John & Pat Hume Doctoral Awards 2025-2026

Faculty of Science & Engineering

Supervisor Research Areas Advertised

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Department of Biology

John & Pat Hume Doctoral Awards 2025-2026

Department: Biology

Supervisor: Prof Andrew Hogan

Supervisor Email: Andrew.E.Hogan@mu.ie

Title of Research Area:

Obesity and it's related complications

Description of research areas supervisor is willing to accept applications in:

Our research focuses on the mechanisms linking obesity to a range of co-morbid conditions including cancer, type 2 diabetes and cardiovascular disease. Specifically we focus on how obesity-related changes in the immune system underpin the development of these co-morbidities, by using state-of-the-art approaches to define the molecular and metabolic mechanisms. Additionally, we are investigating how obesity-focused interventions such as GLP-1 medications (e.g. Ozempic) impact the immune system and might be leveraged for better outcomes.

How supervisor research areas align to Maynooth University research priority areas:

Our research programme is strongly aligned to the University's Strategic Plan 2023-2028 with its primary focus on improving human health by investigating one of the biggest health challenges that exists in Ireland, Obesity. Obesity impacts over 25% of the Irish adult population and is linked to 5000 deaths per year and over €1 billion in expenditure. Our research is helping understand the biological drivers of obesity and it's complications, highlighting novel opportunities for improving outcomes.

END

John & Pat Hume Doctoral Awards 2025-2026

Department: Biology

Supervisor: Prof David Fitzpatrick

Supervisor Email: david.fitzpatrick@mu.ie

Title of Research Area:

Computational OMIC and Evolutionary Analyses of Pathogenic Fungal Species

Description of research areas supervisor is willing to accept applications in:

For the past 20 years my research lab has been at the forefront of fungal comparative genomics. I am interested in the evolution of pathogenicity in human and plant fungal pathogens and the molecular mechanisms that drive these. I am particularly interested in student applicants who have a strong background in computational biology or bioinformatics. The majority of the work undertaken in my laboratory is in silico but students with a competence in molecular biology and microbiology are also welcomed as new research areas will involve directed evolution studies.

How supervisor research areas align to Maynooth University research priority areas:

The research undertaken in Prof Fitzpatrick's Genome Evolution Laboratory strongly aligns with Maynooth University's (MU) Strategic Plan 2023-28. In the short term MU sets out to improve research outputs and impacts across all areas of the University and position MU among global leaders in our selected beacons of research excellence. Prof Fitzpatrick's lab has consistently produced high quality publications and graduated highly sought after postgraduate students. As well as generating high impact publications, bringing in external research funding, Prof Fitzpatrick has also developed strong external links with large multinational companies in the fields of enzyme production and diagnostics. Outputs from his lab positively influence metrics such as University rankings and the novel work to be undertaken in the coming years will contribute towards MU's long term goal to be in the top three public universities in Ireland in global university rankings and well as being known as Ireland's University of Excellence, Opportunity and Impact.

END

John & Pat Hume Doctoral Awards 2025-2026

Department: Biology

Supervisor: Dr Diarmuid O'Maoileidigh

Supervisor Email: diarmuid.s.omaoileidigh@mu.ie

Title of Research Area:

Evolutionary conservation of transcription factor paralogs with pleiotropic activities in plants.

Description of research areas supervisor is willing to accept applications in:

I am willing to accept students with an interest in plant science combined with molecular biology, genetics, genomics, physiology (photosynthesis assessment), development, biotic and abiotic stress, and/or biochemistry. I am primarily interested in how gene regulatory networks are organised and how they evolve to meet the demands of growth and reproduction.

Engagement with these areas normally involve the generation of transgenic plants including reporter systems, transgenic perturbation lines, the use of genome editing (e.g CRISPR-Cas9). Using these lines in combination with other available material, we will investigate the activity of selected transcription factors through genetic analysis, functional genomics (e.g. RNA-Seq, CUT&RUN/ChIP-Seq), biochemistry (e.g. Western blotting, coimmunoprecipitation), physiological evaluation (e.g. infrared gas exchange analysis, chlorophyll fluorescence), and phenotypic evaluation (e.g. chlorophyll content, seed oil content).

These investigations are aimed at understanding the gene regulatory networks that underpin how plants interact with their environment to develop and reproduce. Improving our fundamental understanding of how biological systems operate is our primary goal. However, we are also interested in ways that our research can influence day-to-day agriculture and horticulture (e.g. by improving resource use efficiency and/or yield).

How supervisor research areas align to Maynooth University research priority areas:

Our research is aligned with interdisciplinary research beacons such as Sustainability and Climate Change, Society and Public Policy, and Health and Wellbeing. We aim to understand the genetic mechanisms underlying responses of plants to their environment, which has become more urgent as climate change threatens biodiversity and crop performance.

As plants are the primary global food source, this research will affect the health and wellbeing of the population by identifying genetic material that is useful to farmers to improve resilience and yield of crops, and a decrease in environmentally harmful agricultural inputs that threaten natural ecosystems and human health.

This project is at the frontier of biological research and requires an inter-disciplinary approach. The excellent track-records of the supervisory team demonstrate their ability to manage such projects and to produce research of international quality. The successful applicant will gain skill sets desirable for academic, governmental, and industrial settings thereby contributing to the highly-skilled workforce. The new avenues opened by the proposed research provide opportunities for innovation to address societal challenges, such as food security and sustainable farming. END

John & Pat Hume Doctoral Awards 2025-2026

Department: Biology

Supervisor: Prof Emmanuelle Graciet

Supervisor Email: emmanuelle.graciet@mu.ie

Title of Research Area:

Future proofing crops by understanding how flooding and hypoxia suppress plant immunity

Description of research areas supervisor is willing to accept applications in:

Flooding causes enormous crop losses each year, with an estimated annual cost of $60 billion worldwide. Global climate change will cause more severe and frequent floods in Ireland and other parts of the globe, while also promoting the growth of pathogens that cause disease-related crop losses. The Graciet lab has recently shown that hypoxia, which is caused by flooding, suppresses plant innate immune responses. This finding highlights the need to better understand the connections between hypoxia signalling response pathways and immunity in plants. This PhD project will test whether specific mechanisms underpinning the hypoxia/immunity crosstalk are evolutionarily conserved in different plant species, including two globally important crops: oilseed rape and barley. Molecular, biochemical and genetic approaches will be used in combination with hypoxia treatments, pathogen inoculations and treatments with elicitors of plant immune responses. New technologies such as infrared gas exchange analysis will also be employed. This project will contribute new knowledge to understanding the crosstalk mechanisms that control stress responses in plants, with an evolutionary perspective and while exploring direct applications in crops.

How supervisor research areas align to Maynooth University research priority areas:

Maynooth University has identified the area of “Sustainability and Climate Change” as one of its research beacons. The proposed project falls within this area and is also aligned with the proposed remit of the new Institute in Sustainability and Climate Change. Specifically, this research will contribute knowledge of how plants/crops respond to environmental stresses (specifically flooding and pathogen infection) whose severity and frequency is increasing due to global climate change. This knowledge has the potential to help improve crop resilience to environmental stresses while promoting sustainability in agriculture by reducing agrochemical inputs.

END

John & Pat Hume Doctoral Awards 2025-2026

Department: Biology

Supervisor: Prof Fiona Walsh

Supervisor Email: fiona.walsh@mu.ie

Title of Research Area:

Understanding the burden of antimicrobial resistance across One Health.

Description of research areas supervisor is willing to accept applications in:

I am willing to accept student applications in the area of antimicrobial resistance, genomics and bacteriology.

How supervisor research areas align to Maynooth University research priority areas:

This research falls within the health beacon and aligns with the strategic objectives of community engagement, social justice and excellence. This novel area of research will influence policy across human and animal health in addition to ensuring the sustainability of our water and environment.

END

John & Pat Hume Doctoral Awards 2025-2026

Department: Biology

Supervisor: Dr Grace Hoysted

Supervisor Email: grace.hoysted@mu.ie

Title of Research Area:

Safeguarding Crops and Human Health: Mycorrhizal Fungi, Ochratoxins, and Climate Change.

Description of research areas supervisor is willing to accept applications in:

Arbuscular mycorrhizal fungi (AMF) play a significant role in plant health by enhancing essential nutrient uptake and stress resistance against pests and pathogens. This project will investigate the impact of AMF on the growth of Aspergillus spp. and ochratoxin A (OTA) contamination in crops under different environmental conditions. OTA is a highly toxic mycotoxin produced by filamentous fungi Aspergillus and Penicillium spp., posing serious risks to human health and food safety. It is a known carcinogen and nephrotoxin, linked to kidney disease, immune suppression, and neurological disorders. With climate change, the prevalence of mycotoxin contamination is rising, as increasing temperatures and extreme weather events create favourable conditions for fungal growth and toxin production. This compromises crop safety, threatens global food security, and leads to significant economic losses in agriculture and the food industry.

The project will involve growing different crops with and without AMF inoculation, followed by inoculation with OTA-producing Aspergillus and Penicillium spp. Experiments will be conducted under varying temperature conditions to simulate climate change effects. Fungal growth (both AMF and OTA producing fungi) will be quantified, and OTA levels will be analysed by HPLC. Further, plant stress markers to evaluate plant defence responses and nutritional quality of crops will be assessed.

By integrating mycorrhizal fungi into agricultural practices, crops can be made more resilient to fungal infections and climate stress. This project highlights the importance of AMF as a sustainable biocontrol strategy to mitigate mycotoxin contamination in crops, ensure food safety, while reducing reliance on chemical fungicides, which pose risks to human health and the environment.

This project offers opportunities for students interested in food safety, plant-microbe interactions, and sustainable agriculture, with hands-on experience in microbiology, molecular biology, and analytical chemistry techniques.

How supervisor research areas align to Maynooth University research priority areas:

This project aligns closely with Maynooth University's Strategic Plan 2023-28, particularly within the research beacons of Health and Wellbeing and Sustainability and Climate Change. By investigating the role of mycorrhizal fungi in reducing ochratoxin contamination, this project contributes to enhancing food safety and human health. This aligns with the University's commitment to addressing contemporary health challenges through focussed research

initiatives. Further, exploring sustainable agricultural practices, such as utilising mycorrhizal fungi to mitigate fungal contamination, supports the University's goal of promoting environmental sustainability. Research stemming from this John and Pat Hume Doctoral Award aims to promote the Department of Biology and Department of Sport Science and Nutrition and Maynooth University's research profile, both nationally and internationally.

END

John & Pat Hume Doctoral Awards 2025-2026

Department: Biology

Supervisor: Prof Joanne Masterson

Supervisor Email: Joanne.Masterson@mu.ie

Title of Research Area:

Epithelial Patho-mechanisms of gastrointestinal and rare diseases.

Description of research areas supervisor is willing to accept applications in:

Professor Masterson has a long-standing interest in defining novel mechanisms of mucosal inflammation. Her research has investigated the eosinophils contribution to epithelial cell biology and tissue remodelling. Her studies have identified novel mechanisms, that include hypoxia, metabolism, microRNAs, mechanobiological, novel cytokine and fibrotic mediators through which allergic and mucosal diseases such as Eosinophilic Esophagitis (EoE) and Inflammatory Bowel Disease (IBD) develop.

Recent interests have identified the role of environmental toxicants on pathophysiologic mechanisms of gastrointestinal disease and in particular that of ambient and indoor air pollutants. Interpretation of the signalling and functional effects of these environmental toxicants on the gastrointestinal tract, in particular in epithelial programming is of particular interest and the elucidation of the potential for therapeutic exploitation is advantageous.

How supervisor research areas align to Maynooth University research priority areas:

This research proposal aligns with and is inspired by the University's Strategic Plan 2023-28, aligning with the goals of research excellence, opportunity and impact. It will result in investments in the next generation of excellent research talent and contribute towards Irelands knowledge and skills economy. Given the PI's proactive stance on EDI and MAP status, this will be especially encouraged in potential applicants and in their research environment. It will build MU research recognition by developing impactful research outputs including internationally reputable publications, and identify novel therapeutic options for commercial exploitation, both in a previously underrepresented field of environmental and ambient air pollutant impacts on gastrointestinal health and disease. In addition, it will solidify international collaborations with United States researchers, achieved by student secondment to our US partner's institution and provide the foundation for future international funding opportunities. The impacts of this research will include informing policies and public practices around retrofitting and sustainability actions and the critical nature of health considerations. It will provide important and impactful knowledge to the growing interdisciplinary field of physics in climate change adaptation and health sciences, informing research disciplines of particular interest to MU, including sustainability, health and wellbeing and human medicine.

END

John & Pat Hume Doctoral Awards 2025-2026

Department: Biology

Supervisor: Prof Karen English

Supervisor Email: karen.english@mu.ie

Title of Research Area:

Investigating the role of macrophage migration inhibitory factor in driving trained immunity

Description of research areas supervisor is willing to accept applications in:

Macrophage migration inhibitory factor (MIF) is a proinflammatory cytokine constitutively expressed by macrophages and other immune cells. MIF enhances immune responses through direct induction of proinflammatory cytokines, promotion of immune cell recruitment, proliferation and survival.

Several inflammatory diseases have been associated with a functional promoter polymorphism in human MIF including a tetranucleotide sequence, CATT, that is repeated between 5 and 8 times at position -794 in the gene promoter. My team have shown that macrophages from CATT7 mice have a higher proinflammatory signature.

Over the past decade, novel research has identified the capacity for macrophages to be trained such that upon a secondary heterologous pathogenic stimulus, a pro-inflammatory macrophage population quickly responds to deal with the pathogen. This trained immunity (TI) of macrophages is associated with epigenetic and metabolic imprinting and can be facilitated by exposure to a repeated dose of the fungal chitin beta-glucan. We showed that house dust mite (HDM) challenge trains bone marrow derived macrophages (BMDMs) to produce significantly increased levels of pro-inflammatory cytokines in CATT7 but not in wildtype macrophages. However, it is unknown if this heightened trained immune phenotype in the presence of high MIF expression is specific to HDM or if other training stimuli have the same effect.

This project will investigate if high MIF expression can enhance TI induced by the fungal chitin beta-glucan. TI could be used as an approach to help our bodies protect us against infection. However, TI could also make us more prone to developing chronic or autoimmune diseases due to overzealous immune responses. Approximately 20% of the population have high MIF expression via CATT7/8 promoter polymorphism who may be more susceptible to developing chronic/autoimmune disease following TI. If we can understand if/how MIF enhances TI, then perhaps we can identify strategies to block TI and reduce the burden of chronic/autoimmune diseases.

How supervisor research areas align to Maynooth University research priority areas:

Health and wellbeing are a major focus area for the University's strategic plan 2023-28. This project focuses on reducing the burden of chronic/autoimmune diseases by better understanding ovezealous activation of the immune system driven by trained immunity and the pro-inflammatory cytokine MIF. This project is at the cutting edge of Immunology research

utilising novel transgenic mouse models, immunometabolic and epigenetic approaches as well as patient samples (high MIF producers). The strategic plan also seeks to enhance the internationalisation of MU. We will significantly enhance this goal by developing a collaborative link with our Collaborator Prof. Agostinho Carvalho from Uni of Minho (Arqus Alliance member). This project will involve a research stay at Uni of Minho to develop immunometabolic assays.

END

John & Pat Hume Doctoral Awards 2025-2026

Department: Biology

Supervisor: Prof Kevin Kavanagh

Supervisor Email: Kevin.kavanagh@mu.ie

Title of Research Area:

Characterising the ability of fungi to induce ocular disease

Description of research areas supervisor is willing to accept applications in:

Microbial infection of the eye can be due to bacterial, viral or fungal pathogens but fungal infections (known as fungal keratitis) can be the most difficult to treat and lead to severe vision loss and/or removal of the affected eye. In developing countries this condition most commonly occurs in farmers and rural dwellers, and the filamentous fungus Fusarium solani is the dominant cause. Ocular infection can result from direct physical injury (e.g. thorn), or fungal spores in dust attaching to the corneal surface. The virulence factors (e.g. adherence, enzyme production, secondary metabolites) that allow this fungus infect plants are thought to be important in corneal colonisation and infection. Globally, there are over a million new cases of fungal keratitis per annum leading to severe vision loss and/or eye removal in approximately 10% of cases.

During fungal infection of the eye, host cellular and immune responses are initiated but it appears that these may lead to increased tissue damage and may facilitate the passage of the fungus through the corneal surface leading to scarring, ulceration and penetration of the anterior chamber with associated vision loss. In this project the protein and toxins secreted Fusarium solani will be characterised to assess their ability to disrupt cells and facilitate tissue invasion. The response of a 2D and 3D airlifted cultured corneal cells to Fusarium solani will be visualised using molecular and proteomic techniques as this will give an indication of how the fungus infect the cornea and disrupts vision. The ability of Fusarium solani to trigger cellular and inflammatory responses that could lead to tissue damage will be evaluated. Factors affecting the susceptibility of Fusarium solani to antifungal drugs during ocular infection will be examined and the optimal antifungal agents to treat this condition will be identified.

How supervisor research areas align to Maynooth University research priority areas:

Fungal keratitis is a devastating condition if left untreated due to lack of appropriate antifungal therapies or late diagnosis and is a particular problem in the developing world where it is a disease most associated with impoverished rural dwellers. This project will characterise how the Fusarium solani interacts with the corneal surface using a well establish corneal cell line and highlight therapies for reducing the impact of this devastating condition. This project aligns with the University Strategic Plan as it seeks to address the cause of a devastating disease in the Developing world. In addition it will establish strong research links with colleagues in Dublin City University and foster international collaborations. It will add to Maynooth University's international reputation in the area of microbiological research. END

John & Pat Hume Doctoral Awards 2025-2026

Department: Biology

Supervisor: Dr Martina Schroeder

Supervisor Email: martina.schroeder@mu.ie

Title of Research Area:

Dysregulation of the human RNA remodelling enzyme DDX3X in disease

Description of research areas supervisor is willing to accept applications in:

My lab studies the human RNA remodelling enzyme DDX3X and how its dysregulation contributes to different human diseases: viral infections, cancer, and neurological conditions. One of its main cellular functions is the regulation of mRNA translation, and we aim to understand how this is disrupted in patients that carry mutations in their DDX3X gene. Students should be interested in the regulation of gene expression and/or immune signalling pathways, enthusiastic about uncovering novel mechanistic insights into fundamental cellular processes, and keen to work collaboratively. I am happy to work with students to design a Hume project that suits their particular interests and prior experience.

How supervisor research areas align to Maynooth University research priority areas:

This project aligns with the university's research strength in Health and Wellbeing, as we ultimately aim to generate insights that lead to development of therapeutic strategies targeting DDX3X. Dr Schroeder is a member of the Kathleen Lonsdale Institute for Human Health research.

END

John & Pat Hume Doctoral Awards 2025-2026

Department: Biology

Supervisor: Dr Niamh Lynam-Lennon

Supervisor Email: niamh.lynamlennon@mu.ie

Title of Research Area:

Unravelling the role of the complement-metabolism axis in the pathogenesis of rectal cancer

Description of research areas supervisor is willing to accept applications in:

Colorectal cancer (CRC) is the third most commonly diagnosed invasive cancer and contributes to almost 10% of all cancer-related deaths globally. One in every three cases of CRC are rectal cancers, the incidence of which is predicted to rise in the coming years. Alarmingly, evidence from Europe and North America suggests that this trend is largely driven by an elevated incidence of early-onset rectal cancer in patients <50 y, who typically present with more aggressive and poorly differentiated tumours and have poorer survival outcomes. Consequently, the identification of mechanisms underlying the development and progression of rectal cancer is crucial to improve outcomes for patients.

My group have previously demonstrated that activation of the 'complement system', an important regulator of immunity, is increased in sera and tumours from rectal cancer patients who are resistant to chemotherapy and radiation therapy. Importantly, we have demonstrated that inhibition of complement alters several hallmarks of cancer and can sensitise rectal tumours to treatment, highlighting a novel functional role for complement in the pathogenesis of rectal cancer. Interestingly, we demonstrated that altered complement was associated with alterations in key metabolic pathways, suggesting that complement-mediated regulation of metabolism may drive rectal cancer pathogenesis.

This multidisciplinary project will address an unmet global clinical need and build on our previous work to interrogate the functional role of the complement-metabolism axis in rectal cancer using rectal cancer cell line models, sera and tumour samples from rectal cancer patients. This will identify novel therapeutic targets and strategies to improve treatment options, quality of life and survival for patients.

How supervisor research areas align to Maynooth University research priority areas:

This multidisciplinary project will address an unmet global need in rectal cancer by elucidating the role of the complement-metabolism axis in driving the pathogenesis of rectal cancer. This will identify a novel mechanism and novel therapeutic targeting strategy, which will ultimately improve outcomes for patients. This is aligned with the Maynooth University Research Beacon: Health and Wellbeing. In addition, this project also aligns with the strategy of Maynooth University to enhance Internationalisation, Engagement and Partnerships by strengthening collaborations with the Trinity St James's Cancer Institute, Dublin, Ireland and Akershus University Hospital, Oslo, Norway.

END

John & Pat Hume Doctoral Awards 2025-2026

Department: Biology

Supervisor: Prof Ozgur Bayram

Supervisor Email: ozgur.bayram@mu.ie

Title of Research Area:

Real-Time Metabolic Profiling of Cell Culture Using Offset Raman Spectroscopy and Deep Learning

Description of research areas supervisor is willing to accept applications in:

This project aims to develop a groundbreaking method for real-time metabolic profiling of cell cultures using offset Raman spectroscopy, addressing critical limitations in current techniques. Building on our extensive expertise in Raman spectroscopy and deep learning, the project will focus on recording the spectrum of cell culture medium within plastic 96-well plates using offset Raman, a technique that avoids interference from the plastic spectrum. This approach enables non-invasive, real-time monitoring of metabolic changes, offering a significant improvement over traditional methods like fluorescence probes and mass spectrometry.

Current methods for metabolic profiling, such as fluorescence probes and mass spectrometry, are limited in their ability to provide dynamic, real-time insights. Fluorescence probes are specific to single metabolites and offer only endpoint measurements, while mass spectrometry, though sensitive, is destructive and provides only snapshots of metabolic states. Existing Raman-based methods struggle with long acquisition times and cannot be used with plastic containers due to overwhelming spectral interference. The proposed solution overcomes these limitations through three key innovations:

1. Offset Raman Spectroscopy: By spatially offsetting the laser focus, we selectively record the spectrum of the medium, avoiding plastic interference.

2. Statistical Denoising: Deep learning-based denoising techniques significantly reduce acquisition times, enabling real-time monitoring.

3. Deep Learning for Spectral Unmixing: Advanced algorithms unmix Raman spectra into component metabolites, quantifying their concentrations for comprehensive metabolic profiling.

The ability to perform real-time metabolic profiling in 96-well plates is particularly transformative for cancer research, where understanding metabolic changes in cell cultures can provide critical insights into tumour behaviour and drug responses. For the purpose of this project the methods will be developed around the application area of fungal fermentation and bioreactor monitoring, optimising production processes in industrial settings.

The project builds on the group's 15-year expertise in Raman spectroscopy and deep learning, as well as collaborations with leading industry partners in Raman probe bioreactor monitoring.

How supervisor research areas align to Maynooth University research priority areas:

This project aligns with Maynooth University's strategic priorities in Health and Wellbeing, Data and Digital Transformation, and Sustainability and Climate Change. By advancing real-time metabolic profiling, the research supports the university's commitment to innovation and real-world impact, particularly in biotechnology and healthcare.

The project also aligns with the university's focus on interdisciplinary research and collaboration with industry partners. The involvement of a commercial collaborator ensures that the research is industry-relevant and has strong potential for commercialisation, contributing to the university's strategic objective of fostering innovation and societal impact.

END

John & Pat Hume Doctoral Awards 2025-2026

Department: Biology

Supervisor: Dr Rebecca Owens

Supervisor Email: Rebecca.owens@mu.ie

Title of Research Area:

Identification and characterisation of novel bioactive molecules from fungi

Description of research areas supervisor is willing to accept applications in:

Fungi are a rich source of bioactive molecules with diverse applications in health and disease, bioremediation and food processing among others. These include antibiotics, statins, carbohydrate-degrading enzymes and proteases. Our research has demonstrated that Armillaria species produce distinct profiles of small molecules (primary and secondary metabolites) and proteins depending on the culture conditions used, and has extended to the discovery of fractions with antimicrobial activity against the human pathogen Candida albicans. Through a combined approach of OSMAC (one-strain, many compounds), co-culturing, proteomic analysis and genome mining, the expansion of the known secondary metabolite repertoire of Armillaria species can be achieved. Silent biosynthetic gene clusters can also be avtivated using molecular methods to further enhance production of novel secondary metabolites. Our research area also extends to evaluating the bioactivities of these molecules, including their potential as novel antimicrobials and their effects on human and animal cells. Molecular profiling will be carried out through the use of liquid chromatography tandem mass spectrometry (LC-MS/MS), enabling the identification of changes to the small molecule and protein levels in fungal extracts. This will be facilitated by access to state of the art LC-MS/MS instrumentation at the Department of Biology, along with dedicated training in this valuable technology. Through this we aim to identify new molecules of fungal origin with antimicrobial activity or potential for biotechnological application.

How supervisor research areas align to Maynooth University research priority areas:

The proposed research areas align with the health and wellbeing beacon outlined in the MU strategic plan (2023-2028), based on the target of identifying novel antimicrobial molecules. Antibiotic and antifungal resistance are reaching a critical point, and a key approach to addressing this is the identification of new antimicrobials which have the potential to act on unique targets within the pathogen. As a member of the Kathleen Lonsdale Institute for Human Health Research, this reseach will also be aligned with MUs existing research network in this area.

The proposed research areas also have the potential to come under the Sustainability and Climate Change research beacon. There is the potential to discover novel compounds from a soil-borne plant pathogenic fungus that can be used for bioremediation and enhanced isolation of products from recalcitrant lignocellulosic plant materials. This can bolster sustainable methodologies such as second generation biofuel production from lignocellulosic biomass. The

research student will have the opportunity to join the Sustainable Ecosystems Group at MU, building a supporting network in this research area.

END

John & Pat Hume Doctoral Awards 2025-2026

Department: Biology

Supervisor: Prof Sean Doyle

Supervisor Email: sean.doyle@mu.ie

Title of Research Area:

New directions to overcome bacterial antimicrobial resistance (AMR). Keywords: antibiotics, drug resistance, quantitative proteomics, LC-MS/MS.

Description of research areas supervisor is willing to accept applications in:

Biosynthetic gene clusters (BGC) in fungi and bacteria encode metabolites with potent antibiotic activity. Indeed, most commonly-used antibiotics are actually BGC-encoded molecules. The proposed Supervisor discovered an unprecedented mechanism of antimicrobial resistance (AMR) in pathogenic fungi in 2010 involving BGC-encoded oxidoreductase. AMR, especially in Gram negative bacteria, is a major global problem and is estimated to cause 10 million deaths annually by 2050. Research in the Molecular Biotechnology laboratory, in collaboration with Professor David Fitzpatrick, is focused on investigating AMR, especially in the Gram-negative bacteria. This bacterial category comprise a significant number of the ESKAPE pathogens that demonstrate an increasing resistance to commonly used antibiotics, and cause serious infections in immunocompromised people with a mortality rate of 29-70%.

The proposed research proposes to uncover novel pathways as antibiotic targets and to explore the use of synergistic compounds to effectively overcome AMR. In preliminary work done in my laboratory we have shown the inhibitory effects of fungal metabolites towards bacteria, especially Gram-negative spp and explored same by state-of-the-art OMIC technologies, including both quantitative proteomics and RNAseq. Inhibition is hypothesised to happen by disturbance of essential bacterial pathways by fungal metabolites post-entrance to bacterial cells. The mechanism of interference is still unknown and requires further detailed analysis using mass spectrometry and proteomic analysis to uncover bacterial functional systems and pathways.

Hence, the research aims to a) investigate metabolite toxicity against Gram-negative spp on a molecular level; b) investigate if modified fungal metabolites are toxic and function as antimicrobials against bacteria and c) develop assays to investigate how BGC-encoded metabolites might directly inhibit cellular pathways in Gram-negative spp. to ultimately uncover novel antibiotic targets to overcome AMR. This research is directly related to UN Strategic Development Goals in Health, complements our sepsis-related research and aligns with the MU Strategic Plan and research strategy.

How supervisor research areas align to Maynooth University research priority areas:

This work is directly related to UN Strategic Development Goals in Health and aligns with the Maynooth University Strategic Plan and research strategy. Specifically, it aligns with Objective 1 of the MU Strategic plan as it will improve research outputs and impacts across of the University and position MU amongst global leaders in the HEALTH beacon of research excellence. It will

also directly enable Objective 2 by enabling student graduation with flexible and enriching educational experience and with future-focused skills. Finally, it will align with Objective 4 by enabling the Graduate Research Academy to support significant growth in research student numbers and create a supportive environment for research students. Professor Doyle has been at the vanguard of antimicrobial resistance research and the development of microbial proteomics expertise at MU and in this collaborative proposal with Professor David Fitzpatrick is focused on exploiting pre-existing infrastructure investment, made by both MU and externally funded research organisations, on increasing the quality and depth of the post-graduate experience at MU.

END

John & Pat Hume Doctoral Awards 2025-2026

Department: Biology

Supervisor: Dr Tara Dirilgen

Supervisor Email: Tara.Dirilgen@mu.ie

Title of Research Area:

Terrestrial biodiversity (above and belowground) theory, threats, ecosystem services, conservation and restoration

Description of research areas supervisor is willing to accept applications in:

Ecology, Environmental Science, Zoology, Entomology, Animal behaviour, Botany, Environmental Biology

How supervisor research areas align to Maynooth University research priority areas:

The Terrestrial Ecology lab at Maynooth carry out interdisciplinary research that is aligned with multiple MU Research Beacons, with a focus on (environmental) Sustainability and Climate Change, which also ties into Health and Wellbeing as well as Society and Public Policy.

END

John & Pat Hume Doctoral Awards 2025-2026

Department: Biology

Supervisor: Dr Paul Dowling

Supervisor Email: Paul.Dowling@mu.ie

Title of Research Area:

Exploring the Dark Proteome: The Next Frontier in Multiple Myeloma Research

Description of research areas supervisor is willing to accept applications in:

Background:

Data showing widespread noncanonical translation indicates that the protein-coding potential of the human genome has been miscalculated. These stretches of DNA have the potential to encode 'hidden proteins,' in particular microproteins (40 or 50 amino acids), which could have important biological activity, still to be characterized. Hence, collectively, they have gained the signature, the 'dark proteome.' There are accumulating examples within the literature of noncanonical open reading frames (ORFs)-encoded proteins that possess important functional and physiological roles. The many examples discovered so far, showing the roles of noncanonical coding sequences in humans, emphasize that researchers still do not have an accurate estimation of the protein-coding capacity of the human genome. By integrating microprotein research with innovative technologies such as Artificial Intelligence (AI)-driven protein design and precision medicine, researchers can pave the way for novel diagnostic tools and targeted therapies.

Questions that continue to confound researchers investigating multiple myeloma (MM):

1. Patients with precursor disease do not universally develop malignancy, and among those who transform from monoclonal gammopathy of unknown significance (MGUS)/smoldering multiple myeloma (SMM) to MM the time frame varies greatly.

2. Treatments for MM have improved, however it is still not curable, and patients see their disease eventually return.

3. Extramedullary disease (EMD), an aggressive form of MM, affecting up to 20% of patients, represents an unmet medical need with respect to treatment strategies.

Plan:

Investigate the role microproteins play in MM, especially with the above questions in mind.

Microproteins are emerging not just as molecular curiosities but as central players in cancer biology and as potential therapeutic targets. Their roles in crucial cellular processes, from gene regulation to cell proliferation, position them as key pieces in the intricate puzzle of cancer biology, with microprotein research in the next decade likely to yield exciting advancements.

How supervisor research areas align to Maynooth University research priority areas:

One of the key objects as part of the University's Strategic Plan 2023-28 is to improve research outputs/impacts and position Maynooth University among global leaders in our beacons of research excellence (Health and Wellbeing). The potential outputs of the proposed research scholarship will underpin the priority areas within the University's Strategic Plan by (i) providing detailed mechanistic analysis of the MM proteome that could potentially be exploited in the development of new diagnostics/therapeutics, and could inform the design and interpretation of results from future clinical trials, (ii) establishing potential intellectual property which may either form the basis of indigenous commercial development or be licensed to pharmaceutical companies, (iii) training post-graduate researchers in scientific methodologies and state-of-the-art technologies, (iv) enhancing the visibility of Maynooth University as a key location for research/development in the area of oncology. Fostering international collaboration will ultimately increase the visibility of Maynooth University on the international stage in terms of haematological oncology research. This novel project will help to solidify our connections with world leaders in the MM research sphere, including Prof Caroline Heckman (FIMM); Prof. Ken Anderson, Dana Farber Cancer Institute; Prof. Paul Richardson, Dana Farber Cancer Institute, and Prof. Torben Plesner, Vejle Hospital.

END

Department of Chemistry

John & Pat Hume Doctoral Awards 2025-2026

Department: Chemistry

Supervisor: Prof Carmel Breslin

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Title of Research Area:

Two dimensional materials: a sustainable solution for environmental and renewable energy applications

Description of research areas supervisor is willing to accept applications in:

Two dimensional (2D) materials are attracting much recent attention in Chemistry and Materials Science due to their unique properties and versatile applications. In the Electro-Materials group, we are interested in developing these emerging 2D materials for applications in: (1) environmental analysis and the removal of water pollutants and (2) renewable energy. In both cases, we focus on using sustainable and cost-effective approaches in the design of the materials. The 2D materials will be synthesised and processed using water without the use of chemical solvents. Once formed they will be characterised using surface analytical techniques (SEM, XRD, XPS and TEM) to gain information on the morphology and size of the 2D sheets, the crystallinity and composition of the materials.

For the environmental analysis, the fabricated 2D materials will be immobilised onto a high surface area support, such as carbon cloth or electrospun mats, and employed in both the detection and removal of water contaminants, providing detection at very low concentrations followed by the removal of the contaminants. The work will involve using electrospinning to form the electrospun mats, while methods to incorporate the 2D materials into the electrospun mat will be developed. Once removal of the contaminants is achieved, methods to regenerate the immobilised 2D materials will be considered, enabling the reuse of the immobilised 2D materials.

For the renewable energy applications, the 2D materials will be designed for the production of green hydrogen. Various electrochemical techniques will be used to gain insight into the mechanism of the hydrogen evolution reaction. Biomass-derived molecules will be considered for the hydrogen evolution half reaction. The overall aim of this project will be to design sustainable and cost-effective materials that can be used to promote the formation of hydrogen from water, while the biomass molecules will be oxidised into high-valued products.

How supervisor research areas align to Maynooth University research priority areas:

The research areas in the Electro-Materials research group are well aligned with the Sustainability and Climate Change Research Beacon. The materials used in our research projects are designed using sustainable approaches, no chemical solvents or acids are employed. Furthermore, the detection and removal of contaminants from our aquatic systems is highly relevant to climate change. With Climate Change, increased runoff of pollutants and

sediments is anticipated, making efforts to maintain water quality extremely difficult. Therefore, approaches that can be used to detect and remove pollutants are important not only now, but in the future.

Renewable or green hydrogen is considered an attractive alternative to fossil fuels as it is a clean fuel, and water is the only product generated when it is used. The electrochemical generation of hydrogen offers a clean technology, where water is converted into hydrogen. The energy needed for this process can be obtained from renewables, such as wind and solar energy, making this a viable solution for the future. However, cost is an issue as platinum-based systems are currently used in electrolysis cells. The proposed 2D materials have the potential to provide cost-effective alternatives, contributing to a clean energy future.

END

John & Pat Hume Doctoral Awards 2025-2026

Department: Chemistry

Supervisor: Dr Diego Montagner

Supervisor Email: diego.montagner@mu.ie

Title of Research Area:

Targeted glyco-functionalized Pt(IV) anticancer prodrugs for the treatment of Osteosarcoma

Description of research areas supervisor is willing to accept applications in:

Osteosarcoma (OS) is the main primary bone malignant entity affecting adolescents and young adults; it is an aggressive tumour with a tendency to metastasize and invade to para-carcinoma tissues. The currently primary treatment is a combination of surgery and chemotherapy but unfortunately, the prognosis remains very poor due to chemoresistance and early metastasis. The absence of specific-targeted strategies increased the scientific interest in designing and synthesising new drugs able to selective target OS. The most exciting approach is to modify the non-selective anticancer drugs with specific vectors whose receptors are overexpressed on the cancer cell. These vectors will act as carriers, resulting in the selective accumulation of the drug into the OS tumoral cells. A very recent and promising strategy in the field of targeted-therapy, is the use of carbohydrates as targeting-vectors, exploiting the Warburg effect. Tumoral tissues and in particular OS, require a higher demand of nutrients with respect healthy tissues, such as sugars, to maintain the fast proliferation rate and many OS cells are overexpressing glucose-receptors.

This project aims to produce new platinum-based chemotherapeutics that selectively target and accumulate on OS, by the functionalization of the active anticancer platinum-drug scaffold with both galactose and glucose moieties. The complexes will be designed to maintain a strong affinity of the vector for the cellular target without decreasing the overall anticancer activity. The new chemotherapeutics will act as pro-drugs and will become active inside the OS cell, to minimise the side effects on healthy tissues.

How supervisor research areas align to Maynooth University research priority areas:

MU recently devised its 2023-2028 five-year strategic plan, in which the focus is on four main pillars, including research and impact, students and learning, internationalisation, engagement and partnerships. Among the research strategic beacons, MU Strategic Plan identified Health & Wellbeing and Sustainability and Climate Change as priority areas that also align with UN Development Goals. This project aim at improving the current treatment for Osteosarcoma (OS) that is the main primary bone malignant entity affecting adolescents, whose prognosis remains poor due to chemoresistance and early metastasis. The alignment with the Health and Wellbeing MU beacon is very clear, since the primary objective is the discovery and development of chemotherapeutics that could be selectively accumulated in the OS cancer tissues and combat this fatal disease. As most of the tumoral issues, also OS cancer cells exhibit increased glycolytic activity and accumulate greater quantities of sugars, compared to normal tissues and it has been shown that the overexpression of sugar receptors in OS is predominantly associated with the likelihood of metastasis and poor patient prognosis. The

combination of sugars and of the Platinum core will create a library of targeted chemotherapeutics for the specific treatment of OS.

END

John & Pat Hume Doctoral Awards 2025-2026

Department: Chemistry

Supervisor: Dr Eithne Dempsey

Supervisor Email: eithne.dempsey@mu.ie

Title of Research Area:

Nanomaterials, biosensor development, biodiagnostics, electroanalytical chemistry, sensor design and fabrication.

Description of research areas supervisor is willing to accept applications in:

Research area(s) for the proposed PhD award include design of biosensors for cancer diagnostics coupled with preparation of nanomaterials which underpin the sensing approach. This will enable quantitation of key clinical biomarkers and aspects include research in electrochemical methodologies, fabrication of sensors for enzyme assays, surface confinement of biocatalytic materials and testing in simulated clinical media. Activity in these research areas result in achievements in integrated transducers for electrochemical and physical/chemical measurements with foundation in nanoscience and bespoke electrocatalytic mediators for healthcare applications. The proposed research is inter/multidisciplinary involving elements from Chemistry/Materials (synthesis of novel materials), Electrochemistry (redox films, electron-transfer reactions) and Biodiagnostics (clinical analysis).

How supervisor research areas align to Maynooth University research priority areas:

The research area aligns with the Maynooth University Beacon - Health and Wellbeing, specifically Healthcare Innovation and Technology. The multidisciplinary remit of the research areas proposed above contribute to tools and technologies for healthcare and associated quality of life. The output of this research has enormous societal benefit and global impact and also aligns with the UN Sustainable Development Goal Good Health/Wellbeing (SDG 3). The research paves the way for new wellness applications driven by the upsurge in data analytics, mobile phone apps and wearable technologies.

Through the publication of papers and presentations at international conferences, the research will advance knowledge beyond the state-of-the-art, enhancing both Maynooth University and Ireland's reputation and capability in biodiagnostics, nanotechnology and materials science.

Project outputs will contribute significantly to Maynooth University's Research and Impact focus, leveraging the existing research portfolio at the Kathleen Lonsdale Human Health Institute, building new expertise, advancing knowledge in a quest to address global and imminent health care challenges.

END

John & Pat Hume Doctoral Awards 2025-2026

Department: Chemistry

Supervisor: Prof Frances Heaney

Supervisor Email: frances.heaney@mu.ie

Title of Research Area:

Development of Metal-Based Therapeutics with Antimicrobial or Anticancer Activities.
(Keywords: Bio-organic Chemistry, Synthesis Antimicrobial, Anticancer, Drug delivery)

Description of research areas supervisor is willing to accept applications in:

Two major current areas of concern in the field of medicine are the rise in drug-resistant pathogens and the limitations of conventional cancer treatments. Clearly, there is a need for the development of new therapeutics. Metal-based drugs offer distinct advantages, due to their ability to exhibit multiple oxidation states, variability in structure, and different modes of action from organic compounds.

Our research is centred on the design, synthesis and investigation of metal complexes with the potential to act as anti-cancer or antimicrobial agents. Working with our collaborators in Maynooth University Department of Biology, we have identified classes of complexes which show good promise in these areas. The aim of this project is to extend these studies to develop cationic analogues of the complexes with dual modes of action, including DNA damage.

There are barriers to developing metal complexes as therapeutics, including solubility and selective delivery to cancer cells. To address these challenges in the proposed project the complexes will be encapsulated within water-soluble macrocyclic molecules to improve their solubility and to investigate if encapsulation enhances their efficacy. This study is an essential primary step of our goal to combine the complexes and macrocycles to form nanoparticles that will target cancer cells. Nanosized particles leak preferentially into tumours due to their increased vascular permeability and are then retained at the site due to reduced lymphatic drainage.

How supervisor research areas align to Maynooth University research priority areas:

This project aligns with the Maynooth University Health and Well-being Research Beacon as it is focused on developing novel anti-cancer therapies with the aim of improving cancer treatment and patient health and developing compounds that are active against multi-drug resistant microbes. Significantly, the project is interdisciplinary, involving both chemistry and biology and the student will be a member of the Lonsdale Human Health Institute. The student will join a group which has a focus on student academic and professional development. The student's research training will be through the Department of Chemistry's structured PhD programme, and they will be part of the vibrant postgraduate student community within the department. The research will have an international dimension as we will seek to enhance our international collaborations in this area and the student will present their work at international conferences, such as the European Biological Inorganic Chemistry conference in the Netherlands in 2026 and we aim to publish our findings in international journals. END

John & Pat Hume Doctoral Awards 2025-2026

Department: Chemistry

Supervisor: Prof John P. Lowry

Supervisor Email: John.Lowry@mu.ie

Title of Research Area:

Microelectrochemical Biosensors for Real-time Neurochemical Monitoring

Description of research areas supervisor is willing to accept applications in:

Stroke is the world's second leading cause of mortality resulting in around 6 million deaths annually, with ischemic stroke accounting for 85% of cases. Cerebral ischemia is known to cause a complex cascade of cellular events, leading to both acute and delayed neural death and severe brain dysfunction in both humans and animal models. The main factors mediating the effects of ischemia in the brain are reductions in the supply of O2 (hypoxia) and glucose (hypoglycaemia), both of which are vital substrates for the continual function and survival of cerebral tissue. The complex processes involved in brain ischemia are still not completely understood and the ability to measure analytes of importance in ischemic models, including glucose, O2 and lactate (the end product of aerobic/anaerobic glycolysis and now considered an important energy substrate in the brain when glucose levels are limited) in real-time is of considerable interest and importance.

Over the past three decades we have successfully developed several biosensors (e.g. glucose and lactate) and sensors (e.g. O2) to study brain neurochemistry under normal physiological conditions. Enzyme-modified electrodes, particularly amperometric devices, are the most thoroughly investigated in the biosensor field, with our "first generation" versions, incorporating oxidase enzymes and monitoring the formation of hydrogen peroxide, dominating neurochemical applications. However, there is a critical limitation associated with the use of these devices in vivo under conditions of significantly reduced O2, such as ischemia induced hypoxia; oxygen dependent-oxidases need oxygen to reoxidise their cofactor and return to their electron accepting (oxidised) state. As such, our current biosensors are not suitable for use under such conditions and we thus propose to modify our successfully developed composite manufacturing strategy to design, develop and characterise (in-vitro and in-vivo) new mediated second-generation biosensors for the detection of glucose and lactate.

How supervisor research areas align to Maynooth University research priority areas:

The proposed PhD project aligns with the Maynooth University Health and Wellbeing beacon and the lead research institute affiliated with the project is the Kathleen Lonsdale Institute for Human Health. Stroke is the world's second leading cause of mortality, resulting in around 6 million deaths annually. In Ireland approximately 10,000 people suffer a stroke every year, and it is the cause of around 2,000 deaths. Furthermore, an estimated 30,000 people are living with post-stroke disability, and it is considered the leading cause of acquired neurological injury.

If successful, these new biosensors, specifically designed for use in low oxygen environments, will offer advancements in analyte detection including fast response times, and the ability to monitor changes over extended time periods, facilitating novel studies not possible with current methodologies used in stroke research. The results obtained by the PhD researcher will lead to high impact publications, and enable future funding applications to perform detailed in-vivo studies involving simultaneous real-time monitoring of glucose and lactate, and other targeted analytes (e.g. oxygen and blood flow) under ischemic conditions. This will provide a greater understanding of ischemia and resultant tissue damage/injury, facilitating improved prognosis and more targeted care, with consequent reduced hospital time for patients.

END

John & Pat Hume Doctoral Awards 2025-2026

Department: Chemistry

Supervisor: Prof John Stephens

Supervisor Email: john.stephens@mu.ie

Title of Research Area:

PCR Testing Efficiency: Cost-Effective Fluorescence Quencher Generation via Continuous Flow Technology

Description of research areas supervisor is willing to accept applications in:

PCR (Polymerase Chain Reaction) testing is an essential tool for detecting viral infections, including COVID-19 and HIV, and does so by identifying the virus's genetic material (RNA or DNA). Ensuring access to high-quality yet cost-effective reagents for the production of PCR tests is crucial. However, PCR tests rely on fluorescence quenchers - molecules that are nearly 400 times more expensive than gold. The current production methods for these quenchers are inefficient, requiring high-temperature reactions that necessitate costly cooling systems. Additionally, they involve unstable diazo intermediates, increasing safety risks and costs in large-scale batch manufacturing.

This project aims to develop a continuous flow process for the efficient and cost-effective production of fluorescence quenchers. Continuous flow technology is increasingly recognized as a transformative approach in pharmaceutical and chemical manufacturing, with companies like Pfizer investing significantly in its advancement. Unlike traditional batch reactors, which operate in large, discrete volumes, continuous flow systems use smaller reactors in a steady stream. This approach enhances efficiency, scalability, and safety while reducing waste and costs.

Process development plays a crucial role in optimizing manufacturing performance within the pharmaceutical and fine chemical industries. Key improvements include enhanced reproducibility, better heat and mass transfer, scalability, automated operation, in-line processing, and improved safety - all advantages that continuous processing offers.

This research focuses on applying continuous flow technology to synthetic chemistry, particularly multi-component reactions for fluorescence quencher production. By improving the safety profile and scalability of exothermic multi-component methodologies, this project has the potential to make PCR testing more accessible and affordable. Ultimately, advancements in continuous processing could revolutionize the production of high-value chemicals, benefiting both industrial and academic sectors.

How supervisor research areas align to Maynooth University research priority areas:

The research on continuous flow technology for fluorescence quencher generation aligns with several key research strengths highlighted in Maynooth University's Strategic Plan 2023–2028.

Health and Wellbeing: The project contributes to health-related research by potentially improving the accessibility and affordability of PCR testing, a crucial diagnostic tool for viral infections like COVID-19 and HIV.

Sustainability and Climate Change: Continuous flow processing enhances safety, efficiency, and scalability while reducing energy consumption and waste, aligning with Maynooth's commitment to sustainable research practices.

Data and Digital Transformation: The use of automation and in-line processing in continuous flow technology supports advancements in digital transformation within pharmaceutical and fine chemical manufacturing.

Industry Collaboration: The research supports strategic objectives related to potential external engagement and partnerships, particularly with industry leaders like Pfizer, fostering innovation and commercial impact.

Graduate Research Academy: The project's focus on synthetic chemistry and process optimization aligns with Maynooth's goals of expanding research capacity and provides training in research skills, research engagement, and in skills that are transferrable beyond academia.

END

John & Pat Hume Doctoral Awards 2025-2026

Department: Chemistry

Supervisor: Dr Trinidad Velasco-Torrijos

Supervisor Email: trinidad.velascotorrijos@mu.ie

Title of Research Area:

Glycoconjugates for the Development of New Antivirulence Drugs against Critical Priority Fungal Pathogens

Description of research areas supervisor is willing to accept applications in:

Rising numbers of fungal infections pose a significant public health threat globally, particularly to immunocompromised populations. Moreover, many fungal strains are developing resistance to conventional treatments. To address this, new drugs with novel mechanisms of action are needed. Traditional fungicidal treatments can create selective pressure that fosters resistance. In contrast, antivirulence drugs target the virulence factors of pathogens rather than killing them or inhibiting their growth. These compounds focus on processes essential for a pathogen to cause disease, such as adhesion to host cells or biofilm formation.

Previous research from a collaboration between Prof. Kavanagh (Department of Biology) and Dr. Velasco-Torrijos (Department of Chemistry) identified aromatic glycoconjugates that effectively inhibit Candida albicans' adhesion to buccal epithelial cells. Using chemical proteomics, our goal is to pinpoint the molecular targets of these inhibitors, potentially identifying new fungal adhesion proteins in Candida albicans, a critical priority pathogen according to the World Health Organization. This will enable the optimization and development of a new generation of highly efficient adhesion inhibitors.

Furthermore, the project will explore the conjugation of these aromatic glycoconjugates as targeting vectors to metal chelators, in collaboration with Dr. Montagner (Department of Chemistry), to prevent biofilm formation by fungal pathogens. Biofilms are also considered virulence factors because they significantly enhance the ability of pathogens to cause disease, promoting the development of resistance and leading to persistent infections.

Overall, these findings aim to provide new insights into the complex mechanisms of fungal adhesion and biofilm formation, which are crucial for pathogenesis, and ultimately lead to antifungal treatments with novel modes of action.

This multidisciplinary project will integrate synthetic organic and bioinorganic chemistry, chemical biology, and microbiology, offering excellent training in a wide range of techniques relevant to the pharmaceutical and biopharmaceutical sectors.

How supervisor research areas align to Maynooth University research priority areas:

The research on fungal infections and antivirulence drugs is closely aligned with the Health and Wellbeing beacon, a key research priority in Maynooth University's Strategic Plan (2023-2028). By exploring new antivirulence treatments for fungal infections, this project leverages Maynooth

University's strengths in microbiology and synthetic chemistry. It also builds on the long-standing collaborations between the laboratories of Prof. Kavanagh, Dr. Montagner, and Dr. Velasco-Torrijos. Additionally, all principal investigators are members of Maynooth University's Kathleen Lonsdale Institute for Human Health Research.

This project also contributes to Health and Wellbeing by advancing our understanding of the mechanisms underlying fungal pathogenesis. By identifying new molecular targets and optimizing adhesion and biofilm inhibitors, the research supports the creation of innovative therapies that can prevent infections more effectively.

Furthermore, the interdisciplinary nature of the project ensures a comprehensive approach to tackling fungal infections and will foster a collaborative research environment. Additionally, it will enhance the university's international focus by strengthening research partnerships and networks that the principal investigators are currently involved in.

END

John & Pat Hume Doctoral Awards 2025-2026

Department: Chemistry

Supervisor: Dr Vinnie Fagan

Supervisor Email: vinnie.fagan@mu.ie

Title of Research Area:

Development of Small Molecule Inhibitors of Protein Targets. (Medicinal Chemistry, Drug Discovery, Multidisciplinary Health Research)

Description of research areas supervisor is willing to accept applications in:

This research involves the chemical synthesis of small drug-like molecules, as well as the identification of the protein targets they inhibit, and the structural optimization of hit molecules for the development of selective inhibitors of protein targets with disease relevance. Particular focus will be placed on cancers such as melanoma, leukemia and ovarian cancer.

Although the main research area is organic and medicinal chemistry, the research is multidisciplinary in nature, and knowledge of disease, relevant therapeutic targets, mass spec proteomics, competitive binding assays and cellular assays will all be acquired. This research will also involve the analysis of biological data relating to drug-like molecules, and will use computational methods to design more active molecules.

How supervisor research areas align to Maynooth University research priority areas:

Modern drug discovery research is highly multidisciplinary in nature, and the proposed research involves organic chemistry, medicinal chemistry, biochemistry, molecular biology, cell biology and data science. Therefore, the research sits firmly within MU's Health and Wellbeing Research Beacon, and aspects of it relate to the Data Science and Digital Transformation Research Beacon.

END

John & Pat Hume Doctoral Awards 2025-2026

Department: Chemistry

Supervisor: Dr Fergal Byrne

Supervisor Email: Fergal.Byrne@mu.ie

Title of Research Area:

Bio-based polymers for the construction industry

Description of research areas supervisor is willing to accept applications in:

Concrete and steel are used throughout the construction industry but are two of the biggest sources of carbon emissions. The use of bio-based materials in construction has huge potential to replace concrete and steel and permanently remove carbon from the atmosphere, reversing climate change. However, its use has been limited to chemically treated wood and a very limited use of partially bio-based materials such as "Hempcrete". Bio-based polymers/resins have far superior properties to wood and Hempcrete and are an under-explored possibility to replace concrete and steel. The proposed project is a desk-based chemistry project which aims to explore the use of bio-based polymers/resins in the construction industry.

First, an investigation will be carried out into the properties required (tensile strength, compressive strength, thermal insulation, etc.) by materials used in buildings and infrastructure such as concrete and steel. Secondly, a thorough investigation into the physical properties of the many bio-based polymers/resins published in recent years in academic literature, patents, and commercial brochures. Finally, where they exist, bio-based polymers/resins with the required properties and cost to replace concrete and steel in different aspects of buildings and infrastructure will be identified. A gap analysis will also be carried out where there is no bio-based polymer/resin available to carry out a given function.

This project is novel in that the use of bio-based polymers to replace concrete and steel has not been considered despite advances in construction methods in which they would be ideal (off-site manufacturing, modular construction, etc.). Furthermore, no mapping of existing bio-based polymers/resins for use in construction has been carried out before, which is fundamental to guiding further research in the area. Finally, the project will be carried out with economics at the forefront, to maximise the likelihood of making real-world impact.

How supervisor research areas align to Maynooth University research priority areas:

This project is the first step of a novel approach to removing carbon from the atmosphere in an economic manner. As such, it inherently addresses sustainability metrics not only from Maynooth Universities strategic plan, but also the Government of Ireland's Bioeconomy Action Plan, and the UN's SDGs.

Unusually, for a chemistry project, this is desk-based and therefore does not demand the same level of university resources as other lab-based projects. It is also a first-step towards a subsequent lab-based research project where novel polymers and materials will be synthesised and tested.

END

Department of Computer Science

John & Pat Hume Doctoral Awards 2025-2026

Department: Computer Science

Supervisor: Prof Barak A. Pearlmutter

Supervisor Email: barak.pearlmutter@mu.ie

Title of Research Area:

Automatic Differentiation, Machine Learning, and Theoretical Neurobiology

Description of research areas supervisor is willing to accept applications in:

My research interests are two-fold: understanding information processing in the brain, and figuring out how to build artificial systems that exhibit brain-like performance.

As this plays out in machine learning, I look for novel architectures and algorithms, particularly ones that can expand the reach of machine learning while (a) making more efficient use of computational resources, or (b) providing guarantees like safety or correctness or other desirable properties. A challenge problem we are looking at is learning a compiler.

Automatic Differentiation (AD) is the enabling technology for deep learning and differentiable programming, and I have a sustained project to make AD more robust, general, and performant. Right now we are exploring a new idea called Inverse Mode AD, and are also looking to exploit checkpoint reverse mode, which can allow smaller computers to be used for training bigger models. Making AD a first-class citizen of programming languages holds the promise of allowing even the smallest embedded device to become adaptive, changing its behaviour to serve our needs, and to allow even novice programmers to build adaptive systems.

In theoretical neurobiology, my main interest is in regarding the brain as an adaptive dynamic system and looking at criticality in the brain. Exploring criticality and hallucinations has generated a medical spinoff (Neuromod Devices). Hypotheses about the function of sleep, and of Parkinsonian tremor, suggest opportunities for math and simulations, for experiments in collaboration with physicians, and for more spinoff companies.

How supervisor research areas align to Maynooth University research priority areas:

Research areas in which I am involved strongly align with the strategic research strengths of Maynooth University, particularly the DATA AND DIGITAL TRANSFORMATION and HEALTH AND WELLBEING beacons.

Developing brain-like artificial systems and novel machine learning architectures and algorithms, including advancements in Automatic Differentiation (AD) and in guaranteeing safety properties of deep learning system, aligns with the Data and Digital Transformation focus on “more efficient and reliable AI, crucial for future digital advancements.”

My work on theoretical neurobiology connect with the Health and Wellbeing beacon. Understanding brain function at this level can provide insights into neurological processes, potentially leading to advancements in addressing conditions like Parkinsonian tremor, as explored in my research. The Neuromod Devices spinoff in the medical devices space exemplifies this alignment.

Research in my lab bridges computational intelligence with biological understanding, directly addressing key interdisciplinary research areas prioritized by the University.

END

John & Pat Hume Doctoral Awards 2025-2026

Department: Computer Science

Supervisor: Dr Behnam Faghih

Supervisor Email: Behnam.Faghih@mu.ie

Title of Research Area:

AI and machine learning techniques for music applications

Description of research areas supervisor is willing to accept applications in:

We are working on a wide range of research topics related to Computer Music (Music Technology), including traditional audio signal processing and machine learning (deep learning) approaches. We mainly welcome applicants interested in the following areas:

- Music Information Retrieval (MIR)
- Music modelling, such as singing or performance modelling
- Music Alignments such as score following, music transcription, and music similarity
- Music Assessment

We will publish the outputs of the study, such as models/algorithms and datasets open access. Algorithms will shape an open-source Python library, and datasets will follow FAIR principles.

How supervisor research areas align to Maynooth University research priority areas:

- Focusing on the “Data and Digital Transformation” category.
- Supporting MU research students.
- Building research recognition: The open-source Python library fosters national and international connections among researchers and industries.
- To be recognised for the excellence and impact of MU research: The open-source Python library and the open-access datasets will enhance global recognition of MU research in music technology.

END

John & Pat Hume Doctoral Awards 2025-2026

Department: Computer Science

Supervisor: Dr Cathy Ennis

Supervisor Email: Cathy.Ennis@mu.ie

Title of Research Area:

Virtual Characters, Interactions, Gestures, Virtual Reality, Embodied Conversational Agents, Multi -Modal, Perception

Description of research areas supervisor is willing to accept applications in:

Dr Ennis is looking for projects within VR or games, particularly with a focus on virtual characters across any application e.g., Metaverse or serious games. She is also interested in applications of virtual characters across disciplines e.g., health, education. Examples include looking at employing ML techniques to improve automatic gesture generation, or enhance user engagement/learning with virtual characters.

How supervisor research areas align to Maynooth University research priority areas:

Given that the research area is in cutting edge computer science, VR and virtual character development aligns very clearly with Data and Digital Transformation; using ML and DL techniques to develop gesture synthesis models for real-time applications. With the ubiqituous presence of AI, developers need to embrace developments in this area, finding (and evaluating) their efficacy in new applications and domains e.g., text-to-speech synthesis and conversational agents. However, embodied conversational agents have an important role to place across many disciplines e.g., in the health space to supplement Speech and Language Therapy with at-home applications for patients, or in education as a way to engage students in theri learning. Finally, there is an important avenue for societal impact investigating into safety and inclusion measures in social VR based applications, evaluating current measures of efficacy and using AI to enhance and develop new measures to keep children safe online.

END

John & Pat Hume Doctoral Awards 2025-2026

Department: Computer Science

Supervisor: Dr Congcong Wang

Supervisor Email: congcong.a.wang@mu.ie

Title of Research Area:

Natural language processing for crisis response in low-resource settings

Description of research areas supervisor is willing to accept applications in:

I am open to supervising student applicants interested in natural language processing (NLP) for crisis response, particularly in low-resource settings. My research focuses on developing advanced machine learning techniques to categorise social media messages during emergencies, where rapid identification of critical information is essential for effective disaster management. A key challenge in this area is the limited availability of annotated training data during ongoing crises, and this research explores innovative solutions to address this problem.

There are several promising research directions to address the challenge of low-resource crisis message categorisation. One area of exploration involves improving domain adaptation techniques to transfer knowledge from past crisis events to new situations. Potential research can focus on refining many-to-many adaptation using multi-task learning with pre-trained language models to improve performance across diverse crises.

Another avenue is the development of data augmentation techniques to address limited labelled data. Future research can explore more sophisticated self-controlled and iterative augmentation methods to generate high-quality synthetic training data. These approaches could be further refined to improve performance in few-shot learning scenarios.

Exploring zero-shot learning techniques is another critical research direction. This involves developing innovative strategies to match label names with unlabelled data and generate reliable pseudo-labels. Further work can investigate how to enhance these methods for improved generalisation to new crisis events, as well as extending them to other domains such as emotion and topic classification.

Applicants should have a background in machine learning and NLP, with an interest in creating practical, real-world solutions. While I have outlined several research directions, applicants are encouraged and expected to explore other innovative approaches to improve NLP applications for emergency response in low-resource environments. I value creative problem-solving and collaboration to push the boundaries of this important field.

How supervisor research areas align to Maynooth University research priority areas:

My research aligns with Maynooth University's Strategic Plan 2023-28 by contributing to research excellence and societal impact. By developing advanced NLP techniques for crisis response, my work directly supports the University's commitment to addressing global challenges through innovative research. This aligns with the "Research and Impact" pillar by advancing knowledge in machine learning and providing practical solutions for emergency management. Additionally, the focus on low-resource settings reflects the University's

dedication to "Engagement and Partnerships" by fostering real-world impact through collaboration with emergency responders and humanitarian organisations. My research also complements the "Internationalisation" objective, as the techniques developed can be applied globally to improve crisis communication across diverse linguistic and cultural contexts. Through these efforts, I aim to contribute to the University's vision of being a leader in research, opportunity, and positive societal change.

END

John & Pat Hume Doctoral Awards 2025-2026

Department: Computer Science

Supervisor: Dr Edgar Galvan

Supervisor Email: edgar.galvan@mu.ie

Title of Research Area:

My research integrates evolutionary algorithms and deep neural networks for advanced problem-solving.

Description of research areas supervisor is willing to accept applications in:

I am interested in using evolutionary algorithms for the automatic design of deep neural network architectures. Specifically, I aim to explore how these algorithms can optimise network structures, significantly reducing training time while maintaining high performance. This approach holds great potential for real-world applications such as classification tasks, game strategies, and educational tools, where efficient and scalable solutions are crucial. By leveraging evolutionary algorithms, we can create adaptive, high-performing networks that excel in diverse domains while minimising the computational burden typically associated with training.

How supervisor research areas align to Maynooth University research priority areas:

To enhance research outputs and impact across all areas of the University, positioning MU as a global leader in our key research domains, including Data and Digital Transformation. By focusing on this beacon, we aim to drive innovation and foster excellence, particularly in fields like artificial intelligence, deep learning, and evolutionary algorithms, to address real-world challenges in classification, games, education, and beyond.

END

John & Pat Hume Doctoral Awards 2025-2026

Department: Computer Science

Supervisor: Dr Hao Wu

Supervisor Email: haowu@cs.nuim.ie

Title of Research Area:

SafeAccess+: Ehancing Access Control with Formal Verification

Description of research areas supervisor is willing to accept applications in:

Access control is a fundamental security mechanism in computing systems, ensuring that only authorized entities can access specific resources. Traditional access control models, such as Role-Based Access Control (RBAC) and Attribute-Based Access Control (ABAC), often suffer from vulnerabilities due to misconfigurations and policy conflicts. Formal methods provide a mathematically rigorous approach to specifying, verifying, and validating access control policies, enhancing security and reliability.

This project aims to explore the application of formal verification techniques in designing and verifying access control policies. The primary objectives include: (1) Defining precise and unambiguous access control policies using formal specification languages. (2) Verifying access control policies for consistency, completeness, and security properties. (3) Detecting policy conflicts, misconfigurations, and unintended privilege escalations. (4) Demonstrating the feasibility of integrating formal verification into real-world access control frameworks.

The project will employ formal specification languages Logic for defining access control models. Automated theorem proving (SAT/SMT) and model-checking techniques will be used to analyze security properties and detect policy flaws. The key steps include: (1) Modeling access control policies using formal languages. (2) Using model checkers (e.g., SPIN, NuSMV) to verify security properties such as non-bypassability and least privilege enforcement. (3) Applying theorem provers (e.g., Isabelle, Coq, SAT/SMT solvers) to prove policy correctness. (4) Validating the approach using real-world case studies from enterprise access control systems.

The expected outcomes are (1) A formalized framework for specifying and verifying access control policies. (2) Improved security assurance by identifying and eliminating policy vulnerabilities. (3) Enhanced automation in access control validation and policy management.

By using verification techniques, access control systems can achieve higher security and reliability, reducing risks associated with misconfigurations and policy conflicts. This research will contribute to the development of robust access control mechanisms in modern computing environments.

How supervisor research areas align to Maynooth University research priority areas:

Digital transformation is reshaping enterprises/organisations by integrating advanced technologies to enhance efficiency, security, and scalability. Access control is a critical component of digital transformation, ensuring that digital assets are protected against unauthorized access.

A sound and complete access control can (1) strength cybersecurity that only authorized users can interact with critical systems and data, reducing the risk of breaches, insider threats, and data leaks. (2) protect digital assets and data Integrity and prevents unauthorized modifications, leaks, or deletions, safeguarding data integrity. (3) Enables compliance and regulatory adherence. Digital transformation often requires organizations to comply with regulations like GDPR, HIPAA, and ISO 27001. It can help organizations to meet legal and compliance standards.

This project aligns with digital transformation by: (1) Introducing automation and formal verification to modernize access control frameworks. (2) Enhancing cybersecurity through rigorous validation of access policies, reducing risks associated with digital transformation initiatives. (3) Providing scalable and adaptable security models that support cloud computing, IoT, and AI-driven systems. (4) Enabling organizations to confidently adopt digital transformation strategies by ensuring compliance with security best practices.

By integrating formal verification into access control, this project contributes to building secure, resilient, and future-ready digital infrastructures

END

John & Pat Hume Doctoral Awards 2025-2026

Department: Computer Science

Supervisor: Dr Kolawole Adebayo

Supervisor Email: kolawole.adebayo@mu.ie

Title of Research Area:

Reinforcement Learning-Driven Explainable Multimodal AI for Medical Diagnostics

Description of research areas supervisor is willing to accept applications in:

My research focuses on developing innovative multimodal AI systems for enhanced medical diagnosis and early disease detection. Our goal is to create robust, explainable AI models that integrate diverse data modalities such as imaging (MRI, PET, CT, X-ray, dermoscopic images), clinical text, and audio, to assist clinicians in diagnosing conditions like early-stage cognitive impairments (e.g., dementia) and various forms of cancer (e.g., skin, brain, breast, etc), as well as other critical health issues. I seek PhD candidates interested in advancing AI-assisted diagnosis while ensuring transparency and interpretability of algorithmic decisions for clinical adoption.

Central to this work is the use of state-of-the-art transformer-based vision-language models, which have shown tremendous promise across multiple tasks. A key research challenge is to enhance the explainability of these models. To achieve this, candidates will explore advanced reinforcement learning to integrate reasoning mechanisms into multimodal models using techniques like Group Relative Policy Optimization (GRPO) inspired by Deepseek-R1 or similar methods employed in reasoning-augmented language models.

A promising research direction involves developing systems that generate explanatory diagnostic reports from medical images, providing clinicians with transparent reasoning traces - a step-by-step explanation of its diagnostic process which can be compared against expert clinical notes and reports.

Specifically, the PhD candidate will contribute to:

-Novel architectures combining vision-language models with reinforcement learning for explainable diagnosis

-Methods for aligning AI-generated explanations with clinical reasoning patterns, optimizing for both accuracy and explainability

-Evaluation frameworks measuring both diagnostic performance and explanation quality

-Practical integration of explainable systems into clinical workflows

Through this research, students will have the opportunity to contribute to advancements that could significantly improve patient outcomes and reshape the future of medical diagnostics by creating trustworthy and explainable AI assistants. Prior experience with deep learning, medical image analysis, or natural language processing is valuable but not required.

How supervisor research areas align to Maynooth University research priority areas:

This research area aligns strongly with Maynooth University's Strategic Plan 2023-28, particularly in the beacons of Data Science and Digital Transformation, Health and Wellbeing. Additionally, it has implications for Society and Public Policy. Our work leverages cutting-edge multimodal AI, combining transformer-based vision-language models with advanced reinforcement learning techniques, to integrate diverse data sources such as medical imaging, clinical text, and audio.

1) Data Science and Digital Transformation: Our work leverages cutting-edge AI techniques to process and analyze medical data from multiple modalities, driving a digital transformation in healthcare through enhanced disease detection and diagnosis, epitomizing the application of data science for digital transformation.

2) Health and Wellbeing: By focusing on early detection of diseases like cognitive impairment and cancer, our research aims to improve patient health outcomes and quality of life, directly contributing to health and well-being.

3)Society and Public Policy: Our focus on explainability addresses growing societal concerns around algorithmic transparency in healthcare. This work contributes to emerging policy frameworks for responsible AI deployment in clinical settings, ensuring that technological advances in medicine remain aligned with ethical standards and regulatory requirements for patient care and data privacy.

END

John & Pat Hume Doctoral Awards 2025-2026

Department: Computer Science

Supervisor: Dr Peter Mooney

Supervisor Email: peter.mooney@mu.ie

Title of Research Area:

Sustainable and sensible usage of Artificial Intelligence (AI)

Description of research areas supervisor is willing to accept applications in:

I am very interested in developing research around addressing some of the hype around Artificial Intelligence (AI). More specifically, I am very interested in research that investigates the problems and tasks where AI is best suited but also the situations where AI is a very poor choice. Not every computing or technological task requires powerful AI approaches to generate the best solutions/outcomes. The hype around AI means that simpler, sometimes classical, approaches can often be ignored whilst being just as effective. While AI is incredibly powerful, it should not be overused or poorly applied. Using AI for the wrong tasks wastes energy, increases emissions, and contributes to our planet's already precarious environmental position. Thoughtful application where AI is truly necessary and efficient for problems and tasks is key to maximizing its benefits while minimizing harm. For example, many sources indicate that a single AI-powered search query may use 10 times more energy than a traditional search. AI needs specialized hardware (e.g., GPUs), leading to more e-waste and resource mining. As AI adoption grows, efficiency-first AI development will be critical for a more environmentally sustainable technological future. In this regard, this research will address a very important concern around sustainability. Every major AI model requires significant resources in terms of computing energy and computing infrastructure. These energy and infrastructure requirements have major impact around sustainability. This research will likely involve investigating how to use smaller, task-specific models that require less computation and using pre-trained models with fine-tuning instead of re-training AI models from scratch. Building guidance for AI usage for non-experts will also be an important next step.

How supervisor research areas align to Maynooth University research priority areas:

You will be able to access many of my research outputs at https://scholar.google.com/citations?user=wVs_9twAAAAJ&hl=en which demonstrates a contemporary and multi-disciplinary approach to my research. The research described here intersects with several of the University's research strengths or beacons. Data and Digital Transformation is a key focus area for the University's strategic plan 2023-28. My research lab has won competitive research funding recently in the area of the Circular Economy and AI and the engagement with the Circular Economy for industry and businesses. This research overlaps with the Sustainability and Climate Change beacon of the University where efficiency-first AI and more sustainability-driven computation will be an important contributor to a more environmentally sustainable future.

END

John & Pat Hume Doctoral Awards 2025-2026

Department: Computer Science

Supervisor: Dr Qian Xiao

Supervisor Email: Qian.Xiao@mu.ie

Title of Research Area:

Exploring "Near-Free-Lunch" Data Privacy with Deep Learning for Knowledge Distillation

Description of research areas supervisor is willing to accept applications in:

Recent breakthroughs in model distillation, exemplified by DeepSeek's R1 model, have paved the way for more efficient generative AI. This success highlights the potential to train lightweight, small AI models using in-house data silos from smaller organizations while distilling knowledge from large enterprise models. By leveraging large teacher models, these small student models can capture significantly more insights from in-house data, unlocking a wide range of applications—particularly in healthcare, education, and the economy—where lightweight AI models can operate efficiently in resource-constrained environments.

However, knowledge distillation often requires transmitting sensitive in-house data, raising serious concerns about privacy leakage during training. This issue is especially critical in fields such as healthcare and finance, where data confidentiality is paramount . To address these challenges, we propose investigating the potential of stochastic processes inherent in deep learning—such as those in contrastive learning and diffusion models—to enable efficient, privacy-preserving knowledge distillation. By carefully calibrating the sampling process and the noise introduced during training, we aim to achieve rigorous privacy guarantees under differential privacy (DP) without requiring significant modifications to existing deep learning architectures for contrastive learning and diffusion models.

The work in this area is driven by the growing demand for privacy-preserving AI models in local environments, where computational efficiency, data privacy, and security are critical. The objective of this area is to establish a solid theoretical foundation for efficient and trustworthy AI.

How supervisor research areas align to Maynooth University research priority areas:

The research area on efficient and trustworthy AI with differential privacy protection aligns closely with Maynooth University's Beacon Areas for advancing data science and digital transformation strategies. By addressing privacy-preserving knowledge distillation through lightweight neural architectures and optimized federated learning frameworks, this work advances computationally efficient AI systems tailored for resource-constrained environments. The integration of techniques such as sparse neural networks, adaptive gradient clipping, and quantization-aware training ensures minimal computational overhead while preserving privacy—critical for deploying AI models locally in sensitive sectors like healthcare (e.g., distributed diagnostics), education (personalized learning analytics), and finance (fraud detection on edge devices). These innovations not only enhance data privacy but also address

the university's strategic emphasis on scalable digital solutions that balance efficiency with ethical governance.

Furthermore, the research leverages novel optimization algorithms (e.g., differentially private stochastic gradient descent with adaptive noise calibration) to streamline model training without compromising accuracy. This focus on efficiency and sustainability directly supports Maynooth's goal. It also aligns with Horizon Europe priorities, such as "Efficient Trustworthy AI", by enabling rapid, low-cost AI adoption for small organizations. By pioneering energy-efficient distillation protocols and real-time privacy-utility trade-off mechanisms, the work advances the state-of-the-art in AI, positioning the university as a leader in both theoretical rigor (via publications at NeurIPS, ICLR) and practical impact (through deployment on AI edge devices). The proposed algorithms bridge gaps between theoretical privacy guarantees and real-world usability, fostering interdisciplinary synergies with the university's Futures Institutes and amplifying societal trust in AI through transparent, resource-aware systems.

END

John & Pat Hume Doctoral Awards 2025-2026

Department: Computer Science

Supervisor: Dr Ralf Bierig

Supervisor Email: Ralf.Bierig@mu.ie

Title of Research Area:

Immersive (XR) User Interfaces for Information Search and Discovery with AI support

Description of research areas supervisor is willing to accept applications in:

Search interfaces continuously connect us with information at work and in our daily lives. In the past 25 years, this first democratised search as a digital transformation and was mostly driven by personal computers and smartphones and mostly focused on finding relevant documents, websites, and other content based on textual search queries. Now, immersive virtual and augmented reality (XR) devices have matured and offer new 3D user interfaces where people are either fully immersed or interact with integrated information in their natural surroundings. In addition to this, artificial intelligence (AI) has emerged as a powerful candidate to support users in immersed spaces as a potential means for information representation and visualisation, data processing, new forms of user interaction, social collaborative work, and even emotional support during research and work tasks.

Possible topics in this larger area of user interfaces, XR, and AI could be: 1) Investigations of effectiveness and quality of experience for different types of information search and data exploration 2) Research on alternative modes of interaction with AI in such settings (e.g., visual, auditory, haptic or by other means) e.g., to initiate, create, or refine search requests, discover and refine information, and generate insight. 3) Serendipity and Creativity in information search in XR with AI assistants 4) AI support for personal information management in XR 5) Searching as Learning in XR with an AI tutor, and others. The student may include aspects on relevant topics of social transformation, ethics, data privacy, safety, and others. The student is also welcome to suggest own topics within this subject area or highlight relevant application areas for applied research in this domain.

The supervisor has 15+ years of experience in all relevant areas (information retrieval and behaviour, data science, and human-computer interaction (including XR)) and is an affiliate of the Hamilton Institute.

How supervisor research areas align to Maynooth University research priority areas:

The proposed research area aligns with our Five-Year Focus on Research and Impact and its 'Data and Digital Transformation' beacon. Within this beacon, the research is focused on Driving Data Science Development and the Convergence of Data Science and Digital Transformation in the following aspects: 1) Research on modern interfaces for search and information discovery is enhanced with immersive (XR) technology and artificial intelligence (AI). This directly supports future business needs to effectively interact with complex and large information and data sets with seamlessly integrated AI support through smart interfaces. 2) This research contributes to forming new and modern business processes and initiate societal and cultural change by better integrating AI in the context of information search and discovery.

3) It will generate scientific insight, methods, and tools that will contribute to shaping the future workforce, including its upskilling, for digital transformation with modern user interfaces. 4) The interrelation between social challenges, ethics, and privacy within XR and AI are all aspects of the proposed topics as an important theme of data quality and governance in the context of future digital transformation.

END

John & Pat Hume Doctoral Awards 2025-2026

Department: Computer Science

Supervisor: Dr Kevin Casey

Supervisor Email: Kevin.Casey@mu.ie

Title of Research Area:

Fostering effective collaborative problem solving via Multimodal Learning analytics.

Description of research areas supervisor is willing to accept applications in:

Student applications are welcomed from candidates with an interest in designing and measuring collaboration among students at primary and secondary school level. This will involve collaborative game/problem-solving analysis, design and real world observation using Multimodal Learning Analytics. The application area is the pedagogy of Computational Thinking and Computer Science and will require skills in data analysis and AI techniques applied to data from the physical space (e.g. speech, eye tracking).

How supervisor research areas align to Maynooth University research priority areas:

This research aligns with the University Beacon on Data and Digital Transformation, especially in an educational context. The work will contribute towards data-driven instruction - providing proven, easy to use toolkits for busy teachers. The research will be conducted alongside the PACT group at Maynooth who have a proven track record in working with students and teachers nationally. To date the group has interacted with over 100,000 primary and secondary school students nationally.

The project also aligns with the Health and Wellbeing through the better understanding and promotion of collaborative problem solving in the classroom. There is an overwhelming body of literature supporting the notion that this type of activity can enhance student well-being and resilience. Against a backdrop of students becoming separated by an over-reliance on device-based communication, collaborative problem solving promotes a welcome return to face-to-face, direct communication.

END

John & Pat Hume Doctoral Awards 2025-2026

Department: Computer Science

Supervisor: Prof Thomas Naughton

Supervisor Email: Tom.Naughton@mu.ie

Title of Research Area:

Cancer detection, digital holographic microscopy, deep learning, optical computing, hologram data compression

Description of research areas supervisor is willing to accept applications in:

Digital holography is a novel approach for recording three-dimensional (3D) objects. In microscopy, holograms measure the phase of the light passing through an object, e.g., allowing one to track protein mass distribution throughout a human cell over time. Holography is less invasive than conventional 3D microscopes: no toxic labelling chemicals (dyes/fluorophores) and little light needed (e.g. compared to confocal microscopy), so that cells survive in vitro, and can be tracked, over long timescales. Also, multiple cells at different positions in a 3D environment can be recorded at the same time. For larger objects, digital hologram cameras also record multiple different perspectives in a single frame.

Three related research project areas are described using digital holography. The first is cancer detection. Using the unique information recorded with digital holographic microscopy, a team of computer scientists and cell biologists are developing image analysis software to track cell clusters in an incubator and measure their properties over time, with the aim of discovering if we can detect cancer faster and with higher throughput than established approaches.

The second research project area is hologram data compression. A compressed file format specification for holograms is currently being developed by the relevant ISO JPEG industry standards group, within which our research group is Ireland's participant. However, many scientific questions remain regarding how to most efficiently compress digital holograms for biomedical applications.

The third research area concerns optical computing. Many operations within convolutional neural networks (one class of deep learning models) can be performed efficiently in parallel using light rather than digital electronics (e.g. graphics cards). However many design and implementation challenges remain, and critical advances remain undiscovered, while we wait to realise the promises of optical computing. Our research group has a long track record of successfully designing and building optical computing devices.

How supervisor research areas align to Maynooth University research priority areas:

These research projects align with the Maynooth University Strategic Plan 2023-28 in terms of excellence in research and collaboration. The projects are open research questions, with potential significant impacts on society and industry. The projects bring together collaborators with multidisciplinary mix of backgrounds from computer science, physics, biology, and medicine. The research beacons relevant to these projects are "Data Science and Digital Transformation" and "Health and Wellbeing". The former beacon includes scope for new

computer technologies and discoveries resulting from data analysis, as described by all three projects above. In addition, the first project above is relevant for the “Health and Wellbeing” beacon in that it aims to achieve faster diagnoses for specific cancers (current MU ethical approval obtained for study of prostate cancer samples from human patients with our collaborators at Oulu University Hospital, Finland).

END

John & Pat Hume Doctoral Awards 2025-2026

Department: Computer Science

Supervisor: Prof Rosemary Monahan

Supervisor Email: Rosemary.Monahan@mu.ie

Title of Research Area:

Formal Specification and Verification of Safety Critical Software Systems

Description of research areas supervisor is willing to accept applications in:

Areas of research which I would welcome student applications from should be centered around providing solid mathematical foundations for software systems.Topics include:

- integration of existing tools and techniques for software verification and validation, providing foundations for information exchange between verification tools such as model checkers, theorem provers, runtime verification tools etc;

- developing new approaches to the verification of AI systems to include considerations of the probabilistic nature of both the machine-learned model and the properties that we wish to verify (e.g. safety, fairness, robustness), as well training and evaluation data;

- incorporating learning into formal verification with the aim of providing provable AI;

- investigating logical constraints on dynamic learning, providing for verification of self-improving ML-enabled systems which support continuous-learning;

- Traceability of requirements from natural language through to formal specifications and the verification of the implemented system;

- Computational Thinking and Theoretical Computer Science.

How supervisor research areas align to Maynooth University research priority areas:

My research area aligns with the University Beacon on Data and Digital Transformation focusing on developing methodologies for ensuring accuracy, integrity, and ethical use in digital transformation. We focus on developing core computer science skills, integrating existing and developing new approaches to safety and dependability in software, on analysing, transforming and generating digital content, ensuring explainability and understanding of sophisticated AI models, while impacting software standards and governance.

END

John & Pat Hume Doctoral Awards 2025-2026

Department: Computer Science

Supervisor: Dr Aidan Mooney

Supervisor Email: Aidan.Mooney@mu.ie

Title of Research Area:

Eye tracking and artificial intelligence for personalized programming education

Description of research areas supervisor is willing to accept applications in:

Eye tracking and artificial intelligence for personalized programming education - research on how to combine eye tracking data with machine learning models to enhance programming education by identifying students' cognitive load, frustration and engagement, thereby bringing adaptive and personalized learning experiences.

How supervisor research areas align to Maynooth University research priority areas:

This project is central to Maynooth University's pillars of Research Excellent and Educational Experience. This project looks at enriching the educational experience of students through innovative and research led pedagogical approaches to enhance programming education.

END

Department of Electronic Engineering

John & Pat Hume Doctoral Awards 2025-2026

Department: Electronic Engineering

Supervisor: Dr Bryan Hennelly

Supervisor Email: bryan.hennelly@mu.ie

Title of Research Area:

Deep Learning Spectroscopy: Revolutionising Spectral Analysis with 2D Unmixed Spectra

Description of research areas supervisor is willing to accept applications in:

The proposed research project aims to revolutionise spectroscopic analysis across all types of spectroscopy (Raman, FTIR, NMR, etc.) by developing a novel 2D Unmixed Spectrum representation that will supersede the classical 1D spectrum, and is made possible only by deep learning predictive and generative methods. This groundbreaking approach will use Raman spectroscopy as the primary vehicle for development (building on the host groups 15-years of multidisciplinary research) but will be universally applicable to all spectroscopic techniques. The novel 2D Unmixed Spectrum deconstructs the mixed spectral data (i.e. the 1D spectrum) as a combination of independent lines or modes, each characterised by three parameters: wavenumber peak centre, line width, and amplitude. These independent modes represent independent physical process, the information of which is generally lost through the mixing process that takes place in detecting the 1D spectrum. This new 2D representation has a great many advantages including:

1. Enhanced Physical Interpretation: By decomposing spectra into their fundamental modes, researchers can gain deeper insights into the underlying physical and chemical properties of materials.

2. Improved Classification and Identification: The 2D spectrum cab be applied like a 2D barcode, with classification properties that far exceed 1D spectral identification methods.

3. Advanced Denoising and Deconvolution: Deep learning methods, such as variational autoencoders (VAEs) and generative adversarial networks (GANs), will be employed to enhance spectral resolution, remove noise, and correct baselines

We will focus on two application use-cases for testing: (1) cancer detection using Raman cytology whereby spectra are recorded from various cell types and cancer cells can be identified via multivariate spectral classification. (2) hyperspectral deep learning techniques for spatial-chemical clustering using the 2D Unmixed Spectrum. This method allows tumour margins to be identified without labels during surgery. These two applications build on the groups existing collaborative research in cancer detection and tissue analysis.

How supervisor research areas align to Maynooth University research priority areas:

This project aligns seamlessly with Maynooth University's strategic goals, particularly in the areas of Health and Wellbeing, Data and Digital Transformation, and Sustainability and Climate Change. By advancing spectroscopic analysis, the research supports the university's

commitment to innovation and real-world impact, particularly in biomedical and environmental applications.

The project also aligns with the university's focus on interdisciplinary research and collaboration with clinical and industrial partners. The development of the 2D Unmixed Spectrum and associated deep learning tools has significant potential for commercialisation, contributing to the university's strategic objective of fostering innovation and societal impact.

Furthermore, the project provides an excellent opportunity for research students and early-career researchers to develop high-demand skills in deep learning, spectroscopy, and biomedical engineering, aligning with the university's goal of preparing graduates for impactful careers in science and technology.

END

John & Pat Hume Doctoral Awards 2025-2026

Department: Electronic Engineering

Supervisor: Dr Erivelton Nepomuceno

Supervisor Email: erivelton.nepomuceno@mu.ie

Title of Research Area:

Sustainable Circuits and Systems for Green Computing, System Identifcation, Cryptography, Renewable Energy

Description of research areas supervisor is willing to accept applications in:

I am currently accepting student applicants interested in Sustainable Circuits and Systems with applications in Green Computing, System Identification, Cryptography, and Renewable Energy. My research focuses on designing energy-efficient and sustainable hardware and algorithms that optimize performance while reducing environmental impact.

In Green Computing, we explore low-power and energy-efficient computing techniques, emphasizing sustainable circuit design and system optimization. Our goal is to develop novel architectures that minimize power consumption without compromising computational efficiency.

In System Identification, we investigate mathematical and computational methods to model and analyze complex systems. This includes identifying system parameters for control and prediction applications in engineering, renewable energy, and beyond.

In Cryptography, we focus on secure and efficient cryptographic techniques, including chaotic cryptography, lightweight encryption methods, and hardware-based security solutions. Our aim is to design cryptographic systems that offer robust security while maintaining energy efficiency.

In Renewable Energy, we study energy-harvesting technologies, particularly in ocean energy applications. This includes the development of sustainable circuits and systems that integrate with renewable energy sources for efficient power management and conversion.

Students working in these areas will gain hands-on experience in circuit design, algorithm development, optimization techniques, and simulations, with opportunities to contribute to cutting-edge research with real-world impact. I welcome motivated applicants with backgrounds in electrical engineering, computer engineering, mathematics, or related fields who are eager to explore innovative solutions for a more sustainable and secure technological future.

How supervisor research areas align to Maynooth University research priority areas:

Our research in Sustainable Circuits and Systems for Green Computing, System Identification, Cryptography, and Renewable Energy is closely aligned with Maynooth University's Research Beacons, which emphasize areas of excellence and collaboration.

Sustainability and Climate Change

By developing energy-efficient circuits and systems, we directly contribute to sustainability goals. Our technologies aim to reduce energy consumption, supporting efforts to mitigate climate change and promote environmental sustainability.

Data Science and Digital Transformation

Our work in system identification and cryptography involves advanced data analysis and secure digital systems. This aligns with the beacon's goal to advance data science and facilitate digital transformation across various sectors.

Health and Wellbeing

Although not a direct focus, our research indirectly supports health and wellbeing by developing secure and efficient systems that can be applied in healthcare technologies, enhancing patient data security and system reliability.

By integrating our research with these beacons, we contribute to Maynooth University's strategic objectives of addressing complex global challenges through interdisciplinary collaboration.

END

John & Pat Hume Doctoral Awards 2025-2026

Department: Electronic Engineering

Supervisor: Dr Inbarasan Muniraj

Supervisor Email: inbarasan.muniraj@mu.ie

Title of Research Area:

Personalised Cancer Medicine via multimodal Optical 4D Imaging and artificial intelligence

Description of research areas supervisor is willing to accept applications in:

Early detection is crucial in cancer treatment because it significantly increases the chances of survival and successful recovery. Gold-standard cancer detection tests are often performed either on excised (biopsied) tissues or blood samples. Thus such approaches are known for causing discomfort to the patients for a longer period. Hence, detecting cancer using non-invasive, rapid technique are highly desired as it significantly improving the healthcare outcomes. Owing to the advantages such as non-invasive, early, and accurate diagnosis optical imaging systems are often preferred for cancer detection. Nevertheless, common imaging methods for cancer detection include Mammography, Ultrasound, CT, PET, and MRI have limitations, for instance, the usage of higher energy radiation, poor soft tissue contrast etc. Recently, it was discovered that molecules such as DNAs, RNAs, and other microorganisms that are present in the blood are also available and detectable in saliva. Thereafter, utilizing saliva as a cancer biomarker has gained wide attention as it is easy (also inexpensive) to collect samples with little or no discomfort. This non-invasive imaging technique allows for the visualization of cancer biomarkers that is set to become a key component of precision medicine with improved patient care. Thus, in this project, prospective applicant is aimed to develop a multimodal imaging system such as Hyperspectral Imaging, Microscopy and Raman Spectroscopy etc (Objective 1) to record spectral fingerprints from saliva samples. To automate the recorded image analysis and diagnosis, a bespoke deep learning architecture will be developed (Objective 2) to carry out an classification of samples.

How supervisor research areas align to Maynooth University research priority areas:

Multimodal imaging for cancer detection aligns closely with one of the MU's Strategic Plans i.e., Health and Wellbeing, by achieving early diagnosis, improving patient outcomes, and fostering interdisciplinary research. Additionally, the university encourages collaboration between biomedical researchers, clinicians, and data scientists, fostering a multidisciplinary environment that accelerates innovation. As a prospective applicant, this strategic alignment presents you with an opportunity to engage in transformative research, contribute to meaningful healthcare advancements, and be part of a university dedicated to shaping the future of cancer diagnostics and treatment through technological and scientific excellence. Furthermore, this project is also aligned with the objectives of The National Cancer Control Programme (NCCP) of Ireland, which aims to enhance early cancer detection, improve diagnostic accuracy, and optimize patient care. By leveraging advanced imaging technologies, this project supports the NCCP’s focus on timely diagnosis, reducing cancer mortality rates, and ensuring equitable access to high-quality cancer care services across Ireland.

END

John & Pat Hume Doctoral Awards 2025-2026

Department: Electronic Engineering

Supervisor: Dr Jahan Zeb Gul

Supervisor Email: jahanzeb.gul@mu.ie

Title of Research Area:

AI-Driven Bio-Inspired Soft Robots, Sensors & Actuators for Health Tech

Description of research areas supervisor is willing to accept applications in:

motivated students with backgrounds in mechanical/biomedical engineering, materials science, robotics, with AI knowledge (fine tunning LLMs, ML/DL models) , interested in interdisciplinary collaboration. Experience in prototyping, programming (Python, MATLAB, Microcontrollers), or biomaterials is valued, but curiosity and problem-solving skills are paramount. Projects will balance fundamental research (e.g., material characterization, biomechanics) with translational goals.

How supervisor research areas align to Maynooth University research priority areas:

Research in soft robotics, sensors, and biomedical devices directly aligns with MU's focus on healthcare innovation and AI-driven technologies. Integrated sensors in soft robotic systems enable real-time monitoring of vital signs and adaptive responses, enhancing patient safety and precision in diagnostics . The use of AI optimizes design and functionality, ensuring ethical, human-centric solutions , while biohybrid systems align with MU's vision for interdisciplinary research bridging biology and engineering . This work supports MU's commitment to societal impact through technologies that improve quality of life.

END

John & Pat Hume Doctoral Awards 2025-2026

Department: Electronic Engineering

Supervisor: Dr Joel Ferguson

Supervisor Email: Joel.Ferguson@mu.ie

Title of Research Area:

Development of a Novel Control Strategy for a Wave Energy Converter

Description of research areas supervisor is willing to accept applications in:

Wave energy is a promising source of renewable energy, offering a vast and largely untapped resource for sustainable power generation. However, the efficient extraction of electrical energy from ocean waves presents significant technical challenges, particularly in optimizing power capture while ensuring the structural integrity and longevity of Wave Energy Converters (WECs).

This research focuses on developing a novel control strategy for a WEC to maximize energy capture, improve reliability, and enhance overall performance in varying sea conditions. Traditional control approaches often struggle with the nonlinear and stochastic nature of ocean waves, leading to suboptimal energy conversion efficiency. By integrating advanced control techniques based on machine learning, this research aims to dynamically adjust the WEC's response to incoming waves in real-time.

Key aspects of the study include:

- Hydrodynamic modelling: Understanding the interaction between the WEC and ocean waves through numerical simulations and experimental validation.
- Control system development: Designing and implementing an optimal control algorithm that accounts for wave forecasting, power take-off dynamics, and structural constraints.
- Performance evaluation: Assessing the efficiency and robustness of the control strategy under realistic wave conditions.

By improving the ability of WECs to adapt to changing wave environments, this research will contribute to the commercialization of wave energy by increasing energy yield and reducing operational costs. The outcomes of this work have the potential to enhance the feasibility of wave energy as a reliable and competitive renewable energy source.

How supervisor research areas align to Maynooth University research priority areas:

Developing a novel control strategy for a Wave Energy Converter (WEC) aligns with several of Maynooth University's research strengths as outlined in its Strategic Plan 2023-2028 as follows

- Sustainability and Climate Change: The research directly contributes to sustainable energy solutions by enhancing the efficiency of wave energy conversion, thereby supporting global efforts to mitigate climate change.
- Data and Digital Transformation: The project incorporates advanced control techniques based on machine learning which rely on sophisticated data analysis and real-time processing.

This integration exemplifies the application of digital technologies to optimize renewable energy systems.

- Health and Wellbeing: While not directly related to health, the development of sustainable energy sources like wave energy can lead to broader societal benefits, including improved public health outcomes through reduced pollution and enhanced energy security.

By aligning with these interdisciplinary research beacons, the proposed study supports Maynooth University's goal to position itself as a leader in research excellence and to address contemporary and future challenges through focused investment in defined research areas.

END

John & Pat Hume Doctoral Awards 2025-2026

Department: Electronic Engineering

Supervisor: Dr John Dooley

Supervisor Email: john.dooley@mu.ie

Title of Research Area:

AI-Powered Approaches for Sustainable Cellular Network Management

Description of research areas supervisor is willing to accept applications in:

The EU Green Deal aims to achieve net-zero greenhouse gas emissions by 2050, presenting a significant challenge for the expansion of wireless coverage in remote areas. Traditional methods of network deployment and management are often energy-intensive, making it difficult to meet the stringent sustainability targets set by the Green Deal. This PhD topic explores the potential of AI-driven prediction and management techniques to address these challenges and facilitate the sustainable roll-out of cellular networks in remote regions.

AI-driven solutions can optimize various aspects of cellular network operations, from traffic prediction and load balancing to energy-efficient resource allocation. By leveraging machine learning algorithms, networks can dynamically adjust to changing conditions, ensuring optimal performance while minimizing energy consumption. For instance, AI can predict periods of high and low traffic, allowing networks to scale resources accordingly and reduce energy usage during off-peak times.

This industry informed PhD research will investigate the effectiveness of various AI-driven approaches in achieving sustainable cellular network management, with a focus on remote areas. The goal is to develop and validate models that can be implemented in real-world scenarios, contributing to the broader objectives of the EU Green Deal and paving the way for a greener, more connected future.

How supervisor research areas align to Maynooth University research priority areas:

Sustainability: The PhD topic proposes AI-driven techniques to optimize network operations, reduce energy consumption, and facilitate a sustainable roll-out of cellular networks, aligning with the Green Deal's sustainability targets.

Research Impact: The research has significant potential for impact by addressing a critical challenge in achieving the EU Green Deal's objectives. By developing AI-driven solutions for energy-efficient network management, the research can contribute to reducing greenhouse gas emissions and promoting sustainable practices in the telecommunications industry. The successful implementation of these models could lead to widespread adoption and substantial environmental benefits.

Engagement and Partnerships: The PhD research is industry-informed through collaboration with industry partners. Ireland has an ecosystem of world leading companies in this field. These engagements will ensure that the research is aligned with real-world needs and challenges, fostering partnerships that can enhance the relevance and applicability of the findings.

Internationalisation: The research aligns with internationalisation by addressing a global challenge—the expansion of wireless coverage in remote areas while meeting sustainability targets. This has the potential for global application, benefiting countries and regions beyond the EU. One immediate use case is e-Health provision in rural regions for developing countries.

END

John & Pat Hume Doctoral Awards 2025-2026

Department: Electronic Engineering

Supervisor: Prof John Ringwood

Supervisor Email: john.ringwood@mu.ie

Title of Research Area:

Simple controllers for wave energy systems based on test responses (Keywords: Wave energy; control systems; machine learning)

Description of research areas supervisor is willing to accept applications in:

While wave energy potentially provides an abundant form of clean renewable energy, it has yet to be exploited commercially. Nevertheless, wave energy has very appealing characteristics, particularly when combined with other renewable resources, and could be an important component of a reliable renewable energy system. One of the key reasons for the poor commercial penetration of wave energy is it relatively high cost, in comparison to other renewables, such as wind and solar. A potential game changer in the drive to bring down the cost of wave energy is the application of advanced intelligent control technology, which can improve power capture by a factor of 2-3, significantly improving commercial viability.

However, one of the impediments to the successful application of control technology on commercial systems is the complexity of most current wave energy controllers, also requiring significant background research to develop the mathematical models upon which the control design is based. A further complication is that the mathematical (hydrodynamic) models themselves are prone to significant errors. This project proposes a new approach, which is to develop intuitive and relatively simple controllers based on the response of a wave energy system to some standard test signals. Such a data-based approach considered the actual system dynamics, rather than a mathematical model developed from first principles. Such approaches have been shown to have significant success in other application areas, such as process control, where the simplicity of design, and intuitive appeal of the controllers, have played no small part in their widespread adoption and successful application.

Reference:

Pasta, E., Faedo, N., Mattiazzo, G. and Ringwood, J.V. Towards data-driven and data-based control of wave energy systems: Classification, overview and critical assessment, Renewable and Sustainable Energy Reviews, Vol.188, Paper 113877, pp 1-20, 2023.

How supervisor research areas align to Maynooth University research priority areas:

The Centre for Ocean Energy Research (COER) is a designated research centre of MU, with considerable impact, nationally and internationally. The project focusses on the development of tools and techniques to support the development of wave energy, which is practically underdeveloped clean energy source. Crucially, Ireland has an abundance of wave energy, but currently 0% of this is utilized due to the high levelised cost of wave energy (LCoWE). This project specifically targets LCoWE, adopting a techno-economic optimization approach to

increase the commercial penetration of wave energy. This aspiration is in line with the MU Strategic plan 2024-2029, with specific alignment to the ‘Sustainability and Climate Change’ research beacon.

END

John & Pat Hume Doctoral Awards 2025-2026

Department: Electronic Engineering

Supervisor: Dr Mubasher Saleem

Supervisor Email: mubasher.saleem@mu.ie

Title of Research Area:

Energy-Efficient MEMS and Nanotechnology-Based Sensors for IoTs, Robotics, and Environmental Monitoring

Description of research areas supervisor is willing to accept applications in:

We invite highly motivated PhD candidates to join our cutting-edge research in MEMS and nanotechnology-based sensors and devices, driving the future of intelligent, energy-efficient sensing technologies. This research focuses on developing next-generation, ultra-low-power sensors that seamlessly integrate with AI and edge computing, enabling transformative applications in robotics, IoTs, and environmental monitoring. A key aspect of this work is pioneering AI-driven, low-power signal processing techniques that significantly reduce computational overhead, allowing MEMS and nanotechnology sensors to operate with exceptional energy efficiency and real-time responsiveness. These advancements will be instrumental in enabling autonomous systems, smart environments, and adaptive robotics, paving the way for intelligent and secure sensing solutions across multiple domains.

Potential candidates will have the opportunity to work on sensor applications in diverse fields. In robotics, research may focus on MEMS and nanoelectronics-based tactile sensors for robotic surgery, enhancing haptic feedback and precision for minimally invasive procedures. Other areas of interest include MEMS and nanotechnology-based sensors for soft robotics and bio-hybrid robots, enabling adaptive, flexible, and highly sensitive artificial skin for human-robot interaction, dexterous manipulation, and next-generation prosthetics. In IoTs, candidates may explore MEMS and nanotechnology-based sensors for self-powered and battery-less IoT devices, leveraging energy harvesting techniques such as triboelectric and piezoelectric nanogenerators to enable ultra-low-power sensing networks for smart cities, wearable electronics, and next-generation distributed sensor networks. For environmental monitoring, research can involve photonics and MEMS-based sensors for real-time, high-resolution air quality and greenhouse gas (GHG) monitoring, integrating nanophotonic techniques and multi-spectral sensing for highly sensitive detection of pollutants, including ultrafine particulate matter (PM), volatile organic compounds (VOCs), and carbon emissions, enabling smart environmental surveillance and climate impact assessment. Additionally, candidates can focus on secure sensor architectures using Physically Unclonable Functions (PUFs) for quantum-resistant, hardware-based security, integrating MEMS-based PUFs to develop ultra-secure, anti-counterfeit, and tamper-proof sensor networks for next-generation IoT, autonomous vehicles, and cyber-physical systems. Research will explore innovative MEMS structures to create high-entropy, unclonable security keys, addressing growing concerns in edge device authentication, privacy protection, and secure data transmission in interconnected smart systems.

The ideal candidate should have experience or a strong interest in MEMS and nanotechnology-based sensor development with applications in robotics, IoTs, environmental monitoring, energy-efficient computing, or secure hardware architectures.

This PhD opportunity provides access to cutting-edge research facilities, interdisciplinary collaboration, and real-world applications in next-generation smart sensing technologies. If you are passionate about developing innovative sensor solutions, we encourage you to apply.

For inquiries, please contact us at Mubasher.saleem@mu.ie

How supervisor research areas align to Maynooth University research priority areas:

The research focus on energy-efficient MEMS and nanotechnology-based sensors aligns closely with Maynooth University's Strategic Plan 2023–2028, particularly in its core research strengths in Data and Digital Transformation, Health and Wellbeing, and Sustainability and Climate Change. The development of advanced sensors for robotics, IoTs, and environmental monitoring contributes directly to these priority areas by enabling intelligent, energy-efficient solutions in healthcare technologies, autonomous systems, and environmental sustainability.

This research also aligns with the University’s emphasis on international collaboration and industry engagement. As part of the project, research collaborations will be established with leading research groups and organizations specializing in MEMS and nanotechnology-based devices, ensuring access to state-of-the-art fabrication techniques, testing facilities, and real-world applications. These partnerships will enhance Maynooth University's global research impact, fostering knowledge exchange and innovation in emerging technologies.

Additionally, the University's commitment to student-centered learning and digital literacy is supported by this research, as PhD candidates will engage in hands-on, interdisciplinary training in AI-driven sensor design, photonics, and secure hardware architectures. The project’s focus on next-generation smart sensing technologies will also contribute to engagement and partnerships with industry, healthcare, and environmental agencies, reinforcing Maynooth’s mission to drive research excellence and societal impact.

END

John & Pat Hume Doctoral Awards 2025-2026

Department: Electronic Engineering

Supervisor: Dr Mustafa Kishk

Supervisor Email: mustafa.kishk@mu.ie

Title of Research Area:

Underwater Wireless Networks: A Percolation Theory-based Modeling, Analysis, and Design

Description of research areas supervisor is willing to accept applications in:

Students interested in wireless communications or mathematics are specially welcome to apply for this project. Underwater wireless networks are of significant importance in many sectors such as ocean monitoring, environment protection, defense and security, oil and gas industry, search and rescue missions, and smart fish farming, to name a few. Utilizing mathematical techniques to design such networks in a smart and efficient manner that maximizes performance while saving costs is the main objective of this project.

How supervisor research areas align to Maynooth University research priority areas:

The project aligns with multiple MU research beacons, specially :

* Data and Digital Transformation: Having a reliable underwater wireless network is vital to collecting sufficient data andd having a healthy digital presence in the underwater world.

* Sustainability and Climate Change: Exploiting the monitoring and screening capabilities of underwater wireless networks is vital to saving the underwater and maritime world from the effects of climate change.

END

John & Pat Hume Doctoral Awards 2025-2026

Department: Electronic Engineering

Supervisor: Dr Zain Anwar Ali

Supervisor Email: zainanwar.ali@mu.ie

Title of Research Area:

AI-Driven Sustainable Agriculture and Precision Farming

Description of research areas supervisor is willing to accept applications in:

I invite applications from students passionate about the convergence of artificial intelligence, machine learning, and sustainable agriculture. My research is committed to harnessing the transformative potential of AI-driven technologies to tackle critical agricultural challenges, such as early disease detection, precision resource management, and climate-resilient farming practices. My proposed research aims to enhance agricultural efficiency, reduce environmental impact, and contribute to global food security by integrating deep learning, computer vision, and IoT-based automation.

The field of AI-driven sustainable agriculture offers immense possibilities, particularly in the development of intelligent disease detection models, real-time crop health assessment systems, and AI-powered decision support tools that optimize farm operations. My research seeks to revolutionize farming practices while ensuring ecological balance by applying smart irrigation systems, AI-driven soil health monitoring, and sustainable pest and weed management strategies. In precision farming, I focus on utilizing AI, IoT, and remote sensing technologies to enhance yield prediction, develop autonomous farming solutions, and create scalable AI-powered frameworks adaptable to diverse agricultural environments. Furthermore, my research emphasizes big data analytics, deep learning-driven pattern recognition, and transformer-based architectures to drive advancements in agricultural automation and sustainability.

Students under my supervision will have the opportunity to work on innovative, interdisciplinary research that integrates AI with real-world agricultural applications. Potential research areas include AI-powered plant disease diagnostics, IoT-enabled smart farming systems, and AI-driven climate adaptation models. I welcome applications from individuals with backgrounds in artificial intelligence, machine learning, computer vision, agriculture, or environmental sciences who aspire to develop cutting-edge, data-driven solutions for sustainable farming. If you are eager to explore the role of AI in shaping the future of agriculture and environmental sustainability, I look forward to collaborating with you on impactful research initiatives.

How supervisor research areas align to Maynooth University research priority areas:

Maynooth University's Strategic Plan 2023–2028 emphasizes enhancing research excellence, fostering innovation, and addressing global challenges through interdisciplinary collaboration. The plan identifies sustainability and climate change as key areas for focused research, aiming to position the university among global leaders in these fields. strategy.maynoothuniversity.ie

The research area of AI-driven sustainable agriculture and precision farming aligns seamlessly with these strategic objectives. By integrating artificial intelligence, machine learning, and data analytics into agricultural practices, this research addresses critical issues such as food security, environmental sustainability, and efficient resource management. These topics are central to global sustainability and climate change challenges, which the university aims to tackle through its research initiatives.

Moreover, the strategic plan emphasizes the importance of aligning research endeavors with national and European funding priorities. AI-driven sustainable agriculture aligns with these priorities, as both national and European agendas increasingly focus on leveraging technology to enhance agricultural productivity and sustainability. Engaging in this research area positions Maynooth University to secure funding and contribute to policy developments in sustainable agriculture.strategy.maynoothuniversity.ie

Additionally, the university's commitment to interdisciplinary research is reflected in the establishment of Futures Institutes focused on data and digital transformation, health and wellbeing, and sustainability and climate change. Research in AI-driven sustainable agriculture inherently involves collaboration across these domains, fostering interdisciplinary partnerships that are central to the university's strategic vision.

END

John & Pat Hume Doctoral Awards 2025-2026

Department: Electronic Engineering

Supervisor: Dr Zhu Diao

Supervisor Email: zhu.diao@mu.ie

Title of Research Area:

Investigating Biomechanics Using Thermal Fluctuation Spectroscopy (TFS)

Description of research areas supervisor is willing to accept applications in:

The mechanical properties of biomaterials—including bending modulus, elasticity, and viscosity—are pivotal in medical and biological contexts. They dictate how materials interact with living tissues, influencing cellular adhesion, migration, and differentiation through mechanotransduction, the process by which cells detect and respond to physical stimuli. Conventional biomechanical characterisation methods, such as atomic force microscopy (AFM) and nanoindentation, often require invasive contact and external forces, risking structural perturbation or altered behaviour in delicate biological samples. In contrast, thermal fluctuation spectroscopy (TFS) offers a non-invasive alternative by analysing spontaneous motions driven by thermal energy. This powerful while versatile technique probes biomechanical properties through intrinsic thermal fluctuations, enabling precise measurements without disrupting the system's native state.

In this project, you will design and assemble a novel two-colour confocal laser TFS system in the biophotonics laboratory at Maynooth University. The system's innovative dual-mode design introduces two distinct measurement capabilities: (1) Co-Localised Dual-Channel Analysis: Aligning both laser spots at the same spatial position on the sample to perform cross correlation of the two colour channels. This allows the extraction of TFS signals from sample fluctuations several orders of magnitude below the shot-noise limit of the photodetector; (2) Spatially Offset Correlation Mapping: Separating the laser spots to measure spatial correlations in thermal fluctuations across different regions of a sample, enabling spatially resolved mechanical characterisation. This dual-mode configuration advances the TFS technology by integrating unprecedented displacement sensitivity with sub-micron spatial resolution, representing a significant development in the methodology. Once operational, the instrument will be utilised to characterise key biomaterials central to cutting-edge biomedical engineering research including liposomes, collagen gels, neuron axons, cytoskeletons, and red blood cells. The system will also probe how physiological conditions (e.g. pH, exogenous chemicals, mechanical stress) modulate the mechanical properties of these materials, linking biophysical behaviour to functional outcomes in health and disease.

How supervisor research areas align to Maynooth University research priority areas:

This project seeks to apply thermal fluctuation spectroscopy as an innovative technique for biomechanical studies. It aligns seamlessly with the overarching goals of the university's strategic plan on multiple fronts:

Development of Excellence in Biological and Biomedical Sciences: The university's strategic plan outlines ambitions to establish a school of health and medicine, coupled with an

expansion of research and teaching excellence in biological and biomedical sciences. The inclusion of “Health and Wellbeing” as a university-wide research beacon perfectly resonates with the objectives of the proposed project, placing it at the forefront of advancements in these domains.

Real-World Impact and Innovation: Aligned with the strategic plan’s emphasis on enhancing the real-world impact of research endeavours and fostering the commercialisation of innovations, the proposed project addresses a critical challenge in bioengineering. The prototype device being developed holds the promise of being a commercially viable product with tangible societal impact.

Support Research Students and Early-Career Researchers: The proposed project presents a valuable opportunity for a motivated student to gain hands-on experience in optics, bioengineering, and biomedical sciences. These skills are in great demands in the Irish job market, aligning with the government’s efforts to foster a well-equipped talent pool in these sectors.

END

John & Pat Hume Doctoral Awards 2025-2026

Department: Electronic Engineering

Supervisor: Dr Vahid Fakhari

Supervisor Email: Vahid.Fakhari@mu.ie

Title of Research Area:

Development of a Novel Control Strategy for a Wave Energy Converter

Description of research areas supervisor is willing to accept applications in:

Wave energy is a promising source of renewable energy, offering a vast and largely untapped resource for sustainable power generation. However, the efficient extraction of electrical energy from ocean waves presents significant technical challenges, particularly in optimizing power capture while ensuring the structural integrity and longevity of Wave Energy Converters (WECs).

This research focuses on developing a novel control strategy for a WEC to maximize energy capture, improve reliability, and enhance overall performance in varying sea conditions. Traditional control approaches often struggle with the nonlinear and stochastic nature of ocean waves, leading to suboptimal energy conversion efficiency. By integrating advanced control techniques based on machine learning, this research aims to dynamically adjust the WEC's response to incoming waves in real-time.

Key aspects of the study include:

- Hydrodynamic modelling: Understanding the interaction between the WEC and ocean waves through numerical simulations and experimental validation.
- Control system development: Designing and implementing an optimal control algorithm that accounts for wave forecasting, power take-off dynamics, and structural constraints.
- Performance evaluation: Assessing the efficiency and robustness of the control strategy under realistic wave conditions.

By improving the ability of WECs to adapt to changing wave environments, this research will contribute to the commercialization of wave energy by increasing energy yield and reducing operational costs. The outcomes of this work have the potential to enhance the feasibility of wave energy as a reliable and competitive renewable energy source.

How supervisor research areas align to Maynooth University research priority areas:

Developing a novel control strategy for a Wave Energy Converter (WEC) aligns with several of Maynooth University's research strengths as outlined in its Strategic Plan 2023-2028 as follows

- Sustainability and Climate Change: The research directly contributes to sustainable energy solutions by enhancing the efficiency of wave energy conversion, thereby supporting global efforts to mitigate climate change.
- Data and Digital Transformation: The project incorporates advanced control techniques based on machine learning which rely on sophisticated data analysis and real-time processing.

This integration exemplifies the application of digital technologies to optimize renewable energy systems.

- Health and Wellbeing: While not directly related to health, the development of sustainable energy sources like wave energy can lead to broader societal benefits, including improved public health outcomes through reduced pollution and enhanced energy security.

By aligning with these interdisciplinary research beacons, the proposed study supports Maynooth University's goal to position itself as a leader in research excellence and to address contemporary and future challenges through focused investment in defined research areas.

END

Department of Mathematics and Statistics

John & Pat Hume Doctoral Awards 2025-2026

Department: Mathematics and Statistics

Supervisor: Dr Christian Ketterer

Supervisor Email: christian.ketterer@mu.ie

Title of Research Area:

Geometry and analysis of nonsmooth spaces with synthetic Ricci curvature bounds

Description of research areas supervisor is willing to accept applications in:

The concept of synthetic lower Ricci curvature bounds provides a powerful framework for extending ideas from Riemannian geometry to more general metric and metric measure spaces. Traditionally, Ricci curvature of a Riemannian manifold is derived as the trace of its curvature tensor. It plays a crucial role in controlling geometric and analytic properties, like volume growth, heat diffusion, and eigenvalue estimates of the Laplace operator.

The synthetic approach seeks to generalize these insights beyond smooth manifolds, making sense of lower Ricci bounds in spaces where classical differential structures may not exist. A breakthrough in this direction is the curvature-dimension condition, CD(K,N), formulated by Lott-Sturm-Villani, which links Ricci curvature lower bounds to entropy and optimal transport theory.

Recently, this approach to lower Ricci curvature bounds was extended to the Lorentzian setting, allowing a synthetic treatment of Einstein's field equations in general relativity.

One of the main reasons synthetic Ricci curvature bounds are of interest is their ability to unify and extend results from smooth geometry to non-smooth spaces, including Alexandrov spaces and Gromov-Hausdorff limits of Riemannian manifolds.

Applications include stability theorems for geometric inequalities. For instance, the classical Lichnerowicz inequality asserts that a positive lower bound on the Ricci curvature of a closed manifold implies a sharp lower bound for the first nonzero eigenvalue of the Laplacian. This property is preserved in the larger class of nonsmooth spaces with synthetic Ricci curvature bounds. Moreover, Obata's theorem states that the equality case in Lichnerowicz' estimate characterizes the round sphere. In my previous contributions I showed that the synthetic analog of this theorem allows also other model spaces, so called warped products, and these spaces appear as limits of sequences of smooth manifolds that almost satisfy the extremal case.

How supervisor research areas align to Maynooth University research priority areas:

Since fundamental contributions of Milnor, Cheeger and Gromov, the study of spaces with lower Ricci curvature bounds is a highly active research area connecting fields like differential geometry, analysis, topology and probability. By fostering the development of new mathematical knowledge and techniques in this field, this research supports the University's commitment to advancing fundamental research, helping to position the institution as a globally recognized leader in research excellence.

Through optimal transport and spectral analysis Ricci curvature bounds have deep connections with data science and artificial intelligence. These tools are increasingly relevant in applications such as machine learning, image processing, and network analysis. By exploring geometric structures underlying high-dimensional data spaces, this research aligns with Maynooth's emphasis on Data and Digital Transformation, contributing to both foundational theory and computational applications.

The field is highly international, involving collaborations of myself with leading researchers in geometry, analysis and optimal transport, such as Andrea Mondino (Oxford) and Robert McCann (Toronto). These connections support Maynooth's commitment to building strong global research partnerships.

END

John & Pat Hume Doctoral Awards 2025-2026

Department: Mathematics and Statistics

Supervisor: Dr Ciarán Mac an Bhaird

Supervisor Email: ciaran.macanbhaird@mu.ie

Title of Research Area:

Embedding History into the Teaching of Mathematics and Statistics

Description of research areas supervisor is willing to accept applications in:

I am interested in projects related to Mathematics Education generally. More specifically, ideas relating to the History of Mathematics, for example how it is included in the teaching of mathematics and statistics at all levels in Ireland and internationally. This could be in the context of initial teacher education, designing and implementing innovative teaching materials, taking a critical perspective on the role history of mathematics plays in our mathematics classrooms, and society more broadly, or some combination of these. This could also link to making mathematical curricula more diverse and inclusive, increasing student and teacher awareness of the rich mathematical heritage and contributions of all peoples and cultures. For example, embedding student and teacher engagement with library collections and exhibitions, providing extra context to the topics they are investigating in class.

Depending on the direction a project might take, there is considerable scope for an interdisciplinary collaboration with the Department of Education at Maynooth University. This could expand the range of focuses to include using Lesson Study as a vehicle to enact change within schools, commentary on subject specifications and curricular reforms, and how history of mathematics is perceived by practicing teachers and students in Ireland, with a view to comparing this with similar international studies.

How supervisor research areas align to Maynooth University research priority areas:

There is increasing international impetus to investigate the use of the history of mathematics (HoM) and science in both teacher training and in the teaching of mathematics and science at all educational levels. Maynooth University is ideally positioned in Ireland to lead this research due to its leadership in teacher training and its championing of HoM research. This is recognized at an international level with an invitation to be the Irish representative on a 2024 Europe-wide 'COST ACTION' funding application related to the use of HoM in teaching (decision due May 2025).

This PhD project will continue to promote Maynooth's unparalleled heritage in mathematics and science teaching and research using our unique scientific texts and archives. Furthermore, this interdisciplinary research has the potential to have a significant impact on national and international policies in relation to the teaching and learning of mathematics and science. Due to the current reviews of second level curricula, this project is particularly timely.

Preliminary studies suggest that exposure to the history and development of ideas and topics with STEM can transform student attitudes towards and engagement with these subjects,

resulting in improved student wellbeing and satisfaction as well as having an obvious positive societal impact.

END

John & Pat Hume Doctoral Awards 2025-2026

Department: Mathematics and Statistics

Supervisor: Prof David Malone

Supervisor Email: david.malone@mu.ie

Title of Research Area:

Mathematical Analysis of Computers and Networks, particularly security, passwords, etc.

Description of research areas supervisor is willing to accept applications in:

I am interested in understanding computers and computer networks, particularly if there is a mathematical angle on understanding them. My previous research students have worked on security, privacy and usability Web Services, the performance of hash functions, understanding passwords and the advice we give people about them, energy usage of online services (including Bitcoin), analysing data from social networks/software development/software teams, measuring different aspects of the Internet, making WiFi perform better.

I am also interested in the history of STEM subjects at the Leaving Cert, particularly mathematics, and have built an archive of the state exams in this area.

You can find find many of my papers on Google Scholar, if you want to see more detail on what my research looks like: https://scholar.google.com/citations?user=Dxnd85UAAAAJ&hl=en

How supervisor research areas align to Maynooth University research priority areas:

Much of my work fits under the "Data and Digital Transformation" beacon, where the performance and security of computers and networks is important to the improvement and continuation of much data processing. I would also have some links to the "Sustainability and Climate Change" beacon, through my interest in energy consumption of computer networks. Some of my work on computer time keeping and the leaving cert has limplcations for "Society and Public Policy". Of course, I am to produce high quality research outputs and have impact - my work on WiFi modelling has had academic impact and my work on Bitcoin energy consumption has had policy impact and my work on the Leaving cert has had energy impact.

END

Department of Physics

John & Pat Hume Doctoral Awards 2025-2026

Department: Physics

Supervisor: Dr Graham Kells

Supervisor Email: graham.kells@mu.ie

Title of Research Area:

Solving the quantum postselection problem using replica density matrices and tensor networks

Description of research areas supervisor is willing to accept applications in:

The measurement problem sits at the heart of quantum mechanics, and recent years have seen growing interest in how continuous measurements affect complex quantum systems. Unlike classical measurements that passively observe, quantum measurements fundamentally alter the system being studied. This interplay can create exotic phase transitions, where varying measurement rates dramatically change how quantum information propagates through the system.

To model how measurements affect complex systems, researchers have developed many important methodologies. Among these, master equations (ME) and quantum trajectories have proven particularly influential. The ME approach evolves an averaged quantum state with probabilistic uncertainties incorporated from the outset, while quantum trajectories track ensembles of pure quantum states that evolve stochastically.

Though quantum trajectories provide direct insight into measurement-induced phase transitions by simulating individual measurement sequences, they present significant computational and experimental challenges. Our research focuses on developing “replica master equations” as a powerful alternative. This method creates deterministically evolving, correlated copies of the quantum system, offering access to key metrics like Renyi entropies that characterise different phases while circumventing limitations of trajectory approaches.

The primary challenge lies in managing what is called the infinite hierarchy of replicated systems. Our project develops practical truncation methods that preserve essential physical properties while making computations feasible. We also aim to implement these replica calculations within the Matrix Product States (MPS) framework—a powerful technique for representing quantum many-body states.

This research explores this interdisciplinary frontier, investigating complex many-particle dynamics, exotic quantum phases, and the control of quantum behaviour in and out of equilibrium. Students joining this research will gain expertise in quantum dynamics, many-body systems, and cutting-edge classical and quantum algorithms. The work offers opportunities to develop both theoretical understanding and practical computational skills highly relevant to quantum computing and quantum simulation.

How supervisor research areas align to Maynooth University research priority areas:

This research on quantum measurement and many-body quantum systems directly advances the University's beacon of Data and Digital Transformation. The replica approach and Matrix Product States methods we're developing represent cutting-edge computational techniques

that bridge classical and quantum information processing. These novel algorithms tackle fundamental challenges in simulating complex quantum systems that conventional computing approaches cannot efficiently address.

Our work contributes to the quantum computing ecosystem—a key frontier in digital transformation—by developing more efficient ways to model and predict quantum behaviour. The computational frameworks we're building have potential applications in quantum machine learning and quantum information processing, areas that promise to revolutionize data science and computation.

Additionally, this research indirectly supports the University's Sustainability and Climate Change beacon. More efficient quantum simulation tools enable better modelling of quantum materials and chemical processes critical for developing next-generation energy storage solutions, more efficient catalysts, and improved fertilizers. These applications could significantly reduce energy consumption and environmental impact across various industries.

By training students at this intersection of quantum physics and computational methods, we're developing human capital equipped to lead in both academic research and industry innovation, particularly in quantum technologies—a field recognized globally for its transformative potential in addressing computational and sustainability challenges.

END

John & Pat Hume Doctoral Awards 2025-2026

Department: Physics

Supervisor: Dr James McGrath

Supervisor Email: james.mcgrath@mu.ie

Title of Research Area:

Investigating Indoor Aerosol Dynamics: Characterising Sources, Examining Dispersion and Removal Mechanisms

Description of research areas supervisor is willing to accept applications in:

Ultrafine particles have a diameter smaller than 100 nm and are a significant yet poorly understood component of indoor air pollution, despite being the largest contributors to airborne particles. Due to their unique physical characteristics, specialised equipment and techniques are necessary to measure them. Real-time monitoring is essential to understand particle behaviour, quantify their number and size, and determine the inhalation dose.

While research on outdoor UFPs has progressed significantly, several knowledge gaps remain concerning their behaviour and implications in indoor environments. Although key indoor sources of UFPs, such as cooking, combustion, and electronic devices, are acknowledged, there is still a gap in understanding their relative contributions and interactions compared to outdoor air. Furthermore, the effectiveness of different ventilation strategies and air filtration technology in removing UFPs remains unclear.

Indoor aerosol models often fail to accurately predict UFP behaviour due to a lack of sufficient model parameters data. This research project aims to bridge the gap between experimental measurements and predictive modelling to enhance our understanding of indoor aerosol dynamics. Detailed experiments will characterise indoor aerosol behaviour across different microenvironments by integrating real-time monitoring, controlled and real-world experiments, into computational simulations. The study will employ high-resolution particle counters and advanced numerical models to investigate key parameters such as particle size distributions, residence times, and deposition rates for particles ranging from nanometres to microns. These models will assess exposure risks under different indoor conditions and propose optimised ventilation strategies for improving air quality while maintaining energy efficiency.

How supervisor research areas align to Maynooth University research priority areas:

This proposed area of research aligns excellently with four of Maynooth University's five research beacons identified in the Strategic Plan 2023-2028: 'Health and Wellbeing', 'Sustainability and Climate Change', 'Data and Digital Transformation', and 'Society and Public Policy'. It further complements the Research Institutes and Centres, particularly the 'ICARUS Climate Research Centre', the 'Kathleen Lonsdale Institute for Human Health Research', and the 'Hamilton Institute'. These collaborative groups possess extensive expertise in climate change adaptation, decarbonisation of energy systems, sustainability, and the impacts of innovation on the environment and health, as well as virology and drug delivery. Through its

multifaceted approach, the research project will bolster health protection, sustainability, climate change mitigation, and collaborative efforts, all of which are integral components of Maynooth University's Research Institutes and Centres.

This research facilitates novel investigations to aid Ireland's transition to a sustainable, low-carbon economy by addressing the complex issues at the energy-health-policy nexus. It will support interdisciplinary research, a key focus of the Strategic Plan, and align with the National Research Priority Areas, ensuring that it promotes national interests and enhances Maynooth University's reputation both nationally and internationally.

END

John & Pat Hume Doctoral Awards 2025-2026

Department: Physics

Supervisor: Dr John Regan

Supervisor Email: john.regan@mu.ie

Title of Research Area:

Astrophysics of Black Holes

Description of research areas supervisor is willing to accept applications in:

Massive Black Holes are found at the centres of almost all galaxies. Moreover, they are found out to very high redshifts (early Universe). My research focuses on computational modelling of the formation of massive black holes and in particular understanding the origin of massive black holes. Interpreting current observations with JWST as well as future measurements with LISA (GW observatory) is particular focus.

How supervisor research areas align to Maynooth University research priority areas:

My research aligns with the University research beacon: Data and Digital Transformation. My research is heavily focused on computational modelling, machine learning and high performance computing.

END

John & Pat Hume Doctoral Awards 2025-2026

Department: Physics

Supervisor: Dr Jon-Ivar Skullerud

Supervisor Email: jonivar.skullerud@mu.ie

Title of Research Area:

The concept of a particle in quantum field theory

Description of research areas supervisor is willing to accept applications in:

The proposed research will analyse various aspects of the basic concepts behind our current theories of fundamental physics, written in the language of quantum field theory, and in particular the notion of a particle. Some possible topics include:

1. Confinement of quarks and its implications for the atomist worldview: According to our current understanding, protons, neutrons and their relatives are composite particles containing elementary constituents called quarks. However, quarks are confined, which means they can never exist outside bound states and their properties are fundamentally changed by their interactions. The nature and even definition of confinement is disputed. This project will explore the different proposed definitions of confinement and their implications, and also the extent to which the phenomenon of confinement challenges the ideas of atomism.
2. Particles in quantum field theory are described as states (excitations) of universal quantum fields. In general, such states may be nonlocal, and states with indefinite particle number are allowed. How does this affect the concept of a particle?
3. Much of the common understanding and most popular accounts of quantum field theory, including Feynman diagrams, are based on the perturbative approach which assumes the interactions to be weak and expands in powers of the coupling. This approach is known to fail to describe a number of important phenomena (including confinement), and may

even be fundamentally invalid. How does this affect our interpretation of the theory, including the notion of a particle.

4. Discussions of the philosophy of quantum mechanics are usually based on nonrelativistic quantum mechanics. What (if anything) changes if we take quantum field theory as the foundation, given that it is assumed to be a more fundamental theory? For example, is there a measurement problem in quantum field theory?

How supervisor research areas align to Maynooth University research priority areas:

This research aligns strongly with the focus in the Strategic Plan on interdisciplinary research. It sits at the intersection of physics, metaphysics and philosophy of science and involves staff from the departments of Physics and Philosophy. It may also involve elements of pure and applied mathematics, further fostering cross-disciplinary research initiatives.

Furthermore, it aligns with the Strategic Plan aims to "build on our long history of research excellence across a wide range of disciplines" and "enable reflection on ideas and use of imagination to develop new insights". It will build on the long-standing excellence of the university in the area of fundamental physics and its long philosophical tradition, and reflect on our theories of physics to enhance our understanding of the fundamental properties of nature. The research not only contributes to the philosophical understanding of modern physics but also engages with wider discussions about science's role in shaping our worldview, potentially influencing areas such as ethics, technology, and public policy.

END

John & Pat Hume Doctoral Awards 2025-2026

Department: Physics

Supervisor: Dr Marcin Lukasz Gradziel

Supervisor Email: Marcin.Gradziel@mu.ie

Title of Research Area:

Spectro-interferometric extraction of B-mode polarisation of the CMB using the QUBIC instrument

Description of research areas supervisor is willing to accept applications in:

The Cosmic Microwave Background (CMB), relic radiation from the Big Bang, is of considerable interest in modern cosmology, as it offers one of the few windows for exploring the very early evolution of our Universe. It comes to us from all directions and is quite uniform in its temperature. Importantly, it is not completely uniform, and it contains very faint temperature and polarization features, or anisotropies, imprinted on it in the early Universe. Quantifying them provides

evidence that can be used to differentiate between cosmological models of the early Universe.

Observationally, the challenge associated with that task is twofold. Firstly, the observations must be made at much longer wavelengths than visible light, because of the very low temperature of CMB. The technology for that is still maturing. Secondly, the accuracy in mapping the CMB that is required for scientific progress continues to increase. Early missions like COBE and WMAP provided information about the CMB that stimulated development of more ambitious CMB mapping instruments. The European Space Agency's Planck satellite most recently measured the temperature anisotropies to fundamental limits.

The next ambitious goal for CMB astronomy is to detect and map very faint polarization patterns on the CMB, known as the primordial B-modes. It is expected that gravitational waves produced in the very early Universe produced such polarization. Convincingly detecting (or not!) primordial B-modes will help to answer fundamental questions in cosmology.

The Q & U Bolometric Interferometer for Cosmology (QUBIC) is a novel ground-based telescope that is designed to measure the B-modes. QUBIC uses a novel technique – bolometric interferometry. Its success depends on exquisite sensitivity and control of instrumental systematic errors.

We aim to contribute to this goal through development of accurate models of the instrument, particularly in novel spectro-interferometric mode of operation, using HPC and Machine Learning, where appropriate.

How supervisor research areas align to Maynooth University research priority areas:

This research area is embedded in the wider work of the Space Terahertz Optics group at the Maynooth University Department of Physics. The group has a heritage of work on CMB missions, spanning decades and including QUAD, Planck, MBI, and now QUBIC. The project will build on the acknowledged research and teaching strengths of the Department, both computational and

experimental, as reflected in its strategic plan. Recent merger of the departments of Experimental Physics and Theoretical Physics, into Department of Physics, brought together Astronomy and Astrophysics expertise from both units, with more than half staff members active in this particular area. This also ties in with out popular Physics with Astrophysics undergraduate programme.

The proposed project is also aligned with the wider Strategic goal of the University, of “improving research outputs and impacts across all areas of the University and position MU among global leaders in our selected beacons of research excellence”. The beacon with particular synergy is that of “Data and Digital Transformation”. Model-driven and machine-learning-driven data generation and processing is expected to be an essential, value-adding component of this project.

END

John & Pat Hume Doctoral Awards 2025-2026

Department: Physics

Supervisor: Dr Michelle McCrystall

Supervisor Email: michelle.mccrystall@mu.ie

Title of Research Area:

Polar climate change; its key drivers and consequences

Description of research areas supervisor is willing to accept applications in:

My research focuses on climate change within the polar regions examining both its causes and consequences. The polar regions, in particular the Arctic, is experiencing some of the most rapid shifts in climate relative to the rest of the planet such as warming almost four times as fast. Such drastic changes can have significant consequences both in the polar regions but also further afield.

As part of this research area, I explore how changes in global climate impact and drive changes in polar climate therefore impacting temperatures and sea ice changes and vice versa, how Arctic climate shifts have the potential to impact weather and climate in other regions such as Europe and North America.

I also investigate projected changes in the polar regions through the use of global climate models and assessing various climate change scenarios potential to impact precipitation and other extreme weather events. I explore these changes in relation to their potential human and ecological cost, particularly in the Arctic.

How supervisor research areas align to Maynooth University research priority areas:

My research on directly aligns with the University's strategic research beacon on sustainability and climate change with its focus completely on climate change within the polar regions and its local and global consequences such as sea level rise from melting glaciers. Furthermore, as my research transects many different areas such as oceanography, ecology and climate justice and is in collaboration with international colleagues, my work also advances the University's beacon of interdisciplinary research excellence and internationalisation.

END

John & Pat Hume Doctoral Awards 2025-2026

Department: Physics

Supervisor: Dr Patrick Kavanagh

Supervisor Email: patrick.kavanagh@mu.ie

Title of Research Area:

Probing the evolution of SN1987A with the James Webb Space Telescope

Description of research areas supervisor is willing to accept applications in:

SN 1987A in the Large Magellanic Cloud is the closest observed supernova in centuries and provides a truly unique opportunity to probe various aspects of supernova physics and evolution. It has been continuously scrutinized as it changes significantly year after year providing new discoveries and insights into the evolution of supernovae in general. Despite nearly four decades of observations with the most advanced observatories available, key questions about SN 1987A remain unanswered. Early JWST observations of SN 1987A revealed the onset, and initial evolution of the interaction between the rapidly expanding, metal-rich inner ejecta and the circumstellar equatorial ring, a new phase in the evolution of the object. This interaction provides a direct probe of the composition of the ejecta which encodes conditions at the time of explosion and therefore information on the progenitor and explosion mechanism, which are still unknown. Recently approved JWST observations of SN 1987A to be taken in late 2025 – early 2026 will be used to address these outstanding questions.

How supervisor research areas align to Maynooth University research priority areas:

The proposed research area directly aligns with Maynooth University's Strategic Plan 2023-28 by fostering research excellence and investing in the next generation of scientific talent. SN 1987A is the closest observed supernova in modern times which has and will continue to provide for ground-breaking research at Maynooth University which contributes to its global reputation in astrophysics. The proposed research will contribute to open scholarship through international collaborations, open-access publications, and data and code sharing initiatives, reinforcing Maynooth University's commitment to knowledge dissemination. Additionally, Maynooth University's investment in research students is evident in its commitment to providing a vibrant and supportive academic environment. The position will offer opportunities for professional development, conference participation, and engagement with the academic community as well as the public.

END

John & Pat Hume Doctoral Awards 2025-2026

Department: Physics

Supervisor: Dr Paul Watts

Supervisor Email: paul.watts@mu.ie

Title of Research Area:

Theoretical Physics & Applied Mathematics

Description of research areas supervisor is willing to accept applications in:

Theoretical high-energy physics and quantum field theory: the study of subatomic particles and fields, particularly extensions to the Standard Model

Applications of Lie groups and Lie algebras in physics: using the mathematical tools of group theory when useful (e.g. in high-energy physics and quantum information processing)

How supervisor research areas align to Maynooth University research priority areas:

Encouraging postdoctoral research in subjects that Ireland is, or could be, at the forefront of: the high-energy research will be very relevant when Ireland's application to join CERN is (hopefully) approved, and there are many quantum information processing/quantum computing initiatives to which the group theoretical aspect of my research would contribute.

END

John & Pat Hume Doctoral Awards 2025-2026

Department: Physics

Supervisor: Prof Peter Coles

Supervisor Email: Peter.Coles@mu.ie

Title of Research Area:

Dark Energy Science with Euclid Data

Description of research areas supervisor is willing to accept applications in:

Maynooth University is the only Irish Higher Education Institution involved in the European Space Agency's Euclid mission which was launched in 2023 and which will make a three-dimensional map of the distribution of galaxies across about one-third of the sky. The aim of this survey is not only to plot the large-scale structure itself but also to study the geometry and expansion rate of the Universe in order to better understand its dynamics and content. A key challenge for Euclid is to understand whether the apparent accelerated expansion of the Universe is caused by a cosmological constant or some more exotic form of "Dark Energy" which varies with time or indeed some other cause entirely. Euclid's first "Quick Release" survey dataset (Q1) will be publicly available from March 2025 and the first full data release (DR1) will be made public in late 2026. This project will capitalize on the unique opportunity provided by the involvement of Prof. Coles as a member of the Euclid Consortium (which has over a thousand active members worldwide) and will involve working out how best to use the Euclid data to constrain exotic models of Dark Energy using gravitational lensing and galaxy clustering data. The project will involve theoretical and computational work in developing the models, and developing innovative statistical techniques for extracting relevant information from the Q1 and DR1 data sets to constrain them.

How supervisor research areas align to Maynooth University research priority areas:

ESA's Euclid mission is operated by an international consortium of institutions, not only in Europe, but also the USA and Japan. This project therefore targets the goal of "focusing our research to align with national, European and international priorities". And furthers the internationalisation agenda. Euclid will continue to generate impact through scientific publications and public engagement, enabling Maynooth to be "recognised for the excellence and impact of our research". The high scientific profile of Euclid will help in "attracting developing and retaining the best … students". The Strategic Plan mentions three areas of relevance to this proposal: "Data and Digital Transformation" , "Heritage, Culture and Language" and "Society and Public Policy". The relevance of the first is that the data challenge of Euclid (100 gigabytes of compressed data per day over its ten-year mission lifetime) requires innovative approaches in its processing and analysis, including the extensive use of Machine Learning. The others are relevant too: Ireland has a long and distinguished astronomical heritage which continues to play an important role in the public understanding of science, as well as producing a stream of data experts who can contribute to the wider economy and society as a whole.

END

John & Pat Hume Doctoral Awards 2025-2026

Department: Physics

Supervisor: Dr Joost Slingerland

Supervisor Email: Joost.Slingerland@mu.ie

Title of Research Area:

Low-dimensional and topological quantum physics with applications to quantum information processing

Description of research areas supervisor is willing to accept applications in:

I am interested in the exotic states of matter that appear in low-dimensional quantum systems. Quantum systems which are confined to a surface have exciting properties such as the presence of entirely new types of quasipartticles, anyons, which can have charge and spin which are fractions of those of known elementary particles, and exchange behavior which is fundamentally different from that of any particles known in three dimensions. These properties reflect a long range entanglement characterized by topologically invariant quantum numbers, which can be exploited as a resource enabling fault tolerance in quantum information processing.

Current projects in my group focus on quantum Hall states, which exist in two dimensional electron systems and where anyonic exchange properties have been recently observed experimentally. Beside you, two postdocs will be hired on a RI grant to work in this area and projects would focus on the theoretical and numerical characterization of Hall states with non-Abelian topological order, particularly their ground states and their spectral properties. We would also be interested in modeling devices which can measure and manipulate the topological quantum numbers in these states.

A separate line of research focuses on the mathematical description of topological phases, trying to classify and fully characterize all phases that are possible and relations between them. This leads to the study of mathematical structures such as modular tensor categories and quantum groups. Each such structure describes a potential phase of matter and can serve as a starting point for construction of models and eventually experimental realization. This is partly experimental mathematics, where we attempt discovery and classification using computer algebra. We already have substantial resources in place that can function as a starting point, including a catalogue of small tensor categories and a software toolkit to work with them, but many interesting questions remain, notably dealing with the classification of topological phase transitions. This work also provides essential inputs to the implementation of these phases and their associated quantum error correcting codes on quantum computers.

How supervisor research areas align to Maynooth University research priority areas:

The research area described is well aligned with the research beacon "data and digital transformation" described in the MU strategic plan. Much of this research is in the general area of planar semiconductor physics, which is at the basis of the entire digital and data revolution which has been ongoing at exponential pace since the mid 20th century. Progress in understanding novel phases of matter in condensed matter, and particularly their application to

quantum information processing will be instrumental in allowing progress in this area to compute. In fact, without input on the fundamental many body quantum physics underlying these systems, progress in computing is certain to stall, as miniaturization has reached the limits where individual components of computers are entering the quantum regime. I have managed a research group in this area at MU since 2008, funded through SFI and IRC (now RI) and have built up a body of work in collaboration with a large network of international collaborators, while also collaborating locally with Dr. Kells and Prof. Vala's groups.

It is worth noting that this type of research also underlies much material science which is of essential importance to the energy transition and therefore to the "Sustainability and Climate Change" beacon in the MU strategy.

END

John & Pat Hume Doctoral Awards 2025-2026

Department: Physics

Supervisor: Prof Jiri Vala

Supervisor Email: Jiri.Vala@mu.ie

Title of Research Area:

Topological quantum computation

Description of research areas supervisor is willing to accept applications in:

Quantum computation is fundamentally more powerful than classical computation. While the latter is deterministic, i.e. it proceeds through a single computational path, quantum computation permits processing via the maximal possible number of computational paths in parallel. The main difficulty on the way to harvesting quantum computation power is a protection of computational process against errors. Although engineering of a reliable quantum computer is in principle possible, it requires extremely large overhead in physical resources that renders this approach impractical.

Topological quantum computation is naturally fault-tolerant, thereby circumventing the need for demanding engineering approaches to fault-tolerance. Natural fault-tolerance is built into the quantum computing hardware as an intrinsic property of certain quantum materials where quantum information is stored and processed in a way that is sensitive only to their global, topological structure. Identification and physical realization of these topological phases is a crucial step in implementation of topological quantum computation.

Our research focuses on topological phases as essential materials for topological quantum computing. From abstract description of these phases given by topological field theories, certain basic properties of these phases can be derived. These properties are then used to identify topological phases in microscopic models that can in principle be realized in a laboratory or in technology. We build on our previous studies of various microscopic models that are believed to form topological phases which used a comprehensive set of analytical approaches and high-performance numerical techniques. Our particular objective is to obtain detailed information about properties of these phases, their robustness, behaviour in various limits and conditions and physical realization. We also studied their quasi-particle excitations that possess fractional statistics, i.e. anyons, and analyzed their properties, and their creation/annihilation and control. This work is essential for processing of topologically protected information.

How supervisor research areas align to Maynooth University research priority areas:

The proposed research area in quantum computing will significantly contribute to the University Vision of Excellence. As a PhD project, it organically focuses on Research and Impact as well as Students and Learning while fulfilling several objectives of the University Strategic Plan. It will specifically aim to improve research outputs and impacts of the University in the area of quantum science and technology, it will help to cement our position among global leaders in

the field of Data and Digital Transformation, one of the University Strategic beacons of research excellence. Moreover, it will ensure the funded student will have an enriching educational experience and will graduate with future-focused skills, specifically in quantum technologies. In addition, the proposed project is also aligned with the Quantum 2030: National Quantum Technologies Strategy for Ireland, which we have helped to develop in collaboration with the Department of Further and Higher Education, Research, Innovation and Science, and other institutions as well as research community. The research follows international developments in quantum science and technology via our participation in the Governance of the EU Quantum Flagship, and other engagements including with CERN.

END

Department of Psychology

John & Pat Hume Doctoral Awards 2025-2026

Department: Psychology

Supervisor: Dr Joanne McVeigh

Supervisor Email: joanne.mcveigh@mu.ie

Title of Research Area:

Non-Pharmacological Interventions to Support the Inclusion and Well-being of People with Dementia.

Description of research areas supervisor is willing to accept applications in:

This research topic examines non-pharmacological intervention(s) to support the well-being, social inclusion, and quality of life of people living with dementia. It explores social and psychological factors that underly behavioural and psychological problems that may be experienced by people with dementia, alongside the effectiveness of psychosocial interventions to address such challenges. The proposed research should align with the social and human rights models of disability set out in the Convention on the Rights of Persons with Disabilities, representing a shift from the pathology-led approach.

In addition to a focus at the individual level, this research will examine macro level factors that impact on the inclusion and well-being of people with dementia, using a systems thinking perspective. To do so, national and organisational policies and strategies will be analysed, including the Irish National Dementia Strategy, to assess the extent to which they are inclusive, equitable and rights-based.

From this systems perspective, this research will also focus on contextual factors including healthcare settings and living environments that are conducive to the dignity and psychosocial well-being of people with dementia. The proposed research may also explore the well-being of caregivers and examine psychosocial intervention(s) for both people with dementia and their caregivers.

How supervisor research areas align to Maynooth University research priority areas:

This research aims to address a gap in the literature on non-pharmacological interventions for people with dementia and is therefore closely aligned with the research beacon of 'Health and Wellbeing'. This research area also aligns with the research beacon of 'Society and Public Policy'. This research will comprise policy analysis, and findings from this research will be used to formulate public policy recommendations with regards to healthcare settings and living environments that are conducive to the inclusion and well-being of people with dementia.

The supervisory team has combined expertise in dementia, disability, human rights, law, and public policy, ensuring research excellence and the capacity-building of the researcher to conduct high-quality research. As this research will be conducted with people with lived experience of dementia and their caregivers, it will strengthen external partnerships between the university and care centres in the community. To ensure research impact and to bridge the knowledge-practice gap, the researcher will disseminate their research findings through publications, research presentations, and engagement with civil society. END

John & Pat Hume Doctoral Awards 2025-2026

Department: Psychology

Supervisor: Prof Louise Connell

Supervisor Email: louise.connell@mu.ie

Title of Research Area:

Using language models to better understand human cognition

Description of research areas supervisor is willing to accept applications in:

Much of human conceptual knowledge comes from our exposure to language, and language models (i.e., computational models trained on a large corpus of text) are good at predicting people's responses in cognitive tasks. In particular, there is a growing move to create language models that plausibly approximate human constraints of learning and representation, and use them to provide valuable insights into human cognition.

The proposed research will use cognitively-plausible language models to investigate the nature and scope of how language experience shapes conceptual knowledge in semantic memory, particularly in combination with information from perception, action, and emotion. Specific projects could focus on examining populations with different language experience (i.e., differences between frequent readers and non-readers, or between bilinguals and monolinguals) and/or the change in language experience over the lifespan (i.e., cognitive ageing).

These projects are in the multidisciplinary area of cognitive science (particularly involving cognitive psychology, artificial intelligence, psycholinguistics), and would suit students with good technical/programming skills or a willingness to learn them.

How supervisor research areas align to Maynooth University research priority areas:

This research area represents basic (fundamental) research that aligns with the Health and Wellbeing research beacon in establishing a means of effectively modelling the underlying mechanisms of cognitive function in healthy adults across the lifespan, which will act as a springboard for future research that can examine cognitive impairments. In addition, by examining the role of different forms of language experience, the research area is – depending on the precise project pursued – specifically relevant to the impact of lifestyle choices on cognitive function and to healthy ageing and longevity.

END

John & Pat Hume Doctoral Awards 2025-2026

Department: Psychology

Supervisor: Prof Philip Hyland

Supervisor Email: philip.hyland@mu.ie

Title of Research Area:

Psychological trauma; bereavement and grief; cognition; risk factor for mental health problems.

Description of research areas supervisor is willing to accept applications in:

My research is focused on psychological responses to stressful and traumatic life events, focusing on understanding the nature, predictors, and outcomes of disorders such as posttraumatic stress disorder (PTSD), complex PTSD, and prolonged grief disorder. I am in interested in applying and testing cognitive-behavioural models of psychopathology, and looking at risk factors for all types of mental health problems. I use quantitative methods to study these issues.

How supervisor research areas align to Maynooth University research priority areas:

This advances the understanding of health.

END

John & Pat Hume Doctoral Awards 2025-2026

Department: Psychology

Supervisor: Prof Richard Roche

Supervisor Email: Richard.Roche@mu.ie

Title of Research Area:

An evaluation of technology-based assessments and performance-based intervention delivery.

Description of research areas supervisor is willing to accept applications in:

Debilitating conditions such as Parkinson's Disease (PD) pose challenges for patients and caregivers by significantly impairing the ability to perform daily activities. These conditions can involve motor (e.g., weakness) and non-motor symptoms (e.g., depression), with non-motor symptoms often remaining untreated despite their impact on quality of life. Debilitating conditions such as PD increase the risk of developing mental health issues, which contribute significantly to the global disease burden (World Health Organization, 2023).

Digital health technologies (e.g., smartphone applications) are a positive solution for managing the symptoms associated with debilitating conditions. However, more research is needed to comprehensively evaluate delivery modes of assessment tools to address both motor and non-motor aspects of debilitating conditions, including cognitive, emotional and movement-focused outcomes.

In collaboration with our industry partner, Beats Medical, this research study aims to evaluate how the delivery mode of assessment tools can help to more accurately measure both motor and non-motor symptoms experienced by individuals with debilitating conditions. A mixed-method approach will be employed to gether quantitative and qualitative data from patients and caregivers to provide a better understanding of users' experiences. This will also contribute to the expanding body of research on the benefits of digital health technology interventions benefits.

How supervisor research areas align to Maynooth University research priority areas:

The research addresses a significant societal issue. The aim of the proposed study is to evaluate how the delivery mode of assessment tools may help to more accurately measure both motor and non-motor symptoms experienced by individuals with debilitating conditions. More specifically, the proposed research aims to evaluate the effectiveness of the Beats Medical app in monitoring and improving mobility, dexterity and speech in patients with neurological conditions (e.g., Multiple Sclerosis, Alzheimer's, Parkinson's and other rare diseases) compared to individuals from a control group (e.g. Arthritis). The proposed research also aims to document the individual patient experience of using the Beats Medical app from a user perspective, by conducting qualitative research via interviews and focus groups.

Integrating digital tools such as mobile apps in healthcare may provide a better understanding of the above conditions which pose a significant societal problem. There is a need for more research in this area to comprehensively evaluate assessment delivery modes in order to

address motor and non-motor aspects of debilitating conditions, as well as cognitive, emotional and movement-focused outcomes.

END

John & Pat Hume Doctoral Awards 2025-2026

Department: Psychology

Supervisor: Dr Sadhbh Byrne

Supervisor Email: sadhbh.byrne@mu.ie

Title of Research Area:

Understanding experiences of giving and receiving mental health support

Description of research areas supervisor is willing to accept applications in:

I welcome applicants whose research proposals are broadly interested in understanding experiences of both giving and receiving support and care. My research to date has explored support from friends, parents, and other caring adults (including school staff and healthcare providers), particularly in the context of mental health challenges. I focus primarily on young people, but I am also open to proposals exploring these topics with other demographics. Specific questions/topics of interest may include: who provides support and why/why not; what makes support feel helpful or unhelpful; the roles of perceived responsibility, empathy and stigma; how (professional and non-professional) supporters experience compassion fatigue or burnout and how this can be managed; boundaries in (professional and non-professional) support-giving; the common sense model of illness representations; and digital contexts of support-giving. Additionally, I am interested in how experiences of loneliness — particularly in emerging adulthood or across generations — may intersect with the need for or provision of support. I would particularly welcome proposals incorporating qualitative and/or participatory methods.

How supervisor research areas align to Maynooth University research priority areas:

This area of research is aligned with the Maynooth University research beacon "Health and Wellbeing", as well as Sustainable Development Goal 3, "Good Health and Wellbeing", by addressing factors influencing mental health support, stigma reduction, and compassionate care. This research area aims to enhance understanding of the complexities involved in giving and receiving care, contributing to more inclusive, empathic support systems with long-term goals of improved mental health outcomes.

This research area also connected to the "Society and Public Policy" beacon, which as stated in the Strategic plan, involves developing recommendations that enhance the wellbeing of individuals and communities. For example, insights into managing compassion fatigue amongst those providing support may inform public health strategies and workplace policies.

As noted, I particularly welcome proposals taking a participatory approach to research, embodying the principles of engaged research, which further aligns with the University's commitment to community engagement and engaged research.

END

John & Pat Hume Doctoral Awards 2025-2026

Department: Psychology

Supervisor: Dr Siobhán Woods

Supervisor Email: siobhan.woods@mu.ie

Title of Research Area:

Developing an integrated intervention for the prevention of burnout in sport

Description of research areas supervisor is willing to accept applications in:

Athlete burnout is a psychological syndrome characterised by feelings of exhaustion, reduced accomplishment and devaluation of sport participation. Burnout can have significant negative implications for those affected, including sport dropout, physical illness and psychological ill-health. With a view to combatting rising prevalence rates of burnout symptoms (Madigan et al. 2021), this research topic focuses on the development of an intervention for the treatment and prevention of athlete burnout.

Research in this area involves consideration of how multiple theoretical perspectives of burnout can be effectively integrated to develop a comprehensive understanding of key risk and protective factors for the development of burnout in a specific sport context. This research will also aim to synthesise existing evidence on interventions for burnout, within and outside the sport context, identifying gaps and opportunities for a comprehensive approach to minimising the risk of athlete burnout.

This work will draw on the UK Medical Research Council's (MRC) framework for the development of complex interventions. Specifically, the proposed project will aim to identify underpinning theory through existing evidence and through the collection of quantitative and qualitative data as relevant. In line with the MRC framework, this research will also seek to include perspectives from a diverse range of stakeholders in sport through a co-design approach which positions athletes, coaches and administrator from across genders and playing levels as experts and key contributors to intervention design. Co-design efforts will seek to identify the most appropriate mode, content and timeline of the intervention and consider resource and outcome consequences of the intervention.

How supervisor research areas align to Maynooth University research priority areas:

The proposed research areas, which focuses on the development of an intervention to reduce the risk of athlete burnout, is clearly in line with Health and Wellbeing Research Beacon's emphasis on the interplay between physical and mental health, enhancing quality of life, and the promotion of mental health and broader well-being. Furthermore, focusing on the athlete population, this project can provide insight into the influences of physical activity on health outcomes, in line with a core focus of the Nutrition and Lifestyle research cluster.

Research in this area will employ a collaborative, engaged approach, in keeping with MU's broader Research Strategy. The research will employ a co-design approach, whereby key stakeholders in sport (e.g. players, coaches, administrators) will be involved in all stages of the

project. The work will support open science scholarship practices and will be disseminated to academic and non-academic audiences through peer reviewed papers, conferences, public talks and engagement with relevant sporting bodies.

The findings of this work can demonstrate impact in the area of Health and Wellbeing at the local and national level, through a tailored sport-specific intervention and by informing national policy and wellbeing guidelines for partnering organisations.

END

John & Pat Hume Doctoral Awards 2025-2026

Department: Psychology

Supervisor: Dr Tadhg MacIntyre

Supervisor Email: tadhg.macintyre@mu.ie

Title of Research Area:

An Investigation of the Role of Virtual Environments in Promoting Urban Health

Description of research areas supervisor is willing to accept applications in:

In cities, lack of access to green space access a key risk factor for health. Virtual reality, a digital interface that employs 3-D near-eye displays to give the user an immersive feel of a virtual world, can be used to create scenarios of spaces where re-greening or re-wilding is planned. This is critical as many cities are attempting to promote climate resilience and sustainable mobility (e.g. active travel) through greenways and other types of green infrastructure, often termed nature-based solutions.

To date, studies demonstrate that virtual 'green exercise' (physical activity in green space) may have health benefits. Tentative research indicates that there are differences in the efficiency of first person (e.g. egocentric) compared to third person (allocentric) views of virtual environments. Virtual Reality research has largely overlooked the needs of citizens with mobility challenges or with the lived experience of a chronic health condition (e.g. COPD). It is vital that future parks and green spaces provide universal benefits to communities by ensuring changes in the urban realm meets the needs of diverse communities. This is linked to the UN sustainable development goal 11 and linked target (target 11.7 universal access to safe, inclusive and accessible, … public spaces, particularly for women and children, older persons and persons with disabilities).

Two explanatory models can be utilised in this research relating to cognitive simulation of action (e.g. motor cognition) and motivation theory (e.g. self-determination theory). The theories can lead to the development of testable hypotheses of movements in relation to the navigation of virtual environments.

A key outcome would be the development of an evidence-based framework for the optimisation of virtual reality as a tool to support Nature-Based Solutions and ensure cities of the future are health promoting environments for all.

How supervisor research areas align to Maynooth University research priority areas:

This research will be supported by links to the Horizon Europe GoGreen Next project (2024-2028) which will provide necessary technological expertise, access to equipment and international expertise from partner institutions. Direct links to the project will ensure the student is part of an international consortium with access to a unique learning ecosytem, which will compliment the MU Graduate Academy.

The proposed study can support our internationalisation agenda for research and the research topic clearly links to the following beacons: Data and Digital Transformation; Health and Wellbeing; and Sustainability and Climate Change. The research with a focus on applying cutting-edge digital technology is grounded in the UN sustainable development goals. The following SDG's are directly relevant to this study: SDG 3 Good Health and Wellbeing; . SDG 5 Gender equality; SDG 10 Reduced Inequalities; and SDG 11 Sustainable Cities and Communities. Research from our team demonstrates that up to 8 goals are relevant to sustainable physical activity research.

The research is build upon interdisciplinary perspectives across the Dept. of Psychology/IVI and the Dept. of Sport Science and Nutrition. It includes a lead supervisor with established expertise in urban health and an early stage researcher in exercise physiology with expertise in working with patient groups and those living with a disability.

END

John & Pat Hume Doctoral Awards 2025-2026

Department: Psychology

Supervisor: Dr Unai Diaz-Orueta

Supervisor Email: Unai.DiazOrueta@mu.ie

Title of Research Area:

Virtual reality based neuropsychological assessment through the lifespan

Description of research areas supervisor is willing to accept applications in:

This research area aims to show the value of virtual reality based neuropsychological assessment tools developed for the assessment of attention, working memory, executive functions and memory processes in both community and clinical populations with different conditions across the lifespan, from 6 years-old to older adults. The goal is to validate and demonstrate the accuracy and reliability of these VR based tools both to identify and support diagnosis of different conditions affecting individuals' cognition, as well as to monitor the progress of any intervention programme (which can be both pharmacological and non-pharmacological). There are current undergoing studies with adults with ADHD, but this research can be extensive to other populations, preferably older adults with cognitive impairment and different neurodegenerative conditions.

How supervisor research areas align to Maynooth University research priority areas:

Early and accurate diagnosis of different conditions affecting neurodevelopment and impacting cognition, from childhood neurodevelopmental disorders to neurodegenerative conditions in adults and older adults, pose a significant societal challenge and stress in terms of healthcare, social and family resources. Advanced technologies like Virtual Reality based neuropsychological assessment may establish more accurate, reliable and valid cognitive characterization of different conditions, saving time and resources, and providing more clarity for developing individually tailored treatment and rehabilitation strategies. There is a need to promote the use and validate these technology based assessment tools to assist clinicians better identify patterns of deficits and decline, as well as potential strengths that can be used in preventive and rehabilitation frameworks. In addition, these type of assessments can be very informative and imply a greater relief for caregivers of relatives with different conditions, by providing a clearer prospect and help set expectations about treatment progress and outcomes.

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John & Pat Hume Doctoral Awards 2025-2026

Department: Psychology

Supervisor: Dr Laura Coffey

Supervisor Email: Laura.Coffey@mu.ie

Title of Research Area:

Exploring the experiences and unmet needs of people living with Ehlers Danlos Syndromes in Ireland

Description of research areas supervisor is willing to accept applications in:

Ehlers Danlos Syndromes (EDS) are a group of 13 rare inherited conditions that affect connective tissue often characterised by joint hypermobility, skin hyperextensibility and tissue fragility. As EHS can cause a variety of symptoms in different areas of the body, there is no specific treatment and people with EDS often require multiple providers in different specialties to manage their care. People living with EDS have reported that their daily life is affected by pain, fatigue, social withdrawal and anxiety regarding their condition, with implications for their education and employment. It is estimated that there are about 2,000 people currently diagnosed with EDS in Ireland. However, recent prevalence studies suggest that this figure is likely closer to over 6,000. Little is currently known about the experiences of people living with EDS in Ireland, the impact of these conditions on their wellbeing, or their unmet needs. A group discussion held by the EDS Society during the Global Learning Conference in Dublin in 2023 emphasised the need for increased awareness of EDS and improved supports for those living with EDS in Ireland (https://www.ehlers-danlos.com/post-event-report-addressing-the-unmet-needs-of-people-with-eds-hsd-in-ireland/). The aim of the proposed research is thus to explore the experiences and unmet needs of people with EDS living in Ireland using a mixed-methods approach and incorporating engaged research practices.

How supervisor research areas align to Maynooth University research priority areas:

This research aligns closely with the Health and Wellbeing Beacon and its focus on the interplay between physical and mental health, social determinants, and environmental factors and commitment to enhancing quality of life amongst individuals and communities. The findings of this research could help to inform the development of strategies and interventions that positively impact the wellbeing of people living with EDS in Ireland and further afield.

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