ResearchTogether

Patients guiding the future of science

11th February 2025

Research Summaries

Our Research in a Nutshell

eipETIME
Engineering Underpinning Medicine

UKRI Engineering and Physical Sciences Research Council

Welcome

Our ResearchTogether event aims to bring together patients, clinicians, carers and charities so that we may discuss recent and future advancements in the healthcare field.
By bridging the gap between patients and scientists, we aim to ensure that scientists are tailoring their research in a way to best support patients, and in return, patients can gain insight into the cutting-edge research being carried out for their condition.

"I would like to extend a warm welcome to everyone joining the 2025 Research Together event. The lifeTIME PhD students are the up-and-coming researchers who will make the healthcare advances of the future. This will be done through better engineering and development of new equipment to solve health problems. I hope you enjoy all the talks, ask questions, and make new friends. We want to hear everyone's opinion about how we can improve healthcare by developing new technologies. I wish everyone a thought-provoking and enjoyable day."

Professor Mhairi Copland, lifETIME CDT PPIE Committee Chair

"The Research Together event will bring us all together as stakeholders in advancing healthcare. We come together from different perspectives – including people being trained, to those providing the training, including people undergoing treatment, to those providing the treatment, and also people with interest in research and healthcare management. All of us are there to help to develop better healthcare-focussed researchers - the lifETIME PhD students - so that they will have better motivation and understanding than their predecessors. Our first Research Together event in 2023 was a huge success and it is easy to demonstrate how their PhD training benefitted by the work we have done together as stakeholders since then – but we can do better! My big hope is that we all feel that we all feel very comfortable at the event so that we have the freedom to chat, ask questions big or small and make new friends. This is our meeting and our opportunity to advance UK healthcare together and so I encourage everyone to 'get involved' in the ways they feel most comfortable doing so. In 2023, I was very nervous, now, with some experience, I am very excited!"

Professor Matt Dalby, lifETIME CDT Director

Thank you to all the patients, carers, charities and clinicians both for taking part today, and for being the backbone of this research community!

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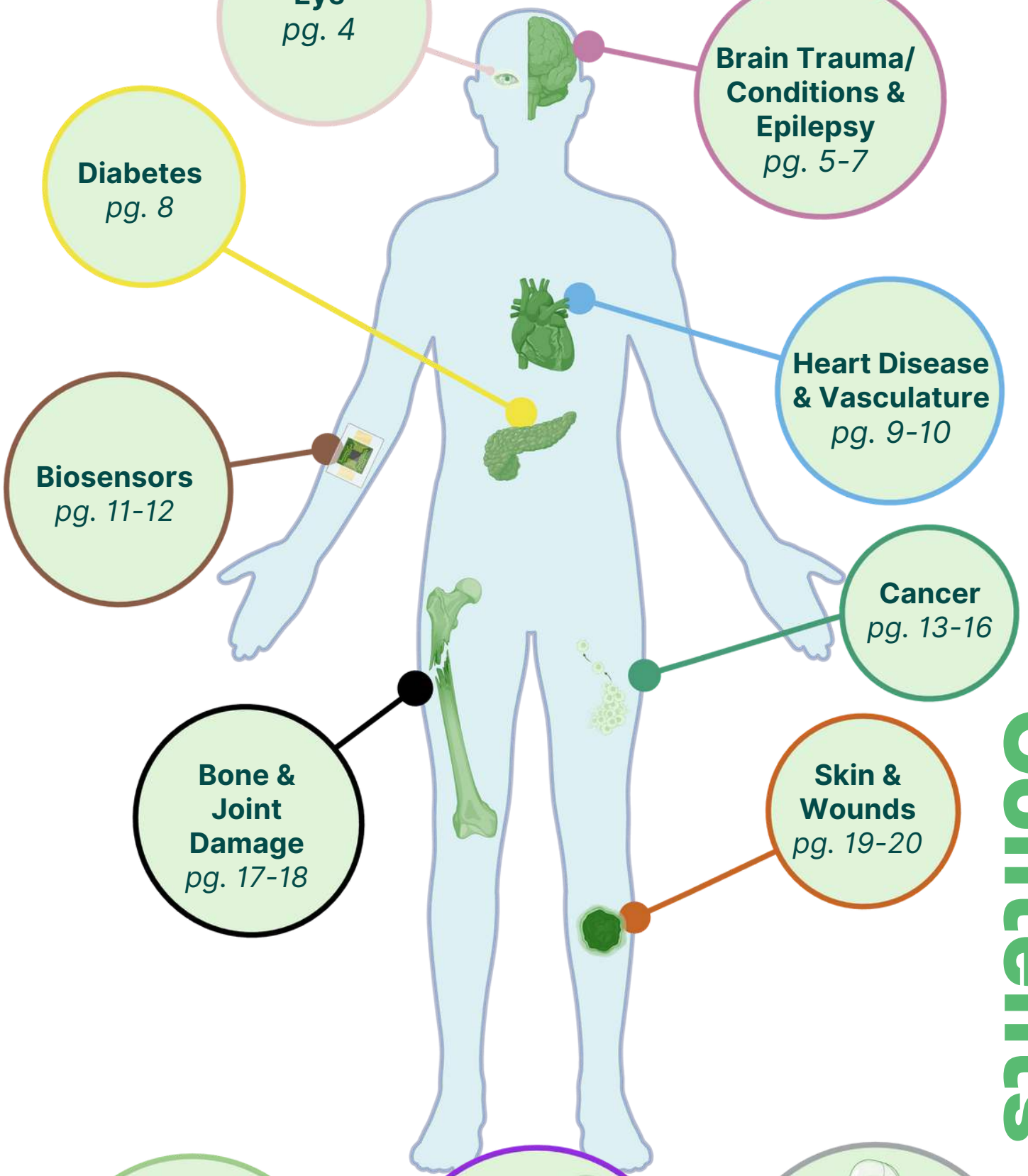

Eye

Delivering stem cell products to the injured corneal surface using an innovative hydrogel system

Seyedmohammad Moosavizadeh
University of Galway, 2021 Cohort

The cornea is the transparent, outer layer of the eye that plays a critical role in both vision and protection. Unfortunately, injuries to the cornea are a major cause of blindness around the world.
This project explores a new treatment approach using Mesenchymal Stromal Cells (MSCs), which are special cells found in tissues like bone marrow. MSCs are known for their ability to reduce inflammation, support tissue healing, and modulate the immune system. Instead of using the cells themselves, we're focusing on tiny particles called extracellular vesicles (EVs) that MSCs naturally release. These EVs carry healing properties similar to MSCs but offer some practical advantages, such as improved safety and ease of delivery.
In our study, we will isolate these EVs from healthy donors, encapsulate them in a safe, biocompatible material, and deliver them directly to injured areas on the surface of the eye. This delivery system is designed to release the EVs gradually, allowing for a controlled healing process.

To watch Impact in 60 seconds video, click here.

Developing and testing mobile apps to improve the testing of new ocular treatments and technologies

Thaiba Bano
Aston University, 2023 Cohort

All new eye treatments and devices must undergo clinical trials for approval. This project will use smartphone technology to make these trials more efficient. The student will develop mobile apps that allow patients to conduct vision tests at home using the smartphone's camera and sensors, enabling more frequent testing with less cost and inconvenience. These apps will also provide valuable data for eye care professionals to monitor and manage patients' eye health. By adhering to strict medical standards, the project ensures that the apps are safe, effective, and high-quality, offering a modern approach to improving eye care.

Brain Trauma/Conditions & Epilepsy

Investigating the role of brain-meninges interface in traumatic brain injury

Erin Reardon
University of Limerick, 2023 Cohort

Traumatic brain injury is a serious health issue worldwide with millions affected per year. This leads to patients having long-term disabilities including memory difficulties. The meninges, which are like a Lycra-suit that tightly wrap around the brain and spinal cord, are known to be important in protecting the brain from injury. However, we know little about the region where the brain meets the meninges. Therefore, my project hopes to develop a model of the brain-meninges interface or “brain-meninges border in a dish” to study its role in both healthy and injured states.

Targeting brain inflammation after injury: Exploring gliosis with mechanobiology and molecular approaches

Akash Garhwal
University of Galway, 2023 Cohort

Gliosis is a detrimental inflammatory process after brain traumatic injuries (TBI). This inflammatory response causes neural loss leading to long-term defects. It is becoming clear, that new molecular targets together with materials approaches will be necessary to modulate this inflammatory response in TBI. This project is targeting both the expression of specialized cell receptors altered in TBI, and cell sensing properties to elucidate new material approaches to address this gliosis problem in TBI.

Enhancing epilepsy treatment with targeted nanoparticle delivery

Katy McGonigal
Aston University, 2023 Cohort

Epilepsy is one of the most common neurological disorders affecting around 65 million people worldwide. It can be brought on by injury, tumours or through genetics resulting in a variety of seizure types. Tuberous sclerosis complex (TSC) is a rare genetic disease where 80% of people have epilepsy. In TSC there are limited treatment options and these treatments only work for 33% of people. Using cutting-edge science, we aim to develop a specialised nanoparticle-based delivery system that can transport epilepsy treatments more effectively to the brain, offering hope for better seizure control in patients with TSC.

Developing and testing mobile apps to improve the testing of new ocular treatments and technologies

Patrick C Hurley
University of Galway, 2021 Cohort

Multiple Sclerosis (MS) is an auto-immune disease of the central nervous system. The disease development is complex initially resulting in intermittent, and subsequently, often progressive neurological defects. An auto-immune disease in origin this project aims to recreate an immunological feature found in up to 40% of patients with progressive MS. The feature consists of a number of cell types and are referred to as lymphoid-like follicles (LLfs). Through the use of a microfluidic device which models the surface of the brain, we are developing a method to assess the factors which may influence their formation and their harmfulness to other cells in the brain. This device will utilise technologies to allow us to miniaturise the model enabling it to reduce cost and increase throughput. Ultimately the development of this device will allow for a more detailed study of these pathological features and their contribution to disease course.

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Building a Brain (Model)

Martha Gallagher
Aston University, 2022 Cohort

Neurodegenerative diseases like Parkinson's, Alzheimer's and Lewy body dementia all have age as a major risk factor and as our global population is ageing, they're a growing problem. Modelling is important to understand and eventually cure these diseases, but current models are lacking – using animals, are difficult to repeatedly make and so on. My project therefore hopes to address these issues by using stem cells created from reprogrammed patient body cells and growing them in gels that mimic the brain microenvironment – including signals that you would find in the creation of new neurons both in the developing and adult brain.

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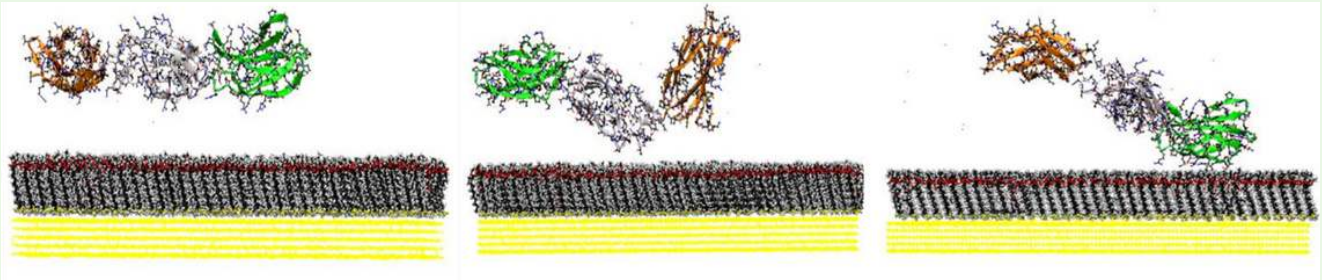
Molecules making magic: Don't blink or you'll miss the cool stuff!

Viswanath Vittaladevaram
University of Galway, 2021 Cohort

Imagine tiny dancers, zooming around in a watery world. These dancers are actually proteins, super important molecules working in our bodies. But they can't just float around everywhere! They need special platforms to land on, like dance floors. These "floors" are surfaces, inside us or even in things we create. By understanding how proteins and surfaces "shake hands," scientists can become design masters!



Think of building a new playground for these protein dancers. By knowing how they like to stick (or not stick) to different surfaces, we can design amazing things! For example, we can make new tissues for injured people, build tiny tools for medicine, or even develop super-sticky bandages. It's all about understanding the secret relationship between proteins and surfaces! So next time you blink, remember, there's a whole world of tiny interactions guiding amazing scientific advances!

To watch Impact in 60 seconds video, click here.

Exploring the potential of different body fluids to implement rapid testing for multiple sclerosis (MS)

Bianca Castelli
University of Galway, 2021 Cohort

Living with a neurodegenerative condition is tough, especially with the hassle of frequent clinic visits. Many struggle to access care due to travel challenges or living remotely. The lack of accessible, rapid, and minimally invasive testing also poses a major challenge when it comes to disease management. There is a clear need for novel ways to identify disease progression and response to treatment. This project aims to identify biomarkers through body fluid samples and develop a user-friendly POC device, potentially enhancing the quality of life for patients. Point-Of-Care (POC) testing brings diagnostics to patients' homes or doctor's offices, offering faster results and non-invasive procedures like finger-prick blood tests. Creating a POC device for neurodegeneration monitoring addresses the difficulty of regular check-ups for conditions like MS.

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Diabetes

Diabetes in a Dish: a new lab-based model to understand complex disease

Elaine Duncan
University of Glasgow, 2021 Cohort

Type 2 Diabetes (T2D) is a complex disease characterised by insulin resistance, resulting in increased blood glucose levels.
We want to understand how inflammation of fat tissue leads to insulin resistance, however this is challenging with existing techniques. Simple cell models are too artificial, whereas animal models have limited human relevance.
I aim to develop a 3D model of diabetic fat tissue by combining human fat cells with markers of inflammation and include a biosensor to measure how the organoids function in real time, helping us to better understand T2D and identify new curative treatments, thus easing the financial burden on healthcare systems and improving patient outcomes.

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The role of metabolite sensing GPCR mechanotransduction in adipocyte function

Euan Purdie
University of Glasgow, 2023 Cohort

Rates of metabolic diseases such as obesity are exponentially increasing in the UK due to increases in high fat diets and sedentary lifestyles. Ways to create new medicines to treat these diseases are vital to curb this growth. An area of research that is gaining traction is the process of applying different physical forces (such as compressing or stretching) on different parts of the body. However, little is known about the effects of applying these forces to fat. My project looks at applying these forces to fat to see if this changes how medicines act.

Heart Disease & Vasculature

Creating an experimental model to visualise how blood flows through medical devices

Eleanor Barton
Aston University, 2022 Cohort

My Biomedical Engineering PhD project focuses on treatments for cardiovascular disease, through development of an experimental method to validate the design and functionality of medical devices, such as aortic grafts. These devices are used to treat patients by replacing damaged or diseased sections of the aorta, the largest blood vessel in the body. The method involves 3 key components: a physical model that matches the geometry of the untreated or treated aorta, a flow circuit comprised of a system of pipes and sensors to control fluid flow, and an optical imaging system to visualise the flow patterns in the model.

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Smart coatings to limit blood clot formation on synthetic vascular grafts

Justine Clarke
University of Glasgow, 2022 Cohort

Synthetic vascular grafts are tube-like structures which can be implanted by non-invasive surgery inside the blood vessels to provide support and aid blood flow when this has been weakened. However, overtime there is a risk of blood clots or scar tissue forming at the implanted site and blocking the blood flow. The aim of my project is to investigate different biological coatings on the surface of the graft material and observe how they interact with different cell types to mimic the in-body situation and assess their effect on blood clot formation.

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Using 3D Gels to Study Heart Healing

Joanne Chang
Royal College of Surgeons in Ireland, 2023 Cohort

Cardiovascular diseases (CVDs) are one of the leading causes of death worldwide. However, we still don't know how the body, particularly immune system and blood vessels, interact in CVD. We will use new techniques to develop a cell model for these interactions. We aim to make a gel with different nutrients to grow cells that make blood vessels. Next, we will add immune cells and see how they interact and change blood vessel growth. Lastly, we will put the system in a low-oxygen environment to mimic CVD events and see how the cells respond.

Bioprinting cardiac organoid models containing structurally and functionally mature vascular networks

Hey Wei Wong
University of Galway, 2023 Cohort

3D bioprinting technologies has the potential in generating cardiac tissues with precise anatomical features and cardiac microenvironment. 3D bio-printed cardiac tissues have gained enormous interest for modelling cardiac disease, but they often lack of functional vascular or immune component for modelling cardiac disease. The overall objective of this proposal is therefore to engineer bio-printed cardiac injury models containing functional vascular and immune components to model the inflammatory response following heart attack. To realise this, we will use our expertise in spheroid bioprinting technology to create cardiac tissue rings with embedded vascular channels and we will use this platform to model the inflammatory response.

The development of high strength vascular adhesives

Ryan Meechan
University of Birmingham, 2023 Cohort

I am developing adhesives to treat bleeding from large arteries. This is important as mortality rates associated with bleeding remain significant, and traditional interventions are time consuming and can lead to infection. I am focused on synthetic hydrogels as they mimic the biology of body tissues, and their properties can be readily controlled. The crux of my research is to synthesise an injectable hydrogel adhesive which forms strong bonds with tissue to withstand a wet, high-pressure environment. Ideally, this should match blood vessel properties, be safe for use in the body and naturally degrade in line with new vessel growth.

Biosensors

From sports performance to health diagnostics: monitoring of biomarkers with non invasive sensors

Clara Cosa Garcia
University of Glasgow, 2023 Cohort

Monitoring biomarkers in our body can provide important information when making decisions for treating long-term conditions, adapting lifestyle, or taking actions to prevent disease. During this PhD I will be developing wearable biosensors as a patch/bandage or watch to measure biomarkers in sweat, exploring design co-creation across a diverse range of individuals of different ethnic backgrounds, complexion, age, gender and possible co-morbidities including non-communicable diseases and mental health. Some key challenges will be designing new ways to manipulate sweat in the sensor and improving the length of time they can be used in a continuous fashion.

A low-cost wearable microneedle sensor based on sweat analysis for daily monitoring of multiple analytes

Junxiang Wang
University of Glasgow, 2023 Cohort

We will develop an integrated wearable device for healthcare applications using a device based around either a watch, a patch, or a ring. Microfabricated microneedles and microchannels will collect the sample non/micro-invasively for the analysis of sweat. These analytes which may include glucose (an important indicator for daily monitoring in diabetics), lactate (characteristic of septic shock diagnosis), and/or more complex analyte will enable individuals to monitor health and wellbeing in real time. We will also create a smartphone application which can store and transmit data for users and provide daily records of their lifestyle choices.

Testing people for Human papillomavirus without a lab

Ella Boswell
University of Glasgow, 2022 Cohort

Human papillomavirus, also known as HPV, is very common, but certain strains cause cervical cancer. Cheap, quick, and easy-to-use tests – similar to the covid lateral flow tests – are required to diagnose people in areas that don't have access to labs. Nucleic acid amplification tests (NAATs) are techniques that involve taking a sample (a vaginal swab, for example), and searching to see whether the DNA or RNA of a disease is present. I'm designing a test for HPV, using a NAAT, for use in low-resource settings in sub-Saharan Africa.

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Developing affordable and accessible diagnostics for Schistosomiasis – a neglected tropical disease

Rory Barnes
University of Glasgow, 2022 Cohort

Schistosomiasis is a parasitic worm infection that is common in tropical and subtropical countries, particularly in rural areas where access to clean water is limited. Diagnosing schistosomiasis currently relies on using a microscope to spot tiny eggs in the faeces or urine of an infected person. This is time consuming and expensive. My research focuses on developing an affordable and easy-to-use diagnostic test that can detect the DNA from the worms in the urine of an infected person. To do this I'm using a technology called LAMP, similar to the PCR tests that were used to test people for COVID-19.

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Increasing access to life-saving cell therapies through automation

Imen Boumar
University of Birmingham, 2022 Cohort

Currently, cell therapies cost between £30k to £1.6 million for treating illnesses such as cancers and autoimmune diseases. Our work focuses on making these treatments more accessible by automating the treatment production process. We are addressing this challenge by integrating smart biosensors to continuously monitor cell quality during the therapy manufacturing process. This concept takes it to the next level by integrating cutting-edge technologies in the nanotech industry. We will then be able to track the efficacy of the treatments much faster and in less steps than the conventional method currently being used.

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Cancer

Enhancing cancer treatments by understanding immune cell communication and responses in influencing tumour growth

Brian Harkin
University of Galway, 2023 Cohort

This research focuses on improving cancer treatments using a promising new approach called immunotherapy. Immune cells, which help fight disease, struggle to penetrate tumours limiting treatment success. Experimental models help us predict how tumours grow and interact with immune cells. Some immune cells show potential in killing cancer, but they can't penetrate the tumour effectively. Current strategies don't consider all forces resisting this penetration. Consequently, we need new models that analyse this. This project aims to build 3D models to study the movement of immune cells and how they penetrate tumours. We aim to uncover the barriers of tumour growth to improve immune cell penetration with the goal of optimising anti-cancer therapies for patients.

"Osteosarcoma, I have a bone to pick with you!" Treating osteosarcoma: a small molecule approach

Francesca Kokkinos
University of Glasgow, 2022 Cohort

Osteosarcoma is the most common primary bone cancer in children and young adults. Features of osteosarcoma tumours indicate to the interruption of the differentiation of stem cells to bone forming cells, known as osteogenesis. This provides a great therapeutic possibility by aiming to restore and promote this differentiation thus making the cancer cells more susceptible to cell death. One way to control the differentiation of stem cells in vitro to bone forming cells is through the use of small molecules, known as corticosteroids. However, their use greatly increases the production of undesired cell types such as fat, muscle and cartilage cells. My project aims to improve the potency and specificity of these molecules through organic chemical synthesis to promote osteogenic differentiation and to improve on the treatment of osteosarcoma.

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A new approach to liver cancer treatment

Megan Bannister
University of Birmingham, 2023 Cohort

Liver cancer is a major UK and global health problem with few effective treatment options. Present research explores how certain immune cells, called monocytes can be used to treat liver cancer. Monocytes can be targeted to the liver where they are vital for the destruction of cancer cells. Monocytes also have a unique ability to be able to transport molecules within themselves and release them when required, meaning they can be used to transport drugs into the liver which can treat cancer. Understanding the pathway of monocyte entry into liver cells will allow a more targeted delivery of anti-cancer drugs, resulting in more effective treatments and improved patient outcome.

Development of in vitro triple-negative breast cancer model for improved targeted therapies

Nivethitha Ashok
University of Galway, 2023 Cohort

Triple-negative breast cancer (TNBC) is a highly aggressive cancer, representing 15-20% of breast cancers globally and causing about 25% of related deaths. Limited treatment options exist, largely due to a poor understanding of TNBC's environment within the body. This project aims to create a realistic 3D model of TNBC using suspended cancer cells in a gel that mimics natural tissue. This model allows for better testing of potential treatments, including promising compounds called metallacarboranes, which have shown the ability to kill TNBC cells. The goal is to advance targeted treatments by understanding TNBC behavior and drug effectiveness in a lab setting.

Bioengineered human tissue models of leukaemia to improve drug development

Celia Ribes Balanza
University of Glasgow, 2023 Cohort

One of the main causes of death in patients with cancer is metastasis. Metastasis happens when the cancer travels to other parts of the body. In blood cancers such as leukaemia, metastasis usually occurs in the spleen, bone marrow and lymph nodes. However, we still don’t fully understand what drives metastasis, or the underlaying biochemistry that takes place. This could be because most of our disease models rely on animals, which do not completely mimic human physiology. In this project we use hydrogels to model human bone marrow, connected to a lymph node-like environment. This will allow us to investigate the metastatic process and the onset of disease to ultimately identify and test new drug targets in human systems.

How the immune system regenerates unhealthy cells in the liver

James Kennedy
University of Birmingham, 2021 Cohort

The liver is our largest internal organ and is extremely important in keeping you running by cleaning your blood of any harmful toxins from alcohol or a fatty diet or keeping your immune system stable and ready to act if needed. My project investigates the vital process which allows your liver to regenerate after it is injured through alcohol or fatty diet damage. I use human liver cells that are isolated from transplanted livers and recreate the environment found during disease, in 3D, and see how we can manipulate this to favour the regeneration of healthy liver.

To watch Impact in 60 seconds video, click here.

Ready-to-use bone marrow models for drug testing

Conor Robinson
University of Glasgow, 2021 Cohort

My project aims to create a simple, highly controlled, and reproducible model of the bone marrow niche microenvironment to use in drug testing. To do this I will use 3D bio-printing to encapsulate key marrow components - haematopoietic stem cells and 3D aggregated mesenchymal stem cells - within alginate. A material isolated from seaweed, alginate can be crosslinked with calcium to form a customisable and biocompatible hydrogel. The gel will keep the cells alive for a minimum of two weeks at room temperature and they should retain all features and behaviours of the cells pre-encapsulation.

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Understanding cancer, one cell at a time

William Mills
University of Glasgow, 2021 Cohort

Cancer is a complex disease, with each tumour often containing many slightly different cells, some of which resist treatment. Most research studies use large groups of cancer cells, which makes it hard to examine individual differences. My project aims to solve this by creating a tool to study one cell at a time. Using fluid channels smaller than a strand of hair and a laser equipped microscope, we can take measurements from single cells and capture those of interest in microscopic water droplets. This lets us test their genetic traits and treatment responses individually, helping us understand cancer diversity and ultimately improve diagnosis and treatment.

How breast cancer cells feel their surroundings – and why it matters

Lola Ajayi
University of Glasgow, 2021 Cohort

Our cells constantly react to their surroundings, responding to hormones, drugs, temperature, and more. In breast cancer, tumour cells are especially sensitive to the stiffness and structure of their environment – a process called mechanosensing. The way proteins and fibres are organised around a tumour can influence how cancer grows, spreads, and resists treatment. To study breast cancer, scientists create models that mimic real breast tissue. However, natural materials are difficult to control, making it hard to replicate both the stiffness and structural organisation of a tumour. Many models use synthetic materials, which can be precisely tuned, but they lack the ability to change in response to cells – something real breast tissue does constantly.

My research focuses on engineering a breast cancer model that is both natural and adjustable in stiffness and structure. I use collagen, the most abundant protein in breast tissue, to recreate the complex environment where tumours develop. This allows us to study how breast cancer cells remodel their surroundings. This helps us better understand – and ultimately target – aggressive breast cancer.

Developing an automated platform to identify and sort cancer therapy resistant cells based on their chemical information

Owen Drabwell
University of Glasgow, 2023 Cohort

This project focusses on creating an advanced tool to sort biological cells of interest based on their chemical makeup. This uses a technique called Raman microscopy, which measures scattered light from the cells to provide valuable chemical information such as its metabolic state or to discover cancer therapy resistant cells. The tools itself will use microfluidics (fluid manipulation on a very small scale) to sort cells. My project aims to create a platform that is Plug-and-Play, meaning that it can be taken, set up easily and used to for studies in any of the labs around the world performing high level imaging research.

Designing gel-like materials to mimic tumour environment and help stop cancer growth

Konstantina Evdokimou
University of Glasgow, 2023 Cohort

As tumours grow, they often modify their surrounding area, leading to faster growth and spreading. This project aims to understand how these changes happen in the area that surrounds the cells, known as the extracellular matrix (ECM). This research will utilise viscoelastic hydrogels, biomaterial suitable for cell growth, to act like the extracellular matrix by making appropriate biological and mechanical modifications. These gels could help visualise and control the behaviour of three different types of breast cancer cells in both flat and 3D environments and even stop the growth, progression, and metastasis of cancer cells.

Bone & Joint Damage

Enhancing cancer treatments by understanding immune cell communication and responses in influencing tumour growth

Joseph Weightman
University of Birmingham, 2023 Cohort

Bone can fully repair itself after injury. However, traumatic injury can cause fractures to not heal and surrounding tissue to die. Treatment methods involve bone grafts to promote growth in the affected area, however how they work is unknown. We believe that the co-delivery of 2 small molecules (called phosphates) found in bone grafts help bone tissue re-heal, however previously it has been challenging to monitor both molecules simultaneously. Using a 3D bone model developed in our lab and small electronic sensors I aim to understand how the co-delivery of these 2 molecules can influence the bone healing process.

Smarter, better, faster, stronger: Advancing rheumatoid arthritis diagnosis

Julia Isakova
University of Glasgow, 2023 Cohort

Rheumatoid arthritis is a joint disease that affects millions globally, but despite being so widespread, receiving an effective treatment can sometimes take months, or even years. Just as each person is unique, so is the way this disease presents itself. We believe that pinpointing distinct types of rheumatoid arthritis could speed up diagnosis significantly. For this, we investigate the presence of small sugar molecules (glycans) on cell surfaces, comparing how these differ among patients. By using Raman spectroscopy, we compare biological “fingerprints” of each patient sample, creating a new way to classify the disease. This will allow for faster diagnosis, earlier treatment, and improved quality of life for people affected by rheumatoid arthritis.

Designing animal-free organoids based on engineered vegetables – VegFold

Xally Montserrat Valencia Guerrero
University of Glasgow, 2022 Cohort

Animal and plant tissues consist of cells entrapped in a 3D network. The former's is mainly made of proteins, while the latter's is made of cellulose. Moreover, their internal microstructure shows a close similarity in specific cases, such as bones and apples (both of them being porous structures). Researchers have assessed diverse materials as template structures for growing cells to build human tissues. Nevertheless, they hardly recreate their internal microstructure compromising cell survival and functioning. Hence, we propose the use of the apple's cellulose network as a template structure material for the formation of bone tissue offering a material that is readily and universally available and compatible with human cells due to its composition. The resulting bone tissue will be applied as a model to test drugs and develop research substituting the current animal models used.

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Better disease understanding using sugar-decorated biomaterial model

Mohamed El-Melegy
University of Galway, 2023 Cohort

The addition of sugars to biomaterials has gained much attention because it could help us create better models of diseases and develop more effective treatments. However, this modification is complex, and how it affects cells has not been thoroughly investigated. Therefore, further studies must be performed at a cellular level to help this process achieve its potential. This project aims to develop a precise model that evaluates the impact of adding sugars to biomaterials on cellular signalling pathways during disease modelling. We hope to enhance our understanding of how these modified biomaterials can be utilised to study and treat diseases.

Miniaturising bone marrows on-a-chip to expand cancer research

Dr Olivia Johnson-Love and Dr Rozan Vroman
University of Strathclyde


Cancer can lay dormant within the bone marrow for many years with the potential for relapse, with possibly devastating consequences. Understanding what triggers this reactivation and diagnosing patients with potentially tumorous cells is critical for preventing cancer recurrence.

Laboratory-on-chip technology, where advanced materials and manufacturing are used to create cell-based models that mimic aspects of human organ function and disease, allows us to perform many more experiments at a miniature scale, opening opportunities for personalised medicine and diagnosis. In our lab, we design and fabricate plastic-based laboratory-on-chip (LOC) devices containing tiny compartments designed to recreate simplified models of human organs, including the bone marrow. We have the opportunity to develop and test different disease conditions such as metastatic breast cancer, where cancer cells can enter a dormant state when they reach the bone marrow, as well as infections and how they develop and influence the bone marrow. As an example, we are investigating whether bacterial infections can 'wake-up' these dormant cancer cells, potentially triggering their growth again. By using this technological approach, we can also test treatments that may influence how cancer cells enter and exit dormancy – critical for developing new strategies to prevent cancer relapse. In a parallel but related project, we can use this bone marrow model to detect pre-cancerous cells from patient blood samples.

Healthy cells are capable of sensing forces and adapting in response, however cancerous cells are not. By modelling a patient's bone marrow with our technology, we can apply forces to the cells and measure their response, thus creating a rapid detection method for blood cancers, such as leukemia. In conclusion, by engineering the bone marrow on a chip, we are creating a powerful platform to study how cancer behaves, what triggers its resurgence, and how we might detect it earlier. Lab-on-chip technologies have the potential to revolutionise cancer research, leading to new treatments and diagnostic tools that could ultimately improve patient outcomes.

Skin & Wounds

Nature-inspired animal-free gels for skin healing application

Athena Mattheou
University of Glasgow, 2023 Cohort

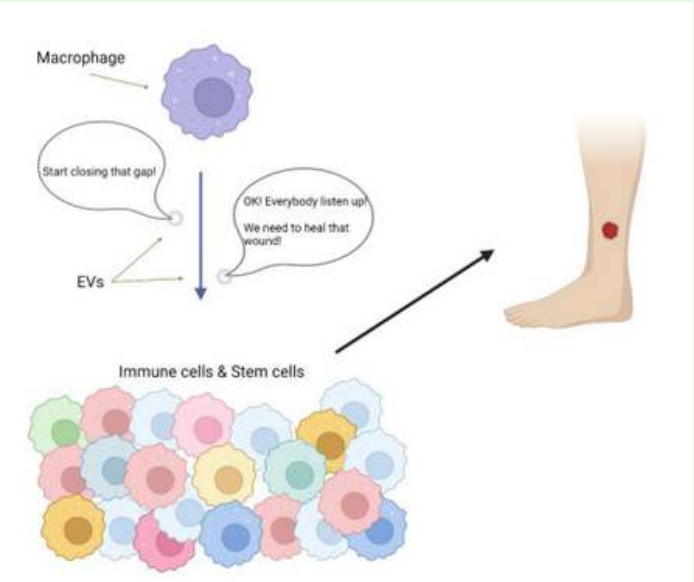
Tissue engineering involves the reconstruction of an injured or diseased tissue. Hydrogels are water-absorbing networks commonly used as materials for cell culture and tissue engineering. While current hydrogels often use animal-derived products, this project focuses on creating animal-free hydrogels. The mechanical properties of hydrogels greatly affect their function. Resilin is an elastomeric protein with remarkable mechanical properties, found in many insects, and is literally the bee's knees. A commonly used polymer, Polyethylene Glycol, and a synthesised resilinlike polypeptide are combined to fabricate hydrogels for cell growth and the printing of biological materials. The hydrogels are designed to be further modified to resemble natural materials even more.

Stretching macrophages to affect their wound healing potency

Cian Whelan
University of Galway, 2023 Cohort

Our cells can communicate with each other by releasing little packages called Extracellular vesicles (EVs). They contain a message, like a speech bubble, that give instructions to other cells. These can be very useful when coordinating complex biological processes.

Macrophages are a type of immune cell that use EVs to coordinate wound healing as they can be pro-inflammatory or pro-healing. Initially macrophages are pro-inflammatory to prevent infection and release EVs that tell other cells to promote inflammation. Then our macrophages become pro-healing and release EVs telling cells to heal the wound. However, if this switch does not happen the wound won't heal and get stuck in a state of chronic inflammation, called an ulcer. Our aim is to use EVs from pro-regenerative macrophages as a treatment for chronic wounds and ulcers.



Graphical Abstract. Macrophages releasing EVs to instruct other cells to heal the wound

A smart device to monitor blood flow in grafts after reconstructive surgeries

Narjes Meselmani
University of Galway, 2022 Cohort

Micro reconstructive surgeries in the head and neck area are crucial for correcting defects from cancer, trauma, or birth conditions, significantly impact patients' lives. However these procedures carry a 5% risk of failure due to poor blood flow to the transplanted tissue. Without blood, the tissue can't get the nutrients it needs and may die, leading to more surgeries and, in some cases, life-threatening situations. This project introduces an innovative device that offers doctors a more precise and effortless way to monitor tissue health after surgery. Utilizing electrical properties of tissues, this device can detect early signs of inadequate blood supply, enabling quicker medical responses. This advancement promises to improve patient outcomes, reduce complications, and potentially decrease mortality rates in these critical surgeries.

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DERMATech: a portable tool for early skin cancer detection using blood-based biomarkers and SERS (Surface-Enhanced Raman Spectroscopy)

Mohamed Patel
University of Birmingham, 2023 Cohort

The high prevalence and substantial treatment costs of skin cancer, estimated at £80 million annually in the UK, make it a critical health issue. Traditional detection methods are expensive, inconvenient, and invasive, often leading to delayed diagnoses that adversely affect prognosis and survival rates. Contributing factors include cumulative sun exposure and lifestyle choices, which drive the rising incidence of skin cancer. An interdisciplinary approach shows promise in addressing these challenges by leveraging advancements in medicine, physics, and microengineering to develop new diagnostic technologies. Surface-Enhanced Raman Spectroscopy (SERS) enhances molecular Raman scattering, detecting molecular fingerprints with high sensitivity. This non-invasive, rapid, and accurate diagnostic tool can identify subtle biochemical changes indicative of cancer, improving early detection, patient outcomes, and reducing healthcare costs.

Sustainability

Adapting cell culture technology to produce cultivated meat for human consumption

Adam Efrat
University of Birmingham, 2021 Cohort

My project focuses on Cultured Meat, a new and exciting technology to produce meat for human consumption in a more environmentally and animal friendly way. It uses stem cells taken from an animal biopsy, which are grown in a laboratory setting to produce animal muscle tissue (meat) without needing to slaughter the animal. As this technology is currently very costly, my project focuses on producing cheaper materials for the cells to grow on and finding animal-free alternatives to materials currently used for production. These steps help make cultured meat scalable and cheaper to get to supermarket shelves sooner.

3D printing of edible materials for cellular agriculture

Louis Hutchings
Aston University, 2023 Cohort

Cultivated (lab-grown) meat is an alternative way to produce meat which is safer and kinder to animals and the planet compared to traditional methods. To succeed, a scalable, edible scaffold for cells must be designed. Additive manufacturing using 3D printing has already been explored in tissue engineering for the creation of artificial tissues and organs. This project researches a combination of edible polymers and 3D printing to create a scaffold material which possesses structural and mechanical properties that support and maintain cellular growth and function, with the production of whole cut cultivated meat as the ultimate goal.

Sustainability in cell research labs

Paola Sofia Serrano Bravo
University of Galway, 2023 Cohort

Laboratories are places of research, creativity and invention. However, they cannot work isolated from the rest of the world. This, on one side, means being conscious of the footprint work leaves in the environment. On the other hand, it also means that scientists need to take the results of their research outside the labs and open a dialogue with the people outside their specialised areas. This project looks at how to improve these relationships between science, society and environment through different perspectives, like workshops, laboratory environment modifications, and dialogue with all the stakeholders involved.

Stem Cell Therapies

Improving liver cell therapies by enhancing cell adhesion

Amaziah Alipio
University of Birmingham, 2021 Cohort

The rapidly advancing field of cell therapies offers hope for complex health issues. One notable example are CAR T-cells, used to treat various cancers. Exciting prospects also exist in the regeneration of damaged organs such as the liver. However, cell therapies face notable challenges that limit their effectiveness, such as low engraftment to their target areas. This project aims to tackle this problem by engineering the cell surface to improve their "stickiness" to the surrounding environment. Using emerging methods, we avoid the genetic modification of cells which is associated with adverse risks and high costs.

Not Enough Stem Cells! Improving the number of stem cells produced from bioreactors for the treatment of autoimmune-related conditions

Jennifer Willis
Aston University, 2021 Cohort

Autoimmune conditions occur when the body's defence system attacks its own healthy cells, driving chronic inflammation and tissue damage. Current long-term anti-inflammatory drug therapies are associated with harmful side effects without restoring tissue functionality, necessitating new regenerative treatment options.
Human mesenchymal stromal cells (hMSCs) maintain healthy tissue function and possess substantial anti-inflammatory properties. Clinical hMSC trials have successfully reduced inflammation in conditions like rheumatoid arthritis, but large quantities are required for therapeutic benefit. Traditional approaches to grow these rare cells lead to a loss of their anti-inflammatory properties, are labour-intensive, and do not meet clinical demand.
Stirred tank bioreactors (STRs) allow increased hMSC production. We aimed to enhance the production and recovery of therapeutically functional hMSCs using STRs, yielding up to fifteen times more cells than traditional approaches. We aim to employ new bioprocessing, bioengineering, and diagnostic approaches to monitor cultures and better maintain hMSCs' anti-inflammatory properties for therapeutic application.

To watch Impact in 60 seconds video, click here.

Magnetic gels to speed up bone healing

Emma Jackson
University of Glasgow, 2021 Cohort

This project focuses on using specially developed magnetic gels, to accelerate the healing of broken bones. The gels mimic the natural bone tissue and provide a supportive environment for the cells to grow. The magnetic component is used to stimulate bone forming cells, speeding up the healing process and making it more effective. We hope this research can one day be utilised as a treatment for those with bone injuries or conditions, improving patient outcomes and speeding up recovery time.

To watch Impact in 60 seconds video, click here.

How Forces in Cells Affect Protein Folding and Disease

Shaima Maliha Riha
University of Glasgow, 2023 Cohort

Proteins are vital for cell function, but when they fold the wrong way, it can cause diseases. We know how things like temperature and pH (how acidic or basic something is) affect protein folding, but we don't fully understand how forces and pressure inside cells – called mechanotransduction – play a role. Mechanotransduction impacts how cells behave, but its effect on protein folding in the endoplasmic reticulum (ER) – a tiny structure inside cells that acts like a factory for making and folding proteins – remains unclear. Our research focuses on how the forces cells feel are linked to the helpers (chaperones) in the ER that assist protein folding. Understanding this could lead to new ways to treat diseases caused by misfolded proteins.

New materials to help stem cells stay young and grow better

Paris Alexandros Kalli
University of Glasgow, 2023 Cohort

This research project focuses on investigating cell senescence in mesenchymal stem cells; a process whereby cells irreversibly stop undergoing cell division and drive tissue aging. The project aims at developing strategies to mitigate it, unlocking the therapeutic potential of these cells that have gained attention for their ability to treat illnesses and damaged tissues through immunomodulation and differentiation. The investigations will employ an array of laboratory techniques to understand senescence mechanisms and explore growth factors, biomaterials, and drugs to combat it. Despite complexities, the project offers exciting avenues for research, potentially leading to significant advancements in regenerative medicine and anti-aging therapies.

The development of a novel "tuneable" microcarrier system using Polyhedrin Delivery Systems (PODS™) to bulk culture therapeutically active Mesenchymal Stromal Cells (MSCs)

Sophie Caprioli
Aston University, 2023 Cohort

Mesenchymal Stem Cells (MSCs) exhibit significant potential for treating diseases such as rheumatoid arthritis due to their ability to repair damaged tissue and reduce inflammation. However, generating enough MSCs without compromising their healing properties is challenging. This project aims to develop a standardized, scalable system for MSC production. MSCs will be grown on degradable beads, or microcarriers, which allow for efficient harvesting whilst preserving the cells therapeutic potential. These microcarriers will be optimised with specific adherent and soluble signals that enhance cell growth, providing a tuneable environment for high-quality MSC production. This approach aims to cultivate sufficient MSCs for effective therapeutic use, thus harnessing their full potential for medical treatments and research.

Cells at the Stem of our Being

Dr Katie Miari
University of Glasgow

Human life begins from a single stem cell, which goes on to create all the specialised cells needed to form the organs and tissues of the human body. As our cells age or become damaged, they must be replaced by new, healthy ones. This task is completed by stem cells located around our body. Due to this incredible ability, stem cells have great potential for the treatment of various conditions and diseases. During this talk, we will dive into the world of stem cells and explore how these can be utilised for medical purposes.

Healthcare Advancements

Synthesis and design of new hydrogels for nerve repair

Lineta Stonkute
University of Glasgow, 2023 Cohort

Nerves can regrow and self-heal when injured. However, this ability is lost when the size of nerve injury is large. Current treatments are only effective for small injuries making it necessary to develop new ways to treat nerve damage. Hydrogels are gel-like materials that are made up of water-loving fibre networks that entangle and trap large amounts of water and are promising for nerve repair applications. To develop materials that are optimal for nerve healing, hydrogels can be modified to create new materials that mimic nerves structurally and encourage nerve regrowth through nerve growth cues including drugs, electrical conductivity, and cells.

Developing a material out of DNA that can be printed in 3D and support cell growth

Emily Maxwell
University of Glasgow, 2023 Cohort

I will be developing biological inks for 3D printing artificial tissue for organ systems. In order to improve the success of these gel-like tissues, it is vital to make materials that are as similar to native tissue as possible. My project will involve making inks that have controllable elastic and plastic properties that will allow me to see how this affects the behaviour of stem cells, the body's building blocks. These scaffolds might even help cells transform into different types, just by changing these mechanical properties, therefore allowing the creation of different tissue types in a controlled manner and specific design.

Tuneable sugar-coated materials for developing implants

Amrutha Varshini Hariharan
University of Galway, 2023 Cohort

Glycans, also known as sugars, attach to proteins on cell surfaces, aiding communication within cells and with the external environment. Similar to our skin, glycans are pivotal in signaling cells when to respond. Problems can result in the loss of sugar molecules, causing erroneous interactions and abnormal cell responses commonly seen in diseases. My project focuses on developing a material adorned with these sugars. Upon injection into the body, this exteriorly sugared material seeks to restore a sense of normalcy by engaging in the necessary interactions to compensate for the lost sugar molecules.

Developing representative in vitro models of the human testis

Kamalnath Selvakumar
University of Limerick, 2023 Cohort

Urological cancers contribute to 12% of all cancer-related deaths globally. Testicular cancer rates have doubled in Europe and are rising worldwide. While the drug Cisplatin is effective initially, resistance towards occurs in 20-30% of patients, requiring further treatment. Optimising targeted therapies is crucial for better outcomes, but current testing human testicular models don't accurately represent the cancer's complexity. We aim to create a new model using hydrogel, reflecting the tissue structure, interactions, and molecular diversity. This model will help refine treatments by better mimicking tumour environments, potentially improving patient outcomes.

The impact of environmental mechanical cues on cells in soft tissues

Dora Rogkoti
University of Glasgow, 2021 Cohort

The bone marrow is the spongy tissue in which all blood and immune cells of the body are produced. Their production requires cellular and physical / mechanical cues from the local microenvironment which are essential for their normal growth and maturation. However, the tissue's mechanical properties in health and how these can change during disease have been widely neglected due to the difficulty of accessing the bone marrow. As such 3D bioengineered models that can imitate the bone marrow and investigate the tissue's different mechanical aspects on cell behaviour are needed and can provide insights into disease-related pathways and potential therapeutic targets.

To watch Impact in 60 seconds video, click here.