Welcome to the Melbourne Dental School

The Melbourne Dental School is proud of its longstanding record of excellence in health research. Research at the School covers a broad range of scientific endeavour from basic science to clinical studies involving various disciplines including microbiology, immunology, cancer cell biology, biochemistry & molecular biology, chemistry, anatomy, and materials engineering.

We are incredibly passionate about the mentoring and the training of future researchers. Indeed, our mission is to continue to be a world-class, research-based school, offering education of the highest quality. To achieve this goal, we provide excellence in research training and support for all laboratory and clinician research students as they develop research knowledge and expertise and help drive new discoveries that lead to better outcomes for patients. So, if you are passionate about improving patient health, we encourage you to join us in the pursuit of knowledge by applying to do Honours or a Masters degree at the Melbourne Dental School. Working closely with researchers, students undertake their project in state-of-the-art research laboratories at the Melbourne Dental School and Bio21 Institute. High-achieving students will automatically be considered for an MDS Honours Scholarship ($5,000).

There are a number of factors you might want to consider when making the decision about undertaking an Honours year or a Masters degree, such as the amount of time spent on your research project, opportunities to undertake professional skills-based subjects, and which pathway would be most advantageous for possible entry into a PhD program in the future. Regardless of your choice, the School provides a stimulating and challenging intellectual environment that allows you to experience research firsthand and put your scientific knowledge into practice. The diverse range of Australian and international students from many social and ethnic backgrounds at the School greatly enhances the learning experience.

This booklet provides information that will help you decide on potential research projects. Please take your time to identify projects that are of interest and contact potential supervisors for more information. I am very confident they will be eager to discuss your research interests and talk about their own research, show you around their laboratories, and introduce you to other students and researchers.

I look forward to seeing you at the School next year and hearing about your research project.

Professor Mike Morgan
Head of School
### Host-Microbe Interactions in Health & Disease

- Investigating mucosal and systemic immune responses to bacteria
- Investigating how IL-36 cytokines prevent bacterial infection
- Regulation of innate lymphoid cells by IL-36 cytokines during infection
- How transcriptional networks control epithelial cell responses to prevent bacterial infection
- Microbial flow cytometry: developing diagnostic tools for immune responses to bacteria, nano- and micro-materials and vesicles

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### Microbiomes in Health & Disease

- Oral microbiomes in health and disease

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### Bacterial Virulence

- Characterisation of potential virulence factors secreted by the type 9 secretion system of *Porphyromonas gingivalis*
- Identification of the interacting regions between an essential component of the type 9 secretion system, PorV, and secreted virulence factors of the oral pathogen, *Porphyromonas gingivalis*
- Role of PG0189 in the assembly of the type IX secretion system in *Porphyromonas gingivalis*
- Proteomic analysis of gingipain catalysed transpeptidation reactions and its relevance to autoimmunity
- Outer membrane vesicles and polymicrobial chronic disease
- Antimicrobial materials – synthesis of novel peptides, nanoparticles and organic polymers to target antibiotic resistance in bacteria
- Bacterial chemotaxis and chronic disease

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### Oral Cancer

- Role of GLUT transporters in oral cancer
- Targetting MMP2 in oral squamous cell carcinoma
- Effects of human mutations on the tumour suppressor functions of the IRF6/RIPK4 axis

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### Vaccine Development

- Vaccine design and development to improve immune responses to viral diseases and cancer

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### Biomaterials for Tissue Repair & Regeneration

- Enhancement of remineralization and prevention of dental erosion

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### Life Events & Environmental Effects on Mineralised Tissues

- Skeletal evidence of periodontal status in the Melbourne Dental School collection
- Sex determination in unknown human remains using dimorphism in femoral head volume
- What is the origin of tetracycline-like staining in a sample of contemporary human femoral cortical bone?

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Project Theme: Host–Microbe Interactions in Health & Disease

Host–microbe interactions: investigating mucosal and systemic immune responses to bacteria

The initial interaction of bacteria and bacterial products with mucosal tissue and the immune response induced are fundamental to bacterial infection and disease. We are focused on investigating how antibiotic susceptible and resistant bacteria differ in their interactions and what materials they produce (e.g. outer membrane vesicles, OMVs) to aid infection. We are also interested in discovering how oral bacteria interact with the host to cause disease and how they are associated with systemic conditions (e.g. oral, pancreatic and bowel cancer). We have already found that there is synergy between pathogenic and non-pathogenic bacteria in causing disease and immunopathology. We are offering a number of projects investigating: (1) mucosal and systemic immune responses to single and multi-bacterial species infection; (2) what and how bacterial factors such as OMVs interact with immune cells; (3) how bacteria effect immune cell trafficking into the mucosa and the effect of infection by multiple bacteria; (4) how OMVs aid infection of antibiotic susceptible and resistant bacteria and oral bacteria that cause chronic periodontitis.

Areas/techniques in which expertise will be developed
Flow cytometry (multi-parameter), fluorescence activated sorting, aseptic technique, bacteriology and microbiological techniques, tissue culture, real-time PCR and cytokine DNA microarray, SDS PAGE, ELISA, ELISPOT, cytotoxicity assays, animal and human sample handing and experiments, report writing, paper editing/writing, working as a member of a team, and research management.

Supervisors
Prof Neil O’Brien-Simpson – neil.obs@unimelb.edu.au
Dr James Holden – jholden@unimelb.edu.au
Dr Jason Lenzo – jlenzo@unimelb.edu.au

Degree availability
Bachelor of Science (Honours)
Bachelor of Biomedicine (Honours)
Master of Biomedical Science

Location
Melbourne Dental School and Bio21 Institute

Number of vacancies
Two students

Recent publications

*Former Honours student; ^former PhD student
Investigating how IL-36 cytokines prevent bacterial infection

Up to ten billion bacteria, including potential pathogens, colonise the oral cavity. Importantly, the epithelial cells that line the oral cavity are equipped with immune receptors, including Toll-like receptors, which enables the detection of bacteria and subsequent production of cytokines that recruit and activate immune cells to prevent infection. We have discovered that oral epithelial cells respond to bacteria by producing the novel cytokine IL-36γ. Furthermore, we have discovered that IL-36γ stimulates the production of other cytokines by innate immune cells (e.g. dendritic cells) to recruit and activate additional immune cells (e.g. T-lymphocytes). IL-36γ also regulates tissue-remodelling proteins, including matrix metalloproteinases. Collectively, our findings therefore position IL-36γ as an important regulator of oral mucosal immunity and homeostasis. In this project, you will use gene knockout mice and _ex vivo_ systems to investigate the role of IL-36γ in the physiological response to bacterial infection.

Areas/techniques in which expertise will be developed

Bacterial cell culture, small animal (mouse) experimentation including bacterial infection, tissue dissection and histological analysis including H&E and immunohistochemical staining, flow cytometry including immune cell sorting, RNA purification and gene expression analysis (qPCR), cytokine analysis (ELISA), critical thinking, project management, scientific writing and oral communication.

**Supervisors**

A/Prof Glen Scholz – glenms@unimelb.edu.au

Dr Jacqueline Heath – jhea@unimelb.edu.au

**Degree availability**

Bachelor of Science (Honours)

Bachelor of Biomedicine (Honours)

Master of Biomedical Science

**Location**

Melbourne Dental School and Bio21 Institute

**Number of vacancies**

Two students

**Recent publications**


\(^*\)Former Honours student; \(^*\)former PhD student
Regulation of innate lymphoid cells by IL-36 cytokines during infection

IL-36 cytokines (IL-36α, IL-36β and IL-36γ) are important mediators of mucosal inflammation and tissue homeostasis. We have discovered that human oral mucosal epithelial cells respond to bacterial pathogens (e.g. Porphyromonas gingivalis) by specifically producing IL-36γ. Furthermore, we have discovered that IL-36γ stimulates oral mucosal epithelial cells to express neutrophil and T-lymphocyte attracting cytokines. Excitingly, gene expression data indicate that IL-36γ may also regulate the functions of innate lymphoid cells (ILCs), a recently discovered type of immune cell with important roles in mucosal immunity. Collectively, our findings therefore position IL-36γ as a critical mediator of oral mucosal immunity and homeostasis. In this project, you will use gene knockout mice and ex vivo systems to investigate the role of IL-36γ in the regulation of ILCs in response to bacterial infection.

Areas/techniques in which expertise will be developed

Bacterial cell culture, small animal (mouse) experimentation including bacterial infection, tissue dissection and histological analysis including H&E and immunohistochemical staining, flow cytometry including immune cell sorting, RNA purification and gene expression analysis (qPCR), cytokine analysis (ELISA), critical thinking, project management, scientific writing and oral communication.

Supervisors

Dr Jacqueline Heath – jhea@unimelb.edu.au  
A/Prof Glen Scholz – glenms@unimelb.edu.au

Degree Availability

Bachelor of Science (Honours)  
Bachelor of Biomedicine (Honours)  
Master of Biomedical Science

Location

Melbourne Dental School and Bio21 Institute

Number of vacancies

One student

Recent publications


*Former Honours student; ^former PhD student
How transcriptional networks control epithelial cell responses to prevent bacterial infection

Every surface of the human body is colonised by bacteria, including potential pathogens. The epithelia covering these surfaces, which are maintained by cells in the basal layer differentiating and migrating to the surface, prevent disease by thwarting tissue invasion by pathogens whilst maintaining immunological homeostasis with commensal bacteria to avoid chronic inflammation. The innate immune receptor TLR2 is a critical regulator of the inflammatory and antimicrobial responses of epithelial cells to bacteria. Significantly, we have discovered that oral epithelial cells downregulate TLR2 levels as they differentiate, resulting in reduced expression of inflammatory cytokines. Remarkably though, the cells exhibit heightened expression of antimicrobial proteins in response to inflammatory cytokines. In this project, you will investigate the molecular mechanisms that mediate the differentiation-dependent regulation of the inflammatory and antimicrobial responses of oral epithelial cells to bacteria. This will involve studying transcription factors as well as epigenetic regulators of epithelial cell differentiation and activation.

Areas/techniques in which expertise will be developed
Mammalian and bacterial cell culture, manipulating gene expression (silencing and overexpression), cell signalling (immunoprecipitation, SDS-PAGE and Western blotting), transcriptional regulation (next-generation sequencing, ChIP and real-time PCR), cytokine analysis (ELISA), immuno-fluorescence confocal microscopy, critical thinking, project management, scientific writing and oral communication.

Supervisors
A/Prof Glen Scholz – glenms@unimelb.edu.au
Dr Jacqueline Heath – jhea@unimelb.edu.au

Degree availability
Bachelor of Science (Honours)
Bachelor of Biomedicine (Honours)
Master of Biomedical Science

Location
Melbourne Dental School and Bio21 Institute

Number of vacancies
One student

Recent publications

*Former Honours student; ^former PhD student
Microbial flow cytometry: developing diagnostic tools for immune responses to bacteria, nano- and micro-materials and vesicles

Analysis of nano-materials and microbes using flow cytometry is a novel area of research. A major issue in studying nano- and micro-particle interaction with mammalian cells or microbes or analysis of microorganisms by flow cytometry has been the sensitivities of flow cytometers. As part of the University’s Cytometry Platform the Melbourne Dental School node has developed methodologies to detect and resolve 100 nm particles, thus allowing detection of exosomes and outer membrane vesicles in biological fluids. The methodologies allow detection and sorting of mixed bacterial populations and enable analysis of rare events in mammalian cells and microbes. The projects offered are in the development of nano- and micro-flow cytometry assays for the detection, analysis and sorting of: (1) bacteria-bacteria interactions, (2) nanoparticle interactions with bacteria and/or mammalian cells, (3) bacterial outer membrane vesicle (OMV) interactions with bacteria and host cells, (4) isolation and identification of bacteria from mixed biofilm and biological samples, (5) isolation of exosomes, OMVs from biological samples and their identification.

Areas/techniques in which expertise will be developed

Flow cytometry, fluorescence activated sorting, aseptic technique, bacteriology and microbiological techniques, tissue culture, peptide/polymer chemistry, peptide/protein purification (HPLC/FPLC), SDS-PAGE, ELISA, ELISPOT, cytotoxicity assays, animal and human sample handing and experiments, report writing, paper editing/writing, working as a member of a team, and research management.

Supervisors
Prof Neil O’Brien-Simpson – neil.obs@unimelb.edu.au
Dr Alexis Gonzalez – alexis.gonzalez@unimelb.edu.au
Dr James Holden – jholden@unimelb.edu.au
Dr Jason Lenzo – jlenzo@unimelb.edu.au

Recent publications

*Former Honours student; ^former PhD student

Honours and Masters Research Project Handbook 2019
**Project Theme: Microbiomes in Health & Disease**

**Oral microbiome in health and disease**

The human oral cavity is home to over 700 species of bacteria, many of these species are beneficial to our health whilst others are associated with the development of chronic diseases. During disease initiation there is a shift in the composition of the microbiome that leads to the development of a dysbiotic biofilm community that sustains disease progression. In this project you will determine the oral microbiome in health compared with that in disease states and identify those bacteria associated with disease. You will have the opportunity to investigate prebiotic and probiotic treatments that restore the health balance to the oral microbiome.

**Areas/techniques in which expertise will be developed**

Bacterial DNA extraction and sequencing, bioinformatics, microbial ecology

**Supervisors**

Prof Stuart Dashper – stuartgd@unimelb.edu.au  
Dr Catherine Butler – cbutler@unimelb.edu.au  
Dr Samantha Byrne – sbyrne@unimelb.edu.au

**Degree availability**

Bachelor of Science (Honours)  
Bachelor of Biomedicine (Honours)  
Master of Biomedical Science

**Location**

Melbourne Dental School and Bio21 Institute

**Number of vacancies**

Two students
**Project Theme:** Bacterial Virulence

**Characterisation of potential virulence factors secreted by the type 9 secretion system of *Porphyromonas gingivalis***

Chronic periodontitis is an inflammatory disease causing the destruction of the supporting gum and bone of teeth. *Porphyromonas gingivalis* is a major agent of this disease and its type 9 secretion system (T9SS) secretes abundant gingipain proteases that are involved in this disease process. Many other proteins are secreted by the T9SS but their function is unknown. Recent structural analyses have predicted virulence functions for several of these T9SS substrates. The honours projects on offer will characterize these candidate virulence factors to further our understanding of the arsenal of virulence factors that *P. gingivalis* deploys.

**Areas/techniques in which expertise will be developed**

Microbiological, molecular biology, immunological and biochemical techniques, including anaerobic bacterial growth, cell growth inhibition assays, *P. gingivalis* gene deletion, PCR, DNA purification, DNA gel electrophoresis, recombinant protein expression, SDS-PAGE, Western blot, 2D Blue-Native PAGE and proteomics.

**Supervisors**

Dr Michelle Glew – mglew@unimelb.edu.au  
A/Prof Paul Veith – pdv@unimelb.edu.au

**Degree availability**

Bachelor of Science (Honours)  
Master of Biomedical Science

**Location**

Bio21 Institute

**Number of vacancies**

Two students

**Recent publications**

Identification of the interacting regions between an essential component of the type 9 secretion system, PorV, and secreted virulence factors of the oral pathogen, *Porphyromonas gingivalis*

The type 9 secretion system (T9SS) of the oral Gram-negative pathogen, *Porphyromonas gingivalis*, is responsible for secreting abundant gingipain proteases that are major virulence factors and contribute to chronic periodontitis in humans. PorV has recently been shown to be an essential outer membrane protein component involved in the secretion of these virulence factors and the covalent linkage to anionic lipopolysaccharide which ultimately anchors them to the cell surface. To better understand how PorV interacts with T9SS substrates, this project will involve mutagenesis of the inner and outer loop amino acids of PorV and characterization of the resulting *P. gingivalis* mutants to observe any effects on secretion. The student will join a team that are leaders in the field and publishing in high ranking journals.

Areas/techniques in which expertise will be developed

Microbiological, molecular biology, immunological and biochemical techniques, including anaerobic bacterial growth, gene mutagenesis in *P. gingivalis*, PCR, DNA purification, DNA gel electrophoresis, SDS-PAGE, Western blot, 2D Blue-Native PAGE and proteomics.

Supervisors
Dr Michelle Glew – mglew@unimelb.edu.au
A/Prof Paul Veith – pdv@unimelb.edu.au

Degree availability
Bachelor of Science (Honours)
Master of Biomedical Science

Location
Bio21 Institute

Number of vacancies
One student

Recent publications
Role of PG0189 in the assembly of the type IX secretion system (T9SS) in Porphyromonas gingivalis

Periodontitis (gum disease) is a major health problem. The main microorganism responsible for periodontitis is the pathogenic bacterium Porphyromonas gingivalis. Infection by this bacterium can cause severe lesions resulting in tooth loss. The major virulence factors of P. gingivalis are cysteine proteinases called gingipains, which are sorted to the cell-surface by the recently identified Type IX secretion system (T9SS). This secretion system is composed of at least 13 proteins, including PorK and PG1058, which are thought to assemble an outer membrane channel that transports the gingipains to the cell-surface. The T9SS is poorly characterised and very little is known about how this system functions to transport the gingipains. More recently, we have identified PG0189 to be a novel component of the T9SS and found that it forms a disulphide bond with PorK. This study aims to understand the role of this conserved cysteine in PG0189. The cysteine will be mutated to alanine and introduced in P. gingivalis. We will then examine the effect of this mutation on the T9SS, i.e. is the formation of the ring structure affected in the absence of the cysteine? This study will improve our understanding of how the T9SS functions to secrete virulence factors to the cell surface.

Areas/techniques in which expertise will be developed
Isolation of genomic DNA, mutagenesis, PCR, DNA gel electrophoresis, plasmid isolation, DNA cloning, growing anaerobic bacteria (P. gingivalis), isolation of large macromolecular complexes using gradient centrifugation, SDS-PAGE, western blots and electron microscopy.

Supervisors
Dr Dhana Gorasia – gorasiad@unimelb.edu.au
A/Prof Paul Veith – pdv@unimelb.edu.au

Degree availability
Bachelor of Science (Honours)
Bachelor of Biomedicine (Honours)
Master of Biomedical Science

Location
Bio21 Institute

Number of vacancies
One student

Recent publications
Proteomic analysis of gingipain catalysed transpeptidation reactions and its relevance to autoimmunity

The gingipains are cell surface cysteine proteases and major virulence factors of *Porphyromonas gingivalis*, a keystone pathogen of human periodontitis (gum disease). We recently discovered that these proteases not only hydrolyse proteins but also cleave them via transpeptidation leading to rearranged peptide sequences. In vivo, this is expected to generate a staggering number of rearranged host protein sequences which may lead to autoimmune reactions. The aim of this project is to further characterise this transpeptidation activity. First, transpeptidation rates will be measured as a function of environmental variables such as pH and temperature as well as a function of the sequence and length of peptide acceptors. In addition, we have noted that gingipains degrade model substrates including human haemoglobin via both transpeptidation and hydrolysis reactions in vitro. This project will study in detail the degradation pathway of human haemoglobin to help predict the kinds of favoured transpeptidation reactions that may also occur in vivo. Finally, a proteomic study of sub-gingival plaque and surrounding protein fluid (gingival crevicular fluid) obtained from periodontitis patients will be conducted to identify in vivo targets of transpeptidation.

Areas/techniques in which expertise will be developed
Mass spectrometry/proteomics, enzyme characterization, UV-Vis and fluorescence spectrophotometry, enzyme activity assay, polyacrylamide gel electrophoresis and immunoassays, protein purification techniques including liquid chromatography, ultrafiltration and ultracentrifugation.

Supervisors
A/Prof Paul Veith – pdv@unimelb.edu.au
Dr Lianyi Zhang – lizhang@unimelb.edu.au

Degree availability
Bachelor of Science (Honours)
Bachelor of Biomedicine (Honours)
Master of Biomedical Science

Location
Bio21 Institute

Number of vacancies
One student

Recent publications
Outer membrane vesicles and polymicrobial chronic disease

*Porphyromonas gingivalis* and *Treponema denticola* display a range of synergistic behaviours including polymicrobial biofilm formation and development, and nutrient acquisition, which together enable them to cause chronic disease. Both bacteria produce and release outer membrane vesicles that preferentially bind to the other species. In this project you will determine how this binding occurs and the benefits to each species of binding outer membrane vesicles.

**Areas/techniques in which expertise will be developed**
Confocal microscopy, molecular biology, anaerobic bacterial culture, flow cytometry

**Supervisors**
Prof Stuart Dashper – stuartgd@unimelb.edu.au
Dr Catherine Butler – cbutler@unimelb.edu.au
Dr Nada Slakeski – n.slakeski@unimelb.edu.au
Dr Alexis Gonzalez – alexis.gonzalez@unimelb.edu.au

**Degree availability**
Bachelor of Science (Honours)
Bachelor of Biomedicine (Honours)
Master of Biomedical Science

**Location**
Melbourne Dental School and Bio21 Institute

**Number of vacancies**
Two students

**Recent publications**


*Former Honours student; ^former PhD student
Antimicrobial materials – synthesis of novel peptides, nanoparticles and organic polymers to target antibiotic resistance in bacteria

By 2050, it is predicted that more people will die from bacterial infections than cancer. Currently, multidrug resistant (MDR) bacterial infections cause >700,000 deaths/year and incur an estimated annual treatment cost of >US $20 billion. Antimicrobial resistance is considered “one of our most serious health threats” and thus new, potent and selective antimicrobial agents that do not induce resistance like traditional antibiotics are urgently required. We wish to recruit students into 3 areas of research: (1) Antimicrobial nanomaterials – we are investigating antimicrobial nanomaterials, termed Structurally Nanoengineered Antimicrobial Peptide Polymers (SNAPPs). This project will use novel and established assays in an iterative chemical biology approach to modify antimicrobial nanomaterials to enhance killing of MDR bacteria. (2) Antimicrobial peptides targeting oral bacteria – the oral cavity is a reservoir for transferable antibiotic resistance, a phenomenon increased in patients with chronic periodontitis. This project will investigate methods for narrowing the activity spectrum of AMPs to target only periodontal pathogens, reduce cytotoxicity, and leave unharmed bacteria associated with oral health. (3) Antibiotic adjuvants – one approach to address antibiotic resistance is to combine antibiotics with an “antibiotic adjuvant”, which potentiates or restores the activity of the antibiotic towards MDR bacteria. This project will use an iterative chemical biology approach to modify AMPs or SNAPPs to enhance their antibiotic adjuvant properties.

Areas/techniques in which expertise will be developed

Bacteriology & microbiological techniques, mammalian tissue culture, peptide & polymer chemistry, peptide & protein purification (HPLC, FPLC), SDS-PAGE, ELISA, ELISPOT, cytotoxicity assays, animal handing and experiments, paper editing & writing, working as a member of a team, and research management.

Supervisors
Prof Neil O’Brien-Simpson – neil.obs@unimelb.edu.au
Dr James Holden – jholden@unimelb.edu.au
Dr Jason Lenzo – jlenzo@unimelb.edu.au

Degree availability
Bachelor of Science (Honours)
Bachelor of Biomedicine (Honours)
Master of Biomedical Science

Location
Melbourne Dental School and Bio21 Institute

Number of vacancies
Two students

Recent publications

*Former Honours student; ^former PhD student
Bacterial chemotaxis and chronic disease

*Treponema denticola* is a chemotactic, motile spirochaete that is an aetiological agent of chronic periodontitis. Its unique form of motility and chemotaxis enable it to move through highly viscous environments. It has twenty chemoreceptor proteins that enable it to respond to a range of stimulatory substances. In this project you will determine how *T. denticola* moves in response to stimuli using a custom-built flow cell and confocal scanning laser microscopy. You will have the opportunity to clone and express the *T. denticola* chemotaxis proteins and determine their substrate specificity using highly novel microarray technologies.

Areas/techniques in which expertise will be developed
Confocal microscopy, molecular biology, anaerobic bacterial culture, protein expression

**Supervisors**
- Prof Stuart Dashper – stuartgd@unimelb.edu.au
- Dr Catherine Butler – cbutler@unimelb.edu.au
- Dr Nada Slakeski – n.slakeski@unimelb.edu.au

**Degree availability**
- Bachelor of Science (Honours)
- Bachelor of Biomedicine (Honours)
- Master of Biomedical Science

**Location**
Melbourne Dental School and Bio21 Institute

**Number of vacancies**
Two students

**Recent publications**

*Former Honours student; ^former PhD student
Project Theme: Oral Cancer

Role of GLUT transporters in oral cancer

Oral squamous cell carcinoma (OSCC) is a prevalent subtype of oral cancer that results in high mortality rates. OSCCs tend to rely on aerobic glycolysis for energy production. GLUT transporters are consistently shown to be overexpressed in several types of cancer, presumably to enable increased glucose transport into cells to meet their increased energy demands. GLUTs upregulation in these cells is associated with increased tumour aggression and reduced survival outcomes. Hence, inhibition of GLUT transporters activity may demonstrate improved clinical outcomes. However, there is still limited research on the effects of GLUT inhibition on OSCC cell lines. The overall objective of this project is to assess the effects of GLUTs inhibition, particularly GLUT1 and GLUT4 on the proliferation, migration and invasive capacities of OSCC cell lines.

Areas/techniques in which expertise will be developed

Cell culture, including proliferation, migration and invasion assays; immunohistochemistry & immunofluorescence; ELISA.

Supervisors

Dr Antonio Celentano – antonio.celentano@unimelb.edu.au
Prof Michael McCullough – m.mccullough@unimelb.edu.au
A/Prof Nicola Cirillo – nicola.cirillo@unimelb.edu.au

Degree availability

Bachelor of Science (Honours)
Bachelor of Biomedicine (Honours)
Master of Biomedical Science

Location

Melbourne Dental School

Number of vacancies

One student

Recent publications

• Celentano A, McCullough M, Cirillo N. Glucocorticoids reduce chemotherapeutic effectiveness on OSCC cells via glucose-dependent mechanisms. Journal of Cellular Physiology (In press)
Targeting MMP2 in oral squamous cell carcinoma

Oral cancer is the sixth most common malignancy in the world with oral squamous cell carcinoma (OSCC) encompassing about 90% of oral cancers. Various biomarkers are currently emerging with their importance in treatment options and disease management in patients with oral cancer. One of these biomarkers are MMPs, which are zinc-dependent proteolytic enzymes involved in remodelling the extracellular matrix (ECM). Whilst all integral to physiological tissue remodelling, among the 23 human MMPs, MMP2 is a type IV collagenase involved in cancer pathology. Active levels of MMP2 in cancer cells are highly associated with metastasis through the degradation of basement membrane ECM proteins. MMPs are also thought to play a major role in other cell behaviours such as cell proliferation, differentiation, angiogenesis, apoptosis and host defence.

Showing a promising significance to the future of cancer therapies, further investigation regarding their role in OSCC and mechanisms to inhibit them are crucial. The aim of the present project will be to investigate the effect of MMP2 inhibition through the use of MMP2 neutralising monoclonal antibody and a selective chemical inhibitor in malignant oral keratinocytes in vitro; as well as to assess the difference between MMP2 expression in normal and malignant tissues.

Areas/techniques in which expertise will be developed

Cell culture, including proliferation, migration and invasion assays; immunohistochemistry & immunofluorescence; ELISA; in silico analysis.

Supervisors

Dr Antonio Celentano – antonio.celentano@unimelb.edu.au
Prof Michael McCullough – m.mccullough@unimelb.edu.au
A/Prof Nicola Cirillo – nicola.cirillo@unimelb.edu.au

Degree availability

Bachelor of Science (Honours)
Bachelor of Biomedicine (Honours)
Master of Biomedical Science

Location

Melbourne Dental School

Number of vacancies

One student

Recent publications

Effects of human mutations on the tumour suppressor functions of the IRF6/RIPK4 axis

Many human cancers (e.g. breast, skin and oral cancer) are caused by gene mutations that dysregulate the normal program of epithelial cell differentiation. The IRF6 transcription factor is a critical regulator of epithelial cell differentiation. Significantly, we have discovered that IRF6 is directly regulated by the protein kinase RIPK4 and shown that they function together as a regulatory axis to drive normal epithelial cell differentiation. Notably, IRF6 and RIPK4 were recently discovered to be mutated in human cancers of epithelial origin. In this project, you will investigate how IRF6 and RIPK4 function together to suppress the development of oral squamous cell cancer. Specifically, you will investigate the effects of cancer-associated mutations on the regulation and function of IRF6 by RIPK4. You will also identify novel regulatory proteins that interact with IRF6 and RIPK4 and investigate the effect cancer-associated mutations have on the regulation of IRF6 and RIPK4 by these proteins.

Areas/techniques in which expertise will be developed

Mammalian cell culture, including cell proliferation, differentiation and invasion assays, manipulating gene expression (overexpression, silencing and mutation/editing), transcriptional regulation (ChIP and real-time PCR), proteomics (immunoprecipitation, SDS-PAGE, Western blotting, and mass spectrometry), immunofluorescence confocal microscopy, critical thinking, project management, scientific writing and oral communication.

Supervisors
A/Prof Glen Scholz – glenms@unimelb.edu.au
Dr Jacqueline Heath – jhea@unimelb.edu.au

Degree availability
Bachelor of Science (Honours)
Bachelor of Biomedicine (Honours)
Master of Biomedical Science

Location
Melbourne Dental School and Bio21 Institute

Number of vacancies
One student

Recent publications

**Former Honours student; ^former PhD student
Project Theme: Vaccine Development

Vaccine design and development to improve immune responses to viral diseases and cancer

Cytotoxic T lymphocytes (CTL) are critical for immunosurveillance and killing of virus-infected cells and cancer cells. Many viral infections and squamous cell carcinomas (SCC) occur at mucosal sites; however, parenteral vaccination does not induce mucosal immunity. For the vaccine to induce a protective CTL response, it needs to be administered via a mucosal route and deliver its antigen cargo to dendritic cells. Further, the vaccine will need to activate these cells to induce both CTL and T helper (Th) cell antigen-specific responses, which is necessary for strong effector and memory CTL responses. We have demonstrated that nanoparticles are effective mucosal vaccine delivery vehicles and different pattern recognition receptor (PRR) ligands used to functionalise antigen-loaded nanoparticles can enhance or abrogate CTL and Th responses. Our research has shown that protein-coated and PRR functionalised nanoparticles are more rapidly phagocytosed and induce stronger CTL and Th cell immune responses. Finally, we have developed a novel and reliable method for producing different sized calcium phosphate nanoparticles that has applicability for a broad range of vaccines. The overall aim of our research is to combine these new technologies for an integrated, preclinical evaluation of novel calcium phosphate nanoparticle vaccines and compare their ability to induce CTL responses via mucosal or parenteral immunisation. We wish to recruit students into 3 areas of research: (1) Determining the immuno-stimulatory capability of antigen and molecular adjuvant loaded calcium phosphate nanoparticles in vitro. (2) Determining the immuno-stimulatory capability of calcium phosphate nanoparticle vaccines in vivo. (3) Evaluating the efficacy of calcium phosphate nanoparticles as mucosal vaccines to induce protective CTL responses.

Areas/techniques in which expertise will be developed
Flow cytometry, fluorescence activated sorting, aseptic technique and mammalian tissue culture, real-time PCR and cytokine array, SDS-PAGE, ELISA, ELISPOT, cytotoxicity assays, animal and human sample handing and experiments, paper writing/editing, working as a member of a team, and research management.

Supervisors
Prof Neil O’Brien-Simpson – neil.obs@unimelb.edu.au
Dr James Holden – jholden@unimelb.edu.au
Dr Jason Lenzo – jlenzo@unimelb.edu.au

Degree availability
Bachelor of Science (Honours)
Bachelor of Biomedicine (Honours)
Master of Biomedical Science

Location
Melbourne Dental School and Bio21 Institute

Number of vacancies
Two students

Relevant publications

*Former Honours student; ^former PhD student
**Project Theme:** Biomaterials for Tissue Repair & Regeneration

**Enhancement of remineralization and prevention of dental erosion**

Dental decay, or caries, starts when bacteria in plaque produces an organic acid which dissolves the tooth enamel, breaking down the calcium and phosphate in tooth enamel. Enamel remineralization is the process of net mineral uptake into partially demineralized tooth structure to prevent and repair early dental decay. Projects are available to study the process of enamel demineralization and remineralization to increase our understanding of dental caries and erosion and will study ways of enhancing remineralization and quantify the effects of these treatments using state-of-the-art quantification methods. Projects are available to test novel oral health products and functional foods designed to assist in the prevention of dental caries and/or dental erosion. The preventive products that include toothpastes, dental cremes, mouth rinse solutions, gels, and varnishes for topical application will contain anti-caries/erosion agents. Alternatively, commonly consumed foods and beverages will be modified to minimize their potential to cause loss of mineral from teeth such as during dental caries and dental erosion or modified to provide a positive health effect. The projects may include laboratory and/or *in situ* studies.

**Areas/techniques in which expertise will be developed**

Demineralization, dental erosion, remineralization, transverse microradiography, microhardness.

**Supervisors**

Dr Peiyan Shen – peiyan@unimelb.edu.au

**Degree availability**

Bachelor of Science (Honours)  
Bachelor of Biomedicine (Honours)  
Master of Biomedical Science

**Location**

Melbourne Dental School

**Number of vacancies**

Two students
Project Theme: Life Events & Environmental Effects on Mineralised Tissues

Skeletal evidence of periodontal status in the Melbourne Dental School collection

Periodontal disease can affect the bone surrounding the teeth and affect the health of these tissues. As there is no soft tissue present in skeletonised human remains, inspecting the alveolar bone of the jaws in skulls may be one way to gain important information about environmental effects causing health changes in an individual that lived long ago, and can be important for determining their overall health (Nelson, Chapter 28, A Companion to Dental Anthropology, Ed. Irish and Scott, 2016). Evidence of periodontitis in the MDS skull collection may indicate the living conditions the individual found themselves in at the time they were alive. Combining this information with other observances of dental health will provide a more complete picture of overall health in an individual. The results of these techniques can then be compared with results of similar techniques in living individuals to determine their accuracy.

Areas/techniques in which expertise will be developed
Assessment of dental hard tissues and bone, bone biology, disease processes and their effects on mineralised tissues.

Supervisors
Dr Rita Hardiman – r.hardiman@unimelb.edu.au
Prof Ivan Darby – idarby@unimelb.edu.au

Degree availability
Bachelor of Science (Honours)
Bachelor of Biomedicine (Honours)
Master of Biomedical Science

Location
Melbourne Dental School

Number of vacancies
One student
Sex determination in unknown human remains using dimorphism in femoral head volume

Sex determination is an important aspect of identifying unknown human remains. Studies on skeletal collections have shown that femoral head diameter may be a useful determinant of sex in humans. This project involves developing a technique to define landmarks and develop volumetric measurement of the human femoral head. The results will then be used to test whether this is an effective method of determining an individual’s sex.

Areas/techniques in which expertise will be developed
3D imaging and image manipulation, skeletal anatomy, biological anthropology.

Supervisors
Dr Rita Hardiman – r.hardiman@unimelb.edu.au
Prof John Clement – johngc@unimelb.edu.au

Degree availability
Bachelor of Science (Honours)
Bachelor of Biomedicine (Honours)
Master of Biomedical Science

Location
Melbourne Dental School

Number of vacancies
One student

Recent publications
What is the origin of tetracycline-like staining in a sample of contemporary human femoral cortical bone?

The Melbourne Femur Research Collection is a well-documented sample of modern femoral bones. A number of years ago, research into the collection brought up a serendipitous finding of fluorescent staining in quite a high proportion of the collection. The staining, which was found in 73% of bones investigated, is characteristic of tetracycline compounds. The extent and severity of the staining raised a number of questions as to its origin and cause. Tetracycline is a broad-spectrum antibiotic but is not recommended for use in those under eight years of age. This is because tetracycline accumulates in the mineralising regions of bones and teeth, and use in those under eight years of age can lead to visible discoloration of teeth. This project will involve investigative techniques such as mass spectrometry to determine the exact cause of the fluorescence (thought to be tetracycline) within the bone tissue of the Melbourne Femur Research Collection, and will aim to determine the origin of the substance incorporated into the growing bone tissue. There are many questions still to be answered about this finding: Is the staining actually caused by tetracycline? If it is tetracycline, what is the origin—therapeutic, or some other source? Is this result unique in this collection, or does it exist in other skeletal collections in Australia or the rest of the world?

Areas/techniques in which expertise will be developed
Research techniques, imaging technologies, bone biology, anthropological research.

Supervisors
Dr Rita Hardiman – r.hardiman@unimelb.edu.au
Dr Louise Shewan – louise.shewan@unimelb.edu.au

Degree availability
Bachelor of Science (Honours)
Bachelor of Biomedicine (Honours)
Master of Biomedical Science

Location
Melbourne Dental School and Earth Sciences

Number of vacancies
One student

Recent publications
Becoming an Honours or Masters Student at the Melbourne Dental School

Entry to the Honours and Masters programs is based on available projects, suitability and academic background.

**HOW TO APPLY FOR HONOURS**

1. Identify projects in this handbook that are of interest to you
2. Contact the relevant project supervisor to discuss your interest in their research. It is a good idea to email them a copy of your CV and your academic transcripts to help them understand your background, interests and academic strengths
3. Make a time to meet with potential supervisors to discuss your project interests and discuss your academic record
4. Visit the laboratory and meet other students and researchers
5. In some cases, supervisors may be willing to offer you a provisional place in their laboratory (a provisional offer indicates that you have a guaranteed place in the Honours course, providing you satisfy all other entry requirements)
6. Apply online through the Faculty of Medicine, Dentistry and Health Sciences website: [http://mdhs-study.unimelb.edu.au/degrees/honours/apply-now#apply-now](http://mdhs-study.unimelb.edu.au/degrees/honours/apply-now#apply-now)

**HOW TO APPLY FOR MASTER OF BIOMEDICAL SCIENCE**

1. Identify projects in this handbook that are of interest to you
2. Contact the relevant project supervisor to discuss your interest in their research. It is a good idea to email them a copy of your CV and your academic transcripts to help them understand your background, interests and academic strengths
3. Make a time to meet with potential supervisors to discuss your project interests and discuss your academic record
4. Visit the laboratory and meet other students and researchers
5. In some cases, supervisors may be willing to offer you a provisional place in their laboratory (a provisional offer indicates that you have a guaranteed place in the Honours course, providing you satisfy all other entry requirements)
6. Apply online through the Faculty of Medicine, Dentistry and Health Sciences website: [http://mdhs-study.unimelb.edu.au/degrees/master-of-biomedical-science/overview](http://mdhs-study.unimelb.edu.au/degrees/master-of-biomedical-science/overview)

**SCHOOL CONTACTS**

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A/Prof Glen Scholz
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**Academic Programs Officer**
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