborating with Dr Joseph Tucci (School of Pharmacy) to find new phages for topical pharmaceuticals that fight bacterial infections and are developing pharmaceutical products that contain phages as an alternative to antibiotics. In collaboration with Defence Science Technology Group we are also developing bacteriophage bioterrorism biosensors to detect highly pathogenic organisms

Lab Head: Assoc Prof Steve Petrovski.

Lab members: Dr Richard Melvin; Dr Mark Chan; Mr Jayson Rose; Ms Liana Theodoridis; Ms Mikaela Whitty; Mr Jarrod Martins; Ms Jessica Owen.

Fields of Study:
Microbiology; Genetics; Microbial Ecology; Evolution; Biosensors.

Capabilities and Techniques:
Electron microscopy; Next Generation Sequencing; Microbial assays; Molecular Biology.

Translational Opportunities:
Developing potential bacteriophage cocktails to be applied to wastewater treatment plants to control bacterial proliferation that cause foaming and bulking; Developing novel pharmaceutical products containing bacteriophages; Developing Phage biosensors detection tools for use by Australian Defence Force.

Hypertension and Diabetes Research Group

Cardiometabolic disease claims 40,000 Australian lives per year due to events such as heart attack and stroke. While current medications, which include blood pressure- and cholesterol-lowering agents, reduce the risk of a deadly event in some patients, they are not effective in all cases. Many patients remain at risk of a heart attack or stroke despite receiving best available care. Clearly, there are disease mechanisms at play that current medicines don't address. Our group is focused on identifying what these unknown mechanisms are and using the knowledge to identify new biomarkers for early disease detection and to develop more effective therapies. We use animal and cell culture models of cardiometabolic disease, as well as physiology, immunology, molecular biology, genomic and imaging techniques.

The NLRP3 Inflammasome and hypertensive end-organ disease

Hypertension (high blood pressure) affects 40% of adults and is the leading risk factor for heart disease and stroke. It also promotes kidney disease, dementia and retinopathy (vision impairment). Drugs that increase urine production, dilate blood vessels and/or reduce heart rate are used to reduce blood pressure; but, over half of all patients still cannot control their blood pressure with these medications. Hypertension also affects the immune system. We discovered that an immune complex called the NLRP3 inflammasome, contributes to the development of hypertension. Knocking out the genes that code for the NLRP3 inflammasome, or its cytokine product interleukin-18 (IL-18), reduces blood pressure, kidney injury and heart failure in mice with hypertension. Our current focus is on developing and screening novel drugs that block IL-18 or its receptor and determining their effectiveness at treating hypertension and its downstream consequences of kidney disease and heart failure.

Deciphering the gut phageome and its role in hypertension

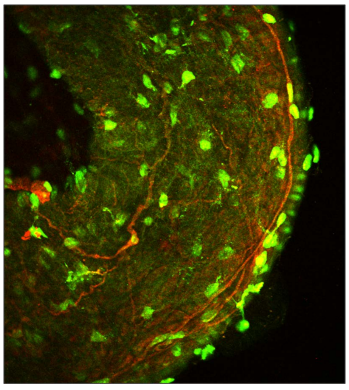
An imbalance in the gut bacterial communities can contribute to hypertension and related end-organ damage. However, an understudied yet vital organism in the gut are phages - viruses that infect and kill bacteria. We have discovered several phages that are highly abundant during experimental hypertension that are known to kill the 'good' bacteria of the gut. These phages may be prime targets for new treatments to improve gut health and high blood pressure.

Understanding the cellular and molecular drivers of heart attacks

Heart attacks are a major cause of global death and disability. They occur when the coronary arteries – which supply blood to the heart –- become blocked by fatty deposits called atherosclerotic plaques. Early detection and therapies that slow or halt their development could prevent blockages. This project will comprehensively explore human atherosclerosis biology using powerful multiomic approaches that include single-nucleus RNA sequencing, spatial transcriptomics, and imaging mass cytometry (through collaborations with the University of Sydney) tools to human coronary artery specimens. This study will likely identify: (1) candidate biomarkers for early detection of atherosclerotic plaques; and (2) crucial disease pathways that could serve as targets for future therapies to halt/ reverse atherosclerotic plaque development.

Comparing the effects of intermittent fasting and sex in metabolic syndrome

Intermittent fasting is an effective and natural strategy for weight control. It can also reverse metabolic disturbances such as hyperglycemia, hypertension, and unhealthy levels of fat in the bloodstream. Many studies have shown the beneficial effects of intermittent fasting in the setting of metabolic syndrome, but very few studies have considered the effect of sex, which our work will now investigate.



Inflammatory macrophages (green) accumulating in blood vessels from a pre-clinical model of high blood pressure

Lab Head:
Assoc Prof Antony Vinh & Dr Maria Jelinic

Lab members:
MrHenry Diep; Dr Courtney Judkins; Dr Narbada Saini; Ms Vivian Tran; Ms Hericka Bruna Figueiredo Galvao; Ms Flavia Wassef; Ms Buddhila Wickramasinghe; Ms Tayla Gibson Hughes; Mr Jake Robertson; Ms Liana Theodoridis; Ms Sarah Hayes; Ms Mikaela Whitty; Ms Maeve O'Keefe, Mr Satar Jamal; Ms Emma Stent; Mr Jad El Rassi

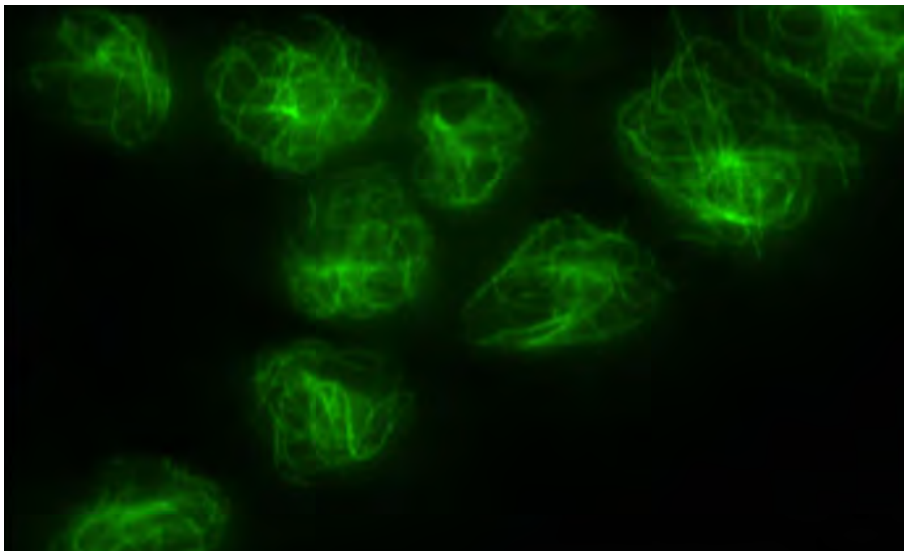
Fields of Study:
Hypertension; Diabetes; Obesity; Immunology; Pharmacology

Capabilities and Techniques:
Animal models of hypertension, diabetes and obesity; flow cytometry; histopathology; immunohistochemistry; biomedical imaging; confocal microscopy; genomic sequencing; spatial transcriptomics; in vivo cardiovascular/renal function; oxidative stress & inflammation assessment; vascular reactivity/compliance.

Translational Opportunities:
Drug discovery, validation; pre-clinical chronic kidney/liver/vascular disease drug assessment; hypertension/diabetes therapy and dietary interventions.v cdf

Microbial Cell Biology Group

We investigate mitochondrial function and associated signalling pathways in neurodegenerative and neurological disorders – namely mitochondrial diseases, Alzheimer's Disease, Parkinson's Disease and Myalgic Encephalitis/Chronic Fatigue Syndrome (ME/CFS). Mitochondria are tiny organelles in cells that are often termed the powerhouses of cells because they are responsible for producing most (>90%) of the cell's energy. Dysregulation of the mitochondria or its associated signalling pathways is associated with neurological disorders, but the exact mechanism remains unclear. We employ different cellular models to investigate this including human cell models and a simple eukaryotic model *Dictyostelium discoideum*. Our ultimate aim is to characterise the underlying cytopathologies of certain neurological diseases and use this to identify disease biomarkers and develop diagnostic tests.



Dictyostelium cells showing microtubules in green. (Photo Credit: Katelyn Mcrozek)

Mitochondrial Disease

The organ system most commonly affected by mitochondrial dysfunction is the central nervous system and all of the major brain diseases are reported to involve impaired mitochondrial function. We use the simple eukaryotic model *Dictyostelium* to study mitochondrial disease. We create disease in *Dictyostelium* by disrupting (knockout), antisense-inhibiting (knockdown) or overexpressing wild type or mutant *Dictyostelium* or human disease genes. The main aim of this project is to characterise the changes to signalling proteins and pathways which occur in mitochondrial disease in order to increase our understanding and identify targets for therapeutic and diagnostic use.

Parkinson's Disease

Parkinson's Disease (PD), is a common neurodegenerative disease, no cure exists and the pathways leading to the disease are still unknown. We use different blood cellular models to investigate PD. In blood cells we characterise the mitochondrial function, measure activities of associated signalling proteins, and investigate pathways by exposing cells to pharmacological agents. We also investigate genetic forms of PD by either genetically altering homologous PD-associated genes in *Dictyostelium* or by expressing in *Dictyostelium* human PD-associated proteins. We then investigate the impacts of these on mitochondrial function and associated cellular signalling pathways. Using these two models allows us to investigate basic cellular roles of proteins and translate this information in a human system.

Myalgic Encephalitis/Chronic Fatigue Syndrome (ME/CFS)

Myalgic Encephalomyelitis/Chronic Fatigue Syndrome (ME/CFS) is incurable and affects 0.7-3.3% of the Australian population. The rate of recovery is only 5% and as the onset age is in the 30s, patients can remain ill for decades. We discovered mitochondrial and molecular and cell signalling abnormalities in ME/CFS cells, and have created new *Dictyostelium* cell models to investigate the causative molecular pathways.

Lab Head: Dr Sarah Annesley and Emeritus Prof Paul Fisher.

Lab Members:
Ms Oana Sanislav; Ms Claire Allan; Ms Katelyn Mcrozek; Mr Xavier Pearce; Ms Gizem Sen; Ms Claire Storey; Mr Daniel Missailidis; Ms Vanessa Musco; Ms Mayu Aburaya.

Fields of Study:
Cell Biology, Metabolism; Molecular Biology; Molecular Genetics.

Capabilities and Techniques:
All techniques of molecular biology; Seahorse respirometry assays; enzyme activity assays; immunofluorescence microscopy; diverse FRET-based; fluorometric and luminometric assays of cellular functions; transcriptomics; proteomics.

Translational Opportunities:
We have published a protocol for a diagnostic test for ME/CFS. It is a clinically useful biomarker test to aid in diagnosis of ME/CFS. We are also engaged in work on the development of a similar blood test for early, prodromal diagnosis of PD prior to it being clinically diagnosable by current neurological criteria.

Microbiology of Natural and Engineered Ecosystems Research Group

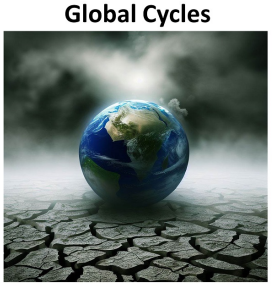
Life on earth relies on six elements C, H, N, O, P, S, which make up the building blocks of its macromolecules. Microbial redox reactions constantly transform and recycle these elements, shaping the environmental conditions of all niches on Earth. Microorganisms such as bacteria and archaea are responsible for approximately 15% of the Earth's biomass and are essential to the biosphere. They drive global carbon and nutrient cycles and regulate the climate. Our group is interested in understanding the ecological significance and biogeochemical basis of these processes, and their interaction with microbial biodiversity and primary production. We integrate culture-independent techniques with biogeochemical measurements (both in the field and the lab), supported by contemporary statistics and ecological theory. Our mission is to advance impactful research with the aim of addressing global challenges such as environmental degradation, food security and climate change. To achieve this, our work is based on the following three research themes:

Biodiversity and Function
Microbes exhibit remarkable diversity and occupy every ecological niche on the planet, including extreme habitats such as deserts and caves. Our research has shown that a surprising diversity of microbial life exists in these ecosystems, despite the common view that they are too challenging and nutrient poor. However, many bacteria exhibit metabolic flexibility and can endure long periods in a dormant state. They can in fact utilise a diverse range of inorganic energy sources, including atmospheric trace gases, to survive and grow. Understanding the diversity, ecology and function of these organisms can help us better predict how life and biodiversity arise and persist in the face of climate risks such as desertification and nutrient depletion.
Key question: What is the functional and biogeochemical basis of microbial persistence and growth in energy-deprived and extreme environments across terrestrial and aquatic systems?

Biodiversity & Function

Soil Fertility & Health

Climate Change & Global Cycles



Soil Fertility and Health
Soil biomes globally make up a multifaceted ecosystem that harbours a high diversity of microbial life. They have a significant impact on soil productivity, by facilitating nutrient cycling, decomposing organic material, and underpinning plant symbiosis. Understanding the structural and functional basis of microbial biodiversity in soil biomes and how this relates to ecosystem services could enable us to develop strategies to improve soil health and productivity.
Key question: What is the structural and functional basis of microbial biodiversity in soils and how does this relate to ecosystem services affecting soil fertility and plant health?

Climate Change and Global Cycles
Microorganisms play a vital role in driving global biogeochemical cycles. They are central actors in global carbon and nutrient cycles and regulate potent greenhouse gases such as methane, carbon dioxide and nitrous oxide. Understanding the microbial basis of these cycles can enable us to develop strategies to mitigate the effects of climate change and improve the quality of our environment.
Key question: What is the microbial role in driving global biogeochemical cycles and regulating greenhouse gases such as methane, nitrous oxide, and carbon dioxide?

Our Impact
Our research contributes to our understanding of the microbial world and its role in shaping the Earth's environment. Our findings provide fundamental advances and could create new methods to enhance environmental stability, food security and mitigate global risks such as climate change.

Lab Head: Dr Sean K. Bay

Lab Members:
Currently seeking PhD, MSc and BSc students.

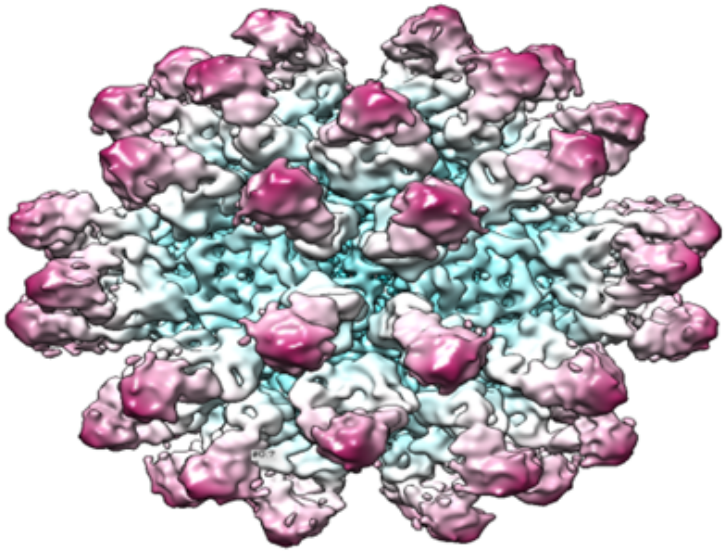
Fields of Study:
Environmental Microbiology; Biogeochemistry; Microbial Ecology.

Capabilities and Techniques:
Microbial biodiversity and functional studies, Gas chromatography of atmospheric trace gases, Microbial activity studies, Radioisotope studies, Nutrient budgets, Soil physicochemistry, GIS spatial mapping.

Translational Opportunities:
Microbial biodiversity monitoring of soil and aquatic systems, Atmospheric gas monitoring, Nutrient and Carbon monitoring, Soil fertility and degradation monitoring.

Molecular and Structural Virology Group

Our group investigates how viral pathogens impact the conservation of both native wildlife and economically important livestock animals. We utilise genomic and structural biology approaches to study the evolutionary dynamics of viruses, with a strong emphasis on animal health conservation. Our research involves partners from local, national, and international communities. Our goal is to elucidate the molecular evolution of viruses and the structure and function of essential viral proteins, in order to guide the development of anti-viral strategies and subunit vaccines against viral pathogens. By utilizing advanced genomic techniques, bioinformatics, viral metagenomics, cell biology, imaging, protein expression and purification, structural biology, and recombinant DNA vaccinology, we explore the following main research themes:



Structure of a viral capsid bound with antibody. (Photo credit: Subir Sarker)

Discovery of novel and emerging pathogens

Our group has a strong track record of sequencing novel animal pathogens and studying their potential impact on the conservation of threatened species. Historically, our ability to detect pathogen diversity has been limited, but recent advances in next-generation sequencing technology have allowed for the discovery of a greater number of novel pathogens. Currently, our group is primarily focused on two areas of pathogen discovery: (1) detecting viral and bacterial pathogens that threaten both wild and livestock animals, and (2) detecting and sequencing novel bacteriophages to control antibiotic-resistant bacterial pathogens in chickens. Our research is aimed at answering specific questions, including the potential development of novel therapeutics and subunit vaccines.

Conservation of threatened species

Our group has undertaken various projects, both past and present, to investigate the impact of viral and bacterial pathogens on the conservation of threatened species. These projects have included research on several endangered species, such as the Orange-bellied parrot, swift parrot, Western ground parrot, red-tailed black cockatoo, and green sea turtle. Our current projects are focused on identifying the key threatening processes caused by viral and bacterial pathogens that continue to endanger them and what management actions can most likely be taken to enhance the survival of these species.

Understanding structure and function of viral protein

An in-depth understanding of the structure and function of critical viral proteins is essential for developing potential anti-viral drugs or vaccines that can effectively treat viral diseases. Our group is well-positioned, with the support of the Australian Research Council, to further explore this area of research, which is directly related to translational research. This research utilizes cutting-edge technologies, such as recombinant protein expression and purification, X-ray crystallography, cryo-electron microscopy, and atomic force microscopy, to determine the atomic structure of viral proteins. By gaining a deeper understanding of the functions of these proteins, our goal is to develop novel anti-viral drugs or vaccines to benefit threatened wild and livestock animals.

Control of viral and bacterial pathogens

Controlling viral and bacterial pathogens is essential in preventing the spread of infectious diseases and protecting the health of animals and the public. Our group is currently collaborating with Charles Sturt University, the Department of Primary Industries, and Australian Zoos to develop a subunit vaccine against a deadly viral pathogen that infects endangered native avifauna. Additionally, we are also working on developing a bacteriophage-based treatment option for an economically important bacterial infection in chickens. Our project involves industry partners and RMIT University.

Lab Head: Dr Subir Sarker
Lab members: Ms Ajani Athukorala; Ms Natalie Klukowski; Ms Betul Yavuzel; Mr Josh Stackpole.

Fields of Study:
Virology; Veterinary microbiology; Structural biology; Metagenomics; Veterinary pathogens.

Capabilities and Techniques:
Recombinant protein expression & purification; subunit vaccine development; X-ray crystallography; Microscopy: Cryo-electron microscopy, transmission electron, confocal; X-ray crystallography; Next generation sequencing; structure and function of bacteriophage in controlling economically important livestock pathogens.

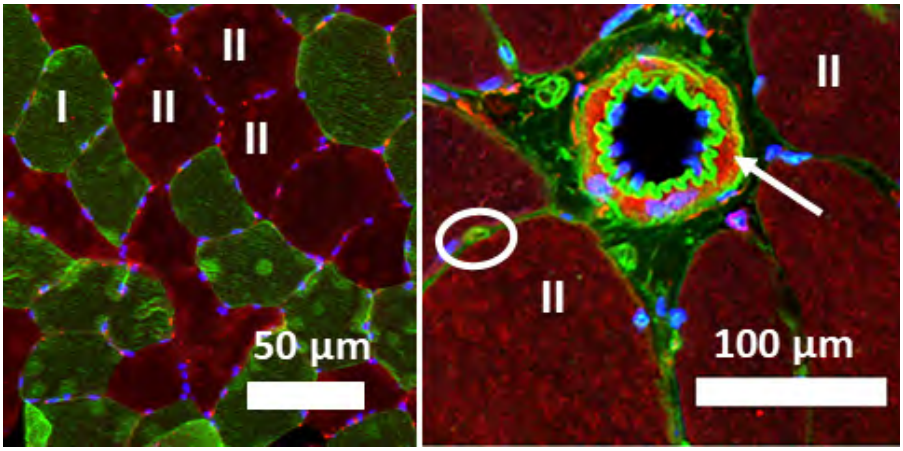
Translational Opportunities:
Animal pathogen detection; targeted subunit vaccine and antimicrobials development; Threatened species conservation; bacteriophage solutions for antibiotic resistant infections in animals.

Musculoskeletal Research Group

Skeletal muscle tissue (the largest mass in the human body) accounts for 45% of total body weight and is essential for human health adapting in function and metabolism in response to increased physical activity and changes to metabolic demands. Loss of skeletal muscle mass leads to devastating consequences causing permanent disability and mortality in many conditions, including cancer, chronic heart failure, burn injury, kidney disease, diabetes, ageing, disuse, and numerous genetic disorders such as muscular dystrophy. We aim to understand the cellular mechanisms that regulate muscle plasticity and adaptation, so that we can identify new targets or develop treatment options for conditions with compromised skeletal muscle health. We study skeletal muscle adaptation and plasticity via a translational research approach using pre-clinical laboratory models including cell culture and multiple animal models of muscle adaptation and plasticity that are complemented with clinical models of exercise in humans.

Identifying novel supplements for muscle health
Endurance athletes consume supplements to minimize exercise-induced stress and enhance recovery and performance. Many supplements claim to positively influence exercise induced muscle adaptation but are poorly investigated regarding in vivo activity and efficacy in humans. We aim to understand supplement effects on healthy skeletal muscle function.

Improving muscle regeneration Skeletal muscle sports injuries are frequently associated with significant morbidity and prolonged loss of function. After injury, skeletal muscle regeneration has distinct phases: inflammation, degeneration and regeneration. These phase transitions are not fully understood. We use complementary cell culture experiments and muscle injury and regeneration animal models to study new muscle repair improvement therapies.



Fluorescent staining of myosin heavy chain and blood vessel in skeletal muscle (Photo credit: Nicole Stupka)

Characterizing genetic models of myopathy
Effective treatments for myopathies are difficult to find because the molecular changes underlying clinical phenotypes are poorly understood. Few mammalian models are available to study disease progression from juveniles to adult and finally in elderly mammals. Ageing effects are important for muscle related disorders as age-related changes in normal muscle protein expression, muscle strength and fibre-type composition can impact animal model responses to therapeutic strategies and pre-clinical therapeutic drug testing. We characterize and define age related changes in skeletal muscle phenotype in new muscle pathology models. We characterize new RyR1 myopathy models to test therapeutic strategies and drugs.

Targeting ER stress to improve skeletal muscle and bone health
The endoplasmic reticulum (ER) is pivotal in protein folding and calcium homeostasis in cell types including skeletal muscle. Selenium, essential for skeletal muscle, bone, and vascular health is present in selenoproteins. Selenoprotein S (Seps1) is one of seven ER selenoproteins and regulates Ca2+ movement and storage, oxidative and ER stress responses, inflammation, and adipocyte differentiation in skeletal muscle. Seps1 is a possible treatment for disorders with decreased muscle strength and endurance, loss of muscle mass, and bone degeneration. Our research group in collaboration with the Australian Institute for Musculoskeletal Science (AIMSS), is investigating the role of Seps1 in muscle and bone health.

Lab Head: Dr Chris van der Poel.

Lab Members:
Dr Jarrod Church; Dr Caroline Taylor; Dr Travis Dutka; Dr Giuseppe Posterino; Dr Brett Gordon; Dr Nicole Stupka.

Fields of Study:
Skeletal Muscle; Sports Medicine; Cell Physiology.

Capabilities and Techniques:
Muscle injury models (chemical, stretch, and ischaemia-reperfusion); Skeletal muscle contractile function testing (in vitro, in situ); histology; immunohistochemistry; cell culture; biochemistry.

Translational Opportunities:
Muscle strength; Inflammatory Myopathies; Genetic Myopathies; Sarcopenia; Sports Supplements; Skeletal muscle health; Adaptation to exercise.

Pain and Childbirth Group

There is an urgent need to improve approaches to supporting women through childbirth, to promote normal birth and positive experiences for women.

The pain associated with labour is unique and complex. While typical occurrences of pain tend to be associated with injury or disease, labour pain is different. It arises during a natural process in which it plays a role in driving the hormonal events of labour.

Despite the unique context and function of labour pain – which differentiates it from the pain associated with injury or disease – labour pain is most commonly treated as a pathological pain, associated with suffering. Rates of birth trauma, fear of birth and medical intervention during childbirth are escalating in developed countries, leading to increased exposure to risks and poorer health outcomes for women and babies. Compounding the issue, women exposed to high intervention rates who also perceive intrapartum care to be poor, are more likely to experience acute trauma symptoms.

Dr Laura Whitburn leads an innovative research program to better understand the experience of childbirth based on contemporary pain science and consciousness theories. This work looks at the neurobiological mechanisms behind childbirth and how these influence women's conscious state and perceptions during labour. This includes the role of the nocebo effect, where negative experiences can be elicited through verbal and non-verbal cues.

This aim of this program is to enhance the care provided to women during this transformative event, to improve the health of mothers and their babies and reduce rates of birth trauma.

Persephone's Birth (Photo credit: Jason Lander)

Current projects:

- Labour pain assessment: Evaluating a new woman-centred approach
- The language of labour pain: Understanding how words influence women's experiences of labour pain
- Midwives' views and experiences of supporting women to manage labour pain

Lab Head: Dr Laura Whitburn.

Collaborators:

- Prof Christine East (School of Nursing and Midwifery)
- Dr Mary-Ann Davey (Monash University)
- Dr Lester Jones (Singapore Institute of Technology)
- Dr Elizabeth Newnham (The University of Newcastle)
- Dr Kate Dawson (Australian Catholic University)
- A/Prof Allan Cyna (The University of Adelaide)

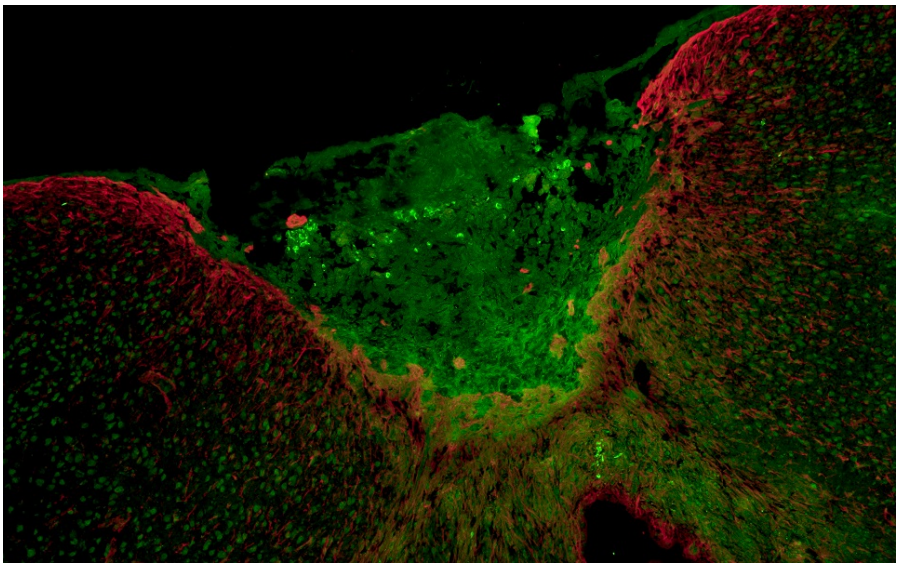
Fields of Study:
Medical and Health Sciences; Midwifery; Physiotherapy; Obstetrics; Gynaecology.

Capabilities and Techniques:
Qualitative research methods, particularly phenomenology; Longitudinal cohort studies.

Translational Opportunities:
The outcomes of this research aim to influence current practices in supporting women in labour, including policy and models of care.

Stroke and Brain Inflammation Group

Our research group aims to understand the fundamental injury and repair mechanisms which occur during stroke. A stroke triggers a series of damaging events following its onset, including inflammation and systemic infection that lead to cell death and changes in mobility. Our team has introduced routine immunological approaches that are now widely used in this field to tackle inflammation. Our key research focuses on whether immunotherapies – that is therapies which either supress or activate the body's immune response - can be used to reduce brain inflammation and consequently reduce the burden of stroke. The team has extensive expertise using rodent studies, as well as new approaches to analysing large data sets to identify new relationships in stroke pathology. Our team aims to address gaps in existing research by addressing key risk factors such as advanced age and sex in our work.



Immunofluorescence image of glial scar surrounding the infarct area after stroke (Photo credit: Samoda Rupasinghe)

Targeting inflammation in stroke

Stroke, from insufficient blood flow to the brain, is treated by clot-buster drugs or surgical clot removal to restore blood flow. However, these interventions are only suitable for 20% of patients and must be used quickly requiring advanced neuroimaging facilities. Brain cells may rapidly die from lack of oxygen or later from inflammation. We study acute and chronic stroke treatments that target and neutralise local inflammation. We assess brain injury, inflammation, motor function and cognition impairment in animal models of stroke, and examine immunotherapies as a treatment for stroke.

Amniotic cell therapy in stroke

We have found that treatment with human amnion epithelial cells (hAECs) is neuroprotective when administered within the acute phase of experimental stroke. That work has been translated into a Phase I clinical trial of hAECs in 8 acute stroke patients. We are also identifying how long after a stroke that hAEC therapy might still be beneficial. We routinely incorporate aged mice of both sexes into our preclinical studies to better simulate the clinical scenario.

hAEC-derived extracellular vesicles in stroke

We are extending our work on hAECs by exploring the potential of tiny particles (extracellular vesicles) released by the cells as another attractive stroke therapy. Extracellular vesicles (40-120 nm in size) can act as signalling mediators between cells, and those released by hAECs contain material that supports blood vessel development and tissue healing. We predict that extracellular vesicles from hAECs may be protective after stroke when simply administered intravenously or intranasally. Purified extracellular vesicles are more drug-like than hAECs and can be readily stored and quickly prepared for use.

Estrogen receptor signalling in stroke

Clinically, pre-menopausal women have a lower incidence and better outcome after stroke than men and post-menopausal women. Pre-clinical studies have reported a neuroprotective role of estrogen. We have previously found that drugs selectively targeting a novel estrogen receptor (GPER1) can substantially influence stroke outcome in a sex-dependent manner. Using mice deficient in GPER1, our research aims to gain a better understanding of sex difference in outcome after stroke, in terms of brain injury and inflammation. Furthermore, we aim to elucidate the importance of GPER1 of estrogen signalling using a selective antagonist, G-15, and agonist, Tamoxifen.

Lab Head: Dr Helena Kim.
Lab members: Dr Richard Zhang; Ms Liz Barreto Arce; Ms Samoda Rupasinghe; Ms Lucy Jenkins.

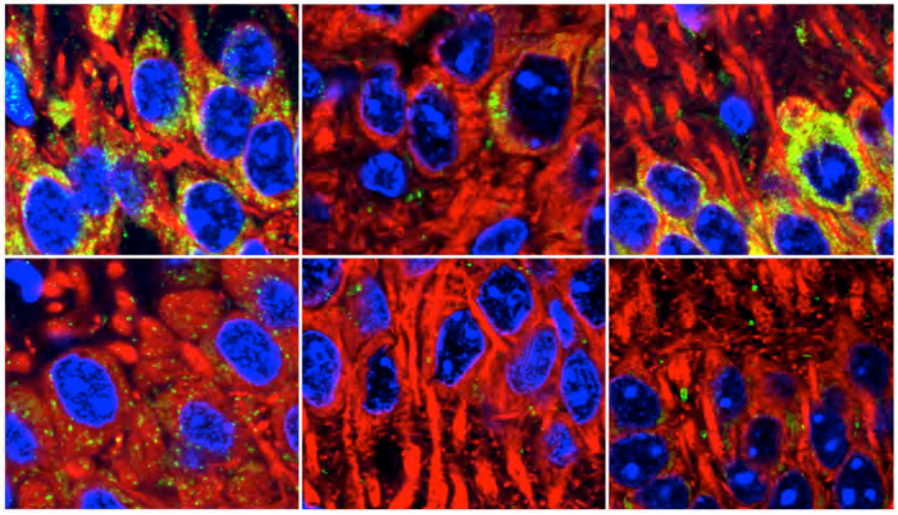
Fields of Study:
Stroke; Brain inflammation; Neuroprotection; Cell therapy; Immunotherapy.

Capabilities and Techniques:
Ischemic stroke animal models; Animal behavioural testing; Immunofluorescence; Flow cytometry; Molecular biology; RNA sequencing; Genomics; Big data analysis.

Translational Opportunities:
Our findings hold promise for clinical translation and have already played an instrumental role in initiating three clinical trials for stroke treatment.

Vascular Dementia and Epigenetics Research Group

Our group aims to identify the epigenetic and molecular mechanisms involved in the injury process of vascular dementia (VaD) in order to develop new therapies for its treatment. Through our research, we have discovered many potential targets and have utilized a range of pharmacological agents.



Immunofluorescence images of inflammasome activation in the hippocampus in Vascular Dementia (Photo credit: Garrie Arumugam)

The Hypoxisome in Neuronal Resilience and Cell Death

Our research has uncovered that both hypoxia, which occurs due to oxygen deprivation at the tissue level, and cerebral ischaemia, which results from insufficient blood flow to the brain, activate five signalling pathways that converge on the hypoxisome - a nuclear multi-protein complex that is associated with DNA. The hypoxisome controls genes that dictate the fate of neurons. Our primary focus is to investigate the effect of hypoxisome on cell death following ischaemic stroke, specifically in cases of severe injury where the hypoxisome up-regulates proteins that trigger and execute neuronal death programs. Additionally, we are studying the hypoxisome during the post-stroke remodelling phase, where it up-regulates adaptive stress response genes encoding proteins that promote neuronal survival. By understanding the role of the hypoxisome in both detrimental and beneficial post-stroke processes, our research aims to develop new therapeutic strategies for treating ischaemic stroke.

Uncovering the Mechanisms of Sterile Neuroinflammation in Stroke and Vascular Dementia (VaD)

Neuroinflammation is known to cause neuronal tissue damage, impairments, and disabilities. However, the mechanisms that initiate neuroinflammation in vascular dementia (VaD) remain poorly understood. Our research has revealed that cerebral hypoperfusion activates innate immune receptors, which then trigger signalling cascades that activate protein kinases, leading to an inflammatory response. This activation of intracellular signalling pathways results in an increased production of inflammasomes, which are multi-protein complexes that contribute to tissue injury and cell death. In our animal model of VaD, we have observed that inflammasomes play a critical role in neuronal tissue damage and behaviour. Specifically, we are investigating how immune receptors recognize self-ligands in neurons undergoing metabolic stress, and activate inflammasomes and caspase-1, ultimately leading to neuronal injury or death. Additionally, our research focuses on how blocking the inflammasome signalling pathways weakens the initiation and amplification of inflammatory cell responses, thereby improving functional outcomes. Our findings provide a novel avenue for the development of potential therapeutic targets for the treatment of VaD.

Intermittent Metabolic Switching and Epigenetics

Recent studies have revealed that individuals with metabolic diseases have an elevated risk for age-related neurological disorders. Intermittent fasting, a dietary protocol characterised by alternating periods of feeding and fasting, has been shown to mitigate or prevent cellular dysfunction and degeneration in various cardiovascular disease models, including dementia. However, the precise mechanisms by which intermittent fasting modifies the expression of proteins involved in these protective effects remain to be elucidated. Our research demonstrates that intermittent fasting provides protection against both ischaemic stroke and VaD. Previous investigations have shown that epigenetic germline inheritance of diet can lead to obesity and insulin resistance. In our own work, we have observed epigenetic changes in animals following intermittent fasting, which may underlie the beneficial effects seen in a range of disease conditions. We seek to identify specific intermittent fasting-induced epigenetic changes that promote expression of protective genes and ultimately improve outcomes in ischaemic stroke and vascular dementia.

Lab Head: Prof Thiruma V. Arumugam (Garrie).
Lab members: Dr Quynh Dinh; Ms Nishat Tabassum; Mr Yibo Fan; Mr Xiangyuan Peng; Mr Xiangru Cheng; Ms Fizza Hussain; Mr Marconi Fung

Fields of Study:
Neurobiology; Pharmacology; Molecular Biology; Epigenetics; Neurodegeneration.

Capabilities and Techniques:
Ischaemic stroke and vascular dementia animal models; Molecular Biology; RNA sequencing; Genomics; Proteomics; Flow Cytometry; Bioimaging; Cognitive Testing.

Translational Opportunities:
Our research on the hypoxisome and inflammasome has revealed novel mechanisms of cell death and potential therapeutic targets for ischaemic stroke and vascular dementia. Our findings hold promise for clinical translation and have already played an instrumental role in initiating three clinical trials for stroke treatment.

About La Trobe University

Our Mission

Advancing knowledge and learning to shape the future of our students and communities.

Our Vision

To promote positive change and address the major issues of our time through being connected, inclusive and excellent.

Our Values

Our early reputation as a radical and challenging institution continues to in uence the way we enrich the experience of our students and engage with our partners and communities.

We were founded half a century ago to broaden participation in higher education in Melbourne's north and, later, in regional Victoria. We have succeeded for many thousands of students who would otherwise have been excluded from the opportunities provided by a university education.

We continue to support access, diversity and inclusivity while undertaking world-class research that aims to address the global forces shaping our world and make a difference to some of the world's most pressing problems, including climate change, securing food, water and the environment, building healthy communities, and creating a more just and sustainable future.This approach is based on our values of:

- inclusiveness, diversity, equity and social justice
- pursuing excellence and sustainability in everything we do
- championing our local communities in Melbourne's north and regional Victoria
- being willing to innovate and disrupt the traditional way of doing things.

Of all Australian universities, we are the most successful at combining accessibility and excellence, and have become a place where social inclusion and globally-recognised excellence come together for the bene t of our students, our staff and our communities.

Our academics and researchers achieve national and international recognition, our public intellectuals demonstrate an enduring social conscience and in uence, and our alumni achieve extraordinary success and impact in government, industry and not for pro t organisations.

We strive to be exemplars for the sector in our commitment to gender equity and to inclusivity for marginalised groups; and we work with indigenous peoples and organisations to support their social, cultural and economic aspirations.

We embrace sustainable practices across all our campuses because we are committed to improving environmental, social and economic outcomes for our communities.

We contribute to economic development for our local communities, and our future activity will increasingly be international as we become a globally connected university in everything we do.

Our Culture

La Trobe Cultural Qualities

Our cultural qualities underpin everything we do. As we work towards realising the strategic goals of the University we strive to work in a way which is aligned to our four cultural qualities:

Connected

- We are Connected: Connecting the students and communities we serve to the world outside

Innovative

- We are Innovative: Tackling the big issues of our time to transform the lives of our students and society

Accountable

- We are Accountable: Striving for excellence in everything we do. Holding each other to account, and working the highest standards

Care

- We Care: We care about what we do and why we do it, because we believe in the power of education and research to transform lives and global society.

About Victoria and Melbourne

Experience Melbourne

Melbourne is the capital of the state of Victoria, and Australia's second largest city. It's a multicultural hub with 4.5 million people from over 153 countries. It's one of the world's best sporting cities, and is Australia's art and culture capital. Melbourne is a safe, well-serviced city in which to live. The main campus of the University at Bundoora is close to many world class hospitals, schools, research centres, shopping centres, bike paths and parklands. Melbournians enjoy, affordable healthcare, world-class education, reliable infrastructure, business opportunities and a healthy environment. In Melbourne you'll find just about every cuisine: French, Italian, Spanish, Greek, Chinese, Malaysian, Indian, Thai, Japanese, Moroccan and lots more. Melbourne has over 100 art galleries as well as theatres, international and local opera, ballet, comedy and live music.

Each year Melbourne hosts major international sporting events like the Australian Open Grand Slam tennis tournament, the Formula One Grand Prix, the Rip Curl Pro surfing championship, the Australian Masters golf tournament, the Melbourne Cup and the Grand Final of Australian Rules Football. As well as over 2500 festivals and events including the Melbourne International Arts Festival, Melbourne International Film Festival, Melbourne International Comedy Festival and the Melbourne Spring Racing Carnival.

Find out more: https://liveinmelbourne.vic.gov.au/discover

Victoria: The Garden State

Victoria has many notable gardens and 36 national parks covering two and a half million hectares. Victoria's many attractions include the Great Ocean Road, (stunning coastal views and the world-famous Twelve Apostles), the Grampians and the High Country.

Find outmore.visitvictoria.com

La Trobe University Campuses in Australia

Each of our seven campuses (Melbourne, Albury-Wodonga, City, Bendigo, Shepparton, Midura and Sydney) is a unique expression of place, people and history that play an important role in social, cultural and economic life. We are located in Victoria's major regional cities, creating a unique network of research, industry and innovation expertise that can be accessed across the state.

Melbourne Campus

La Trobe's Melbourne Campus has 27,000+ students and is surrounded by bushland. Students from across the world take advantage of state-of-the-art facilities, including our AgriBio Research Centre, the La Trobe Institute for Molecular Science and our very own Wildlife Sanctuary.

Albury-Wodonga Campus

La Trobe's Albury-Wodonga Campus has 800+ students and is home to our leading regional research centre, the Centre for Freshwater Ecosystems which focuses on water science and policy of the Murray-Darling basin. Here, undergraduate students work alongside Honours and research students on local issues.

School of Agriculture,
Biomedicine and Environment
La Trobe University