Physiology in Ireland

Ireland is world leading in science, research and development, including the physiological sciences. Physiology expertise in Ireland ranges from respiratory physiology, oncology and neuroscience through to sport and exercise science.

Over 45 undergraduate degrees in Ireland have a physiology component, these include pharmacy, medicine, sports and exercise physiology, biological sciences, biomedical engineering and agriculture. These courses are offered at institutions all across the country as seen on the map below.

Physiology related courses in Ireland provide students with real-world experience by equipping students with the practical and experimental techniques required for successful careers. Graduates of physiology in Ireland enter a broad range of career paths from medicine and allied health professions such as physiotherapy and pharmacy to biomedical research both in industry and academia.

What is physiology?

Physiology is the science of life. It is the branch of biology that aims to understand the mechanisms of living things, from the basis of cell function at the ionic and molecular level to the integrated behaviour of the whole body and the influence of the external environment.

Physiology underpins translational research and clinical medicine. Research in physiology helps us to understand how the body works in health and how it responds and adapts to the challenges of everyday life. It also helps us to determine what goes wrong in disease, facilitating the development of new treatments and guidelines for maintaining human and animal health. The emphasis on integrating molecular, cellular, systems and whole-body function is what distinguishes physiology from the other life sciences.

Physiology by nature is an interdisciplinary science; it provides the interface between the physical sciences and the life sciences. Physiologists focus on a wide range of topics, from researching microscopic organelles to ecophysiology, which looks at whole organisms and how they adapt to changing environments. Further, physiology creates natural bridges into other disciplines such as medicine, engineering, product development and testing, as well as sport and public health.

Foreword

Members of The Physiological Society carrying out physiology research and teaching in Ireland have been at our core since our foundation in 1876. Gerald Francis Yeo from Trinity College Dublin was one of 19 physiologists who first gathered to form The Society. He also served as the Secretary of The Society until 1889 and campaigned for the value of in vivo research in response to Victorian anti-vivisection campaigns.

More recently, physiologists in Ireland have made a significant contribution to the success of The Society’s journals and conferencing programme. This document is designed to give a brief overview of the impact that Irish physiology has both in Ireland and throughout the world, and highlight challenges that our members have raised to increase the impact of their research.

Our asks

The Irish Government should commit to meeting its target of 2.5% of GNI* spend on R&D by 2025, five years earlier than its current stated ambition.

As a thriving R&D sector becomes increasingly important to economic growth, jobs and meeting the challenges of the future, Ireland should have the long term ambition of matching the OECD average R&D spend.

The Irish Government should put basic research funding at the heart of meeting the key national challenges and opportunities and the National Grand Challenges Programme, both identified in Impact 2030.

TDs and Senators should visit their local research institution to see first-hand the work of physiologists. Contact: policy@physoc.org

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Physiology-related courses in Ireland

Maynooth University
Atlantic Technological University
Athlone Institute of Technology
University of Galway
University of Limerick
University College Cork
Trinity College Dublin
South East Technological University
Munster Technological University
Dundalk Institute of Technology
University College Dublin
Royal College of Surgeons in Ireland
Technological University Dublin
Dublin City University

Examining the influence of oxygen dysregulation during early life on neonatal physiology using clinical data and animal models

Dr Fiona McDonald is seeking to bridge the gap between clinical and preclinical neonatal research in Ireland. The primary interest of the group is to examine the influence of perinatal oxygen dysregulation on neonatal physiology. They developed a novel rat model of neonatal stress to assess cardiorespiratory function and long-term behavioural outcomes (SFI - Starter Investigator Award 2019). In parallel, we are performing data-driven machine learning analysis of cerebral near infrared spectroscopy on retrospective cohorts of infants born either preterm or full term with confirmed brain injury (INFANT research centre).

They have shown that while oxygen dysregulation during early life did not change baseline respiratory pattern it changed the autoresuscitation response to asoxia in animals challenged with bacterial proteins. They found that neonatal oxygen dysregulation suppresses sex hormones. They report that animals exposed to dysregulated oxygen environment exhibited developmental milestone delays and locomotor deficiencies. They also revealed that prior oxygen dysregulation can augment the inflammatory response to gram positive bacteria. While examining clinical data in the first week of life they have identified novel data-driven patterns in NIRS that can predict brain injury in preterm infants.

What is Basic Research?

Basic research, also known as fundamental research, is experimental or theoretical work undertaken to further scientific knowledge without any targeted benefit of application in view. Applied research (problem-solving research) aims to solve specific problems and thus, has immediate practical applications.

For instance, basic research could explore the function of newly discovered molecules and cells or processes that are not well-understood. It analyses properties, structures and relationships with an aim to formulate and test hypotheses, theories or laws.

Basic research is driven by curiosity and the desire to expand scientific knowledge in a specific research area. Despite the fact that there may be no obvious benefit when the experiments are performed, this new knowledge can lead to breakthrough methods and treatments years or decades later. For example, in 1914 Irish scientist John Joly developed a method for extracting radium and later applied it to treat cancer. He used an approach which laid the groundwork for many modern cancer therapeutic strategies and is now known as the “Dublin Method”.

Similarly, hypodermic syringes, which are widely used to administer vaccines and other therapeutics today, were invented by Irish doctor Francis Rynd in 1844. Rynd had a patient who was unresponsive to orally administered drugs. He tried using a thin, hollow needle to feed a solution of morphine and creosote into the patient’s bloodstream resulting in a complete cessation of the pain.

Government spending on basic research as a proportion of GDP in Ireland remains low relative to international comparisons. The following graph shows the Gross Domestic Expenditure on R&D (GERD) in Ireland by type of R&D (basic and applied research) for the government sector. This sector includes all departments, offices and other bodies of the government, and other non-profit institutions (NPIs) controlled and mainly financed by government.
Brain blood flow in health and disease

Jack Leacy, PhD candidate at the Department of Physiology, University College Cork is using transcranial Doppler ultrasound to assess the physiology of the specialised circulation of the brain.

Field work at high altitude (Nepal and California) assessed the effects of low oxygen stress on the brain. Recent laboratory-based studies are exploring brain physiology in post-menopausal women at increased risk of cerebrovascular disease and in patients with dementia with impaired cognition.

High altitude studies revealed vulnerability in several aspects of brain blood flow control related to blood gas and chemistry changes arising at high altitude, which are relevant to clinical disorders such as chronic lung and renal disease. Current studies are seeking to explore the influence of sex hormones (and their loss in menopause) on the physiological mechanism of neurovascular coupling. Combined assessment of brain blood flow and EEG (brain waves) is exploring cerebrovascular pathophysiology in people with dementia.

Researchers at Department of Physiology University College Cork are exploring brain blood flow and EEG (brain waves) during task specific protocols in people with dementia to better understand the pathophysiological processes leading to cognitive impairment with a long term view to the assessment of interventions to protect health. Photo credits: University College Cork

Overall Research Spending in Ireland

The Irish economy has seen a tremendous growth over the past few years, however, the overall investment in Research and Development (R&D) has not been made at the same rate. Ireland has achieved limited progress towards the Innovation 2020 research intensity rate target of 2.5% of GNP, which rose from 1.55% in 2015 to an estimated 1.63% in 2020.

As Impact 2030 notes, ‘failing to keep pace with other small advanced economies in terms of investment in R&I represents a significant risk to the competitiveness of our economy, to our labour market productivity, to the growth of high-value employment, to our attractiveness to foreign direct investment and to our global standing as a “strong innovator”.

Irish expenditure on R&D as a share of GDP remains significantly lower than its nearest geographical neighbour the UK. As evident from Figure 3, in the early 2000s R&D expenditure as a share of GDP in Ireland was almost at par with the UK, but has dropped off over the years. Irish spending on R&D also remains lower than the OECD average. For 2021, Ireland spent a 1.06% of GDP on R&D, compared to the OECD average of 2.71%.

Additionally, Irish innovation will be crucial in meeting global challenges such as a rapidly ageing population and climate change. Government spending on Irish R&D should not therefore, be seen as a cost, rather an investment in finding solutions to address both economic and social challenges and a key ‘pump-priming’ to ensure confidence in the Government’s continued focus on innovation and encourage greater investment from the private sector.

The Irish Government should commit to meeting its target of 2.5% of GNI* spend on R&D by 2025, five years earlier than its current stated ambition.
Identification of novel therapeutic targets for treatment of chronic obstructive pulmonary disease

With funding from European Union’s INTERREG VA Programme, researchers from the Smooth Muscle Research Centre (Dundalk Institute of Technology, DkIT), Queen’s University Belfast (QUB) and the University of the West of Scotland (UWS), established a pioneering cross-border research partnership named ‘BREATH’ (Border and Regions Airways Training Hub). BREATH created a world-class cluster of researchers, involving collaborations between scientists and clinicians, focused on the causes, treatment and prevention of Chronic Obstructive Airways Disease (COPD).

BREATH funded 16 full-time PhD students and 14 Post-Doctoral Research Fellows across the network to i) identify novel diagnostics and therapeutic targets to treat COPD and ii) increase Research and Innovation across the island of Ireland and Western Scotland by providing world class training to the next generation of researchers.

BREATH successfully trained 30 scientists to PhD level and beyond in scientific and complementary industry-relevant skills. All of these scientists have progressed into high level jobs in industry or academia within Ireland and abroad. They have active collaborations with 3 industrial partners and have engaged with another 16 local and international companies over the course of the project. To date the project has produced nearly 100 research publications. They also have an extensive public outreach programme consisting of multiple school visits and media events, through which we have actively engaged over 5,000 pupils to date.

Among the many highlights of BREATH were results achieved by Tuleen Alkawadri, a PhD student in Dundalk Institute of Technology. Tuleen is originally from Syria and graduated with her PhD in 2022. She is now undertaking the role of post-doctoral researcher in the Smooth Muscle Research Centre in DkIT. Tuleen made an exciting discovery that highlighted a novel mechanism for the causes of COPD & asthma that will aid in the development of better medications for the treatment of these conditions. These findings were published in the journal ‘Function’ and were described as ‘outstanding’ by peer researchers in perspective articles, which also noted that ‘the elegant study by Alkawadri et al., has inspired many questions with physiological and clinical implications’. Several news outlets also picked up on these studies, under the headline: ‘Better Asthma and COPD Drugs with Fewer Side Effects Are Within Reach’.

How can physiology meet the social, economic and environmental challenges facing Ireland?

In 2022, the Irish government announced Impact 2030: Ireland’s Research and Innovation Strategy, an R&D innovation strategy designed to maximise the impact of research and innovation on many national priorities. It will progress objectives shared across the Irish research and innovation system such as maximising its impact on public policymaking and implementation, and nurturing and attracting talent.11

As The Society and its members have demonstrated through reports like Growing Older, Better, Contribution of physiology education and training to the UK economy and The Climate Emergency: Research Gaps and Policy Priorities, physiological research and insight is at the heart of creating a more sustainable, healthy, equal and economically prosperous society.
Using physical activity to target inflammation in the brain and protect brain health throughout life

Professor Áine Kelly’s lab in the Discipline of Physiology, Trinity College Dublin, aims to understand how being physically active throughout life can protect cognitive function by counteracting the damaging neuroinflammation that accumulates as we age.

The question of why regularly increasing our muscle and cardiovascular activity during exercise results in better long-term brain function is an interesting physiological puzzle, but it has serious implications for brain health at the level of the population. This is especially relevant in Ireland, where only 19% of primary and 12% of post-primary school students, and only 30% of adults, meet the physical activity requirements for good health. Any associated cognitive decline that appears in older age will impact quality of life and independence.

Postdoctoral fellow Dr Zsuzsanna Barad and PhD student Joana Augusto, funded by an SFI Frontiers for the Future Project Grant, are using mouse models to investigate whether the lactate produced by active muscle is the molecular link between physical activity and preserved brain function.

The lab has shown that even short periods of exercise can modulate the activity of the brain’s microglial cells, dampening their proinflammatory activity and sparing neuronal function. They aim to understand the cellular and molecular mechanisms that underpin this effect, and to compare the effects of short- and long-term physical activity on brain health and function.

### References

The Physiological Society

As the largest network of physiologists in Europe, with academic journals of global reach, The Physiological Society continues a 145 year tradition of being at the forefront of the life sciences. We support the advancement of physiology by promoting collaboration between physiologists around the world, organising world-class conferences and publishing the latest developments in our scientific journals. Research in physiology helps us to understand how the body works in health, what goes wrong in disease, and how the body responds to the challenges of everyday life.