Physiology in Scotland: Achieving the Sustainable Development Goals
Foreword

The subtitle to the Scottish Funding Council’s Strategic Plan 2022-27 is ‘Building a connected, agile, sustainable tertiary education and research system for Scotland’ and this ambition aligns succinctly with the ambitions of the United Nation’s Sustainable Development Goals (SDGs).

While the SDGs reach across 17 different areas, education and health underpin key targets in almost all these diverse development areas. For example, Goal 2 focusing on ending global hunger and food insecurity includes targets to improve childhood development, reduce malnutrition across the whole population and reduce the prevalence of anaemia among pregnant people. Similarly, Goal 13 to tackle climate change includes a target to reduce the number of deaths, missing persons and directly affected persons attributed to disasters per 100,000 population.

Improving health is therefore at the heart of the SDGs, and Scotland’s response to these challenges will only be successful if we take a whole life course approach. Physiology, as the science of how the human body works and maintains homeostasis in the face of changing external stimuli, is fundamental to this. This manifests itself not just in the undertaking of cutting edge research but also the education of the future generations of Scotland’s science community. This will equip them with the skills to ensure Scottish science is at the forefront of a more sustainable world.

The Chief Healthcare Science Officer in Scottish Government as head of profession for the scientific workforce within the NHS in Scotland is responsible for the leadership and professional advice on all aspects of policy which impacts over 50 different scientific job roles within NHS Scotland. Many of these are underpinned by an education or understanding in physiology. As our healthcare needs evolve, we must ensure that healthcare science roles are recognised and the skills of healthcare scientists are well placed to respond to a changing world.

The case studies included in this short summary report give a glimpse into the ways in which physiologists across Scotland are helping to bring the targets and ambitions of the SDGs to become a reality.

Scottland and the Sustainable Development Goals

Scotland’s universities have an international reputation for excellent research which delivers economic and social benefits both at home and abroad¹. This research will be critical in developing innovations that the world will rely on to meet the ambitions of the Sustainable Development Goals (SDGs).

The case studies included in this short summary report give a glimpse into the ways in which physiologists across Scotland are helping to bring the targets and ambitions of the SDGs to become a reality.

Take action. We are asking Members of the Scottish Parliament to:

1. Over the last decade, a third of Scotland’s research was directly related to the ambitions set out in the Sustainable Development Goals.
2. Physiology, as the science of how the body works, underpins humanity’s survival and is key to improving health, treating disease and tackling global challenges.
3. Scotland is world leading in the physiological sciences, with a proud history of Nobel Prize winners continued today by cutting edge research and teaching.


Professor Derek Scott
The Physiological Society and the University of Aberdeen

Catherine Ross
Chief Healthcare Science Officer, Scottish Government

Support Motion on ‘Scotland at the heart of meeting global challenges’.

Visit your local research institution to see first hand the work of physiologists. Contact: policy@physoc.org

We are asking Physiologists to:

Join your community at The Physiological Society physoc.org/join
What are the Sustainable Development Goals?

In September 2015, the General Assembly of the United Nations adopted the 2030 Agenda for Sustainable Development that includes 17 SDGs. Building on the principle of “leaving no one behind”, the SDGs emphasise a holistic approach to achieving sustainable development for all.

They combine a number of initiatives targeting the end of poverty and other socio-economic inequalities with objectives relating to improving health and education, while tackling climate change and working to preserve the planet’s oceans, agriculture, wildlife and forests.

What is physiology?

Physiology is the study of how the human body works. It is core to understanding all the different components associated with age, health and wellbeing. Physiologists use their knowledge and insight to advise on effective interventions to keep people healthy.

Physiology has already played a valuable role in demonstrating the impact of health interventions in support of the Sustainable Development Goals such as the benefits of physical activity, better nutrition and sleep for preventing or mitigating the impacts of disease. For example, physical activity can help people maintain cardiovascular health and higher levels of muscular capacity as they grow older. This booklet features several research spotlights from across Scotland highlighting the important role physiologists are playing in meeting the ambitions of the SDGs. For more information, please visit physoc.org/sdgs

How can physiology inform the delivery of the SDGs?

Each SDG has a series of targets totaling 169 individual targets overall. Many of these goals have a direct health target which will be informed by physiological underpinning and research. For example, SDG 11 (Sustainable Cities and Communities) includes targets related to reducing deaths caused by flooding and improving transport systems.

The infographic on the following page shows how physiology underpins 10 out of the 17 SDGs. Thus, physiological research plays a key role in preserving the health of our planet and promoting long-term sustainable development. More information about the SDGs and their targets can be found on the UN’s website: un.org/sustainabledevelopment
End hunger, achieve food security and improved nutrition and promote sustainable agriculture.

As the science of how the body works, physiology can help develop diets that meet nutritional requirements of various populations.

Build resilient infrastructure, promote inclusive and sustainable industrialisation and foster innovation.

Interdisciplinary research is a core component of innovation to address climate change. Physiology is an interdisciplinary science. It helps us understand how fundamental processes work and interact with other systems in the body in good health to then understand how to respond to ill health.

Ensure healthy lives and promote well-being for all at all ages.

Physiology underpins the diagnosis of disease and facilitates the development of new treatments and guidelines for maintaining human health such as developing physical activity and diet regimens.

Conserve and sustainably use the oceans, seas and marine resources for sustainable development.

Marine physiology is critical to supporting life below water. This discipline focuses on the adaptation of organisms to the marine environment.

Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.

Physiology education is a core component of STEM education. Physiology also underpins clinical curricula and health professionals performing holistic assessments of people in their care.

Take urgent action to combat climate change and its impacts.

Physiological research helps develop tools to mitigate climate change as well as help us adapt to its effects such as changing temperatures and heatwaves.

Reduce inequality within and among countries.

Physiological research helps us understand the multifaceted correlation between socioeconomic deprivation and poorer health outcomes, increased rates of comorbidities and shorter healthy life expectancies.

Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss.

Physiological research can help people understand the benefits of active travel and engaging with nature which will indirectly help protect and preserve our ecosystem.

Make cities and human settlements inclusive, safe, resilient and sustainable.

Developing green cities requires cross-disciplinary collaboration between physiologists, botanists, architects and local government.
Development of an accurate and sensitive antibody test against SARS-CoV-2 virus.

Professor Delibegovic led the Scottish Government’s Chief Scientist Office (CSO) Rapid Response in COVID-19 (RARC-19) research programme to develop an accurate and sensitive antibody test against Sars-Cov2 virus, in collaboration with an SME, Vertebrate Antibodies Limited (VAL) and NHS Grampian.

In this project they used an artificial intelligence (AI) application and bioengineered a novel antigen display platform for development of accurate COVID-19 antibody screening tests. The University of Aberdeen team worked with VAL, using VAL’s proprietary AI platform to identify the specific elements of the virus that trigger the body’s defence systems.

The approach was successfully used for the development of a combination of sensitive tests that could be used for mass screening of COVID-19 cases, identification of high-risk patients/carriers, providing data on the prevalence of COVID-19, surveillance of vaccination programs and evaluating the efficacy of vaccines against circulating SARS-CoV-2 strains.

The team developed a “game changing technology” with the tests successfully passing Phase 2 independent validation by the National Institute for Biological Standards and Control (Department of Health and Social Care). This led to international interest including from the Tony Blair Institute for Global Change, that believes these tests will be crucial in low- and middle-income countries where vaccines are scarce.

The platform has received worldwide media attention and is now available for research purposes through several international distributors. Two tests are in final rounds of independent verification at the National Institute for Biological Standards and Control (Department of Health and Social Care): Universal EpitoGen test intended to identify cases with an antibody response to SARS-CoV-2 following infection or vaccination; Differential EpitoGen test intended for use to distinguish between vaccine-induced and infection-induced antibody response to aid ongoing vaccine and virus surveillance efforts.

Several international stakeholders are evaluating the platforms to roll out in their respective countries including the USA and South Africa.

Professor Mirela Delibegovic
University of Aberdeen
Brain health for life: Fundamental research by physiologists to understand brain function in health and disease.

The human brain is the most complex biological entity we know of and it controls our every thought, feeling and action. Our brains comprise approximately 100 billion nerve cells (neurons) and an equivalent number of supporting cells called glia. A rich blood supply ensures the function of these cells and of the brain as a whole. Throughout life the brain must retain the ability to respond and adapt to information it receives. Thus, it processes, stores and recalls information over time scales of milliseconds to tens of years. The unique set of experiences that the brain acquires defines each of us as an individual. Neurons communicate with each other at specialised points of contact known as synapses, of which there are estimated to be around 100 trillion in the average human brain.

Neuronal circuits and interconnected networks of synapses relay all the signals the brain receives and transmits, embodying an information superhighway that we depend on for normal cognition and behaviour over our entire lifetime. Given this complexity it is perhaps not surprising that our brain information highway breaks down. In fact synaptic or network failure occurs rather frequently, although such failures are mostly inconsequential and unnoticed. However, sometimes network failures have devastating consequences for an individual. The global consequences of brain dysfunction are profound. For example, and closer to home, in 2010 there were approximately 45 million cases of “brain disorder” in the UK; these were estimated to have a cost burden in excess of £100 billion. This financial cost is compounded by the immense burden brain disorders place on families, carers and society. The largest burden in terms of cost (more than £70 billion per annum) are neurodegenerative and neurodevelopmental diseases, psychotic disorders, clinical depression, anxiety and addiction. These represent a diverse group of disorders but what they have in common is that for each there is a disruption in the fundamental process of signalling between brain cells, leading to network failure, which is ultimately manifest in impaired overall function of the brain and other parts of the central nervous system (CNS). Disruption in signalling may also result from abnormal development of neuronal circuits, degeneration of circuits, and inadequate or excessive actions of the chemicals used by neurons to signal to each other. The ultimate causes of these conditions are genetic mutations; diseases affecting neurons, glia or blood supply; environmental hazards, including narcotic drugs and alcohol toxicity; or traumatic injury. Neurophysiologists seek to understand the fundamental processes and mechanisms that underpin normal and abnormal brain function. Fundamental research into brain function and dysfunction is essential for our understanding of life-long brain health. This allows us to identify potential therapeutic targets for the treatment of diseases and disorders which ultimately benefits all of society.

Professor David J A Wyllie
University of Edinburgh

Physiology curricula within pre-registration nursing education in Scotland.

An expert group of physiologists and nurse educators developed and agreed a core curriculum of physiology outcomes which identified the physiology all nurses require to know on qualification for safe practice and patient care and also supporting the achievement of the Nursing and Midwifery Council (NMC) standards for future nurses.

The project, funded by The Physiological Society, provides those in nurse physiology education a structure and guide of learning outcomes divided into a systems approach to structure their physiology teaching across the nursing degree.

In the end, there were 177 outcomes agreed. These learning outcomes do not suggest how they should be delivered, but gives the basic level required for qualification as a nurse commensurate with the Nursing and Midwifery Council new standards for the “future nurse.”

In Scotland, the numbers for student nurses and midwives continues to increase. For 2022-23, this has been set at 4,837 – a rise from 4,449 in 2021-22 and 4,206 in 2020-21.

At Queen Margaret University (QMU), offering a four year Master’s degree and adult nurse registration, our target is 101 for 2022/23, having been 82 for 2021/22. This means we have over 300 students actively engaging with physiology across their nursing programme.

At QMU, we are embedding these outcomes across our four year programme for adult nursing registration. The Master’s programme is based on the person-centred practice framework, therefore physiology is incorporated throughout some of the module streams rather than being within one distinct module.

We are continuing to ensure our programme includes the required breadth and depth of physiology content within new person centred curriculum framework.

Physiology knowledge underpins clinical skills which are key in the nursing curriculum; e.g. cardiopulmonary resuscitation (see image) and venepuncture – the requirement to understand the physiological response for cardiac cycle and perfusion and clotting underpin being able to carry out these skills safely.

The pre-registration outcomes provides a benchmark for considering those who are post-registration require in further qualifications e.g. advanced clinical practice roles.

Dr Alison Wood
Queen Margaret University, Edinburgh
Science Travels - Physiology as a bridge to improve access to STEM for Gypsy, Traveller, Roma, Showman and Boater Communities: Physiology for Social Change.

Gypsy, Roma, Traveller, Showmen and Boater (GTRSB) communities are poorly represented in the world of STEM; only 4% of these communities enter higher education and they endure some of the worst healthcare inequalities in the UK.

For the last 2 academic years, students at the University of Glasgow have worked collaboratively with staff and their peers to design physiology outreach activities, centred around the ‘fun of the fair’, to engage young people in STEM and to provide role models in science for GTRSB communities without othering them. Physiology is the perfect bridge to connect these groups and support their journey of discovery into the fascinating world of living systems.

Science Travels has delivered two online sessions with our first partner primary school in Wiltshire, which have received overwhelmingly positive feedback from pupils and teachers. Marie Bowers has delivered cultural awareness sessions to University of Glasgow staff and students, as well as sessions with undergraduate nursing students and teaching staff on healthcare inequalities faced by GTRSB groups. It doesn’t stop there. Science Travels is forging links with GTRSB community groups, advocacy groups and human rights groups and encouraging their engagement in the design and co-production of teaching materials for University of Glasgow students in Nursing and Medicine centred around lived experience of GTRSB interactions with healthcare providers.

The project has supported 3 summer studentships for individuals from GTRSB groups to design activities and vlogs blogs about the project, and why it’s needed. Vlogs were included in a multidisciplinary event to raise awareness of GTRSB cultures during the opening festival for the Mazumdar-Shaw Advanced Research Centre (ARC) at University of Glasgow. This project is truly promoting physiology as a medium for social change.

Science Travels is raising awareness of embedded anti-Gypsyism and other issues GTRSB individuals face in the UK today. The project is encouraging GTRSB groups to engage with STEM and is developing links with educators, students and the wider public to encourage meaningful discussion and understanding of GTRSB communities. The project is helping to reduce inequality, improve the education and the health and wellbeing of some of the most marginalised minorities in the UK.

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Students educate local communities on health and exercise.

Abertay offers its sport students a variety of opportunities to put their learning to use by taking sustained placements as part of their second, third, and fourth years of their degree programmes. Dundee’s high levels of deprivation lead to lower life expectancies and high rates of premature death. To assist this situation, the more than 20 hours per year of social work engaged by Abertay students through agencies like Active Schools help Dundee residents make beneficial choices about health and exercise that have been linked to economic impact for the community. The scheme also provides students with experience and ability, with around 75% of former students surveyed indicating they are in graduate sport occupations and with a large number starting up their own businesses.

3 Good Health and Well-being
4 Quality Education
10 Reduced Inequality

Photo credit: University of Glasgow

Photo credit: Abertay University

Ms Andrea Cameron
Abertay University
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.