MONASH University | ARMI AUSTRALIAN REGENERATIVE MEDICINE INSTITUTE

STUDENT RESEARCH PROJECTS 2025

Research at ARMI is structured along five integrated Discovery Pipelines that allow research groups to explore specific aspects of the regenerative process.

HEART AND MUSCLE DEVELOPMENT AND REGENERATION

Cardiovascular diseases are the number one cause of death globally: more people die annually from CVDs than from any other cause. An estimated 17.9 million people died from CVDs in 2016, representing 31% of all global deaths. Of these deaths, 85% are due to heart attack and stroke.

ARMI researchers are studying animals with highly sophisticated and specific tissue regenerative qualities, to develop cures for heart disease and other muscular disorders including dystrophies that can be translated to the patient bed-side.

IMMUNITY AND REGENERATION

Soon after birth, our own immune systems mature and we lose our capacity to respond to damage with scar free healing. ARMI scientists are exploring the relationships between immunity and regeneration in the animal kingdom to enhance tissue repair in patients with wounds or degenerative diseases.

STEM CELLS AND REGENERATION

Stem cells are integral to the development of tissues in the embryo and persist in adults as essential building blocks for our bodies. ARMI studies embryonic stem cells as a window on the mechanisms of human development, and as an essential part of the tool kit of regenerative medicine.

ARMI has devised methods for growing stem cells that can be used to repair damaged tissue, investigate particular diseases, test drug candidates for therapeutic safety and effectiveness, and develop ways to enhance the intrinsic mechanisms of stem-mediated repair. ARMI is able to offer IP on specific stem cells for culturing and scale up and models that allow testing of stem cell potency.

NEURAL REGENERATION

Unlocking the regenerative potential in the central nervous system so it can be harnessed to treat neurodegenerative disorders.

ARMI scientists are tackling the fundamental obstacles in neural repair for diseases such as multiple sclerosis and Alzheimer's, by uncovering neural regenerative potential across the animal kingdom.

ORGAN ENGINEERING AND SYNTHETIC BIOLOGY

ARMI is exploring a number of innovative techniques to enhance function and form that is lost as a consequence of ageing and degenerative diseases.

These techniques explore various aspects of tissue engineering including organoid and organ on a chip technology, bioactive biomaterials and biointerfaces that simulate the cellular microenvironment at the micro and nanoscale, functional biomaterials and synthetic and biological matrices for tissue engineering and transplant development.

DRIVING REGENERATIVE SCIENCE

ARMI was established in 2006 to deliver on this medical research field's promising work of harnessing the healing power of stem cells to unlock the body's own potential to heal and regenerate damaged organs or tissues caused by disease, injury or genetic conditions.

A research institute of Monash University's Faculty of Medicine, Nursing and Health Sciences, ARMI is located at one of the world's largest regenerative medicine and stem cell research centres at Clayton in Victoria, Australia.

The Institute was established through a joint venture between Monash University and the Victorian State Government with additional funding from the Australian Federal Government. ARMI today acts as a focus for public engagement in regenerative medicine and is the source of advice for policymakers.

The Institute builds on Monash University's existing strengths in biomedical research, and the work of the University's pioneers in IVF and stem cells, to attract global regenerative science leaders and a new generation of young and creative researchers; to inspire and lead discoveries and developments in this exciting new therapeutic field.

ARMI's science focuses on delivering the next generation of discoveries in regenerative medicine. The Institute is actively engaged in the emerging area of systems biology, or "systems medicine" – the study of biological components, be it molecules, cells, organisms or entire species – which views the dynamic systems of the human body as an integrated whole, incorporating biomedical, physiological, and environment interactions that sustain life.

This research takes a new approach to clinical problems.

Some species in the animal kingdom have high regenerative potential. ARMI researchers are learning about this ability for self-repair in order to develop new therapies for conditions such as heart disease, muscular dystrophy, diabetes, multiple sclerosis, Alzheimer's Disease, brain injury and autoimmune disorders.

The Institute is one of the largest regenerative medicine and stem cell research organisations in the world and Australia's only research institute specialising in regeneration and stem cells; with a broad program across five overlapping key research streams:

- neural regeneration
- stem cells, cancer and regeneration
- heart and muscle development and regeneration
- immunity and regeneration
- organ engineering and synthetic biology

The Institute trains the next generation of research and clinical scientists.

Most ARMI researchers are based at Monash University's Clayton campus with some having joint appointments with other Monash academic department or the CSIRO. Some of the Institute's research is undertaken through participation in national initiatives including Stem Cells Australia and the EMBL Australia Partner Laboratory.

OUR RESEARCH TEAMS

HEART AND MUSCLE DEVELOPMENT AND REGENERATION

CURRIE GROUP

The Currie group is curious about the biological mechanisms of the Zebrafish, a fresh water fish that is native to South East Asia. Zebrafish are used in scientific research to understand human genetics and the biological processes of human diseases.

The Currie group use zebrafish embryos to learn about muscle cell types. In particular, they are interested in how specific muscle cell types are determined within the developing embryo, how they grow and how they regenerate after injury, to provide insights into muscle wasting and other diseases including the dystrophies.

MCGLINN GROUP

The McGlinn Group is interested in how genes influence the pattern mechanisms of the vertebrate skeleton. Pattern formation refers to how particular cells develop into final cell types.

The group use the limb bud and axial skeleton as points of study because it helps them understand broader developmental processes. A greater level of comprehension into the limb bud and axial skeleton will allow the group to provide insight into how genetic hierarchies govern how the vertebrate skeleton is formed. This work has developed an understanding of how to grow and shape different tissue for therapeutic benefit.

DEL MONTE NIETO GROUP

The del Monte-Nieto group is interested in the study of the molecular mechanisms and developmental processes orchestrating normal heart development in embryos by integrating all the cellular and non-cellular components involved.

The lab aims to apply multidisciplinary approaches including mathematical modeling and bioengineering to developmental biology studies in order to generate in silico and in vitro models to confirm our biological results and formulate new hypothesis. The group aims to apply multidisciplinary approaches including mathematical modeling and bioengineering to developmental biology studies in order to generate in silico and in vitro models to confirm our biological results and formulate new hypothese to design novel therapies for heart disease.

CHOW GROUP

The Chow group is interested in the study of heart valve development, disease, and regeneration. The lab develops novel micromanipulation methods to perturb mechanical forces in the zebrafish heart and combines these methods with computational modelling, live imaging, and genetics to uncover the role of mechanical signals caused by heartbeat and blood flow on heart valve biology.

EYNON GROUP

The Eynon Group is interested in the study of epigenetics and other molecules associated with healthy aging and exercise. The group investigates the role of epigenetics in ageing and exercise adaptations, as well as sex differences in response to exercise. The lab uses a combination of wet-lab and bioinformatics analyses, with a particular focus on ‘omics’ datasets including DNA methylation, transcriptomics and proteomics.

IMMUNITY AND REGENERATION

LIESCHKE GROUP

The Lieschke group studies the haemopoietic system and leukocytes.The haemopoietic system is a collection of organs and tissues (bone marrow, spleen, lymph nodes etc.) responsible for the production of blood in the body.

Leukocytes (white blood cells) are the keys cells involved for counteracting foreign substances and disease. They also play a major role in determining whether tissue repairs and regenerates rather than scars after injury. The group's increased understanding of the role of the leucocytes when the immune system is compromised, eg as in leukemias has helped identify potential target molecules.

MARTINO GROUP

Dr Mikaël Martino and his group focusses on the immune regulations of stem cells and regeneration, seeking to design regenerative medicine strategies integrating a control of the immune system.

Compounds that can accelerate regenerative processes in a wide range of tissues and organs are being identified and evaluated.

STEM CELLS AND REGENERATION

NILSSON GROUP

The Nilsson Group is currently involved in a number of research projects that focus on understanding haemopoietic stem cells (HSC). Haemopoietic stem cells are responsible for the production of blood and immune cells.

The main objective of the group's research is to characterise the microenvironment in which blood stem cells reside. They also look at blood stems cells at a cellular and molecular level, as well as analysing how they create new blood cells.

This can be used to treat a range of blood diseases including leukemia.

ZENKER GROUP

The Zenker group seeks to understand how a cell's structure and function is regulated by the continuous re-organization of the microtubule network. Live imaging is used to discover the spatio-temporal accuracy of the microtubule dynamics in animal models of developmental and stem cell biology. Understanding the formation of the first stem cells in embryos is leading to insights into how these cells can be harnessed for therapeutic benefit.

NEURAL REGENERATION

KASLIN GROUP

The Kaslin group is interested in cellular plasticity, which is the ability of cells to take on characteristics of other cells in the body. But rather than study the process throughout the entire body, the group are focused in understanding the molecular and cellular mechanisms that control this process in the intact or injured vertebrate brain.

Understanding the process of cellular plasticity is essential to the development of successful therapies to promote neural regeneration.

CALEGARI GROUP

The Calegari Group's goal is to promote the expansion of endogenous neural stem cells (NSC) to improve the function of the mammalian brain.

ORGAN ENGINEERING AND SYNTHETIC BIOLOGY

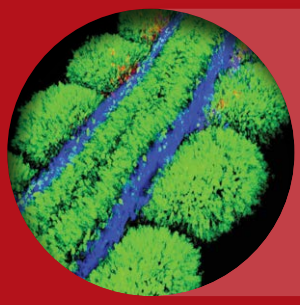
ROSSELLO-DIEZ GROUP

The Roselló-Díez group studies the signals that operate within the bones and between them and other tissues/organs during development and regeneration. At the local level, they study phenomena such as compensatory proliferation in response to biochemical and mechanical changes in the cell vicinity. At the systemic level, they are exploring the role of the vascular and nervous systems in the bidirectional communication between the bones and the rest of the body. The group has devleoped insights into growth regulation in the developing body enabling the design of therapeutics for situations where tissue growth and organ repair is perturbed.

ROMAN GROUP

The Roman Group is investigating how cells communicate to establish organ architecture and function. We use the skeletal muscle cell as a model to study cell-cell interactions by focusing on specialized regions such as the neuromuscular junction or the stem cell niche. Combining microscopy, tissue engineering and spatial genomics, we can monitor intercellular signals with high spatiotemporal resolution during development or homeostasis and observe how these are affected in diseases and ageing. The lab aims to identify fundamental principles of intercellular communication as well as translational discoveries to improve muscle disorders and ageing.

ARMI DISCOVERY PIPELINES

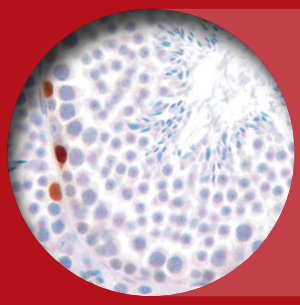


HEART AND MUSCLE DEVELOPMENT AND REGENERATION

Currie	www.armi.org.au/our-groups/currie-group
McGlinn	www.armi.org.au/our-groups/mcglinn-group
del Monte Nieto	www.armi.org.au/our-groups/del-monte-nieto-group
Chow	www.armi.org.au/our-groups/chow-group
Eynon	www.armi.org.au/our-groups/eynon-group

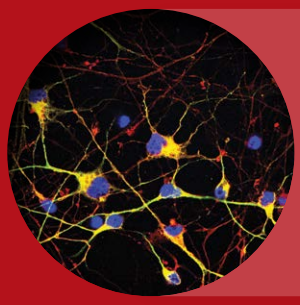
IMMUNITY AND REGENERATION

Lieschke	www.armi.org.au/our-groups/lieschke-group
Martino	www.armi.org.au/our-groups/martino-group



STEM CELLS AND REGENERATION

Nilsson	www.armi.org.au/our-groups/nilsson-group
Zenker	www.armi.org.au/our-groups/zenker-group



NEURAL REGENERATION

Kaslin	www.armi.org.au/our-groups/kaslin-group
Calegari	www.armi.org.au/our-groups/calegari-group

ORGAN ENGINEERING AND SYNTHETIC BIOLOGY

Rossello-Diez	www.armi.org.au/our-groups/rosello-diez-group
Roman	www.armi.org.au/our-groups/roman-group

WHY STUDY AT ARMI?

- Our Higher Degree by Research (HDR) and Honours programs attract talented students from Australia and abroad.
- Our students reflect ARMI's international perspective with students from India, China, Canada, Mexico, Iran, The Philippines and Sri Lanka.
- The highly collaborative, interdisciplinary nature of the ARMI research program exposes students to cutting edge science in our laboratories.
- Students are supported to engage in career building opportunities in Australia and overseas.

ARMI'S VISION IS FOR TODAY'S STUDENTS TO BE TRAINED TO AN EXCEPTIONALLY HIGH STANDARD, TO BE THE NEXT GENERATION OF SCIENTIFIC LEADERS.

HOW TO APPLY FOR HONOURS AT ARMI

Students from the following fields of study are encouraged to apply to do an Honours project at ARMI Biomedical Sciences:

- Science
- Medical Science
- Health Science
- Engineering
- Pharmacy.

The next step is to contact the Group Leaders to discuss the project further.

Current projects are listed below in this booklet or to suggest your concept for a project, please contact one of our research group leaders. All are happy to meet with potential honours students.

Once you and your supervisor have agreed on a project:

1. **Your supervisor will need to fill out an ARMI Honours EOI undertaking to be your supervisor and stating the name of the project.**
2. **Prepare a copy of your transcript highlighting the subjects you wish to be considered for entry.**
3. **Submit completed ARMI Honours EOI, Faculty and transcript to the ARMI Honours Coordinator for approval.**
4. **Complete the relevant faculty's online application form**
   BMS Students: https://www.monash.edu/discovery-institute/honours
   Science Students: www.monash.edu/science/current-students/science-honours/

ELIGIBILITY CRITERIA FOR HONOURS

Completion of a Bachelor's degree in either Science or Biomedical Science.

If you are a BSc student, you need an average of at least 70% in four relevant third year units.

BMS students need an average of at least 70% across BMS3021, BMS3042 and the two highest level 3 electives.

How to apply:

BMS students must enrol directly through the Med Faculty for BMS Hons.

An application form can be found at: https://www.monash.edu/discovery-institute/honours

BMS Honours Students must enrol for the following units:

- BMS4100 Biomedical science research project
- BMS4200 Advanced studies in biomedical science.

BSc students enrol through the Science Faculty for BSc Hons.

Application details can be found at: http://www.monash.edu/science/current-students/science-honours

BSc Honours Students must enrol for the following Regenerative medicine units:

- MIS4100 Regenerative medicine research project (36 points)
- MIS4200 Advanced studies in regenerative medicine (12 points).

RESEARCH GROUPS
HEART AND MUSCLE DEVELOPMENT AND REGENERATION

CURRIE GROUP

Research Themes:

- Dissecting molecular mechanisms that act to pattern the vertebrate embryo
- Discovering how specific muscle cell types are determined within the developing embryo
- Discovering how different muscle cell types have evolved
- Determining how muscle types cells grow and regenerate after injury
- Large-scale mutagenesis of the zebrafish genome to produce different classes of mutations which disrupt gene function.

Project title	**Shark heart regeneration: Cellular and molecular characterisation of the myocardium response**
Project summary	The heart of different species shows varying regenerative capacities, but the reason for this remains unclear. To explore heart regeneration and trace it back to the root of vertebrate evolution, this project aims to characterize cellular responses of the injured shark heart. We will analyse how the various cells in the heart react, including proliferation, gene activation and tissue remodelling.
Main techniques	Animal handling, immunofluorescence, microscopy (brightfield, wide field, confocal), DNA and RNA work (PCR, cloning, …), flowcytometry
Group leader	Prof Peter Currie
Supervisor	Benoit Haerlingen

Project title	**Studying the vascular system's role in early skeletal muscle regeneration in zebrafish**
Project summary	Skeletal muscle demonstrates a remarkable ability to regenerate post injury. This results in extensive regrowth and remodelling of the injured muscle and its supporting tissues. Among those are the blood vessels. Surprisingly, little is known about the relationship and communication between skeletal muscle stem cells and endothelial cells during regeneration, despite a wealth of knowledge of vasculature crucial roles in muscle maintenance. This project aims to map and identify endothelial cells behaviour and interaction with the muscle stem cells post muscle injury using the zebrafish larva model.
Main techniques	Zebrafish husbandry, stab wound experiments, immunostaining, imaging (fixed and live samples), image analysis, In-Situ Hybridization, muscle sections, knock out using CRISPR/Cas9
Group leader	Prof Peter Currie
Supervisor	Dr Hila Barzilai-Tutsch

DEL MONTE-NIETO GROUP

Research Themes:

- To study the molecular mechanisms and developmental processes controlling heart development.
- To understand the molecular and cellular etiology of Congenital Heart Disease.
- To study ECM composition/patterning during heart development, adulthood and disease/injury models.
- To develop computational models for the different developmental processes in the heart.
- To apply the knowledge generated from developmental biology to improve heart regeneration, organ-on-a-chip technologies and tissue engineering.

Project title	**Characterization of cardiac defects resulting from human patient mutant variants in the HOPX gene**
Project summary	HOPX is one of the core transcription factors controlling heart development. The lab is characterizing new human patient mutant variants predicted to cause cardiac defects. We will perform morphological characterisation of the cardiac defects present in adult mouse hearts carrying these mutations.
Main techniques	Cardiac morphological characterizations, tissue computational segmentation, 3D heart reconstruction methods, 3D volumetric quantifications and data analysis.
Group leader	Dr Gonzalo del Monte Nieto
Supervisor	Dr Gonzalo del Monte Nieto

Project title	**Study of the endocardial control of cardiac muscle growth during development and congenital heart disease**
Project summary	The endocardium is the main tissue organiser controlling the growth and patterning of the cardiac muscle tissue during embryonic development. This project will investigate if this control is executed by regulating the direction of division of cardiac muscle cells. This is a critical knowledge to understand tissue patterning during normal heart development and congenital heart disease conditions.
Main techniques	Embryo dissection, tissue embedding in paraffin and microtome sectioning, histological stainings, immunofluorescence and *in situ* hybridization in wholemount samples and sections, 3D two-photon microscopy imaging, 3D reconstructions and 2D and 3D image quantification.
Group leader	Dr Gonzalo del Monte Nieto
Supervisor	Dr Gonzalo del Monte Nieto

RESEARCH GROUPS
HEART AND MUSCLE DEVELOPMENT AND REGENERATION

DEL MONTE-NIETO GROUP CONT.

Project title	**Study of the EndMT process during cardiac valve development**
Project summary	The project aims to investigate in detail the process of EndMT taking place during cardiac valve formation in the developing embryo. We will identify the specific cells activating this process, the cellular behaviours controlling this process, the molecular regulation activated in the cells undergoing EndMT and how the surrounding cells maintain the integrity of the endocardial layer.
Main techniques	Embryo dissection, tissue embedding in paraffin and microtome sectioning, histological staining, immunofluorescence and in situ hybridization in wholemount samples and sections, qPCR, 3D and 4D light-sheet/two-photon microscopy imaging, 3D reconstructions and 2D and 3D image quantification.
Group leader	Dr Gonzalo del Monte Nieto
Supervisor	Dr Gonzalo del Monte Nieto

Project title	**Study of the process of atrial development**
Project summary	The project aims to investigate the process by which the atrial chambers form during embryonic development. We will apply the new notions described in our recent study (del Monte-Nieto et al., Nature 2018) on ventricular chamber development to determine the cellular behaviours, ECM dynamics and molecular regulation controlling atrial development.
Main techniques	Embryo dissection, tissue embedding in paraffin and microtome sectioning, histological staining, immunofluorescence and in situ hybridization in wholemount samples and sections, qPCR, 3D and 4D light-sheet/two-photon microscopy imaging, 3D reconstructions and 2D and 3D image quantification.
Group leader	Dr Gonzalo del Monte Nieto
Supervisor	Dr Gonzalo del Monte Nieto

MCGLINN GROUP

Research Themes:

- microRNA control of Hox gene networks
- Genomic/epigenomic regulation of axis elongation and vertebral patterning
- Formation and patterning of spinal cord circuitry
- Evolutionary acquisition of microRNAs shapes developmental networks

Project title	**Using ES cells to model formation of the vertebral column and spinal cord**
Project summary	Our lab is interested in understanding how early progenitor cells of the embryo make lineage choices between neural and mesodermal cell fate. We use mouse genetics, combined with in vitro ES cell differentiation protocols, to understand gene networks and regulatory mechanisms that guide this process.
Main techniques	ES cell differentiation Quantitative PCR Immunofluorescence
Group leader	A/Prof Edwina McGlinn
Supervisor	A/Prof Edwina McGlinn

Project title	**Signals controlling formation of the head and face**
Project summary	The formation of the head and face is a tightly regulated process, with gene defects and environmental insults both contributing to craniofacial defects. We have established a mouse model of craniofacial malformation that shows cleft lip and cleft palate upon inhibition of the retinoic acid pathway. Strikingly, removing the *Gdf11* gene in this context is able to rescue these craniofacial defects. We are investigating the mechanisms underlying this genetic interaction, with the aim of harnessing this observation for therapeutical purposes.
Main techniques	Mouse genetics, micro computed tomography (µCT), light-sheet microscopy, *in situ* hybridisation, embryonic stem cell and neural crest cell cultures, RNA sequencing.
Group leader	Associate Professor Edwina McGlinn
Supervisor	Dr Jan Manent

Project title	**microRNA control of developmental haematopoiesis**
Project summary	Developmental haematopoiesis, the process by which all blood cell types arise in the vertebrate embryo and are maintained throughout adult life, is a tightly regulated process. We have uncovered a novel and important role for a specific microRNA family in developmental haematopoiesis. We are using state of the art mouse genetics, microscopy, flow cytometry and in vitro stem cell differentiation techniques to characterise the function of this microRNA family, with the ultimate goal to harness this discovery for therapeutical purposes.
Main techniques	Mouse genetics, flow cytometry, confocal and light-sheet microscopy, embryonic and hematopoietic stem cell cultures, RNA sequencing.
Group leader	Associate Professor Edwina McGlinn
Supervisor	Dr Jan Manent

RESEARCH GROUPS
HEART AND MUSCLE DEVELOPMENT AND REGENERATION

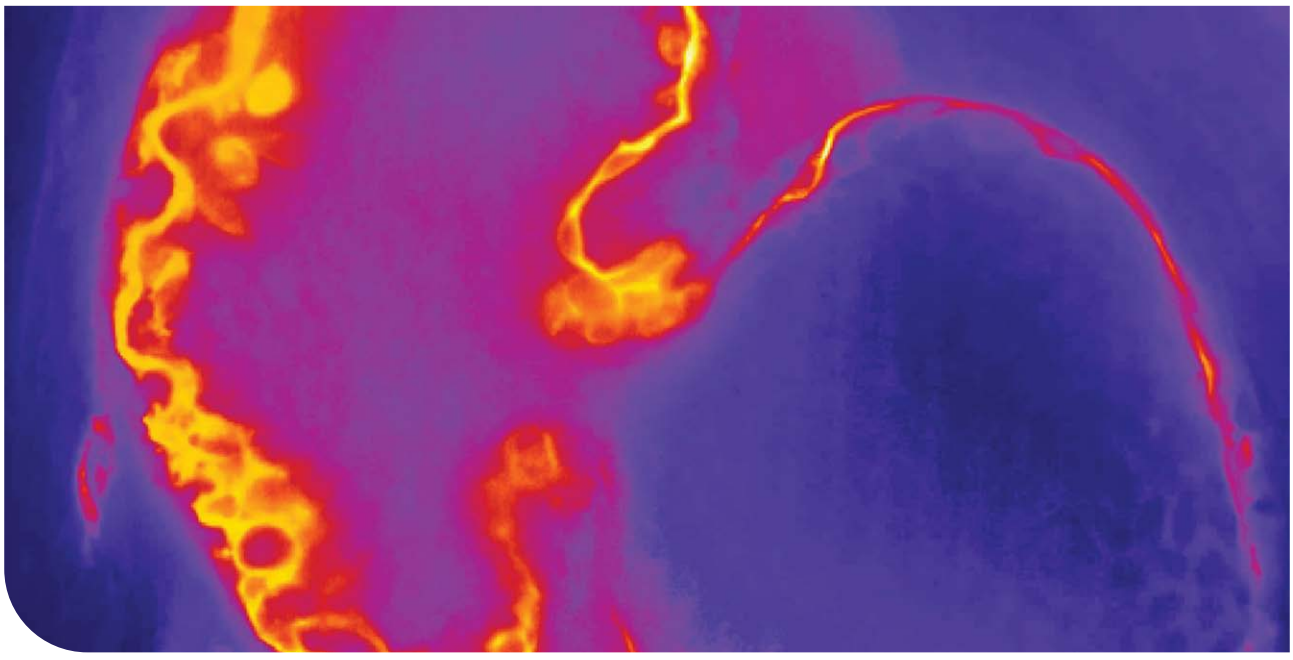
CHOW GROUP

Research Themes:

- Heart valve development, disease, and regeneration
- Mechanobiology
- Cell-based therapies (endothelial progenitor cells)

Project title	**The role of mechanical forces on heart development**
Project summary	The embryonic heart pumps blood around the body before it is fully formed. Using the zebrafish as an animal model, this project aims to determine how mechanical forces due to heartbeat and blood flow regulate heart morphogenesis.
Main techniques	Molecular and cell biology, micromanipulation, microscopy, zebrafish husbandry
Group leader	Renee Chow
Supervisor	Renee Chow

Project title	**Nfat and fat valves**
Project summary	Heart valves are tissue structures that prevent the backward flow of blood in the heart. Inhibiting the activity of transcription factor Nfatc1 during development can result in abnormally thick heart valves. Using the zebrafish as an animal model, this project aims to determine the role of Nfatc1 in heart valve development.
Main techniques	Molecular and cell biology, micromanipulation, microscopy, zebrafish husbandry
Group leader	Renee Chow
Supervisor	Renee Chow

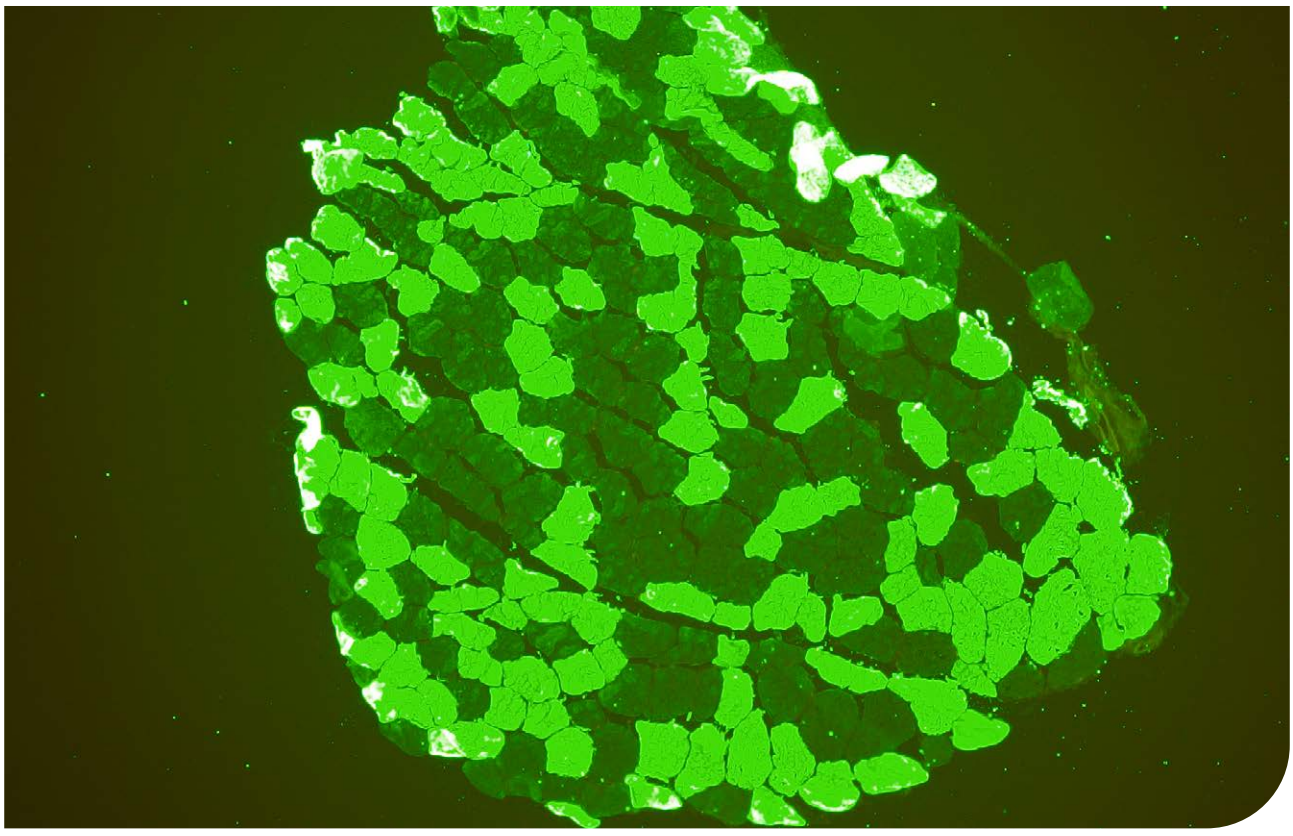


EYNON GROUP

Research Themes:

- Epigenetics and adaptation to exercise in health and disease
- Epigenetics, Gene and Proteins expression and aging
- Exercise and muscle physiology

Project title	**Uncovering molecules associated with healthy ageing and exercise responses**
Project summary	This project aims to uncover sex-specific molecular marks that either predict or mediate healthy ageing and exercise responses in muscle.
Main techniques	Human exercise trials to measure fitness outcomes (VO_2 max and strength) and molecular outcomes via analysis of blood and muscle samples. Techniques used for molecular analysis include muscle cross-sectional area and fibre type using immuno-histochemistry, preparation and analysis of 'omics' datasets including methylation, transcriptomics and proteomics. In addition, we use Bioinformatics techniques for data analyses.
Group leader	Professor Nir Eynon
Supervisors	Professor Nir Eynon Dr Bernadette Jones-Freeman Dr Robin Grolaux Dr Macsue Jacques



RESEARCH GROUPS
IMMUNITY AND REGENERATION

LIESCHKE GROUP

Research Themes:

- Discovery of genes critical for white blood cell development
- How the inflammatory response is regulated
- How modulating the inflammatory white blood cells might tip the outcome to favour regeneration rather than scarring
- Investigating how white blood cells keep out and contain micro-organisms.

Project title	**The immune synapse in cellular anticancer immunotherapies**
Project summary	Natural killer (NK) cell-mediated cancer killing involves the formation of direct cell-cell contact (immune synapses) for specific granule delivery into the target cancer cells, thus preventing the cytotoxic content being released into the surrounding environment. Occasionally, transiting of an entire NK cell into the cancer cell cytoplasm has been observed, a phenomenon known as emperipolesis. The process of emperipolesis has not been studied extensively, and its biological significance in the context of cancer immunity remains unclear. The goal of this project is to investigate the tendency of various cancer and immune cell types to undergo emperipolesis and assess the fate on tumour/NK survival using cell-culture and microscopy approaches. The results will provide valuable insights into this distinct tumour-immune cell interaction and raise important points for consideration when designing and implementing adoptive cell transfer and other anti-cancer immunotherapy approaches.
Main techniques	Cell culture techniques, immunofluorescence, biochemical assays, widefield/confocal microscopy
Group leader	Professor Graham Lieschke
Supervisor	Dr Connie Fung

MARTINO GROUP

Research Themes:

- Dissecting how the innate immune system affects tissue-resident/transplanted stem cells and growth factors activities.
- Understanding the immune modulations of stem cells and regeneration by T lymphocytes.
- Developing effective systems for delivering stem cells and cytokines/growth factors, using biomaterials and protein engineering.

Project title	**Engineering myeloid cell-targeting cytokines to improve tissue regeneration**
Project summary	The goal of this project is to engineer immunomodulatory cytokines with therapeutic potential to specifically target myeloid cells (e.g. neutrophils, monocytes, macrophages) within injured tissues in order to promote a pro-regenerative immune microenvironment. These therapeutic protein candidates will be recombinantly produced in the laboratory and tested *in vitro* using cell culture methods to verify their activity, as well as *in vivo* using mouse skin and/or muscle injury models to assess their overall capacity to promote tissue regeneration. This novel approach has the potential to create powerful immune-centric regenerative therapies and may form the foundation of a future PhD project.
Main techniques	Protein engineering; recombinant protein production; cell culture; mouse injury models.
Group leader	A/Prof. Mikaël Martino
Supervisors	A/Prof. Mikaël Martino Dr Julien Legrand

RESEARCH GROUPS
STEM CELLS AND REGENERATION

NILSSON GROUP

Research Themes:

- Understanding the role of the endosteal niche in the regulation and function of haemopoietic stem cells
- Characterising the role of megakaryocytes in the endosteal niche and haemopoietic stem cell regulation
- Isolating bone marrow sinusoidal endothelial cells and characterising their role and potential
- Understanding the role of key extracellular matrix molecules in the adult bone marrow microenvironment in foetal haemopoietic development
- Design and synthesis of novel haemopoietic stem cell mobilisation agents
- Characterising adult cells that have been directly differentiated into hemopoietic stem cells.
- Functionally assessing embryonic stem cell subpopulations whose differentiation has been directed towards hemopoietic stem cells.

ZENKER GROUP

Research Themes:

- The establishment of new methods to visualize and manipulate the microtubule dynamics in complex 3D model systems
- To determine how the microtubule architecture regulates early embryonic development
- To uncover the role of the inner skeleton in stem cell plasticity

Project title	**Live cell imaging to illuminate the inner secrets of pluripotency**
Project summary	The transformation of a mammalian embryo from a tiny soccer ball-like structure into a newborn with four limbs, a beating heart and big bright eyes is one of the most remarkable and fundamental processes of life. Inside the soccer ball-like embryo resides a handful of "all-rounder" cells, known as *pluripotent cells*, which can give rise to any type of cell in the adult body. Enigmatically, the capacity for pluripotency is lost in the embryo less than one week after conception. But why? Knowing precisely how pluripotency is controlled can transform the way we think about how cells behave during development and in adulthood. By looking into the inside of single pluripotent cells of the living mouse embryo or human induced pluripotent stem cells (hiPSCs) using cutting-edge imaging technologies, this project will visualise how the inner organisation of organelles and the microtubule cytoskeleton contributes of the astonishing capabilities of such "all-rounder" cells. Findings from this study have the potential to be applied to technologies for engineering cell fates, for sorting cell subtypes, as well as for the fast and accurate detection of abnormal embryos.
Main techniques	Microscope techniques, computational data analysis, mouse embryo handling, molecular cloning including PCR, plasmid transformation, *in vitro* synthesis of RNA as well as cell culture techniques and cell transfections.
Group leader	Dr Jennifer Zenker
Supervisor	Dr Jennifer Zenker and Yi Louise Li

RESEARCH GROUPS
NEURAL REGENERATION

KASLIN GROUP

Research Themes:

- Understanding the molecular and cellular mechanisms that control cellular plasticity in the intact and injured vertebrate brain
- How neuronal stem cell niches arise and are being maintained, using high-resolution in vivo imaging, novel genetic tools and cellular reprogramming
- Using high-throughput methods to get a comprehensive understanding of the genetic networks that regulate cellular plasticity during homeostasis and regeneration.

Project title	**Evolution of spinal cord regeneration in vertebrates**
Project summary	In this project we aim to define how the ability to regenerate axons and neurons originated during evolution. In particular, we aim to identify the ground plan by using elasmobranch models (sharks).
Main techniques	Vertebrate models (fish, sharks and avian). Diverse imaging techniques, cloning, in situ hybridisation, immunohistochemistry, genetic tools.
Group leader	Dr Jan Kaslin
Supervisors	Dr Mitra Amiri Dr Frank Tulenko

Project title	**Architectural transcription factors in controlling metabolism and neural stem cells**
Project summary	In this project we examine how architectural transcription factors control neural stem cells during development and after injury. The architectural transcription factor expression is induced after tissue injury and is pivotal in stem cell control.
Main techniques	Zebrafish model. Diverse imaging techniques, genetic tools and molecular techniques. In vitro models and biochemical assays.
Group leaders	Dr Jan Kaslin Dr Minni Anko (Hudson)
Supervisor	Dr Jan Kaslin

Project title	**Inflammatory control of neurogenesis in the intact and injured brain**
Project summary	In this project we examine how immune cell and glia interaction control neural stem cells during homeostasis and after injury
Main techniques	Zebrafish model. Diverse imaging techniques, genetic tools and molecular techniques. In vitro models.
Group leaders	Jan Kaslin Minni Anko (Hudson)
Supervisor	Dr Jan Kaslin

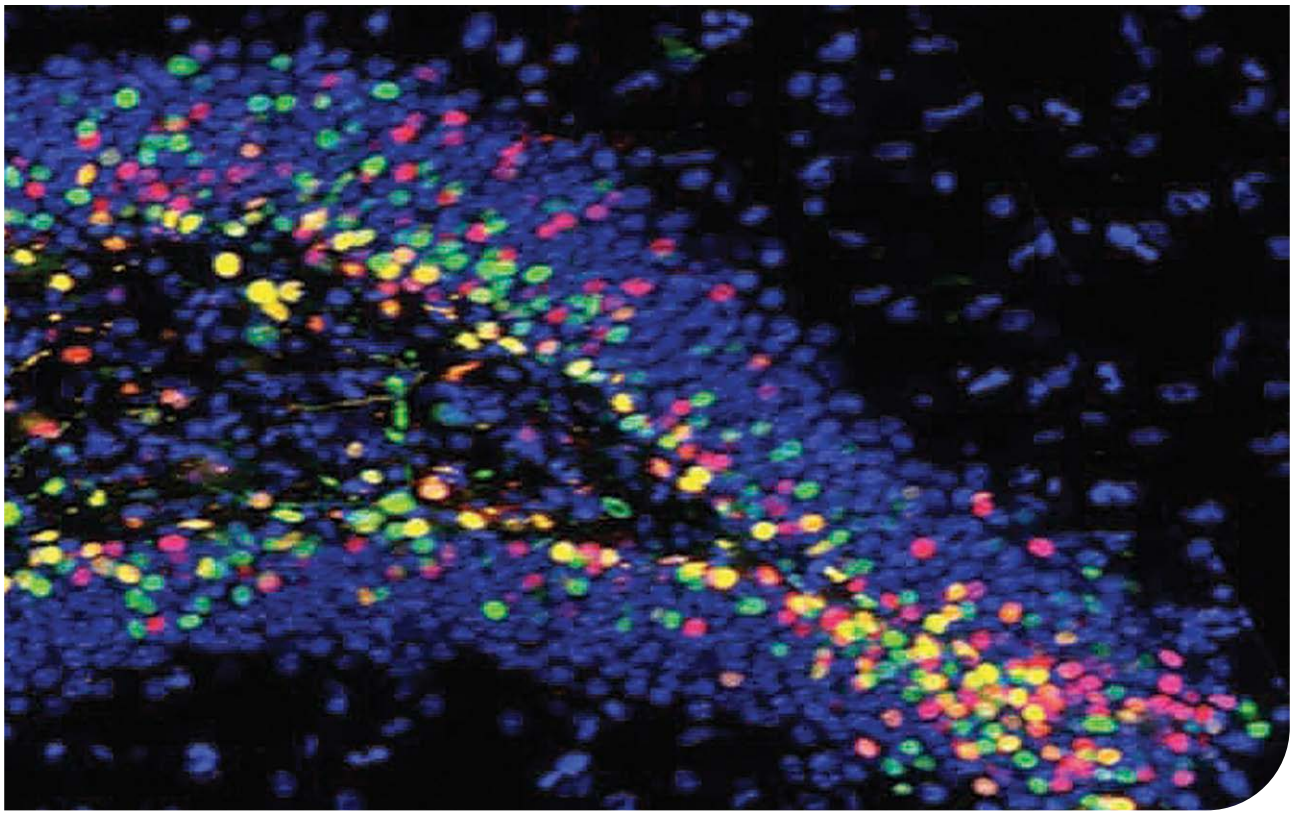
KASLIN GROUP CONT.

Project title	**Investigating genetic components of cerebral palsy**
Project summary	In order to elucidate the so far relatively unknown genetic background of cerebral palsy, this project plans to use zebrafish (danio rerio) and methods like CRISPR/Cas to rapidly screen the previously identified candidate genes for their involvement in the disease. This should help to recognise and understand the underlying molecular pathways, which in return hopefully provides opportunities for prevention and treatment in the future.
Main techniques	CRSIPR/Cas9 genome editing, molecular cloning, behavioural analysis, diverse imaging techniques.
Group leaders	Jan Kaslin Michael Fahey
Supervisor	Dr Samuel Crossman

CALEGARI GROUP

Research Themes:

- Understanding endogenous neural stem cell progenitor subtypes and their role in development, evolution and adult neurogenesis
- Using neurogenesis to rescue brain deficits associated to aging or disease



RESEARCH GROUPS
ORGAN ENGINEERING AND SYNTHETIC BIOLOGY

ROSELLO-DIEZ GROUP

Research Themes:

- Characterising the local cell-autonomous and nonautonomous responses to an injury, including the production and role of alarm signal(s) and the response of stem/progenitor cells
- Dissecting the inter-organ communication mechanisms that lead to systemic growth effects upon local injury, with a focus on the role of the vascular and nervous systems
- Exploring the impact of the discovered injury response pathways on the buffering of developmental noise (random perturbations during normal development)
- Exploiting the discovered injury response pathways for the treatment of animal models of dwarfism and fracture repair

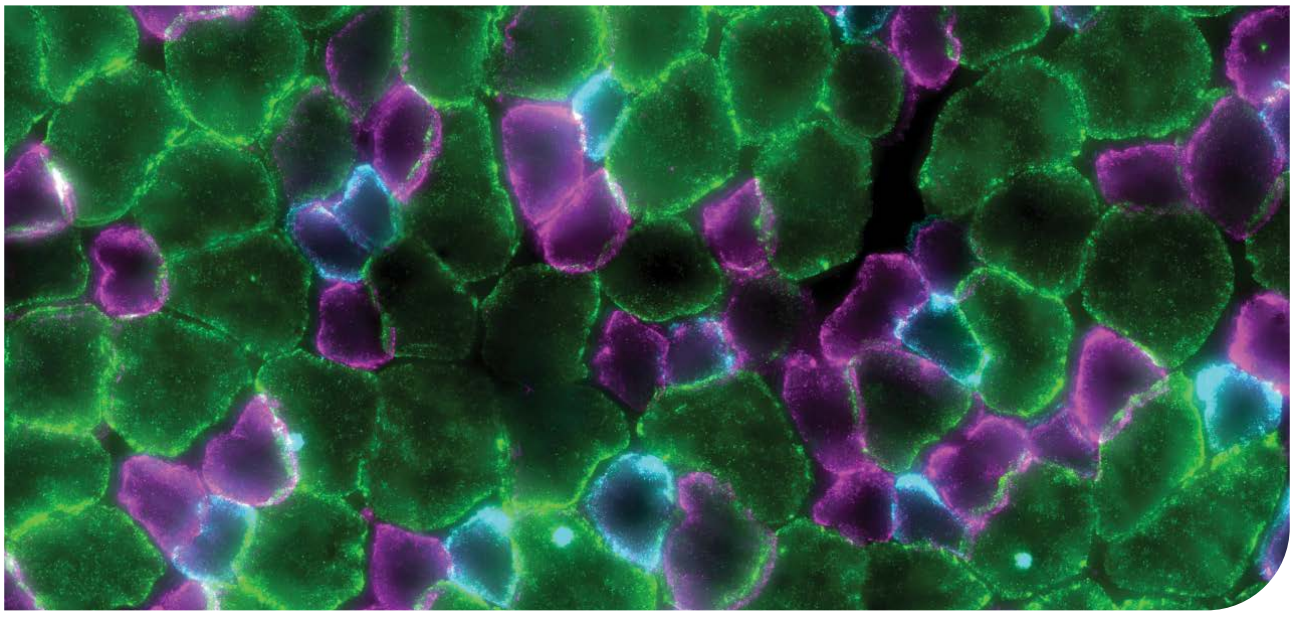
Project title	**Identifying key mediators of inter-organ communication in tissue injury**
Project summary	The regulation of tissue development and healing is a complex biological process influenced by both genetic factors (intrinsic) and external signals (extrinsic). These signals can be local (originating and acting within the same tissue) or systemic (produced in one tissue and acting on distant tissues). Systemic signaling is crucial for maintaining body proportions and initiating whole-body responses to injury. Our recent findings indicate that upon injury, alarm signals are transmitted to distant organs. This project aims to identify and analyse the key mediators involved in this inter-organ communication by examining transcriptome, lipid, and protein profiles to understand their roles.
Main techniques	Mouse timed mating and embryo collection, PCR genotyping, histology, immunofluorescence on tissue sections, image analysis.
Group leader	Alberto Rosello-Diez
Supervisors	Alberto Rosello-Diez Chee Ho H'ng

ROMAN GROUP

Research Themes:

- Skeletal muscle cell biology, regeneration, and repair.
- Tissue bioengineering of skeletal muscle organs using iPSCs and microfabrication.
- Intra- and intercellular communication from cell behaviour to genomic response.

Project title	**Performing exercise in a dish to study muscle injuries**
Project summary	Movement is natural to us. From slowly crawling out of bed to the occasional dash to catch the bus, our muscles are hardwired to mechanically comply to our command. It is therefore easy to overlook the extent of the stress and strain they endure as a biological system. And despite an architecture geared for contraction, our muscles are prone to ripping and tearing. In this project, we will mimic the damage that occurs during exercise in in vitro muscle cultures using optogenetics. By reproducing injuries in a dish, we will strip all the barriers separating us from the cells we are observing. This will allow us to monitor how cells repair their damage with unprecedented spatial and temporal resolution. We will first assess how cells change their behavior after damage using a panel of cell biology and microscopy tools. We will also identify which repair genes are upregulated and determine when and where they are expressed using sequencing and imaged-based spatial genomic techniques. The ultimate objective is to find a master regulator of the repair transcriptional program which we can then modulate to preserve muscle function. We will then be able to improve muscle health in myopathies, after exercise and during aging but other outcomes could also surface for in vitro meat production or preserving muscle in space flight.
Main techniques	Tissue engineering, RNA-sequencing, microscopy, cell biology and spatial transcriptomics.
Group leader	William Roman
Supervisor	William Roman



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