THE UNIVERSITY OF MELBOURNE

School of Biomedical Sciences

Department of Physiology

Masters/Honours Research Projects 2017

Welcome to the Department of Physiology

In many ways the decision to undertake an Honours year or a Masters degree is one of the most important you will make.

It is often the first step towards an independent scientific career when you get the chance to pursue a research area of interest. The extra qualification will also help set you apart from competitors when seeking employment or entry into other courses or specialties.

There are many things to consider – the research topic; your need and desire to undertake additional, advanced coursework, the laboratory and its resources, the potential supervisor and the departmental support of students.

The Department of Physiology has a strong record of award-winning research training and mentorship with our graduates securing leadership roles in universities, institutes, industry and in the private sector. A recent winner of the highly prestigious 'Premier's Award for Health and Medical Research', Dr. Stefan Gehrig, trained as an undergraduate and graduate researcher in the Department of Physiology.

We are very proud of our students and have developed a carefully structured program of coursework to complement your developing laboratory and analytical skills. The Department environment provides support in a number of ways for our Honours and Masters students, but perhaps none is more important than the friendship, advice and mentoring they receive from our graduate students.

This booklet provides information that will help you decide on a potential research project in Physiology at Honours and Masters levels.

Our research is focused on themes related to cardiovascular health, neurophysiology, and muscle and exercise. Take your time and look at the different projects on offer. Identify projects that appeal to you and contact potential supervisors for more information and visit their laboratories. Ask lab heads, staff and students about the projects and your potential career options with the new qualification.

Physiology offers many exciting research opportunities and we welcome the chance to discuss these with you.

Best of luck!

Professor Gordon S. Lynch
Head of Department

General overview of the courses

The Master of Biomedical Science program offered by the School of Biomedical Sciences is a postgraduate specialty degree, which has been created to provide an alternate pathway into a research career and/or PhD studies, and to offer additional professional training for a career in science. In the Masters program, you are able to undertake a more substantial research project, and also select coursework subjects to develop your technical, communication, business and professional skills. A variety of 'Discipline' and 'Professional' subjects are offered across the University from which you can select.

Honours is a fourth-year undergraduate program which gives you the opportunity to draw together your previous studies and focus your knowledge and skills on an original research project. The Honours program is a one year extension of your undergraduate degree, which gives you a taste of what working as a scientist would be like as a career, allows you to demonstrate academic excellence in an area of special interest to you, and provides an entry point for further research higher degree study (ie PhD).

The Department of Physiology offers a range of research projects which can be tailored to fit the Masters or Honours context. Discussions with individual potential supervisors will be helpful for you in determining how a project might take shape if it is configured to fit within the Masters or Honours framework.

In the Department of Physiology the Masters or Honours students interact extensively and share some core coursework components. The course outlines are summarized in the Table below.

Overall, Masters students complete 200 points of coursework / project work over 4 semesters and Honours students complete 100 points of coursework / project work over 2 semesters. Both student groups take the core Discipline Subjects 'PHYS90008 Advanced Seminars in Physiology' and 'BIOM40001 Introduction to Biomedical Research'. Usually Masters students will take these subjects in the first semester of their course enrolment. Masters students complete a research project which comprises 125 points and Honours students complete a project comprising 75 points (including Literature Review and Oral Presentation tasks). During their enrolment, Masters students will take additional 'Professional Skills' subjects and other 'Discipline Subjects' (to complete the 200 points as indicated in the table below).

Program Component	Description	Masters (points/200)	Honours (points/100)
Core Discipline subject	Advanced Seminars in Physiology PHYS90008	12.5	12.5
Core Discipline subject	Introduction to Biomedical Research BIOM40001	12.5	12.5
Research Project	Literature Review, Thesis, & Oral Presentations	125	75
Other Discipline subjects		25	Not Applicable
Professional Skills		25	Not Applicable
Total		200 points	100 points

The Master of Biomedical Science

The Master of Biomedical Science is an important step into the world of Postgraduate study. You have increased independence to direct and manage your learning and training program to suit your career goals – in research and professional realms. The program, with extended time allocation for research, allows you to tackle a project at greater depth and possibly to employ more technically demanding techniques.

As the program extends over 2 years, your opportunities to be involved in detailed planning of your project and moving your work through to publication are increased. You will achieve a postgraduate qualification of recognized Discipline relevance to take you on the road confidently into further higher degree research. You will also develop competence in a range of professional skill areas relevant to science which might include technical, business, planning and communication strengths.

To be considered for entry, applicants must have completed a Bachelor degree with a major in an appropriate biomedicine/bioscience discipline (ie Physiology or related discipline) with at least an H3 (65%) in the third year Major subjects or equivalent relevant to the selected Project. Students may commence a MBiomedSc program in Semester 1 or Semester 2, with Supervisor agreement, although Semester 1 is preferred.

For further information, including fees and scholarships, entry requirements, degree structure, non-core subject selection and how-to-apply, see:
http://mdhs-study.unimelb.edu.au/degrees/master-of-biomedical-science/overview and
http://mdhs-study.unimelb.edu.au/degrees/master-of-biomedical-science/enquire-now#nav

Enquiries

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Graduate Team

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The BBiomed/BSc Honours program

Honours is very different from earlier undergraduate years, allowing and requiring a greater degree of independence and flexibility that will help develop the maturity and skills for transition to employment in a range of occupations and industries or a research higher degree. Overall the Honours year adds value to your basic degree, provides you with an additional undergraduate year to demonstrate academic excellence and sets you apart as a student with extended experience of research methodology and with practical research credentials.

To be considered for entry, applicants must have completed a Bachelor of Biomedicine (BBiomed), Bachelor of Science (BSc) or equivalent qualification with a weighted average mark (WAM) of at least 65%. It is important to realize that meeting this minimum faculty level is not a guarantee of admission. Entry into the Honours program is subject to the capacity of the Department and individual labs to take on new students. Honours students commence studies in Semester 1.

For further information, about entry requirements, key-dates for application and information on how-to-apply, see
http://sc.mdhs.unimelb.edu.au/entry-requirements, and
http://sc.mdhs.unimelb.edu.au/how-apply

Enquiries

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Summer Studentship and Scholarship

Are you a third year student and start your Honours or a Master of Biomedical Science degree within the Department of Physiology in 2017? If so, consider a Summer Studentship to work on a supervised research project. The following is available:

R D Wright Summer Studentship

Application forms available from the Department of Physiology. Please contact our Department by emailing Physiology-Info@unimelb.edu.au to request a copy. The deadline for application is 31 October.

The purpose of the Summer Research Studentships is to provide an opportunity for undergraduates to gain first-hand experience in research. Students currently enrolled in the Third Year of the science or biomedical science courses at this University are eligible to apply for this Studentship worth $1000. Please note that you must discuss a project with the appropriate supervisor before applying.

Department Scholarship and Prizes

Masters and Honours Students who undertake an RD Wright Summer Studentship and achieved > 83 weighted average for their third year subjects will also receive a Physiology Scholarship worth $2000.
Masters Students are also eligible to compete for prizes at the Department's annual graduate student symposium.

Research supervisors and laboratories

The Physiology Department identifies several broad areas of research emphasis. These include:

Cardiovascular Health

Prof Lea Delbridge	- Cardiac Phenomics
Prof Mary Wlodek	- Fetal, Postnatal & Adult Physiology and Disease
Prof Stephen Harrap	- Genetic Physiology

Muscle and Exercise

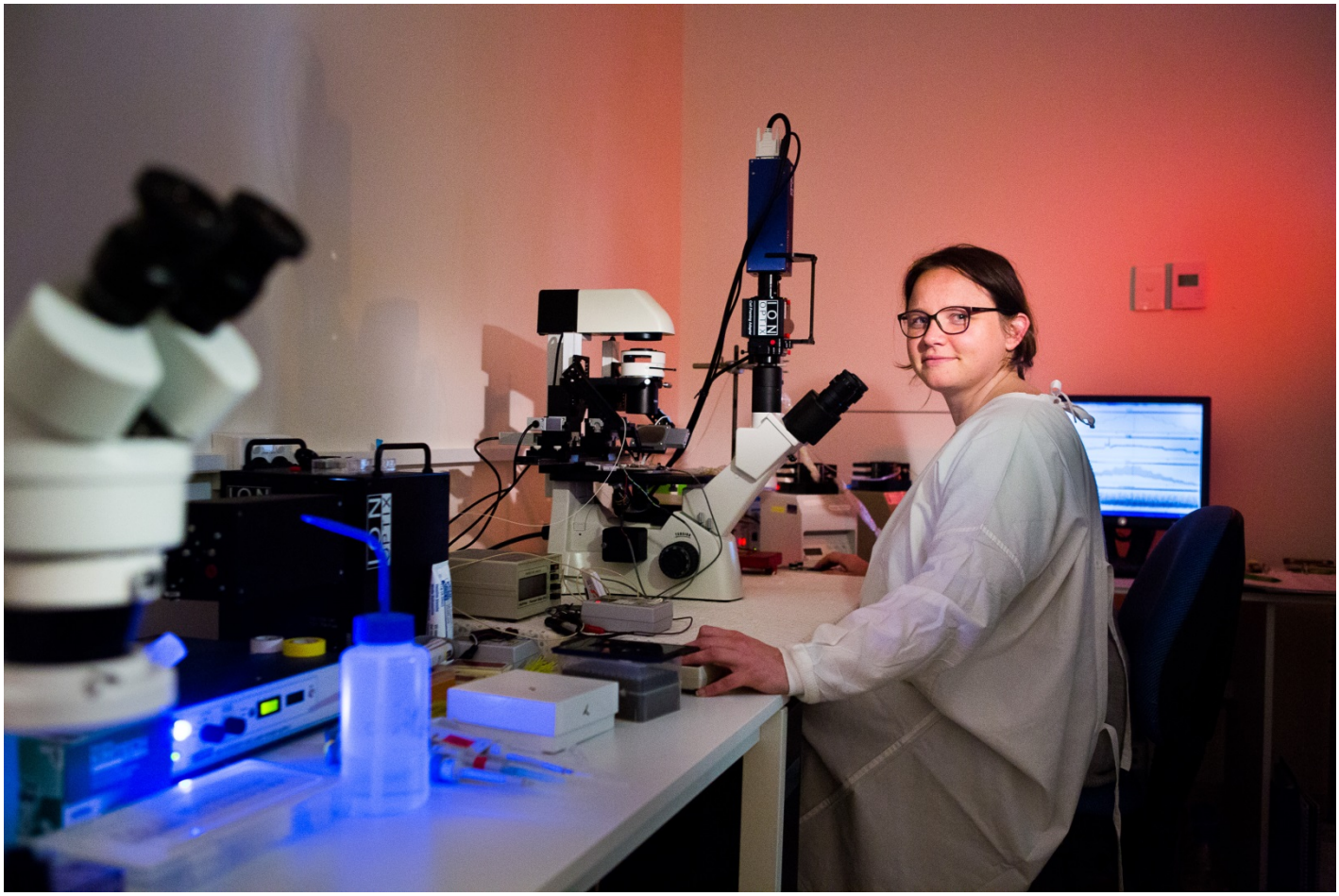
Prof Gordon Lynch	- Basic & Clinical Myology
Dr René Koopman	- Clinical Nutrition and Muscle Metabolism

Neurophysiology

Prof Andrew Allen -	- Central Neurogenesis Regulation
Prof Joel Bornstein	- Enteric Neuroscience

Unless otherwise indicated, all projects listed are suitable for students undertaking Masters or Honours.

Projects are managed by the Primary Supervisor within that area of Research. In some instances they are co-supervised as indicated.



Cardiovascular Health Laboratories and Projects

Prof Lea Delbridge

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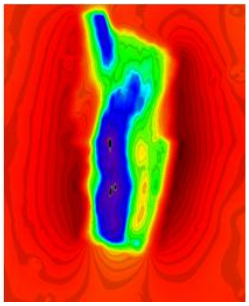
Dr James Bell
Dr Clair Curl

CARDIAC PHENOMICS LABORATORY

The Cardiac Phenomics Laboratory research is about understanding how the heart response to stress can be managed to minimize the damaging impacts of a variety of disease conditions. We investigate responses of the working 'pumping' heart, of specialized muscle tissues and cells from different regions of the heart and of molecular signaling processes. As our name suggests, we look at how the cardiac '*genome*' (the genetically defined heart) is translated in different stressor situations to create the '*phenome*' (the structurally and functionally defined heart).

Our pre-clinical work focuses on cardiac pathology arising from Type 1 and Type 2 diabetes and on the factors which determine how female and male hearts respond differently to stress and disease challenges. These areas of heart health are of critical significance in shaping the demographics of cardiovascular disease. We use experimental models to mimic human disease conditions, and we look for links between the performance of single muscle cells and the functioning heart. Our goals are to inform the development of new treatments for diabetic cardiomyopathy and to understand how for women and men, cardiac 'difference' may be managed with optimized therapeutic tools.

Student projects in the Cardiac Phenomics lab could incorporate a range of methodologies including animal dietary and pharmacologic treatments, instrumented working heart preparations, immunohistochemistry, cell culture and adenoviral expression manipulation, cell kinetic imaging, biochemical assay, confocal microscopy, microarray gene profiling, realtime PCR, and western blot techniques. Projects are particularly suitable for MSc students, as there is scope for progression to publication within the degree time frame and research work is supported by complementary skills development coursework.



DIABETIC CARDIOMYOPATHY – AN EPIDEMIC DISEASE

Globally, diabetes is an epidemic disease with a specific cardiopathology independent of vascular and other cardiovascular risk profile. In the diabetic heart, one of the first signs of pathology is deterioration in the capacity of the heart to relax (in diastole) – and later signs of active pump failure (in systole) emerge. Our work focuses on understanding the mechanisms of both diastolic and systolic dysfunction, examining how circulating and locally produced hormones impact on cardiopathology and identifying potential molecular targets for intervention. Using genetic and experimental models of type 1 and type 2 diabetes we are investigating the structural bases for relaxation abnormality in the diabetic heart – evaluating active and passive components of stiffness which reflect both cardiac muscle cell and extracellular matrix pathology. These areas of research involve active collaboration with partners in Auckland, Beijing, and Los Angeles.

PROJECTS:

1) Glycogen handling pathology in diabetic cardiomyopathy.

An investigation of the cellular mechanisms which underlie energy storage defects in muscle cells from the diabetic heart. Increasingly, we are thinking about diabetic cardiomyopathy as a glycogen storage disease.
Honours/Masters/PhD

2) Defining mechanisms of cardiac muscle cell death in the diabetic heart.

How are cardiac muscle cells dying in the diabetic heart – and what are they most important pathways for cell death? Exploring triggers and processes for autophagy and apoptosis to identify protective therapies
Honours/Masters/PhD

3) How is dietary fructose especially bad for the heart?

(with Dr Kimberley Mellor, University of Auckland).

Too much sugar intake has bad consequences healthwise – related to obesity and diabetes. In this project the hypothesis that fructose in particular has direct adverse cardiac effects is investigated.
Honours/Masters/PhD

4) New strategies to rescue diabetes-induced cardiac dysfunction.

(with A/Prof Rebecca Ritchie, Baker IDI Heart & Diabetes Institute).

Looking at interventions to deliver small molecules with potential therapeutic benefit in rescuing function in the diabetic heart.
Honours/Masters/PhD

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STEROID HORMONES AND HEART FAILURE – SEX PERSPECTIVES

Important differences exist between women and men with regard to cardiovascular disease. Sex differences have been reported in left ventricular hypertrophy, cardiac remodeling with aging, arrhythmogenic activity, and post-infarct myocardial salvage. In recent years there has been controversy about the use of steroid therapies in men and women – and the cardiovascular problems of anabolic steroid abuse have become apparent. Therapies involving mineralocorticoid block have differential cardiac effectiveness in men and women. The molecular bases for sex-related differences in myocardial disease and response to steroids are poorly understood.

The goal of this research is to determine how sex steroids (testosterone & estrogen) and mineral/glucocorticoid steroids (aldosterone, cortisol & corticosterone) regulate heart growth and function under normal and metabolic stress conditions. We investigate the early developmental origins of progression to failure in males and females– and have demonstrated that cell loss in the neonatal transition period is linked with life-long cardiac muscle cell deficit and susceptibility to autophagy.

PROJECTS:

5) Discovering the importance of cardiac aromatase in converting androgens to estrogen – new therapeutic targets.

Following up our exciting new lead in discovering that the heart can make it's own estrogen – for better or for worse!

Honours/Masters/PhD

6) Making and breaking hearts – tracing the journey to heart failure back to early developmental influences
(with Prof Stephen Harrap and Prof Fadi Charchar, Federation University)

Exploring the mechanisms during development which condemn enlarged heart muscle cells to lose mechanical effectiveness and succumb to early death.

Honours/Masters/PhD

7) Sex differences in cardiac stress resilience – why are female hearts protected?

An experimental project to understand why, although women are less likely to experience heart attack, when they do the consequences are likely to be more dire.

Honours/Masters/PhD

8) Is a 'fat heart' an especially vulnerable heart?

(with Prof Jon Kalman (Royal Melbourne Hospital)

Evidence is accumulating that cardiac adiposity is an important risk factor – but the mechanisms are not understood. This project involves molecular and tissue recording studies of human and rodent tissues to uncover the reasons why these hearts are vulnerable to arrhythmia.

Honours/Masters/PhD

9) Identify new leads in stem cell therapies for heart recovery after infarction.

(with Dr Max Lim, O'Brien Institute University of Melbourne).

After a myocardial infarction, the priority is to salvage vulnerable cells to recover cardiac function. In this project small molecule strategies working with cardiac stem cells to support cell viability and mitochondrial function are investigated.

Honours/Masters/PhD

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FETAL, POSTNATAL & ADULT PHYSIOLOGY AND DISEASE LABORATORY

Small size at birth for gestational age occurs in 10% of human pregnancies in developed societies. This results from restricted growth of the fetus, which primarily reflects a poor environment within the uterus, commonly due to uteroplacental insufficiency. Recent human studies have confirmed that being born small is associated with the increased risk of developing adult diseases. Our results have proved pivotal to shifting programming research paradigms to now include the postnatal lactational environment.

We are exploring how a reduction in the number of functioning units of the kidney (nephrons), heart (cardiomyocyte) and pancreas (beta cell) program rat offspring born small to develop renal, cardiovascular and metabolic disease and the transgenerational transmission of diseases. We aim to identify developmental stages during which nutritional, exercise or other lifestyle interventions may have beneficial consequences. We are now exploring how these programmed diseases can be passed to the next generation. We are currently studying the impact of maternal stress, obesity and exercise during pregnancy on disease development of the next generation. These studies will enable us to identify individuals at increased risk of developing later life diseases that can be transmitted to the next generation. Our studies will provide the scientific basis for the design and testing of appropriately targeted lifestyle interventions to reduce adverse health effects of pregnant mothers and their babies. Identification of groups of individuals at risk of developing diseases will become increasingly important due to the ever-increasing incidence and earlier age at onset of these diseases.

PROJECTS:

7) Benefits of exercise training during pregnancy for overweight females born small: influence on F2 fetal nephron number.

Many experimental and human studies worldwide have shown that babies born small for gestational age (or who are light at birth) are strongly and consistently at an increased risk of developing cardiovascular and metabolic diseases as adults, and that this risk is passed onto subsequent generations. We have also shown that exercise training can normalise programmed F1 deficits. This proposal addresses the likelihood that a mother born small who becomes overweight will develop serious pregnancy complications, affecting growth of her baby. The aim of this study is to identify whether exercise training during pregnancy, in normal and overweight females, can prevent the likelihood of developing cardiovascular and renal diseases in offspring by restoring normal fetal growth and development and specifically nephron endowment.

Honours/Masters

8) Benefits of exercise training during pregnancy in overweight females born small: metabolic transgenerational effects.

This proposal addresses the likelihood that a mother born small who becomes overweight will develop serious pregnancy complications, affecting growth of her baby. The aim of this study is to identify whether exercise training during pregnancy, in normal and overweight females, can prevent the likelihood of her offspring developing metabolic disease.

Masters/PhD

9) Benefits of exercise training during pregnancy in overweight females born small on the maternal microbiome.

(With Dr Elisa Hill (elhill@unimelb.edu.au)

This proposal addresses the likelihood that a mother born small who becomes overweight will develop serious pregnancy complications, affecting growth of her baby. The aim of this study is to identify whether exercise training during pregnancy, in normal and overweight females, can restore the gut microbiota which may have beneficial effects on maternal metabolic health.

Honours/Masters

10) Benefits of exercise training during pregnancy in overweight females born small: impact on fetal oxidative stress.

This proposal addresses the likelihood that a mother born small who becomes overweight will develop serious pregnancy complications, affecting growth of her baby. The aim of this study is to identify whether exercise training during pregnancy, in normal and overweight females, reduces fetal tissue oxadative stress by improving telomere length.

Honours/Masters

11) Role of paternal overweight in the transgenerational transmission of cardiovascular disease.

Many experimental and human studies worldwide have shown that babies born small for gestational age (or who are light at birth) are strongly and consistently at an increased risk of developing cardiovascular and metabolic diseases as adults, and that this risk is passed onto subsequent generations. Being overweight or obese can exacerbate these consequences. The relative role of paternal transmission is less well understood. We have demonstrated in our model of uteroplacental insufficiency that the fetal growth restriction is associated with hypertension, a nephron deficit and metabolic dysfunction. The aim of this study is to determine whether cardiovascular dysfunction and nephron deficits are transmitted to the next generation and if these are exacerbated if the growth restricted father was overweight or obese.

Masters/PhD

12) Role of paternal overweight and its influence on the sperm in the transgenerational disease transmission

Many experimental and human studies worldwide have shown that babies born small for gestational age (or who are light at birth) are strongly and consistently at an increased risk of developing cardiovascular and metabolic diseases as adults, and that this risk is passed onto subsequent generations. Being overweight or obese can exacerbate these consequences. The relative role of paternal transmission is less well understood. We have demonstrated in our model of uteroplacental insufficiency that the fetal growth restriction is associated with hypertension, a nephron deficit and metabolic dysfunction. The aim of this study is to determine whether F1 germ cell and sperm mRNA and microRNA levels are perturbed thereby programming altered F2 phenotypes in males born small and if they are exacerbated if the male was overweight or obese.

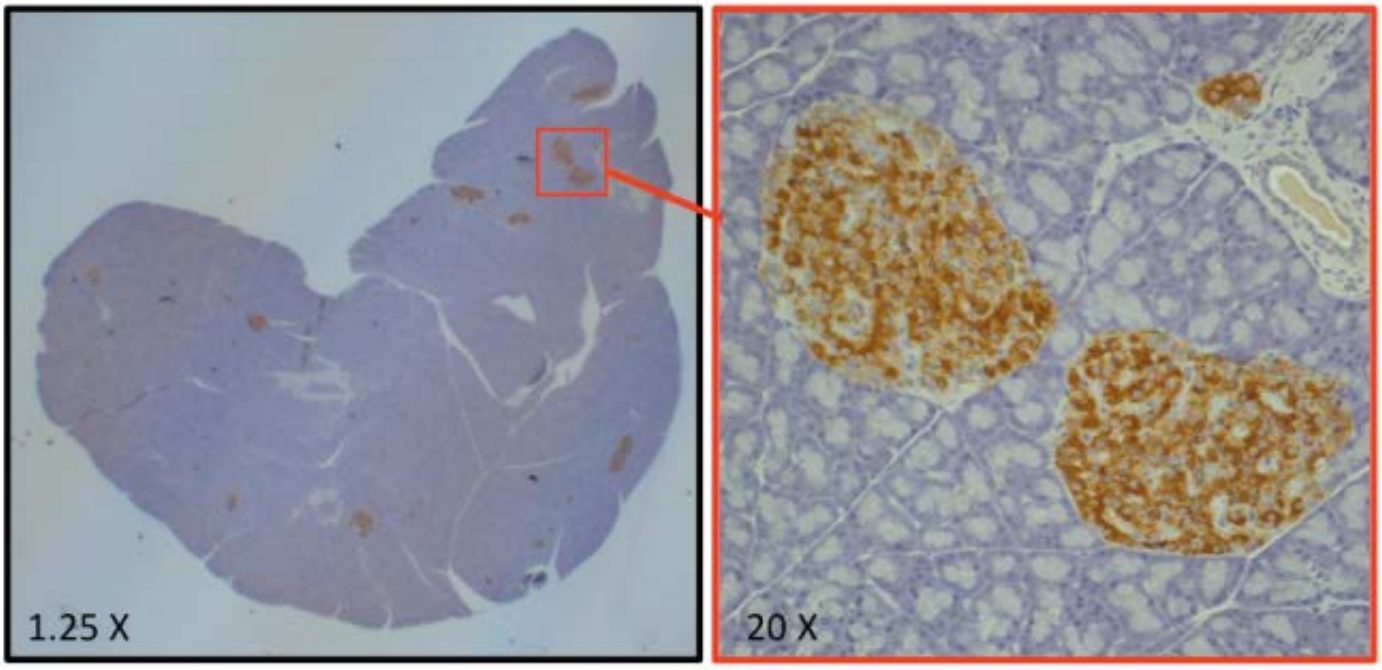
Honours/Masters

13) Placental and pregnancy complications for obese women

(With A/Prof Joanne Said, Sunshine Hospital) (jsaid@unimelb.edu.au)

Obesity during pregnancy has adverse consequences for a mother's pregnancy and her children's later life health. This proposal addresses the likelihood that a mother born small who becomes obese will develop serious pregnancy complications, affecting placental function and the growth of her baby. The aim of this study is to characterise pregnancy outcomes and altered placental function (including gene and protein expression) in obese women (Sunshine Hospital) that were either born small or of normal weight.

Honours/Masters



Muscle and Exercise Laboratories and Projects

Prof Gordon Lynch

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Dr Kate Murphy
Dr James Ryall
Dr Kristy Swiderski

BASIC AND CLINICAL MYOLOGY

Our group investigates the mechanisms underlying skeletal muscle wasting and weakness and develops and tests therapies to counteract muscle wasting disorders.

Our research is focused on ageing (sarcopenia), muscle diseases (such as the muscular dystrophies), and cancer cachexia. We also investigate novel approaches for improving muscle repair after injury.

We are testing the efficacy of pharmacological interventions to counteract muscle wasting and hasten muscle repair after injury

Our work has application for many other muscle wasting conditions including: sepsis and other forms of metabolic stress; denervation, disuse, inactivity, unloading or microgravity; burns, human immunodeficiency virus (HIV)-acquired immunodeficiency syndrome; chronic kidney or heart failure; and chronic obstructive pulmonary disease.

Our studies involve investigation of molecular pathways regulating muscle size and function with a translational approach of cell culture experiments complemented by studies utilizing different animal models for these muscle wasting conditions.

PROJECTS:

14) The role of heat shock proteins for improving skeletal muscle structure and function in dystrophic mice.

The heat shock proteins (Hsp) are a family of molecular chaperone proteins known to be involved in the cell stress response. We have recently revealed how induction of one member of this family, heat shock protein 72 (Hsp72) (through transgenic manipulation, heat therapy and drug-induction) can protect dystrophic muscle against functional decline and improve lifespan in severely affected dko mice (Gehrig et al., 2012) This project aims to further examine the role of other heat shock proteins and the therapeutic potential of Hsp induction in the skeletal and cardiac muscles of various models of muscular dystrophy, with the ultimate aim to develop a novel treatment to improve both skeletal and cardiac muscle function and quality of life for patients with muscular dystrophy

Honours/Masters/PhD

Dr James Ryall
Basic and Clinical Myology

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15) Inhibition of stem cell commitment via metabolic reprogramming.

Despite the success of hematopoietic stem cell transplant, almost all other stem cell therapies have proven disappointing, with most still considered experimental and in various stages of preclinical testing. One of the major limitations of transplantation (particularly with regards to skeletal muscle stem cells) is premature specification and the rapid loss of "stemness" of cells to be transplanted. Recent work has identified a process of stem cell metabolic remodelling that occurs during changes in cell fate, with a shift in metabolism occurring during stem cell specification and differentiation. Interestingly, preliminary evidence suggests that by forcing stem cells into a different metabolic state (a new approach termed "metabolic reprogramming") it is possible to prevent or even reverse the process of stem cell specification. These exciting results suggest that metabolic reprogramming may provide a new avenue for improving stem cell transplant therapy. The current application seeks to make use of metabolic reprogramming to improve the process of stem cell transplantation, using adult skeletal muscle stem cells as a treatment for muscle injury. The results from this study have important implications for patients suffering from one of a multitude of muscle injuries and/or muscle disorders.

Honours/Masters/PhD

Dr Kristy Swiderski
Basic and Clinical Myology

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16) Addressing gastrointestinal dysfunction in Duchenne musculardystrophy (DMD)

(with Prof Joel Bornstein)

DMD is a devastating muscle wasting disorder which results from mutations in the dystrophin (*dmd*) gene. However, since the *dmd* gene encodes multiple dystrophin protein isoforms of various length and tissue distribution, the loss of dystrophin also affects other organ systems with serious impact on patient quality of life. DMD is associated with clinical manifestations of abnormal gastric and colonic motor activities. Constipation, bloating, and feelings of fullness, are reported as a matter of fact in DMD patients and those with other muscular dystrophies. Since dystrophin deficiency affects nNOS localisation and NO production in skeletal muscle fibres, it is likely that dysregulated NO production causes GI dysfunction in DMD. This project investigates whether treatment with compounds that can increase the activity of NOS and/or production of NO improve GI function in muscular dystrophy.

Honours

Dr Kate Murphy
Basic and Clinical Myology

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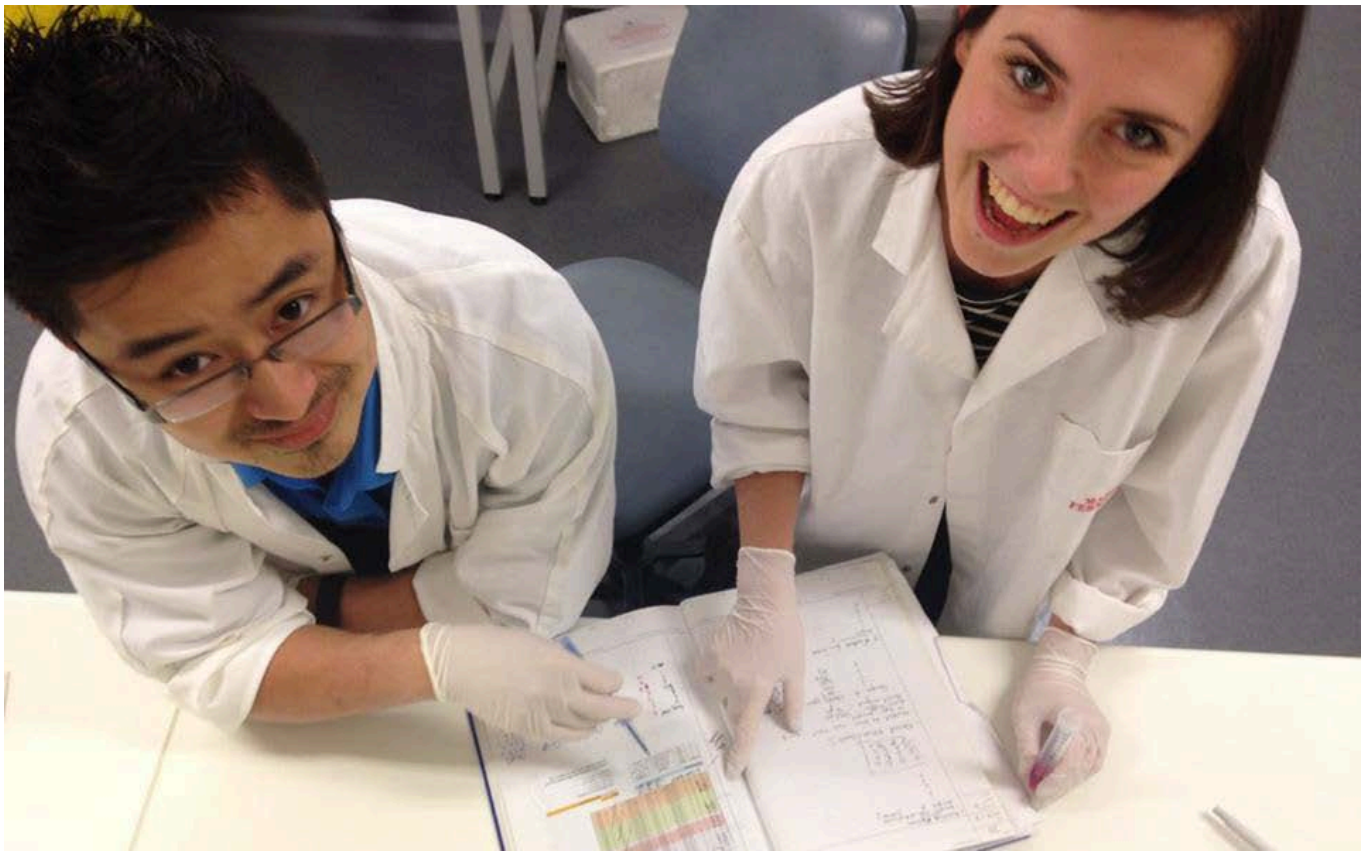
17) Role of cancer cachexia in chemotherapy-induced muscle wasting – mechanisms and treatments

(with Dr René Koopman)

Cancer cachexia is the progressive skeletal muscle wasting and weakness in cancer patients. Many chemotherapy agents induce muscle wasting which impairs the efficacy of these treatments. We have recently found that existing cachexia exacerbates chemotherapy-induced muscle wasting in tumour-bearing mice, and have identified the potential mechanisms. This project uses cell- and animal-based experiments to comprehensively test these mechanisms as well as the therapeutic potential of targeted strategies. Findings from these studies may help attenuate the muscle wasting associated with many chemotherapeutics and enhance the efficacy of these treatments in cancer patients.

Honours/Masters/PhD



Dr René Koopman
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Dr Marissa Caldow

CLINICAL NUTRITION AND MUSCLE & EXERCISE METABOLISM

We specialise in basic and translational (bench-to-bedside) research programs focussing on (nutritional) interventions to improve muscle protein and carbohydrate metabolism in health and disease. The main fields of interest include skeletal muscle protein and carbohydrate metabolism in response to food intake and exercise in health and disease, exercise metabolism, clinical nutrition, type 2 diabetes and aging. Working together closely with Gordon's Basic and Clinical Myology Laboratory, we also examine the metabolic mechanisms underlying skeletal muscle wasting in mammals.
Our research aims to increase knowledge that will enable us to define the most effective interventions to improve the anabolic response to food and exercise in acute and chronic metabolic diseases and ageing

PROJECTS:

18) Establish the effect of glycine/serine metabolism on skeletal muscle cell growth.

Skeletal muscle cell proliferation and growth require the production of building blocks for new cellular components (proteins, lipids and nucleic acids) as well the maintenance of cellular redox status. Observations in other cells suggest that the metabolism of the amino acid L-serine and its intermediate glycine can provide carbon units that satisfy many of these requirements. However, the cellular demand for L-serine is much greater than its uptake suggesting that the de novo production of L-serine is of critical importance to sustain cellular growth. Surprisingly, to date no detailed investigation of the role of L-serine biosynthesis in skeletal muscle has been performed and whether L-serine can support the production of biomass in growing muscle cells remains to be established.
Honours/Masters/PhD

19) Novel Nutritional Strategies to protect muscle from cancer and chemotherapy

(with Dr Kate Murphy)

Glycine/serine metabolism is emerging as a key point of control in the regulation of tumour growth and muscle homeostasis. We have identified the therapeutic potential of the amino acid glycine for inhibiting tumour growth and reducing muscle wasting in mice with non-metastatic cancer. Chemotherapy is a widely used option for cancer therapy. Unfortunately, many cancer patients treated with these drugs experience deleterious side effects such as loss of appetite, nausea and vomiting, diarrhoea, muscle wasting and fatigue that reduce quality of life. Therefore, the development of more safe and effective chemotherapeutic adjuvants or supplements to prevent chemotherapy-triggered toxicity and cachexia is very urgent. Preliminary work showing that glycine supports the muscle antioxidant capacity, suggests that glycine treatment during chemotherapy may reduce off target cytotoxicity and therefore further enhance the efficacy of these treatments.

Honours/Masters/PhD

Neurophysiology Laboratories and Projects

Prof. Joel Bornstein

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Dr Elisa Hill
Dr Jaime Foong

ENTERIC NEUROSCIENCE

Our major research interests are the neural mechanisms that control intestinal motor functions underlying the digestive process, including both muscle movement and the secretion of water and salt by the mucosa, and how these are disturbed by bacterial toxins and in neuropsychiatric disease. This work involves experimental methods ranging from electrophysiological analysis of synaptic transmission in reflex pathways, to immunohistochemical analysis of enteric neural circuits, to measurements of intestinal movements and secretions both in vitro and in vivo and computer simulation of the networks of neurons that mediate these functions.

Much of this work, especially that involving interactions between intestinal movements and secretion, is carried out in close collaboration with Prof Henrik Sjovall of Goteborg's University in Sweden and Dr Tor Savidge of Baylor College of Medicine in Texas. Other international collaborations include studies of GI disorders in autism with Prof Thomas Bourgeron in France and Dr Kent Williams of Ohio State University in the USA and a consortium funded by NIH whose goal is a predictive anatomical map of the enteric nervous system. Melbourne collaborators include Prof Heather Young of the Department of Anatomy and Neuroscience in a study of the functional development the enteric nervous system of the mouse.

PROJECTS:

20) Modelling nerves and networks.

Modelling is an essential form of inquiry in the quest to understand how the nervous system performs its tasks. We are engaged in a number of modelling projects that examine aspects of the nervous system from constructing models of synaptic transmission and detailed biophysical models of single cells through to elucidating emergent properties of large networks. The main techniques are computer simulation and some mathematical analysis. We concentrate on the enteric nervous system, which controls reflexes and motor patterns of the intestine, but the insights gained are also applicable to the brain and we are developing models that directly test some central nervous functions.

Masters/PhD

Dr. Elisa Hill
Enteric Neuroscience

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21) Understanding gastrointestinal dysfunction in autism – how do synaptic mutations affect enteric neurons?

(with Dr Elisa Hill)

Gastrointestinal disorders are common in patients with autism, but the biological mechanisms responsible are unknown. Many gene mutations identified in autism patients alter neuronal development and function, and studies in genetic mouse models show altered neural activity in the brain. Our recent studies show that mice carrying a mutation in a synaptic protein found in some autism patients have disordered gastrointestinal movements due to a change within the enteric nervous system. In this project, you will use video-imaging of motility, immunohistochemistry, molecular and electrophysiological methods to determine how synaptic proteins in the enteric nervous system are modified in these mice and how this affects the neural circuits that control colonic motility.

Honours/Masters/PhD

Dr. Jaime Foong
Enteric Neuroscience

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22) Mechanisms by which cholera toxin and *Clostridium difficile* toxin A affect intestinal movements

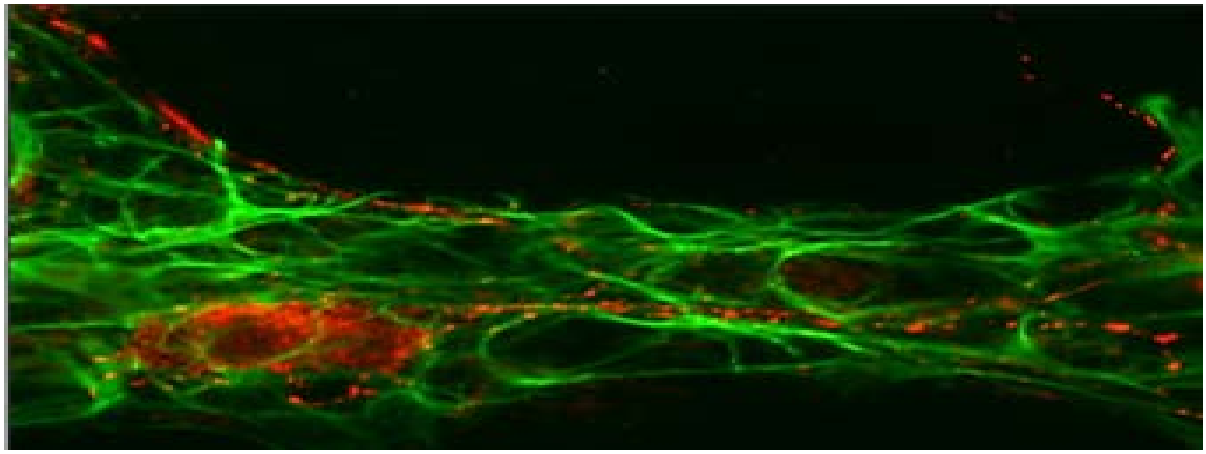
(with Dr Jaime Foong)

Our recent data indicate that cholera toxin and toxin A, bacterial exotoxins, in addition to causing massive diarrhoea due to over-secretion of water and salt across the intestinal mucosa, also modify the neural circuitry that controls the movements of the intestine (motility). This set of projects will address the mechanisms responsible. Two distinct studies are needed.

(a) Pharmacological analysis of the role of serotonin and other mucosal mediators in coupling the actions of cholera toxin and/or toxin A to intestinal movements recorded using video-imaging. Interactions of the toxins and nutrients that independently activate intestinal motility patterns will be a specific focus.

(b) Electrophysiological analysis of site of action of cholera toxin or toxin A in the reflex pathways that regulate intestinal movements. This will use extracellular recordings from contracting preparations in multi-chambered organ baths to dissect whether the toxin acts via sensory neurons, interneurons or motor neurons, or a combination of all three.

Honours/Masters



23) Development of the enteric nervous system in the mouse – what is the role of the intesti*nal* microbiota?

(with Dr Jaime Foong)

The cells that make up the enteric nervous system are derived from neural crest cells that migrate along the path that will become the vagus nerve and enter the upper gut at about embryonic day 9. By embryonic day 14.5, these neural crest cells and their derivative neurons and glia have completely colonised the intestinal tube. However, our data indicate that neural control of intestinal function does not become completely mature until at least 6 days after birth. Immediately after birth the intestinal is colonised by various microbes that proliferate and ultimately reach adult proportions and composition sometime after weaning. Virtually nothing is known about the interactions between these microbes and the developing enteric nervous system, although it is known that the intestinal microbiota can alter activity of enteric neurons in adult gut. This project will address this question by using antibiotics and probiotics to modify the maturing microbiota during critical periods of enteric nervous system development and maturation and then measuring the consequences for neuron number, neurochemistry and function. Methods used will include immunohistochemistry, video-recording of contractile activity and measurement of water and electrolyte secretion across the intestinal mucosa. Masters students will also be able to pursue functional aspects of the question using electrophysiological analyses of the development of synaptic and neuromuscular transmission.

Honours/Masters

Prof. Andrew Allen

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CENTRAL NEUROGENESIS REGULATION

The focus of our research is to understand how neural circuits generate and regulate sympathetic activity to the cardiovascular system. Our evidence suggests that this activity is a critical component in the development of hypertension, and subsequently cardiovascular diseases.

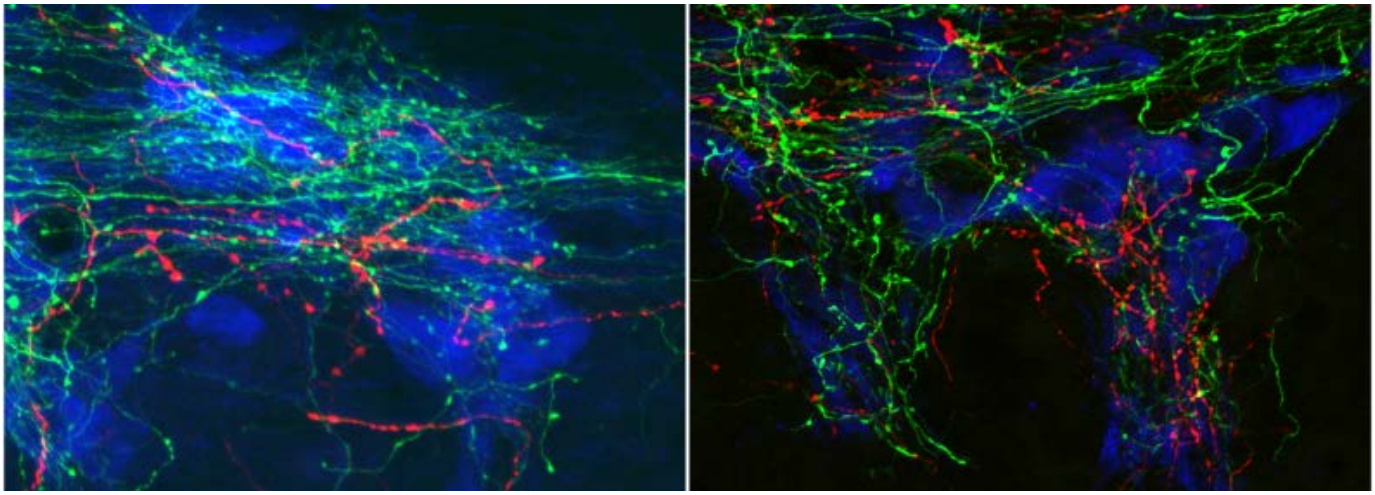
Key to deciphering how neural circuits generate particular outputs is knowing how different cell groups interact anatomically, and how the activity of one group affects that of others. We utilize cutting edge viral approaches to introduce transgenes into specific cells so that we can trace their axonal projections and connections (Sevigny et al., J. Comp. Neurol. 2012) or receptor expression (Simonds et al., Cell 2015). Using this same approach we also introduce activity-modifying proteins that enable us to remotely alter the activity of particular neurons – this technique is called opto- or pharmaco-genetics (Marina et al., Cardio. Res. 2011; Menuet et al., J. Neurosci. 2015). Using these approaches we are re-defining our understanding of the neural circuits involved in complex behaviours.

PROJECTS:

24) Optogenetic regulation of neuronal function.

We tailor projects towards the interests of the student with emphasis on experimental physiology, electrophysiology, neuroanatomy or molecular biology approaches. In addition the scope of the projects can be modified to enable sufficient experimental work for Honours, Masters or PhD level degrees. Interested students are invited to discuss the projects, see similar experimental work in progress and meet the other members of the laboratory. To organize this, please contact Andrew Allen.

Honours/Masters/PhD



Using viral transduction we have labelled one group of neurons with a red fluorophore and a different group with a green fluorophore. These neurons are located in the medulla oblongata. Their axonal projections are seen here in the vicinity of sympathetic preganglionic neurons in the spinal cord (blue neurons). These projections are many centimetres away from the cell body.

NOTES

PHYSIOLOGY CONTACT

For further information regarding individual laboratories, their current staff, recent publication and research themes use the web link below

http://biomedicalsciences.unimelb.edu.au/departments/physiology

HONOURS INFORMATION SESSIONS

MDHS DISCOVERY RESEARCH EXPO

Thursday 8th September 2016
2.00-4.30pm
Ground Floor – G01, Alan Gilbert Building, Grattan Street

HONS/MASTERS PHYSIOLOGY INFORMATION SESSION

Wednesday 14th September 2016
1.00-2.00pm
Level 3 Prac Labs (North Wing), Medical Building (181)
Q&A session, pizza and drinks to follow.

PHYSIOLOGY EXTRA INFORMATION SESSION

Friday 16th September 2016
11.00-12.00pm
Peter McCallum Seminar Level 4 West, Medical Building (181)