2017-2018 Summer Research Projects
PROJECTS AVAILABLE IN THE AREA OF VASCULAR SCIENCE AND CARDIOLOGY

1. EFFECT OF ARTIFICIAL REALITY ON BLOOD PRESSURE
SUPERVISORS: DR. EDWARD BARIN, PROF. ALBERTO AVOLIO AND DR. MARK BUTLIN
Visual immersion in an artificial reality that pictures a cool calm place has been shown to reduce perception of pain in people experiencing high levels of pain. This study will study the effect of visual immersion in a artificial reality of a calm setting on blood pressure. Blood pressure, heart rate, and arterial stiffness will be measured before, during, and following immersion in the artificial reality. Analysis of changes in these variables and in heart rate variability and baroreceptor activity will show the effect of the artificial reality and possible mechanisms behind any changes. If results are positive, the device could be used to assist in treatment of acute hypertensive events. contact: mark.butlin@mq.edu.au

2. CUFF-LESS MEASUREMENT OF BLOOD PRESSURE
SUPERVISORS: PROF. ALBERTO AVOLIO AND DR. MARK BUTLIN
Wearable medical devices ideally should be small and comfortable, reliable, accurate, and able to provide regular measurement of the parameter of interest. Wearable blood pressure devices currently rely on cuffs around the arm, which whilst reliable, do not provide a regular or comfortable measure of blood pressure. This project, with the assistance of PhD candidate Fatemeh Shirbani, investigates the use of non-contact pulse detection for the measurement of blood pressure. Depending on your skills set, the project could either involve creating algorithms to process video data to extract pulse waveforms from skin tone changes or measuring cardiovascular parameters under different blood pressure conditions to create a device calibration process. contact: mark.butlin@mq.edu.au

PROJECTS AVAILABLE IN THE AREA OF BIOMECHANICS

1. MEDICAL IMAGE ANALYSIS
SUPERVISOR: DR. ITSU SEN
A series of medical image segmentation software technologies have been developed. This project is to apply those medical-image segmentation software to reconstruct the vessels of brain arteriovenous malformations (AVM).
The project aims to identify the factors influence the haemodynamic changes in the feeding arteries after treatment of AVMs. Contact: itsu.sen@mq.edu.au

2. ARTIFICIAL HEART (BLOOD PUMP) RESEARCH AND DEVELOPMENT:
SUPERVISOR: DR. ITSU SEN
The project aims to introduce computational hemodynamic technology to improve blood pump suspension technology. The project is to cooperate with Australian local industry to research and develop a new generation artificial heart. Contact: itsu.sen@mq.edu.au

3. BIOREACTOR PROJECT:
SUPERVISOR: DR. ITSU SEN
The project is to use tissue-engineering bioreactor to grow living tissues and organs from cells. The use of engineered tissues instead of testing on animals or in over-simplified conventional cell cultures will improve research quality by providing access to more realistic tissue models and accelerate experimental outcomes by bypassing ethical and research management problems. Contact: itsu.sen@mq.edu.au
PROJECTS AVAILABLE IN THE AREA OF ORTHOPAEDIC BIOMECHANICS

1. ANATOMICAL MODELLING OF KNEES

SUPERVISORS: A/PROF RICHARD APPELWARD AND DR DANÈ TURNER

Computer modelling of human bones and joints help to answer biomechanical questions related to the stresses and strains of the structure, through use of finite element analysis, and also to answer kinematic questions, for example through use of fluoroscopic analysis. In both cases, accurate anatomical models of the structures need to be developed.

This project will require the student to create three-dimensional bone geometries from medical images. The lower limb is either CT or MRI scanned and using dedicated segmentation software, these medical image stacks will be segmented and further processed to create 3D anatomical models. Contact: daneh.turner@mq.edu.au

2. FLUOROSCOPY OF THE KNEE JOINT (SUITE TO MECHANICAL OR SOFTWARE ENGINEERING STUDENT)

SUPERVISORS: A/PROF RICHARD APPELWARD AND DR DANÈ TURNER

Fluoroscopy is an effective way of determining the in-vivo motions of the knee joint. Already developed anatomical models are used to match up with the cine-fluoro images in order to calculate the motion of the joint. This is particularly useful to compare biomechanics of a patient before and after surgery.

For this project the student will use custom-written software to position the already created anatomical models over each of the fluoroscopic images in order to calculate the position and orientation of the joint over a number of time frames, depending on the activity (eg. Stair climbing) Contact: daneh.turner@mq.edu.au

3. BIOMECHANICS/GAIT ANALYSIS AND BIOMECHANICAL MODELLING (SUITE TO MECHANICAL OR SOFTWARE ENGINEERING STUDENT)

SUPERVISORS: A/PROF RICHARD APPELWARD AND DR DANÈ TURNER

Gait analysis is commonly used to better understand the biomechanics of the musculoskeletal system. Optical markers are placed on specific sites of the body and patients are asked to undergo different physical movements. Cameras collect three-dimensional motion of the markers, which provide information regarding the person’s kinematics. This study has two main components, which may or may not be undertaken by the same student:

Gait data collection and analysis: On the day of testing, the laboratory will be set up, with cameras positioned 3D space optimised and calibrated. Study participants will have markers placed, questionnaires filled out and measurements made. 3D gait data will be collected and notes taken during testing. This data will be processed using the Nexus program.

Biomechanical modelling and analysis: The processed Nexus data will then be further processed to scale the model, calculate the joint angles and joint moments as well as the muscle forces. Contact: daneh.turner@mq.edu.au
PROJECTS AVAILABLE IN THE AREA OF BREAST CANCER RESEARCH

1. IMPROVING THE SURVIVAL OF INDIVIDUALS WITH ADVANCED BREAST CANCER BY STOPPING THE SPREAD OF THE DISEASE.

SUPERVISOR: DR. BEN HENG

Breast cancer is the most diagnosed cancer in Australia. Treatment of primary breast cancer has vastly improved, and 90% of patients now survive for at least 5 years after treatment. However, treatments for advanced stage cancer that have spread to other parts of the body (known as metastasis) are less effective. Hence, metastasis remains the underlying cause of death in the majority of breast cancer patients. Therefore, this proposal will explore a different approach for treatment based on a key biochemical pathway, the kynurenine pathway (KP). In this project, we will aim to examine the KP protein expression (immunohistochemistry) and activity (uHPLC and GC/MS) in metastatic breast cancer patient's tumour sample and serum as compare to early stage patients. Contact: benjamin.heng@mq.edu.au

PROJECTS AVAILABLE IN THE AREA OF PROTEOMICS

1. MEMBRANE PROTEOME OF HCT116 COLORECTAL CANCER CELL LINE

SUPERVISOR: DR. CHARLIE AHN, DR ABIDALI MOHAMEDALI AND PROF. MARK BAKER

Globally, colorectal cancer is the 3rd most common cancer in men (10%) and 2nd in women (9%), with Australians having particularly high age-standardised rates (44 or 32 per 100,000 respectively). Metastasis is directly responsible for >90% of all cancer deaths, and yet its biology remains unknown. Through the work in our lab, we have identified a protein uPAR that is a critical factor in pushing cells towards metastasis. This is a GPI anchored membrane protein that is known to interact with over 40 partners on the surface of cells. The proteins on the surface of the cells are particularly difficult to study but in our lab we have developed a number of specific membrane protein fractionation and purification techniques to enable the study.

The aim of the project will be to extract membrane proteins from a particularly virulent model colorectal cancer cell line (HCT116) and to analyse the proteins using state-of-the-art mass spectrometry. The goal is to elucidate the membrane proteome to understand what interactions and signalling may be taking place. Contact: charlie.ahn@mq.edu.au

PROJECTS AVAILABLE IN THE AREA OF SURGERY AND INFECTION CONTROL

1. STRATEGIES TO PREVENT BACTERIAL CONTAMINATION OF BREAST IMPLANTS AT TIME OF SURGERY

SUPERVISORS: A/PROFESSOR KAREN VICKERY, DR HELEN HU AND MARIA MEMPIN

Capsular contraction (contraction around the implant resulting in implant failure) is the most common complication in breast augmentation surgery. An association exists between bacterial contamination, subsequent biofilm formation on breast implants and capsular contraction. Recently, a 14 point process plan recommends using methods at time of surgery, to aid in reducing bacterial contamination of breast implants. These include topical cleaning solutions, barriers or protective sleeves around the implant as it passes through the skin into the breast augmentation pocket. There has been limited experimental data comparing the effectiveness of these methods in the literature and quantifying the reduction in bacterial contamination.

Aim: To assess various methods and devices utilised to help prevent bacterial contamination of breast implants at the time of insertion.

Implants will be inserted through artificially contaminated material using our newly developed in vitro model. Different preventative strategies will be tested. Following exposure, the bacteria contaminating implants will be enumerated by plate culture following sonication of the implant in TSB. Contact: karen.vickery@mq.edu.au or maria.mempin@students.mq.edu.au
PROJECTS AVAILABLE IN THE AREA OF PHARMACOLOGY

1. TRPA1 ACTIVITY OF ILLICIT SYNTHETIC CANNABINOID REGIO-ISOMERS.
   **SUPERVISOR:** DR. MARINA SANTIAGO & PROF. MARK CONNOR

Recreational use of synthetic cannabinoids (SC) is associated with a significant morbidity and mortality. The reasons underlying the toxicity of this diverse group of chemicals are a topic of intense investigation, but remain opaque. We have discovered that many SCs are also agonists of the sensory ion channel TRPA1, the protein which tranduces the sensations associated with wasabi, mustard, tear gas and noxious cold. Seized SCs often contain manufacturing impurities, including isomers of the putative main active ingredients. We have established that the regio-isomers of a series of illicit SCs have a reduced activity at cannabinoid receptors, but their relative effectiveness at activating TRPA1 remains unknown. In this project you will examine the relative potency of these drugs on human TRPA1 using fluorescence-based sensors of channel activation. The project will be an opportunity to learn basic tissue culture and will serve as an introduction to high throughput screening technologies and ion channels. Contact: marina.junqueirasantiago@mq.edu.au

PROJECTS AVAILABLE IN THE AREA OF NEURODEGENERATIVE DISORDERS

1. TESTING DISEASE TREATMENTS ON TRANSGENIC ZEBRAFISH MODELS OF NEURODEGENERATIVE DISEASE
   **SUPERVISORS:** DR. ANGELA LAIRD AND DR. EMILY DON

We have developed transgenic zebrafish models of the neurodegenerative diseases motor neuron disease and spinocerebellar ataxia-3 (also know as Machado Joseph disease). In humans these diseases cause death of neurons throughout the brain and spinal cord, resulting in impaired movement control. Our zebrafish develop various signs of disease including motor dysfunction (decreased swimming speeds), abnormal motor neuron morphology, increased cell death and accumulation of aberrant protein fragments. In this project we will test whether treating the transgenic motor neuron disease and spinocerebellar ataxia zebrafish with selected drugs can improve the swimming ability of the zebrafish and prevent related disease phenotypes. Training will be provided in transgenic zebrafish mating, zebrafish embryo collection, observation and imaging using a fluorescent microscope, drug treatment, behavioural testing and western blotting. The project will allow students to develop new skills and gain insight into the field of neurodegenerative disease research. The results of the project will contribute to a broader project that aims to identify treatments for these debilitating human diseases. Contact: angela.laird@mq.edu.au

2. CHARACTERISING THE KYNURENINE PATHWAY IN MODELS OF NEURODEGENERATIVE DISEASE.
   **SUPERVISORS:** DR. DAVID LOVEJOY AND DR. BEN HENG

Dysregulation of the kynurenine pathway (KP) plays a role in the progression in neurodegenerative disease, like Alzheimer's disease. We have been examining how small-molecule inhibitors of the KP can re-balance the KP and slow disease progression. This project aims to explore these changes in animal tissues. Techniques to be used include immunohistochemistry, western blotting, microscopy and UHPLC. Contact: david.lovejoy@mq.edu.au
3. MAKING THE BRAIN AND SPINAL CORD 'TRANSPARENT' TO FACILITATE MOLECULAR STUDIES OF NEURODEGENERATIVE DISEASE PROGRESSION

SUPERVISORS: DR. DAVID LOVEJOY, DR. MIMI SABARETNAM AND DR. DMITRI PERRIN

Our laboratory is interested in disease mechanisms in neurodegenerative disease and we have recently been keen to explore how making the brain and spinal cord transparent in mouse models of Alzheimer’s and motor neuron diseases may enable us to better visualise the molecular events involved disease progression. The student will use CLARITY and CUBIC methods to make brains and spinal cord '3-dimensional' for advanced microscopy. Contact: david.lovejoy@mq.edu.au

4. DRUG DEVELOPMENT IN NEUROSCIENCE, TRANSITIONING A LEAD CANDIDATE TO AN ACTUAL DRUG

SUPERVISORS: DR. DAVID LOVEJOY AND MS. KELLY JACOBS

We recently completed a high-throughput screening (HTS) drug discovery project where we identified several promising leads that inhibit an enzyme involved in neurodegenerative disease progression. However, a lead candidate is not an actual drug and this project will involve various cell-based pharmacological assessments to progress our leads to drugs. Contact: david.lovejoy@mq.edu.au

5. GENETIC AND CELL BIOLOGY STUDIES OF MOTOR NEURON DISEASE

SUPERVISOR: DR. SHU YANG

The motor neurons are nerves that extend from the brain to the spinal cord and muscles and provide the stimulus through which we move, breathe, eat and drink. Unlike other cells of the body, motor neurons are not replaced when they die. Motor neuron disease (MND, also known as amyotrophic lateral sclerosis, ALS) is a rapidly progressive disease that causes the death of motor neurons leading to paralysis and death. MND is a devastating illness with appalling prognosis. Median survival is around two years. There is a pressing need to develop more effective diagnostic tools and treatments for MND.

The only proven causes of MND are gene mutations that lead to motor neuron death. Current insights have been insufficient to develop effective treatments in humans, despite the promise shown in existing animal models. Identification of the genes that cause or predispose to MND will lead to the unravelling of the underlying molecular mechanisms as a prerequisite to effective disease diagnosis, treatment and prevention. But known MND genes only account for less than 10% of cases. Our research aims to use cutting edge genetics, genomics and bioinformatics to identify gene mutations that cause MND. We further investigate the effects of those mutations using cell biology techniques, such as immunohistochemistry/immunocytochemistry, transfection, confocal microscopy and flow cytometry. We have found mutations in several new disease genes among MND patients (published in Science and Nature Neuroscience). Work is now underway to determine how these mutations lead to motor neuron death.

The aim of this project is to use genetics, molecular biology, bioinformatics and cell biology techniques to identify and investigate gene mutations that cause MND. The biological mechanisms underlying the disease will guide selection of candidate genes. Contact: shu.yang@mq.edu.au
6. WHAT CHANGES OCCUR EARLY IN MND AND FTD TO CAUSE NEURODEGENERATION?

SUPERVISORS: DR PRACHI MEHTA AND DR ADAM WALKER

Neurodegenerative diseases such as motor neuron disease (MND) and frontotemporal dementia (FTD) are inevitably fatal and have no effective therapeutics. MND primarily affects the spinal cord and causes paralysis, whereas FTD primarily affects the brain and causes progressive and debilitating changes to behaviour, language and personality. Despite these many differences in disease symptoms, most patients with MND and FTD develop the same characteristic pathology in neurons involving the same protein: TDP-43. Our lab aims to understand how TDP-43 causes neurodegeneration, using various biochemical, imaging and in vivo techniques to study neuronal cell cultures, genetically modified mice and human tissues.

Using quantitative mass spectrometry, our group has recently identified a group of proteins that are changed in levels in the brains and/or spinal cords of genetically modified TDP-43 mice during disease. The aim of this project is to define how these potential new therapeutic targets contribute to neurodegeneration, to guide future drug development.

The student involved in this project will isolate proteins from mouse brains and spinal cords at different stages of disease, produce micrometre-thin sections of tissues, perform immunoblotting and immunofluorescent staining using specific antibodies followed by fluorescence and confocal microscopy and image analysis.

These experiments will show how different proteins are altered in level and location in neurons in the TDP-43 mice, and will investigate whether these proteins form pathology during disease. This information will be important to select the most promising proteins for therapeutic targeting for people living with MND and FTD. Contact: adam.walker@mq.edu.au

7. PRE-CLINICAL DRUG TRIALS FOR MND AND FTD IN GENETICALLY MODIFIED MICE

SUPERVISORS: DR SHENG LE AND DR ADAM WALKER

Neurodegenerative diseases such as motor neuron disease (MND) and frontotemporal dementia (FTD) are inevitably fatal and have no effective therapeutics. MND primarily affects the spinal cord and causes paralysis, whereas FTD primarily affects the brain and causes progressive and debilitating changes to behaviour, language and personality. Despite these many differences in disease symptoms, most patients with MND and FTD develop the same characteristic pathology in neurons involving the same protein: TDP-43. Our lab aims to understand how TDP-43 causes neurodegeneration, using various biochemical, imaging and in vivo techniques to study neuronal cell cultures, genetically modified mice and human tissues.

We are conducting pre-clinical drug testing of several potential therapeutic compounds in the TDP-43 mice that target specific disease-related biochemical pathways. The aim of this project is to investigate whether these drugs affect TDP-43 pathology formation and neuron death in the brains and spinal cord of mice, to show whether these could be useful for therapeutics in humans.

This project offers opportunities to students to gain exposure to working with genetically modified mice, including but not limited to handling, behavioural testing, animal monitoring, surgeries, and dissections. The student involved in this project will also perform immunofluorescent staining, imaging and immunoblotting on the tissue collected from TDP-43 mice.

These experiments will validate potential therapeutic targets, and demonstrate whether these new drugs prevent disease development, pathology and neurodegeneration. These studies therefore have the potential to lead to new clinical trials for MND and FTD. Contact: adam.walker@mq.edu.au
8. WHY ARE NEURONS SELECTIVELY VULNERABLE IN MND? OPTOGENETIC APPROACH TO UNDERSTAND THE ROLE OF OXIDATIVE STRESS IN ALS

SUPERVISORS: DR. MARCO MORSCH AND DR. EMILY DON

Motor neurons (MNs) are selectively vulnerable to oxidative stress in comparison to other neurons, and mutations in the anti-oxidant enzyme SOD1 are associated with 20% of all inherited cases of ALS. We have generated experimental zebrafish models that allow us to selectively induce oxidative stress within a single spinal motor neuron, in the presence or absence of co-expression of ALS genes (SOD1, TDP-43).

The aim of this project is to investigate how sub-lethal and lethal levels of oxidative stress, delivered specifically to motor neuron subpopulations, contribute to the etiology of ALS. Our newly designed transgenic zebrafish allow us to induce different levels of oxidative stress in single spinal motor neurons and to visualize real-time responses of both the individually stressed neurons and surrounding cells such as neurons, microglia and astrocytes.

This project will help to demonstrate if oxidative stress is a primary instigator of the disease and if oxidative stress can trigger neurodegeneration in MNs.

Aim 1: Establish the susceptibility of individual spinal motor neurons to experimentally induced oxidative stress.

Aim 2: Investigate the effects of stress induced degeneration of a single spinal MN upon surrounding cells.

Our approach will determine mechanisms of stress induced motor neuron degeneration using a range of different techniques, including transgenic zebrafish lines, optogenetic techniques and confocal live-imaging protocols.

This approach will provide in vivo evidence that oxidative stress is an important driver of MN degeneration. By providing critical insights into the sequence of stress induced neurodegenerative processes this project will establish the foundation to examine if motor neurons in ALS patients are more vulnerable to oxidative stress than healthy motor neurons. Contact: marco.morsch@mq.edu.au

9. INVESTIGATING THE REGULATORY AND FUNCTIONAL ROLES OF CYCLIN F IN THE DEVELOPMENT OF MOTOR NEURONE DISEASE (MND)

SUPERVISOR: DR. ALBERT LEE

This project will investigate the cellular and functional roles of a new motor neurone disease (MND) gene discovered by researchers at the Macquarie University Centre for Motor Neurone Disease (MND) Research. Mutations in this new MND gene, CCNF, which encodes the protein Cyclin F, is involved in maintaining cellular health by tagging unwanted proteins (ubiquitylation) for breakdown and recycling within the cell. Mutant versions of Cyclin F, found in some MND patients, are defective in that they lack the necessary features needed to regulate proper function, which ultimately leads to impaired ubiquitylation and accumulation of proteins. This project will systemically investigate the regulatory and functional role of post-translational modifications (such as phosphorylation, O-GlcNAc and ubiquitylation) of Cyclin F focusing on those that have been mapped to MND mutations, and determine whether upstream kinases can be modulated to promote survival responses in MND cell models. Moreover, this project will investigate the role Cyclin F on its nuclear and cytoplasmic translocation and degradation and will examine:

Aim 1: Whether phosphorylation plays a role in nuclear/cytoplasmic shuttling through dephosphorylation treatments and artificial cyclin F constructs.

Aim 2: E3 ligase activity using our customised ELISA and other biochemical techniques and determine to effect does mutated versions of cyclin F influence protein inclusion formation.

MND mutations to Cyclin F was discovered by researchers at our Centre. This project will contribute to our understanding of how disease-variant mutations in this protein causes MND. By providing insights into the post-translational modifications in cyclin F, we will be able to better characterise the regulatory elements of the protein that are responsible for its function, and how impairments can lead to perturbations and cellular death. Contact: albert.lee@mq.edu.au
10. THE ROLE OF TBK-1 IN THE AGGREGATION OF TDP-43
SUPERVISOR: CYRIL JONES JAGARAJ AND A/PROF. JULIE ATKIN

Cytoplasmic inclusions containing TDP-43 are the major pathological hallmark of motor neuron disease (MND) and are found in almost all cases of MND. These inclusions may be cleared from the cell by a degradation process known as autophagy, however previous studies have suggested that autophagy is dysfunctional in MND, implying that this may underlie the formation of inclusions. TBK-1 is an important regulator of autophagy. Moreover, TBK-1 is mutated in familial MND patients. The aim of this project is to determine if TBK-1 mediates the aggregation of TDP-43 into inclusions using a SH-SY5Y neuroblastoma cell line. The project will involve cellular fractionation and quantification of insoluble TDP-43 in cells in which TBK-1 has been depleted via CRISPR/Cas9 editing. The formation of inclusions formed by wildtype and mutant TDP-43 will be analysed using epifluorescence microscopy in these cells. Contact: julie.atkin@mq.edu.au

11. ACTIN REGULATION IN AMYOTROPHIC LATERAL SCLEROSIS (ALS)
SUPERVISOR: A/PROF. JULIE ATKIN

Amyotrophic lateral sclerosis is a fatal neurodegenerative disease characterised by the loss of lower and upper motor neurons. Actin dysregulation has been implicated in several neurodegenerative diseases but in ALS this is not very well understood. Actin in eukaryotic cells exists as monomer (G-actin) and polymers (Filamentous actin, F-actin) and actin regulation in neurons is important for cell motility, axonal transport and synaptic vesicle formation. Oxidative stress is major pathological mechanism in ALS but the mechanisms triggering this are unclear. The aim of this project is to examine how oxidative changes modifies actin regulation in NSC-34 motor neurons like cells. This project will involve techniques such as cell culture, fractionation of G-actin and F-actin followed by western blotting and confocal microscopy. Molecular pathways leading to actin regulation upon oxidative stress will therefore be characterised in this project. Contact: julie.atkin@mq.edu.au
PROJECTS AVAILABLE IN THE AREA OF AUTONOMIC NEUROSCIENCE

1. HYPOTHALAMIC REGULATION OF BLOOD PRESSURE IN POLYCYSTIC KIDNEY DISEASE

SUPERVISOR: DR. CARA HILDRETH

Polycystic kidney disease (PKD) is a major hereditary form of chronic kidney disease characterised by the development of renal cysts and the loss of kidney function. As is common with any chronic kidney disease, high blood pressure is observed in people with PKD. The underlying cause however of high blood pressure in people with PKD is poorly understood. Yet, this information is critical as it is linked to the development of cardiovascular events such as heart attack and stroke which are the leading causes of death in people with PKD.

Our research is studying the underlying mechanisms that result in high blood pressure in PKD. The brain plays a very important role in controlling blood pressure and work in our laboratory has revealed that increased activity of a very defined region of the brain called the paraventricular nucleus of the hypothalamus (PVN) as well as the hormone, vasopressin, are involved and may offer a novel way in which to treat high blood pressure.

Students will be involved in projects aimed at addressing this and will be exposed to a variety of research techniques including, but not limited to, in vivo electrophysiological recordings and brain microinjections, radiotelemetry and immunohistochemistry. Contact: cara.hildreth@mq.edu.au

PROJECTS AVAILABLE IN THE AREA OF NEUROSURGERY

1. DEVELOPING NOVEL TREATMENTS FOR BRAIN ARTERIOVENOUS MALFORMATIONS (AVMs)

SUPERVISOR: DR. LUCINDA MCROBB

The work of our group focuses on developing new treatments for these devastating vascular malformations that can form in the brain. Brain AVMs are characterised by the formation of abnormal, tangled collections of blood vessels in the brain that bypass the normal blood flow pathways and are prone to rupture. Brain AVMs are a major cause of intracerebral haemorrhage (stroke) in children and young adults that can lead to sudden death or severe neurological disability if left untreated. Current therapeutic options remain limited with over 30% of patients considered untreatable.

We hypothesise that highly focused radiation ( radiosurgery) can be used to induce protein changes at the surface of blood vessels located within an AVM. Further, that we can then use these protein changes as targets, to direct novel drugs to the irradiated AVM blood vessels to induce vessel closure, eliminating the risk of haemorrhage or bleeds.

Our current focus is on identifying and validating radiation-induced protein markers on the endothelial surface of AVM vessels and use of these markers to target AVM vessels with pro-thrombotic conjugates. This is important pre-clinical work required before translation to human studies.

Current project aims include:

Validating the endothelial surface expression of vascular targets induced in response to ionising radiation;

Performing antibody-fluorophore conjugate preparation and testing for use with in vivo fluorescent optical imaging.

Methods: We have recently identified a series of proteins in earlier screening studies that may be potential vascular targets. These targets need further validation to confirm that they are surface expressed and that they are targetable by specific antibodies labelled with fluorophores in vitro and in vivo. This area of study encompasses aspects of neuro-vascular biology and radiobiology. Techniques employed in this project include endothelial cell culture, biotin-labelling of surface proteins, western blotting, immunocytochemistry, cryostat sectioning, immunohistochemistry, and fluorescent microscopy. Contact: lucinda.mcrobb@mq.edu.au
PROJECTS AVAILABLE IN THE AREA OF CLINICAL COMMUNICATION

1. USING CONVERSATION ANALYSIS TO EXPLORE CLINICAL COMMUNICATION
SUPERVISOR: DR. SARAH WHITE

To support research and teaching in clinical communication in the Faculty of Medicine and Health Sciences, a library of clinical interactions is being developed. In this project, the student will contribute to ongoing research into how clinicians communicate. This will include work such as: recording clinical interactions, transcribing and coding the videos within the library, creating clips for research and teaching, preparing literature reviews, and participating in data analysis sessions. Methods of analysis include conversation analysis, other forms of interaction analysis, and coding (e.g. RIAS). Students interested in this project will be studying linguistics and/or anthropology and/or sociology and have an interest in qualitative interaction analysis. Contact: sarah.white@mq.edu.au

PROJECTS AVAILABLE IN THE AREA OF HEALTH AND HEALTHCARE BEHAVIOUR CHANGE

1. COMPLEXITY IN HEALTH CARE
SUPERVISORS: PROFESSOR JEFFREY BRAITHWAITE, DR KATE CHURRUCA, DR LOUISE ELLIS, DR JANET LONG

Health care can be usefully viewed as a complex adaptive system; i.e. one in which independent agents can act in sometimes unpredictable ways, and each agent’s actions are interconnected. The Centre for Health Care Resilience and Implementation Science’s Complexity Group have a number of projects looking at aspects of health system function through a complexity lens. For example, we are working with the Australian Genomic Health Alliance to understand how this cross sectoral and multidisciplinary network functions as it moves across time to introduce genomic testing into practice. We will be using interviews, document analysis and social network analysis to understand dynamic processes and strategies. Other projects look at cultural influences on hospital and clinical outcomes; and how we can make improvements to provide safe, high quality care in multiple settings.

Students would assist in data collection and analysis for one of these projects as negotiated, depending on current skills, which skills they would like to develop, and where their primary interest lies. Contact: janet.long@mq.edu.au

PROJECTS AVAILABLE IN THE AREA OF HEALTH INFORMATICS

1. SURGICAL INFORMATICS FOR PATIENTS AND CONSUMERS
SUPERVISOR: DR. ANNIE LAU

Surgical practice, unlike other health specialties, has its own unique needs. In particular, surgical patients have specific needs across different stages of surgical care (e.g. preoperative, intra-operative, and post-operative). Can advances in informatics (e.g. mobile apps) help support surgeons and their patients?

This project involves understanding the needs of patients across different stages of surgical care, and identifying areas where informatics can help address their needs. Students will have an opportunity to work with surgeons, nurses, other surgical team members, and patients in this project. They will participate in designing and evaluating mobile apps for patients in areas such as orthopedics, cancer or vascular surgery.

This project is suitable for students interested in surgery, medicine, psychotherapy, health sciences, psychology, computer science, or other related disciplines. Contact: annie.lau@mq.edu.au
2. ROLE OF DIGITAL HEALTH IN PATIENT-CLINICIAN RELATIONSHIP

SUPERVISOR: DR. ANNIE LAU

We use technology everyday yet the use of technology for health is limited. Although digital health technologies (e.g. websites, wearables, mobile apps) are available, they are not used routinely in our encounters with healthcare professionals.

This project examines ways we can utilise digital technologies to enrich our relationship with healthcare professionals. Students will have an opportunity to work closely with healthcare professionals, consumers and patients to understand the tasks that digital technologies can assist in health, and examine ways we can incorporate digital technologies in our encounters with healthcare professionals.

This project is suitable for students interested in health sciences, psychology, health services, medicine, computer science, or other related disciplines. Contact: annie.lau@mq.edu.au

3. CAN SOCIAL NETWORKS HELP US BECOME HEALTHIER?

SUPERVISOR: DR. ANNIE LAU

Social networks (e.g. friends, families) influence our health. Past studies have shown that if we are surrounded by people who are overweight, we are more likely to experience weight gain. Can we ask our social networks to help us become healthier? Can we use wearable devices and mobile apps to help us monitor our weight?

This project examines ways we can use wearable devices, mobile apps and social networks to help us stay active. Students will conduct data analysis and/or interview consumers on ways we can use social networks, wearable devices and mobile technologies to help us become healthier.

Students will work in a multidisciplinary team and have an opportunity to work with clinicians, patients, and researchers from Macquarie University. Contact: annie.lau@mq.edu.au

4. UNDERSTANDING “WORK” FROM PATIENT AND CONSUMER PERSPECTIVE

SUPERVISOR: DR. ANNIE LAU

To accomplish a health goal, a lot of effort and time is required, regardless of whether it is for achieving an optimal level of fitness or managing illness. However, there is lack of research examining the ‘work’ involved in managing our health and illness, especially from a patient/consumer perspective.

This project examines the activities that patients and consumers do for their health and illness. Students will examine how these health activities fit into one’s routine, and provide suggestions on whether digital technology has a role to empower consumers, patients and their carers in their everyday settings.

Students will work in a multidisciplinary team and have an opportunity to work with clinicians, patients, and researchers from Macquarie University and University of Oxford. Contact: annie.lau@mq.edu.au

5. ARTIFICIAL INTELLIGENCE FOR PATIENTS AND CONSUMERS

SUPERVISOR: DR. ANNIE LAU

Artificial Intelligence (AI) is an area of study that examines intelligence behaviour in machines, such as reasoning, planning, learning, perceiving and interacting to maximise its chance of achieving a goal. Current applications of AI include: self-driving cars, chess, and understanding human speech.

This project examines whether AI has a role for patients and consumers. Students will review current applications of AI in healthcare, and identify areas where AI can help address patients’ and consumers’ needs and the associated risks and benefits.

Students will work in a multidisciplinary team and have an opportunity to work with clinicians, patients, and researchers from Macquarie University. Contact: annie.lau@mq.edu.au
6. PATIENT SAFETY IN THE AGE OF ARTIFICIAL INTELLIGENCE

SUPERVISOR: DR. FARAH MAGRABI

In the next few years, a new generation of interactive software agents incorporating artificial intelligence (AI) will support both clinicians and consumers across a wide set of healthcare tasks. Alongside its many benefits AI can introduce new, often unforeseen, modes of failure that affect the safety and quality of care and lead to patient harm.

This project is centered around a brand new research program at the Centre for Health Informatics to investigate the safety risks of AI in healthcare. Students will have the opportunity to work a multidisciplinary team alongside computer scientists, engineers, health professionals and patients. They will participate in (a) identifying and evaluating the safety risks of clinical and consumer technologies; (b) design technical and social solutions to mitigate these risks (c) develop new methods and protocols for timely detection and response to emerging threats.

This project is suitable for students interested in medicine, health sciences, ethics, psychology, computer science, or other related disciplines. Contact: farah.magrabi@mq.edu.au

7. SAFEHEALTHAPPS: MONITORING THE SAFETY OF MOBILE HEALTH APPS

SUPERVISOR: DR. FARAH MAGRABI

Health apps linked to smartphones and wearable devices are growing in popularity. At the same time, the use of such technologies can introduce new, often unforeseen, errors that can affect the safety and quality of care and may lead to patient harm.

In this project students will have the opportunity to work a multidisciplinary team alongside computer scientists, engineers, health professionals and patients. They will participate in investigating the types of problems with the use of apps that can pose risks to patient safety as well as their consequences.

This project is suitable for students interested in medicine, health sciences, psychology, computer science, or other related disciplines. Contact: farah.magrabi@mq.edu.au