murdoch children's research institute

MCRI 2025 PhD Projects

Lab Based Projects

Clinical Sciences

One size does not fit all: optimising respiratory support for the smallest neonates

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The number of neonates in Australia receiving intensive care at the borderline of viability (22-25 weeks gestation) has increased 2.3-fold in the last decade. These neonates have the highest early mortality and suffer life-long disability, mainly from early respiratory failure. How best to care for this new generation of our most vulnerable neonates has lagged as the threshold of viability has decreased. Current clinical care is extrapolated from evidence-based practices established in neonates born >25 weeks' gestation. Our previous work has shown that this premise may be fundamentally flawed, as the lungs of our most preterm neonates are developmentally and structurally different from other preterm neonates, resulting in different and unique patterns of lung injury. Clinicians have no scientific framework on how best to apply the fundamentals of good-evidence-based neonatal intensive care, antenatal corticosteroids, surfactant replacement therapy and lung protective ventilation to neonates born at 22-25 weeks. This project will address this knowledge gap by using a human induced stem cell platform and our established preterm lamb model of the 22-25 week gestation lung to assess the cellular, functional, and proteomic impact of current clinical care scenarios.

SPILLOVER! Exploring the Extrapulmonary Impact of Mechanical Ventilation in Preterm Infants

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This PhD project investigates the extrapulmonary impacts of mechanical ventilation in preterm infants, with a specific emphasis on the effectiveness of lung protective strategies in preventing extrapulmonary damage. Mechanical ventilation is a cornerstone intervention for managing respiratory distress syndrome (RDS) in preterm infants, yet it carries inherent risks of ventilator-induced lung injury (VILI) and potential extrapulmonary effects on neurological, cardiovascular, and gastrointestinal. This project bridges basic research with clinical applications, leveraging the preterm sheep model to simulate human neonatal conditions and investigate comprehensive impacts of mechanical ventilation. The project will utilise the extensive an biobank of plasma, lung fluid and tissue samples collected during simulations of delivery room scenarios. The extrapulmonary impact of these strategies will be investigated in brain, heart and gastrointestinal tissue using mass spectrometry-based proteomics to characterise molecular changes within systemic plasma and tissues and histology to identify structural alterations. Findings from this study aim to advance understanding of the holistic impacts of mechanical ventilation in preterm infants, informing evidence-based practices to optimize lung protection and mitigate extrapulmonary complications. The research will contribute crucial insights into improving long-term outcomes for vulnerable neonatal populations, guiding future developments in neonatal intensive care protocols and reducing the burden of neonatal morbidity associated with respiratory support.

Genomic Medicine

Discovering novel genes and pathways to ataxia

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Ataxia is the term for a group of neurological diseases that affect movement and coordination, impacting ~1:15,000 individuals. While there is considerable evidence that gene mutations cause ataxia, currently only ~30% of affected individuals receive a genetic diagnosis. We have a large program that aims to identify novel genes that cause ataxia and subsequently generate cell and animal models to understand development and progression of the condition. There are PhD opportunities within multiple areas of the research program that can be tailored to suit a candidate's research interests. One area of focus is novel gene identification, performing next generation sequencing and analysis of individuals with ataxia to identify new causes of the condition. In addition, opportunities are available to investigate the molecular causes of ataxia. We have recently identified several novel genetic causes of ataxia, caused by pathogenic repeat expansions. Candidates will utilise modern genomic and proteomic technologies to characterise these genes. Subsequently, patient-derived cells will be used to generate neuronal cell and organoid models to study disease-specific mechanisms and identify potential therapeutic treatments. Finally, current diagnostic testing methods for repeat expansions are inefficient, low throughput and only test a small subset of known repeat expansions. One area of active research is developing new testing methods and technologies that can subsequently be utilised by diagnostic laboratories to screen all repeat expansion simultaneously and at low cost. Candidates will work closely with clinicians and bioinformaticians within a large multidisciplinary team.

Improving outcomes of mitochondrial diseases using human stem cell models

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Mitochondria are our cellular power plants that burn sugars, fats and proteins to generate energy. Each week in Australia a child is born with a severe mitochondrial disorder. Many of these children die in the first years of life and most suffer from severe disease, particularly affecting their brain and/or heart. Access to these tissues from patients is limited, making it difficult to assess the impact on mitochondrial and other pathways contributing to disease pathology. This project involves the characterization of human pluripotent stem cell models of mitochondrial energy generation disorders that can be differentiated into clinically relevant cell types.

The aims include:

1) Developing cellular models of mitochondrial disease using human Embryonic Stem Cells (hESCs) and human Induced Pluripotent Stem Cells (iPSCs) to study phenotypic rescue of novel defects, pathogenicity and treatment approaches.

2) Characterize pathogenic pathways by assessing the impact of these energy generation defects on cardiomyocytes generated from hESCs or iPSCs, as well as their impact on mitochondrial function and cellular physiology.

3) Define the impact of targeted therapeutic strategies in these models on the cellular proteome and other markers of cellular homeostasis.

We have established a mitochondrial disease panel of hESCs using CRISPR/Cas9 mediated gene disruption, and iPCs from mitochondrial disease patient fibroblasts. This project will validate selected cell lines from this panel and differentiate them to cardiomyocytes and/or neurons to assess the impact of the gene knockout on various aspects of mitochondrial and cellular function. Molecular and cellular characterizations may include generation of correction lines, mitochondrial and cellular functional assays (e.g. ATP synthesis, fluorescence microscopy, FACS, multi-electrode arrays), quantitative proteomics and RNAseq. Students will develop skills in cell culture, molecular biology and biochemistry.

Understanding the role of histone methylation in neurodevelopment and intellectual disability

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The brain is the most complex organ in the human body where billions of interconnected neurons provide the framework for us to interpret our environment, instruct other organs, and enable intellectual thought which uniquely defines our human qualities. Development of the brain, termed 'neurodevelopment,' is a highly organised process governed at the molecular level by epigenetics - a cellular process regulating which genes to silence and activate. Epigenetic regulatory proteins are responsible for silencing non-neural genes and activating transcriptional programmes driving neurodevelopment in a temporal and spatial manner to ensure the brain develops and matures correctly. What happens when epigenetics goes wrong? The brain is highly susceptible to loss-of-function in epigenetic genes, even when a single allele is not functional. A growing body of evidence has linked errors in over 70 epigenetic regulator genes to neurodevelopmental disorders resulting in intellectual disability. Beyond clinical and behavioural assessment, little is known about how these genetic errors affect neurodevelopment and neurobiology in these individuals. This PhD project is focused on a class of epigenetic neurodevelopmental disorders affecting the KMT2 family of histone methyltransferase genes - an epigenetic process which adds methyl groups to histone tails. 6/7 members of this family are associated with a neurodevelopmental disorder resulting in lifelong intellectual disability. This project will involve using CRISPR/Cas9-mediated gene editing in human pluripotent stem cells to generate genetic models of the KMT2 neurodevelopmental disorders, differentiating these models into neurons, assess neurobiological phenotypes including neuronal activity, synaptogenesis, and neurite morphology and multi-omic analysis including RNAseq, CUT&Tag and ATACseq. This program of work will determine how molecular pathology of these disorders culminate into cellular pathology and to what degree these disorders overlap in molecular and cellular phenotypes. This PhD project will provide vital information into these neurodevelopmental disorders and the role histone methylation plays in neurodevelopment.

Infection, Immunity and Global Health

Determinants of COVID-19 risk and severity

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Following SARS-CoV-2 exposure, outcomes range from asymptomatic-mild disease to severe disease and death. There are multiple known clinical and demographic risk factors for severe COVID-19 including age and comorbidities. However, even among high-risk individuals there is high variability in COVID-19 severity. The BRACE trial is our international RCT of 6828 healthcare workers across 36 sites in five countries. This trial is working to determine if BCG vaccination reduces the impact of COVID-19 and other respiratory diseases. The availability of BRACE trial samples taken prior to SARS-CoV-2 infection will give us the unique opportunity to assess associations between the pre-existing immunophenotype with disease severity in COVID-19. Using the unique collection of samples from the BRACE trial, you will determine how pre-existing interindividual variability in the immune system contributes to the range in the severity of diseases resulting from SARS-CoV-2 infection. In this project you will have the opportunity to use a combination of analysis techniques including multi-omic analysis, single cell immunophenotyping, multiplex cytokine assays, and serological analysis. This project will establish an immune signature of COVID-19 susceptibility and reveal key immunological pathways for protection against COVID-19 to be targeted in future vaccine development and COVID-19 treatments. The Infectious Diseases Laboratory is located at the Murdoch Children's Research Institute, part of the Melbourne Children's Campus, which also includes the Royal Children's Hospital and the University of Melbourne. Interested in being part of the largest BCG vaccine trial of its kind worldwide?

Defining the mechanisms that underpin the beneficial off-target effects of BCG

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In addition to protecting against its target disease, tuberculosis, the Bacillus Calmette-Guérin (BCG) vaccine has beneficial off-target ('heterologous' or 'non-specific') effects on human health. This includes reducing all cause infant mortality, likely by protecting against non-mycobacterial infectious diseases. The protection is proposed to result from the immunomodulatory effects of BCG. Our team has established two randomised controlled trials investigating whether BCG protects against non-mycobacterial diseases:

- The BRACE trial: our international RCT of 6828 healthcare workers across 36 sites in five countries. This trial is working to determine if BCG vaccination reduces the impact of COVID-19 and other respiratory diseases.
- Melbourne Infant Study: BCG for Allergy and Infection Reduction (MIS BAIR): our RCT of neonatal BCG vaccination in >1200 children in Melbourne to determine if BCG protects against allergic disease, eczema, asthma and infections.

Using samples from these trials we have previously shown that neonatal BCG vaccination reduces cytokine responses to a range of pathogens (MIS BAIR) and adult BCG vaccination reduces cytokine but increases T cell responses to SARS-CoV-2 (BRACE). You will use samples from participants in one or both of these clinical trials to help characterise BCG-induced changes in the immune system and the underlying mechanism of action. In this project you will have the opportunity to use a combination of analysis techniques to investigate the immune system such as in vitro stimulation, single cell RNA sequencing, flow cytometry and more. The findings of this project will provide important insights into the immunomodulatory effects of BCG and the associations between these changes as well as the beneficial clinical effects of this 100-year-old vaccine. The Infectious Diseases Laboratory is located at the Murdoch Children's Research Institute, part of the Melbourne Children's Campus, which also includes the Royal Children's Hospital and the University of Melbourne. Interested in being part of the largest BCG vaccine trial of its kind worldwide?

Stem Cell Biology

Unraveling the complexity of Alexander Disease by using advanced brain organoid models.

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Alexander Disease (AxD) is a progressive neurodegenerative disease caused by gain-of-function mutations in the glial fibrillary acidic protein (GFAP) gene and is characterized by alterations in astrocytes, microglia activation and oligodendrocyte damage that ultimately cause myelin loss. Animal models do not fully recapitulate disease pathology, therefore are unsuitable to model AxD. Pluripotent stem cell-derived 3D brain organoids offer a significant opportunity to understand the pathogenesis of AxD in vitro. To investigate complex processes of neuronal and glial dysfunction in this condition we will generate an advanced brain organoid model which incorporates cell types found in the developing human cerebral cortex, including astrocytes, oligodendrocytes, and microglia, which are affected in AxD. By leveraging organoids obtained from pluripotent stem cell lines derived from patients with different disease severity and age of onset and advanced experimental technologies, including single-cell multiomics, we aim to disentangle the intricate crosstalk between cell types and understand its role in disease pathogenesis and progression. This research will pave the way for effective therapeutic strategies targeting AxD and other neurodegenerative disorders. The selected candidate will use a variety of laboratory techniques, including stem cell culture, differentiation into 3D brain organoids, immunohistochemistry, microscopy, and single cell RNA-sequencing. This project would suit a student with an interest in developmental neurobiology, and disease modelling. Essential criteria: Bachelor in neuroscience or computational biology; High academic marks that would meet eligibility for enrolment at the University of Melbourne. Desirable: previous experience in stem cell culture techniques and cell/tissue analysis (immunohistochemistry and microscopy), or single cell RNA sequencing data generation and analysis. The successful applicant will be co-supervised by A/Prof. Velasco and A/Prof. Ramialison and will work closely with stem cell biologists and bioinformaticians within their teams. This project involves close collaboration with neurologists leading the Australian Leukodystrophy Clinical and Research Program at the Royal Children's Hospital.

Characterising the pathophysiological mechanism of congenital nephrotic syndrome to develop novel treatments

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Congenital nephrotic syndrome presents early in life and results in kidney failure and severe proteinuria which can be life threatening. No treatments are available for this condition other than renal transplantation and dialysis. The genetically inherited forms of this condition most commonly result from variant in genes expressed in the podocytes of the glomerulus. Using human kidney tissue generated from pluripotent stem cells, we have characterised the pathophysiological mechanism associated with one of the most common causative gene in congenital nephrotic syndrome, NPHS2. This project will explore the pathophysiological mechanisms linked to other common causative genes looking to identify a shared molecular mechanism that could be targeted for broader treatment development.

Improving the growth, maturation, and accuracy of human kidney organoid models

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Within the human kidney, approximately 1 million functionally segmented nephrons perform blood filtration, secretion, and re-absorption roles critical to maintain body homeostasis. However, common conditions such as diabetes, hypertension, and drug toxicity, can reduce the number of these functional nephrons and increase the risk of chronic kidney disease (CKD) in later life. As a leading causes of death worldwide, the great need for novel CKD treatments and improved disease models has driven our development of kidney tissue from human stem cells. These mini kidneys, or 'kidney organoids', show striking similarity to human fetal kidneys, with nephrons, stroma, and endothelial populations. However, their potential applications are limited by their immaturity and the growth off-target cell types. In this project, the pathways governing kidney development will be explored and manipulated to improve the growth, maturation, and accuracy of human kidney organoid models with a view to applying them to disease research and treatment approaches.

Non-Lab Based Projects

Clinical Sciences

Understanding the relationship between cognitive development and academic achievement in children and adolescents

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There is strong evidence that key aspects of healthy development such as academic achievement, prosocial behaviours, and positive emotional health are underpinned by cognitive development, which in turn is dependent on healthy brain maturation. Unfortunately, current knowledge about brain-behaviour relationships and their maturation is limited. Major contributing factors to this are the cost and complexity of large-scale neuroimaging studies and a reliance on traditional psychological assessments that do not accurately reflect the nature and timing of development across different brain regions and the differential trajectories of brain-behaviour relationships from childhood to adulthood. In the COGNITION study, we address these limitations using a comprehensive battery of neuroscientifically informative cognitive tasks, recently updated to improve access and facilitate administration, to map brain maturation across the school-age years. This observational study will use the 'CANTAB' to reliably assess and describe cognitive development and brain maturation in children and young people without the need for expensive neuroimaging. Approximately 1100 participants (aged 6-17 years) will be tested twice, at baseline and approximately 12 months. There is an opportunity for a PhD student to contribute to this study by investigating the relationships between neurocognitive development and academic achievement. This project would suit a student with an interest in developmental psychology, neuropsychology, and education. The successful candidate will be supported by an experienced supervision team with expertise in developmental and educational psychology, neuropsychology, and child and adolescent psychiatry.

Improving identification of ADHD in high-risk settings

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Attention deficit/hyperactivity disorder (ADHD) is a major cause of disease burden across the life course and has a devastating impact with significant social, economic, and personal consequences. However, only a minority of Australians with ADHD receive a diagnosis and current approaches to identification and screening are inefficient. Screening, as a mechanism for improving identification, is only appropriate if it is then possible to provide appropriate care for those screening positive. As ADHD is a common disorder affecting 5-7% of children and youth, population-based screening for ADHD, no matter how accurate, is not currently considered feasible as the demand created would far exceed capacity. However, targeted screening focussed on high prevalence/high-risk clinical settings, where individuals with ADHD are already engaged with clinical services, but whose ADHD is currently not recognised or treated, is a viable alternative. To develop a scalable approach to screening we have identified a need for 1) better understanding of the barriers to recognition within services and 2) an approach to screening that avoids the high rates of false positives inherent to traditional single stage approaches. We have NHMRC funding to develop and test varied approaches to augmented screening for ADHD within high-risk settings. There is an opportunity for a PhD student to explore the impact of demographic characteristics (e.g., gender and age) on the accuracy of varied augmented screening approaches for ADHD. A three-year stipend is available for this project. The successful candidate will be supported by an experienced supervision team with expertise in developmental mental health and child and adolescent psychiatry.

Divergence of typical brain development over childhood and adolescence: identifying cortical signatures of psychiatric symptomatology

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The transition from childhood to adolescence is a dynamic period of development that involves remodelling and reorganisation of brain structure, partly in response to the rising pubertal hormone levels that cross the blood-brain barrier. Coinciding with brain reorganisation at the time of pubertal onset, is an increased risk of onset of mental health disorders. In Australia, 50% of all lifetime cases of mental health disorders start by age 14. And about 50 per cent of people who develop a psychotic disorder - a condition that describes a person's loss of contact with reality, will do so by the time they are in their early 20s. Brain imaging studies using MRI have been key in revealing ongoing cortical thinning and volume loss over adolescence. However, the exact neurobiological mechanisms underlying these changes are unclear. Diffusion MRI is one way to access micro-metre structural properties in vivo. Cortical morphology and myelination abnormalities have been linked to various neuropsychiatric disorders, including psychosis. This project will aim to build a comprehensive understanding of typical cortical development of morphology and microstructure and assess deviations to typical patterns of cortical development with symptoms of psychosis. To do this, the student will leverage diffusion MRI data from previously collected datasets consisting of typically developing youth (such as the Philadelphia Neurodevelopmental Cohort, Developmental HCP) and longitudinal cohorts consisting of young people at-risk for, or diagnosed with, psychosis.

Improving outcomes of childhood brain tumour and epilepsy surgery with advanced MRI and tractography

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Brain tumour and epilepsy are among the leading causes of childhood chronic illness-related death in Australia and worldwide. Brain surgery is the mainstay treatment that reduces disease burden and prolongs survival. Surgery performed near functional brain regions and the inter-connecting nerve fibre tracts has a high morbidity risk, particularly in paediatrics due to the dynamically developing brain. Advanced MRI-based nerve fibre tract imaging (tractography) has been a key imaging development that assists surgeons in the pre-operative (before surgery) planning and intra-operative (interactively, during surgery) stages. Accurately mapping fibre tracts can greatly assist with post-surgical functional preservation by avoiding surgical tract injuries. Existing commercial surgical tractography software is based on outdated techniques producing anatomically inaccurate tractography image reconstructions that urgently need updating. However, tractography processing takes a long time, relying heavily on a neuroanatomical expert to manually process imaging data, making it infeasible in acute brain surgery settings. The aim of this project is to develop and implement an automated surgical tractography technique leveraging neurosurgical knowledge and machine learning. To do this, the student will leverage locally and internationally collected multi-modal MRI data and build an automated AI-based tractography model. Neurosurgeons from local and international sites will evaluate the anatomical accuracy and surgical utility of the tractography, to help validate and improve the model. This project will suit a student that has technical knowledge in computational neuroscience or engineering, and a keen interest in learning how to apply machine learning techniques for use in clinical imaging and neurosurgery. This project is a collaboration between the Neuroscience Advanced Clinical Imaging Service (NACIS) at the Royal Children's Hospital, the Developmental Imaging Group MCRI (https://www.mcri.edu.au/research/research-areas/clinical-sciences/developmental-imaging), and the University of Melbourne. The project would suit an individual with a background in computational neuroscience or engineering (or similar) background, with a keen interest in applying machine-learning approaches in clinical imaging and neurosurgery.

Surgical Outcomes of Gastrocsoleus Lengthening and Bony Foot and Ankle Surgery

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Motion Connect is a new network over Australia and New Zealand which consists of seven Motion Laboratories. We plan several retrospective studies and prospective data collection through all of the sites. Ethical approval has already been granted, and we offer a fully funded PhD position for 3 years through the University of Melbourne. Project The research question would be to compare different surgical outcomes including short- and long-term results from multiple sites in regards to gastrocsoleus lengthening including bony correction of foot and ankle surgery. Outcome parameters; The primary outcome would be gait kinematics and kinetics as well, represented by Movement Analysis Profile (MAP)/Gait Variable Score (GVS) and Gait Profile Score (GPS). Secondary outcome would include function and participation represented by FMS Goal Questionnaire. PhD Project The PhD project will start with a systematic review analysing all existing literature from 2000 to present. Furthermore, we will then stratify the large set of data by age, type of involvement and type of surgery. Funding Full scholarship through the University of Melbourne and as well, affiliation the world leading Murdoch Children's Research Institute (MCRI) will be granted through the project. Further information Please do not hesitate to reach out in case of any questions or interests to Associate Professor Erich Rutz.

Foot deformities in children with cerebral palsy

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Foot and ankle deformities are common in children with cerebral palsy and can cause pain as well as have a severe impact on a child's walking. To improve function and reduce pain, these children may undergo surgical correction. Structural deformities of the foot are assessed pre- and post-operatively using radiology. We evaluate foot function and structure pre and post-surgery using a range of measures; radiology, 3D motion capture, plantar pressure and physical examination. This project will explore methods for analysing foot function from 3D motion analysis and plantar pressure data, and their relation to structural measures from radiology and physical examination. These methods will be used to compare foot structure and function pre- and post-surgery and will ultimately serve as an objective clinical measure for assessing and grading foot deformities in children. This project can be tailored to the interests of the successful applicant. Areas that may be explored are machine learning approaches for image analysis of plantar pressure data, musculoskeletal modelling and relationship between clinical measures and 3D motion analysis of the foot. The successful candidate will require some programming experience. This project is a collaboration between the Hugh Williamson Gait Analysis Laboratory Royal Children's Hospital and the Murdoch Children's Research Institute (https://www.rch.org.au/gait/, https://www.mcri.edu.au/research/themes/clinical-sciences/gait-lab-orthopaedics).

The Self-and Others' emotion and Cognition in Adolescent Life (SOCIAL) study

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Social processes, such as empathy and theory of mind, are vital for social functioning and building social competency in young people. Empathy is a social-affective process involving sharing someone's emotion. Theory of mind (ToM) on the other hand, is a social-cognitive process that involves reasoning about the thoughts or emotions of others. Both of these processes are required for successful social interactions. Impairments in these processes have been found in mental health and neurodevelopmental disorders. This project will validate an innovative empathy and ToM task for adolescents for use in the Magnetic Resonance Imaging (MRI) scanner. This will result in a tool for neuroscientists to investigate these processes, how they are impacted in clinical populations, and evaluate treatments aimed to improve social processes. Depending on length of project (Masters versus PhD) and student interest/experience, this project may involve the following: working with young people, fMRI task programming and piloting, investigation of psychophysiological or neural correlates of social processing.

Take C.A.Re (Concussion Assessment and Recovery Research) Team

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Concussion is defined as a traumatic brain injury where an impulsive force, caused by direct blow to the head, neck or body, is transmitted to the brain, triggering a neurotransmitter and metabolic cascade, with possible axonal injury, blood flow change and inflammation affecting the brain. Concussion results in a constellation of non-specific and heterogeneous post-concussion symptoms (PCS), including balance impairment, somatic and/or emotional symptoms, cognitive impairment, and/or sleep disturbance. For most children and adults, PCS tend to resolve spontaneously within 2 to 4-weeks post-injury, however, approximately 30% will experience persisting PCS (pPCS) for greater than 4-weeks. pPCS can interfere with participation in school, sport, social, and recreational activities, with secondary consequences on mental health and quality of life. For the 30% of children and adolescents who experience pPCS, emerging biopsychosocial conceptualisations emphasise the contribution of injury, pre-injury, psychological, social, and environmental factors to the development and maintenance of these symptoms. Our team developed a multimodal intervention, Concussion Essentials (CE), that combines targeted education and management strategies for common symptoms, with physiotherapy and psychology treatment. Student projects could involve examination of child, parent or intervention factors that contribute to recovery of pPCS. Relevant for longer projects (e.g. PhD), the team is also beginning a new study piloting a pediatric concussion clinic. This is an implementation study which will examine the acceptability, feasibility, adoption and costs of a new concussion service. The Concussion Clinic will offer an innovative, integrated stepped-care model that provides individualised, evidence-based intervention and continuity of care for children and adolescents following the initial assessment and diagnosis of concussion in Emergency or Primary Care settings. This would suit students interested in translation, implementation science and people interested in the multi-disciplinary context (ED physicians, psychologists, physiotherapists).

Measuring involvement in important life situations: A necessary precursor to designing effective participation interventions for those with childhood-onset disability

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Being able to attend and be involved in a variety of activities and meaningful life situations is a strong contributor to long-term health and wellbeing. There is a growing body of evidence about effective approaches and interventions that promote participation outcomes in those growing up with childhood onset disabilities. However, most research focuses on measuring and changing the attendance aspect of participation - can you turn up to a life situation. 'Being there' (attendance) is necessary but not sufficient to ensure involvement. Involvement is necessary to drive development, a sense of belonging and a good life quality. Research addressing the involvement element of participation is limited by the lack of measures that capture of the experience of involvement, as well as the lack of measures that assess the elements of the environment that most strongly influence involvement. This research sits within an international network of participation-focused research encompassing Australia, Canada, Sweden, The Netherlands, South Africa, China and Taiwan. We hope to recruit a high-quality allied health, psychology or educational professional into this PhD position. Experience in disability is desirable. Interested applicants should email Professor Christine Imms at christine.imms@unimelb.edu.au

Infection, Immunity and Global Health

Off-target effects of BCG vaccination on allergic and infectious disease in adults

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Interested in being part of the largest BCG vaccine trial of its kind worldwide? In addition to protecting against its target disease, tuberculosis, the Bacillus Calmette-Guérin (BCG) vaccine has beneficial off-target ('heterologous' or 'non-specific') effects on human health. This includes reducing all cause infant mortality, likely by protecting against non-mycobacterial infectious diseases. Studies also suggest the BCG vaccination protects against allergic disease in children. The BRACE trial is an international RCT of 6828 healthcare workers across 36 sites in five countries. This trial aims to determine if BCG vaccination reduces the impact of COVID-19 and other respiratory diseases. In addition to data on respiratory illness, data were collected on other non-respiratory infections, and allergic and autoimmune disease. Using data collected from participants in the BRACE trial you will investigate the clinical off-target effects of BCG on non-respiratory infections, allergic and autoimmune disease in adults. Moreover, you will identify factors which influence the off-target effects of BCG. In this project you will have the opportunity to combine clinical findings with existing immunological data from the BRACE trial. The findings of this project will provide important insights into the off-target effects of BCG vaccination in adults and the factors that influence these responses. The Infectious Diseases Laboratory is located at the Murdoch Children's Research Institute, part of the Melbourne Children's Campus, which also includes the Royal Children's Hospital and the University of Melbourne.

Immune mechanisms driving treatment failure following treatment for food allergy

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Food allergies are a global health burden with a severe impact on quality of life. Currently there is no cure. A long-term treatment solution will improve quality of life and prevent deaths. Treatments in development have been shown to induce remission of allergy. Peanut oral immunotherapy (OIT) is effective at inducing desensitisation but only induces remission in a subset of patients. Our previous work enabled us to identify key pathways linked to treatment success (remission). We now aim to extend this work by characterising immune mechanisms leading to failure to achieve remission (desensitisation without remission). The distinction is critical to our understanding of the pathways supporting long-term redirection of the underlying allergy. Furthermore, we are one of the few groups internationally who are set up to achieve this. Our biosamples are internationally unique, with long-term patient outcomes complete up to 5-years post-treatment. To achieve this, the student will use a systems biology approach which harnesses gene expression techniques combined with computational approaches to map changes to gene-gene communication networks. These findings will generate important information which could differentiate pathways leading to treatment failure from those leading to treatment success. Defining the biology underpinning desensitisation without remission will enable development of a long-term treatment solution for patients with food allergy. Blood samples have already been collected and are immediately available the project. This research represents an exciting opportunity to address a major knowledge gap.

Population Health

Why are babies in SCNs/NICUs at higher risk of permanent hearing loss?

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This PhD offers potential for practice changes that could improve lifelong hearing for infants admitted to SCNs/NICUs. Supervised by leading researchers in children's hearing loss, epidemiology, paediatrics and audiology, it offers immense opportunities to establish a career and leadership in transformative newborn and child hearing loss research within the GenV initiative and beyond. Around one in five liveborn babies require admission to a special care nursery (SCN) or neonatal care unit (NICU). Admission to SCN/NICU is a known risk factor for permanent hearing loss. Compared to healthy babies, those admitted to NICUs are at 8 times the risk of hearing loss, with many hypothesized and interacting causal factors including immaturity, anaemia, infection/inflammation, ototoxic drugs, environmental noise, jaundice, intracranial haemorrhage/encephalopathy, hypoxia and genetic susceptibility. Large sample sizes and variations in care that equate to natural experiments are needed to clarify causal pathways and thence effective prevention and treatment. This PhD project will be conducted within the GenV (short for Generation Victoria) cohort and encompassing Victoria's 5 NICUs and 40 SCNs. GenV seeks to transform the health and wellbeing of an entire generation. Led from the Murdoch Children's Research Institute (MCRI), with over 120,000 participants across Victoria, GenV is Australia's largest parent and child longitudinal cohort. You will help set up a new statewide SCN data registry within GenV within which you will study critical SCN/NICU causal to hearing loss, including objective measurement of noise in each SCN/NICU.

Use and impact of psychotropic medication in pregnancy

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Up to 20% of women suffer from mood or anxiety disorders during pregnancy, whose impacts on adverse pregnancy and child outcomes could be mitigated by antenatal psychotropic medications (such as antidepressants, antipsychotics, sedative-hypnotics and other sleep medications). While these medications appear safe in pregnancy, the knowledge base is incomplete, so some mothers choose against needed medication due to fear it may affect their unborn baby. This PhD project will be conducted within the GenV (short for Generation Victoria) cohort. GenV seeks to transform the health and wellbeing of an entire generation. Led from the Murdoch Children's Research Institute (MCRI), with over 120,000 participants across Victoria, GenV is Australia's largest parent and child longitudinal cohort, comprising consent, biosamples, and wide-ranging exposures and outcomes including administrative and clinical data. The student will contribute to creating a unique whole-of-state prescribing dataset within GenV by linkage/access to both primary care/outpatient medicines (Pharmaceutical Benefits Scheme (PBS)) and birthing hospitals prescribing data during pregnancy and the perinatal period. They will map ante/perinatal psychotropic medication use in the GenV cohort and then use causal techniques (including consideration of regional variations in medication use) to assess impacts on perinatal and infant/toddler outcomes such as language development, fine motor skills, and body composition. The student will need a stipend to undertake this PhD.

Do we have sufficient safe medicine use information for pregnant women and their offspring?

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Most women are prescribed at least one medicine during pregnancy. However, data are scant regarding the safety of medicines exposures for infants, as >98% of medicines do not have evidence regarding teratogenic risks and 73% of them have no human data. This PhD project will be conducted within the GenV (short for Generation Victoria) cohort. GenV seeks to transform the health and wellbeing of an entire generation. Led from the Murdoch Children's Research Institute (MCRI), with over 120,000 participants across Victoria, GenV is Australia's largest parent and child longitudinal cohort, comprising consent, biosamples, and wide-ranging exposures and outcomes including administrative and clinical data. The student will contribute to creating a unique whole-state prescribing dataset within GenV by linkage/access to both primary care/outpatient medicines (Pharmaceutical Benefits Scheme (PBS)) and birthing hospitals prescribing data during pregnancy and the perinatal period. Exploring the expected systematic variation in prescribing patterns by hospital region, size and sector, they will investigate pathways from prescribing policies to variations in medication use and thence pregnancy and newborn outcomes, seeking causal insights into medicine benefits and safety. The landmark GenV platform thus offers immense opportunities to establish a career with leadership in pregnancy pharmacovigilance and child health research. The student will need a stipend to undertake this PhD.

Neighbourhood environment exposures prior to birth and child health and development

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The environments in which we live, work and play impact our health. It is also likely that the neighbourhood environments that parents are exposed to during preconception and pregnancy have lifelong health impacts. Studies have shown that exposure to air pollution in pregnancy is linked to a range of negative health effects at birth and in later life. However, we don't yet know:

1) whether preconception exposures to neighbourhood environments are linked to health;

2) how parental exposures to other aspects of the neighbourhood environment such as greenspace, noise and access to services influence health; or

3) how different aspects of the neighbourhood interact, for example, does living in a greener neighbourhood offset the negative effects of air pollution?

This PhD project will address these knowledge gaps by investigating the relationship between different aspects of the neighbourhood that parents were exposed to prior to birth and health outcomes in the early years of life. The project will use data from the Generation Victoria (GenV) cohort, which has collected parents' residential address data and has information on child health. Multiple measures of the neighbourhood will be developed using geospatial data and methods (e.g., geographic information systems and remote sensing). These measures will be linked to GenV participant addresses, and statistical analyses will be used to investigate the relationship between parental exposures prior to birth and child health (e.g., preterm birth, child development). Findings from the PhD will inform environmental interventions via urban planning and design. This project will suit a researcher with strong quantitative skills, an interest in geography and neighbourhood environments, and a willingness to learn geospatial skills.

PhDs within the Generation Victoria (GenV) program

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Interested in a PhD with Generation Victoria (GenV), Australia's largest and most inclusive children's and pre-midlife cohort? Make cutting-edge discoveries or test new interventions to help young children and adults flourish and manage 21st-century challenges. Contact a GenV Director to discuss. The GenV cohorts, an international asset led from Victoria (population 6.8m), Australia, include 120,000+ young children and parents representing Victoria's birthing population. It comprises a consented cohort, linked data, universal biosamples, GenV-collected data, collaborator-led studies and an Open Science platform, offering access far beyond a stand-alone PhD. With its establishment phase complete and building blocks emerging, now is the perfect time for a PhD in GenV as children approach school age and parents approach mid-life. Explore discovery, effectiveness or policy questions through trials, natural experiments and causal epidemiology. GenV also supports PhD opportunities in -omics bioassays, data science, AI, ecological and linkage data, universal-capable measurement technology, and implementation science. We look forward to developing projects with high-potential students, placed with senior and early career supervisors tailored to need. While stipends and/or top-up scholarships may sometimes be available, students generally need to attract scholarship stipends for these PhDs. Supervisors: Prof Melissa Wake, Prof Sharon Goldfeld, Prof Richard Saffery. (We will help match successful students with supervisors.)

Dysmenorrhoea, Pelvic Pain and Endometriosis

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Dysmenorrhoea (period pain) affects 90% of adolescents and for 21% this pain is severe. An estimated one in seven to one in ten women have endometriosis, and persistent pelvic pain is reported by about 25% of women. Period pain and pelvic pain and endometriosis-associated pain often begins in adolescence and often results in school absenteeism as well as contributing to worse mental health and quality of life. To date, there have been no rigorous studies that further our understanding of the origins of endometriosis in teens, and yet we know that managing dysmenorrhea (period pain) can prevent long-term complications such as endometriosis-associated pain, chronic pain and infertility. LongSTEPPP is an established observational study that has recruited over 200 participants across Australia. LongSTEPPP tracks young people's (aged 10-23) development and trajectories of period and pelvic pain, and endometriosis with current gynaecological care. LongSTEPPP has a comprehensive set of data variables from young people and families through questionnaires and clinic visits for pain-orientated sensitivity testing. The PhD student will examine survey, clinical and administrative data, to consider the wide-ranging exposures and outcomes in relation to endometriosis and persistent pelvic pain, as well as differences in care pathways between settings. We are looking for an enthusiastic PhD candidate to join a dynamic team of gynaecologists and researchers. The candidate will analyse the wealth of LongSTEPPP data to determine trajectories of pain and quality of life. Findings from LongSTEPPP will directly inform guidelines for the management of dysmenorrhoea in teens to improve long-term outcomes. The project gives the possibility of reducing presentation of endometriosis and persistent pelvic pain through identifying predisposing factors and potential positive interventions for adolescents. The project would suit someone with a background in medical science or epidemiology. Some experience in data management and statistical analysis is required. For candidates with a background in psychology, there is also the potential to examine mental health trajectories more closely in relation to pain and employ qualitative research methods. A stipend may be available.

Stem Cell Biology

Analysis of spatial data in congenital heart disease

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Congenital heart disease affects 1 in 100 babies, while no cure currently exist, surgery in early weeks of life is usually required generating a great burden for the babies and their families. Most of the aetiology of congenital heart disease remains unknown. Spatial gene expression patterns are critical to understand how the heart develops and what underlying genetic patterns are behind heart malformation. High-throughput spatial temporal data have been recently generated with spatial transcriptomics technologies. Capitalising on these rich datasets, we aim to build a custom analysis workflow in which the cells are profiled with precise spatial gene expression information. The student will provide fundamental contribution to of this project, by:

(1) analysing the spatial and single-cell RNA-seq datasets;

(2) cross-validating the pattern in independent datasets and

(3) associating observed spatial patterns with known literature in congenital heart disease.

The outcome of this project is to discover novel genetic causes for congenital disease to improve the diagnostic and subsequent treatment of heart defects. Skills focus: proficiency in one programming language (e.g. Matlab, R, Python), basic understanding of cell and development biology, simulation, data visualisation, bulk / single-cell RNA-sequencing analysis.

Laboratory Links: https://ramialison-lab.github.io/index.html

The impacts of adolescent stress and adversity on the developing brain.

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Prof. Sarah Whittle

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This project investigates how the experiences of stress and adversity during adolescence impact the developing brain, as well as consequences for future mental health and wellbeing. The project will use data from a unique longitudinal study, the Child to Adult Transitions Study (CATS) that has followed a cohort of young people since they were 8 years old (currently 21 years old). CATS has collected information on participants' social environments and mental health at every year, over 13 waves of data collection so far. In addition, two waves of MRI assessments have collected information on brain structure, function, and connectivity in earlier adolescence, and a third wave is planned for 2025. The overarching project will investigate how stressful and adverse environments influence brain development across adolescence, but the successful PhD candidate will have the opportunity to develop their own research questions using this wealth of data. They will gain expertise in neuroimaging analyses and longitudinal modelling, as well as developmental and clinical psychology. Supervisory team: The successful candidate will be co-supervised by Dr Nandi Vijayakumar, Prof Marc Seal & Prof Sarah Whittle. They will be based across the Centre for Adolescent Health and Developmental Neuroimaging at MCRI. They will also work closely with Prof Whittle's team at Orygen and the Centre for Youth Mental Health (University of Melbourne).

The successful candidate:

- They will conduct high-level neuroimaging research, work collaboratively within a team, and contribute to publications in international journals.
- An undergraduate or graduate degree with upper class honours in psychology, neuroscience, or a closely related field.
- Research experience in neuroimaging is desired, but not a requirement. • Excellent analytical thinking, data analysis and critical problem-solving skills.
- Willingness to learn neuroimaging software and programming languages (such as R and Python) for data analysis. • Strong writing and communications skills in English.
- Ability to work independently and as part of a multidisciplinary team.

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