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The Journal of the Parliamentary and Scientific Committee – All-Party Parliamentary Group

SCIENCE IN PARLIAMENT

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SUMMER 2021

RESPONSIBLE INNOVATION

DO NO HARM

DR IAN GIBSON MP FOR NORWICH NORTH 1997-2009

The biological community has lost a real champion with the death of Dr Ian Gibson the former MP for Norwich North who died of pancreatic cancer on 9 April aged 82.

When he was first elected in 1997 he stood out as being in a minority of Members who had had a substantial career prior to arriving in the House. Following his degree and doctorate at the University of Edinburgh Ian had worked at the University of East Anglia from 1965 until his election to the House. He started as a research scientist and became Dean of the School of Biological Sciences in 1991 with experience in two American universities along the way.

With this solid scientific experience Ian emerged as a strong campaigner for science (and cancer care in particular) and both remained close to his heart throughout his life.

He also relentlessly lobbied for science which (contrary to current controversy) he did openly as Member of Parliament. One senior scientist recalled his gratitude that Ian had been able to "get a letter on the top of Charles Clarke's in tray" (who was Secretary of State for Education at the time) which "lead to a meeting of some of our Executive Committee with Clarke."

His most significant period of influence came with his chairship of the House of Commons Science & Technology Select Committee having joined as a Member upon his election. That Committee was distinguished in having at one point three highly qualified scientists as Members (Ian, Michael Clark and Brian Iddon). Gibson used his position to promote the case for science and for better cancer treatment. He chaired the Select Committee from 2001 to 2005 (despite some opposition from Labour whips) and was also Chair of the All-Party Parliamentary Group on Cancer.

Just before the 2005 General Election Ian was involved in a very unusual situation. His Committee had been investigating the very important issues involved in embryo research and the question was whether or not it would make a report before the General Election. A filibuster by those opposed to a report threatened to block its work.

Ian took advice on what would happen if the Committee could do if there was a split in opinion (which there was) and in the end the Motion moved by his colleague Dr Brian Iddon MP meant Ian could use his casting vote as Chair to get the Select Committee's report published. This report paved the way for the Human Fertilisation and Embryology Act 2008.

One very experienced Member who served with Ian at that time said that "Being on 'his committee' was a bit like being on a bus, with him as the driver, going downhill without any brakes! In other words, it was hard to keep up with him - he put a lot of energy into the S&T Committee."

Ian stayed in Parliament until he (deliberately) left in 2009 in the wake of the Parliamentary expenses scandal having reached the conclusion that he had been badly treated by a kangaroo court. In the subsequent By-Election the seat changed hands.

For the remaining years of his life Ian continued to be based in his beloved and adopted City of Norwich (though he did teach at Harvard) whose football team he had passionately supported for so long. Born in Dumfries he loved football and had been a player in his youth for three different Scottish sides. He was also the coach of the cross-party Parliamentary football team and from 1999 to 2005 was the team's joint manager.

After leaving Parliament Ian remained active and was engaged outside Parliament (both while he was still a Member and when he no longer was) in using his experience to help Newton's Apple, the charity which organised meetings up and down the country for research scientists to enable them better to understand how science policy was organised and worked both in Parliament and Government.

When watching Ian in action he always managed to connect with the students because he himself had been through the experiences they were going through – and it showed.

In the words of one of his Parliamentary successors for Norwich Ian was "a man who gave his life to the scientific and political betterment of humankind." How true that is.

Dr Stephen Benn

Stephen Metcalfe MP
Chairman, Parliamentary & Scientific Committee (All-Party Parliamentary Group)

A warm welcome to the Summer edition of the journal.

In addition to our usual features we have 13 excellent articles dealing with a wide range of STEM topics, which I hope you enjoy reading.

In June the Queen's Birthday Honours List recognised many in the science and engineering community for their dedicated work, especially those who have contributed to tackling Covid-19.

Amongst the recipients were two of our recent discussion meeting speakers: Steve Rees, Vice President Discovery Biology at AstraZeneca and Dr Shaun Fitzgerald, Director, Centre for Climate Repair at the University of Cambridge, who were both appointed OBE. Our congratulations Steve and Shaun and all those who were also deservedly recognised.

Steve's article is on pages 22/23 and Shaun's piece will appear in the Autumn edition.

Since the Spring issue, it had been a pleasure to chair four excellent discussions: 'UK National Quantum Programme', sponsored by InnovateUK;

'What is the role of science in delivering the Government's plan to 'Build Back Better', in partnership with The Physiological Society; 'Natural Capital Initiative' with Plymouth Marine Laboratory; and 'Transition to net Zero' sponsored by the Met Office.

Our Programme Committee, chaired by Carol Monaghan MP, met in June to determine meeting topics for 2022. These will be announced in the Autumn issue and on our website.

This edition is due to be published in the same week as the Government's lockdown restrictions are due to be lifted. We will keep you informed on when it may be possible to return to Parliament for our regular meetings.

On the 22nd June, it was my great pleasure to chair the annual Parliamentary Links Day for which the theme, in this year of COP26, was entitled *Science and Climate Change*. I want to congratulate Dr Stephen Benn and the Royal Society of Biology for organising such a successful and informative event. A full report will feature in the next issue of the journal.

Stephen has written an excellent appreciation of the late Duke of Edinburgh, which follows our initial thoughts, penned immediately following the announcement of the passing of His Royal Highness on the 9th April, and appearing with the Spring issue a few weeks later.

Stephen Benn also pays tribute to two very distinguished Parliamentarians who gave great service to science and engineering: The Earl of Selborne, twice Chair of the House of Lords Science and Technology Committee, and the former Chair of the House of Commons Science and Technology Committee, Dr Ian Gibson, Member of Parliament for Norwich North from 1997 to 2009, both of whom sadly died earlier this year.

Looking ahead we hope that we will be in a position to go ahead with the P&SC Annual Luncheon in the Cholmondeley Room, House of Lords, on the 16th November, which will be hosted by our President Lord Alec Broers.

Plans are underway for STEM for BRITAIN 2022, which is scheduled to take place in the Attlee Suite, Portcullis House on the 7th March. Please help to promote this important event in our calendar which showcase the best work of our early-career researchers.

Finally, I should like to extend a warm welcome to the National Biofilms Innovation Centre, as a Scientific and Technical Organisation member and Denise McLaverty as an Individual Member. Denise previously represented the Society of Cosmetic Scientists on the Committee.

Wishing you a good Summer.

SCIENCE IN PARLIAMENT
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The Journal of the Parliamentary and Scientific Committee (All-Party Parliamentary Group).

Science in Parliament has two main objectives:

1. to inform the scientific and industrial communities of activities within Parliament of a scientific nature and of the progress of relevant legislation;
2. to keep Members of Parliament abreast of scientific affairs.

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RESPONSIBLE INNOVATION: DO NO HARM!

Professor Sa'ad Sam Medhat
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FRSA FIKE FIoD
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The combination of innovation and responsible leadership presents a very powerful mandate that touches every part of the 17 United Nation's Strategic Development Goals (SDGs), as it activates the critical behaviours of citizens, public and private business leaders, and policy makers.

Adoption of innovation, either in the form of new technologies or new approaches, is often driven by the expectation of increased future profits and the development of differentiated capability. Such an undertaking is predicated on the availability of the necessary capital, a willingness to take risk and having a capable workforce. These elements often form an organisation's 'Adaptive Capacity'.

Investment in new technologies, processes and products have multiple benefits. Generally, such benefits can be manifested in the following:

- Productivity Gains, which contribute to meeting the targets of *SDG 8 'Decent Work and Economic Growth'*;
- Efficiency Gains, which contribute to meeting the targets of *SDG 9 'Industry, Innovation and Infrastructure'*;
- Carbon Intensity Reductions, which contribute to meeting the targets of *SDG 12 'Responsible Consumption and Production'*, and the targets of *SDG 13 'Climate Action'*;
- Reduction of Polluting Emissions, which contribute to meeting the targets of *SDG 3 'Good Health and Well-Being'.*

However, decarbonisation of electricity supply is ostensibly a critical part of meeting the targets of many of the UN SDGs. This involves the replacement of fossil-fuelled generating capacity by renewable supply. It also requires providing comprehensive electricity supply to many countries, particularly in Africa, where this is likely to involve renewable microgrids for cost, and, speed of diffusion reasons.

GREEN INNOVATIONS

At our partner Institution, the South West College (SWC) in Northern Ireland, where the IKE Institute NI branch is located, two great interlocking projects come together to accelerate green innovations. The first project is an Erasmus+ trans-European project that started three years ago known as Creative Engine (CE). It's purpose is to respond to the creativity and innovation skills gap identified in an earlier study that the IKE Institute conducted across 240 engineering and technology businesses in partnership with SWC, Dublin City University in Ireland, Thomas More in Belgium, and Tknika in Spain. An online programme that covers ideas management, innovation culture, innovation process and planning, innovation strategy and evaluation, customer analysis and market analysis was developed by CE, and is now available freely online for all educational providers and engineering and technology businesses to benefit from. Innovation as a taught discipline provides the fundamental underpinning to help organisations come up with coherent, workable solutions to the toughest problems. And Climate Change is one of the toughest ever!

Dovetailing into that innovation focus on Climate Change, has been SWC's second project entitled - Renewable Engine (RE), which was funded under the EU's Interreg VA programme. RE supports research work at PhD level and above in Renewables and Eco-Engineering alongside ten other organisations from the micro-sized to the multinational, working in harmony to find answers in the critical areas of energy generation and energy storage. RE's industrial partners include B9 Energy Storage, Booth Welsh, Caley Ocean Systems (in collaboration with Industrial Systems & Control), Doosan Babcock, Kastus Technologies, Kingspan Water and Energy, Organic Power, Platinum Tanks, RotoSim, and Soltropy. Alongside SWC are leading research organisations - Queens University Belfast, Advanced Forming Research Centre University of Strathclyde, and Institute of Technology Sligo.

This cross-border collaboration and co-creation has focused on advanced engineering and manufacture of innovative smart materials and processes to support the renewables industry. Within RE, there are projects aimed at wind energy, such as the development of a new rotomoulding simulation and modelling software specifically for the renewables energy sector; the creation of large, low cost and lightweight multi-layered rotomoulded structures for off-shore windfarms that offer an alternative to steel, but are resilient enough to overcome challenging marine environments; research into advanced control methods to enable high performance lifting from floating vessels for installation and maintenance of off-shore wind platforms, and an industry 4.0 project incorporating augmented reality to provide digital twinning of windfarms, aiding remote maintenance and control of such rigs.

RE has also given attention to the rural community, supporting farmers with off-grid energy generation through such innovations as combining new thermoplastic composite materials with new rotational moulding techniques to develop new solar frames, and development of robust, modular, and small-scale anaerobic digestion systems enabling 24/7 power supply for farms.

The aspect of energy storage, often a bugbear in renewable tech, has also been targeted by RE. With projects such as the development of a novel isothermal compressed air energy system using liquid piston technology, and the use of smart or phase-change materials to enable thermal energy storage inside solar collectors providing pre-heating before entry into a combi-boiler, are some of the innovations that are emerging.

Through this project, new energy efficient products and processes are being founded by leaps in physiochemistry. Conversion of materials into their greener component parts using nanocatalysts converting CO2 into renewable fuels like hydrogen; first-gen PV modules being recycled through pyrolysis – a thermochemical conversion process – into sustainable materials, and photocatalysts being used to create energy efficient LEDs thus, supporting the journey to a greener, circular economy. Even transitioning to green power is being supported by a development within RE using AI algorithms to find and visualize the best economics, energy performance and social benefit optimisation metrics for an organisation anticipating a move toward sustainable energy systems.

RESPONSIBLE INNOVATION

As the combination of CE and RE projects demonstrated, Responsible Innovation (RI) can be defined as *"the careful consideration of, and action to address, the potential impacts of introducing a new product, service, process or business model. It considers the benefits that are derived from innovation and seeks to eliminate, minimise or mitigate any potential downsides from the perspectives of the company, its employees, suppliers and customers, and stakeholders…"* (Innovate UK - British Standards Institution, PAS 440, 2020, p8).

As a relational concept, RI is the result of the intersection of three main contexts: the Governance Context, which includes the rules, regulations and policies within which RI occurs; the Innovation Context, which includes the technical possibilities and the social responsibility priorities set by governments including the UN SDGs; and the Stakeholder Engagement Context, which includes the whole company as part of the governance context, and, also transparency about the direction of innovation, and its likely outcomes.

However, to activate the SDGs drive in business, to compel senior business leaders, particularly those of large industrial businesses, and their global supply chains and ecosystems, requires policy makers to consider a means to offset the inevitable cost and complexity implications to businesses, by creating incentives to galvanise collective action. Spreading the success stories of use-cases across the UN member states will also increase the adoption of RI.

THE INNOVATIVE RESPONSIBLE LEADER

The global pandemic crisis and its resulting business dislocations have unlocked change, at a pace and magnitude, that has made even the boldest and most progressive of leaders to question their assumptions.

Responsible Innovation Leadership mandates formally to establishing multi-faceted reviews that act as a brake on purely money-making schemes or just a nationalistic focus, operated at all costs. Clearly, establishing a Code of Practice recognition for UN-inspired RI Leaders would be an effective step forward. RI Leadership is a collective mission, that includes amongst others, the following actors and influencers:

- Policy makers in governments, who are willing to support the mission of addressing Climate Change and addressing the SDGs;
- Scientists, whose research addresses the critical issues of providing a sustainable infrastructure;
- Entrepreneurs, who ensure that technologies are adopted and delivered at scale to produce sustainable infrastructure;
- Financiers, who provide the needed innovative financial structures that deliver this sustainable infrastructure; and
- Individuals, who choose more sustainable lifestyles.

Orchestrating partnerships amongst all these actors and influencers to achieve the global goals, in less than ten years, requires better knowledge. Promulgating and assimilating the UN's 17 SDGs and their targets will provide the foundational knowledge-base needed to rebalance profit vs. purpose responsibly.

The power to reimagine the possible to recalibrate what can be achieved, is now profoundly critical. Questioning, where should we be, aspiring 10 times higher or 10 times faster, and therefore, what do we say no to, or stop doing to create the additional space to "do no harm" should be a key attribute of the RI Leader of the future.

And, we hope the forthcoming 26th UN's Climate Change conference in Glasgow will embrace vivaciously the underlining essence of **Do No Harm!** □

FUNDING FOR INNOVATION – AN IRRECONCILABLE PROBLEM?

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INTRODUCTION

Funding is key to innovation. Companies, countries and organisations have wrestled with this over many years – indeed to the extent that deciding which projects to fund has become a time-consuming end in itself. In the EU, the success rate for proposals submitted under the HORIZON 2020 programme was about 11%. This is significantly lower than the Seventh Framework Programme (20%). In the UK, success rate for Innovate UK proposals was about 7.5% (Freedom of Information request: FOI2020/000910). Low success rates are problematic and, despite attempts to copy the US DARPA model (the EU ERC programme and the soon to be instigated ARIA programme in the UK) and fund breakthrough (and impactful) science, research quality is only one of perhaps a dozen criteria that reviewers will have been told to use when assessing proposals. Each of these is an opportunity to differentiate (i.e. downgrade) a proposal compared to another one, based on something other than simply excellence. This means that the funding may go to the best written, most carefully crafted proposal rather than the best. Even then, sometimes deciding which proposal to fund may be an almost impossible task. Random allocation of grants by drawing lots has even been tried as a way of surmounting the challenge of deciding between a plethora of well written applications [1].

Confusion in the research funding environment is often a result of unclear objectives. *Researchers* want to be funded to carry out research designed to advance knowledge and their careers. *Governments* are proud of the achievements of their scientists and their institutions as this helps them to emphasise the human capital value of the country but increasingly they are also looking at return on investment as a metric. *Companies* fund science and research in order to make discoveries that will benefit the company. Research credibility is important but the most significant commercial driver is the measurable value of the research. High performing businesses often consider (or are told) that they need to operate at the cutting edge of excellence but they still regard 'blue sky' research with considerable suspicion.

The conflict between knowledge and utility is reflected in the attitudes and responses of individual scientists, companies and institutions. Problems arise when knowledge and utility are assessed as shared parts of a metric. It is akin to trying to find the perfect pair of shoes – ones that will be outstandingly good in the ballroom, for the daily commute, climbing a mountain and running round a race track. Such a shoe does not exist. Compromises are not fit for one purpose or the other - like wearing a pair of dance shoes to climb up a mountain.

SCIENTIST RESPONSE

Individual scientists compete and collaborate. There is a trend towards larger scale collaborations. When Watson and Crick first published the structure of DNA, the number of scientists involved was relatively small and the seminal paper had two authors. Some 50 years later the publication of the sequence of the human genome named 25 different institutions, each represented by multiple scientists. Despite this increased collaboration, individual scientists are still singled out for awards and prizes – most notably the Nobel Prize - in various branches of science. They are also required to apply for grants as leading individuals (Principal Investigators) and not only as part of a team. The need for larger teams of scientists

working in collaboration is driven by the increase in multidisciplinarity, the increasing range of techniques and specialisms used, the nature of the equipment (e.g. the CERN facility in Switzerland) and the encouragement of formation of transnational consortiums by funding bodies such as the EU. This balance between individual research and recognition which is necessary for an individual to develop a career in science and collective cooperation that is necessary in order to make an impact is crucial to basic research.

Scientists also develop more informal collaborations. These have been described as 'participatory' collaborations where there is less hierarchical structure and more informality. They rely upon trust and mutual benefit and less on shared resources and formal grant agreements.

COMPANY RESPONSE

The development of organisational-led collaboration in science was one of the most significant changes in the ecosystem of science in the 20th century. The development of in-house facilities helped to commercialise science and companies came to see the development of novel science, that they owned, as a route towards profit. This trend accelerated as science increased the understanding of how things work.

Companies that grew to be sector leaders demonstrated their faith in research and development (R&D) but with an important caveat. Unlike individual researchers, companies do not conduct R&D for its own sake – otherwise they may develop a technologically fantastic product but one for which no market exists. This is a common failing of researcher-driven translational efforts. For a company, meeting a market need (or creating a need that they are able to meet) is the primary driver. To industry the nature of the technology is relatively unimportant so long as it accomplishes the primary aim. In that sense, research is *solution-driven* while industry is *opportunity-driven*.

INSTITUTIONAL RESPONSE

There has been an increasing movement towards ensuring that even academic R&D is relevant and impactful as well as intellectually robust. The simplest way to ensure this is to squeeze as much commercial value as possible from each piece of research. This has encouraged collaboration (particularly between different disciplines) but has also created competition over IP ownership and commercial exploitation. A whole industry has grown up around the commercialisation and exploitation of non-industrial research. Part of the incentive for this has paradoxically been changes in corporate structures. David Hsu (Wharton School, University of Pennsylvania) said "We're no longer in the age of basic research from AT&T/Bell Labs, GE Labs, Kodak and DuPont — all that is business history," Universities now occupy this space. University technology, however, is typically much more basic compared to applied research and so identifying academic discoveries which could have the potential for commercial translation ("latent commercialisability") is challenging. This has led to an explosion in the numbers of patents granted to universities but not to a corresponding increase in value capture compared to commercial organisations. A recent study from the US calculated that universities capture about 16% of the value they help create through licensing revenues or equity stakes in the start-ups their research produces compared to commercial exploitation [2]. The figure for the UK is likely to be lower. This study also suggested that there were two key factors that defined the success of university commercialisation - the degree to which an academic team is interdisciplinary and the presence of a "star commercializer,". The main author, David Hsu noted, "Interestingly enough, it's not the star academic that is correlated with commercialization — it's the star commercializer, those with substantial prior experience bringing products to market via start-up formation." The conflict between scientific excellence and commercialisation is laid bare.

CONCLUSION

The commercialisation of innovative R&D is driven by a number of factors. There is a fundamental disconnect between the traditional role of universities (teaching and research) and translation of research into profit. The current paradigms around technology transfer, whether in the US or Europe, do not work effectively. A new paradigm is needed.

1. Universities need to decide what level of commercialisation is appropriate for them while maintaining their roles in teaching and knowledge creation.
2. There is too much emphasis on how to write a good proposal (which boxes to tick) rather than what it will achieve if funded.
3. Current systems to capture value from university research are inadequate. There is no benchmark for what value is generated and so no coherent vision of what a sensible target should be.
4. Government needs to decide if it wants to decouple R&D from commercialisation (wholly or partly) or strengthen this link and to then create the conditions that will enable either to happen. One does not naturally flow from the other.

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DID YOU KNOW THAT GLOBALLY ONLY 30% OF SCIENCE RESEARCHERS ARE FEMALE*?

However, a UK Government backed scheme is helping foster a better balance

Access to inclusive, quality education and lifelong learning opportunities is a distant dream for many young people across Africa, especially women. Few have the opportunity to finish school, let alone reach university to study world-class science, be mentored by experts or continue to postdoctoral studies. This can be due to lack of access to resources at home institutions, insufficient grant writing experience, lack of mentors or supervisors, inadequate of facilities, and poor postdoctoral pay.

Globally UNESCO* figures show only 30% of researchers are female and they occupy only 20% of STEM leadership positions. These figures are even lower in many countries in Africa underlining how important it is to challenge women's under-representation. And this is exactly what an innovative collaboration is doing the UK's national synchrotron, Diamond Light Source (Diamond), and higher education and research partners in the UK and Africa. This initiative is a grant called Synchrotron Techniques for African Research and Technology (START), which is funded by the UK's Government Global Challenges Research Fund (GCRF) through UKRI's Science and technology Research Council (STFC).

Launched in March 2018, the GCRF START grant programme is giving young African researchers, over half of whom are women, access to world class scientific facilities, collaborations, funding, training and expertise. Already these female scientists are achieving impressive results in the fields of structural biology and energy materials. But just as importantly they are powerful role models and mentors inspiring the next generation of women to choose careers in science and to find African and joint UK-African solutions to some of the world's most pressing health and environmental challenges in line with the UN's Sustainable Development Goals. They are actively changing perceptions with outreach activities and mitigating cultural and other barriers which have, in the past, hindered access to STEM careers.

One young scientist collaborating with the GCRF START grant is **Dr Gugulethu Nkala**. A South African Energy Materials PhD student at the University of the Witwatersrand (Wits University) in South Africa, she is the first in her family to go to university. Investigating new generation renewable energy storage, she is also enthusiastically involved in science outreach to impoverished schools, helping to motivate and assist young people from disadvantaged backgrounds to fulfil their dreams. *"Seeing a black girl in science, makes girls see that there is someone, just like them, who has gone this far," she says, "We are breaking barriers that makes science seem unattainable, by being the link between science and society, made possible by funding bodies like the GCRF START grant."*

Gugu explains that her goal is closing the energy poverty gap in sub-Saharan Africa where many, especially in rural areas, are without access to basic electricity, sanitation and health care. Her love of STEM brought her to the School of Chemistry in the Energy Materials Research Group at Wits, where her research focuses on improving battery storage systems to make them more efficient, affordable, safe, and environmentally friendly. Through the GCRF START grant, she visited Diamond and gained essential research skills and networks. *"Visiting Diamond in the UK was a life changing opportunity which took me from a position of remotely learning about synchrotrons and taking virtual tours, to experiencing this first-hand."*

The grant's main research focus is to generate insights using synchrotron science into sustainable energy and improvements in health that will have long-lasting legacies across Africa, and global impact.This involves developing and characterising new energy materials for applications such as solar cells, new generation renewable batteries, fuel cells, and novel catalysts; and structural biology to understand diseases, develop drug targets

for better treatments and potential vaccines, and develop cutting edge biotechnologies to tackle pollution, climate change and food security. To date, the GCRF START grant has directly collaborated with nearly 50 young African research students and given access to almost 100 synchrotron beamline sessions and indirectly benefitted many more.

"Being a young woman in science, forging my career, can be challenging at times. However, I want to be an inspiration for young African girls and women, so they know that it is possible to fulfill your dreams and passions," says Zimbabwean, **Dr Thandeka Moyo**, a GCRF START Postdoctoral Research Fellow at the South African National Institute for Communicable Diseases (NICD) and affiliated to Wits University.

Thandeka is part of a leading South African team working on HIV/AIDS vaccine research and is currently researching Covid-19. Her desire to end HIV stigma; mentoring of early career female scientists, and her own research successes, mark her out. She says the grant has given her opportunities she could have never imagined as a young student. *"I now have access to a world-class synchrotron, the UK's national synchrotron – where I can send my HIV-antibody complexes to obtain the vital diffraction data I need for my research."* Thandeka actively encourages young women to pursue a career in academia and other science-related industries, with school outreach initiatives, involvement in student 'shadowing,' and presentations to school children.

Recently, using Diamond Light Source, Thandeka and her team were able to solve the structure for one member of a family of antibodies revealing a uniquely long loop up to three times longer than other published anti-HIV antibodies. *"Such insights provide opportunities not only to expand my skills and knowledge as an early career scientist but also inspire hope for an effective vaccine to end the global HIV pandemic, as well as insights into other pandemics."* Thandeka's research is with a unique cohort of women on a long-term vaccine research clinical trial at CAPRISA. https://start-project.org/2020/12/01/the-hunt-for-an-hiv-vaccine-unique-insights-from-an-inspiring-cohort-of-women-in-south-africa/

Dr Priscilla Masamba says she learned many scientific techniques for the first-time using Diamond Light Source remotely from a lab in South Africa, which enabled her in 2020 to solve the partial structure of a protein from *Schistosoma mansoni* - a parasite responsible for the debilitating disease Schistosomiasis (Bilharzia). This disease is endemic in more than 78 countries, and over 4 million people are infected in South Africa alone. Only one drug, Praziquantel, is available to treat Schistosomiasis which is only partially effective. Priscilla's research focus is to find new drug targets to treat Schistosomiasis. The unique collaboration between structural biologists at the University of Cape Town and the University of Zululand introduced by START Co-I, Prof. Trevor Sewell, provided Priscilla with the rare opportunity to access Diamond for her experiments – an experience she describes as "close to a cool sci-fi movie!"

Priscilla explains, *"I could literally control and see a robot that was thousands of miles away, mount a microscopic crystal (sample) within the firing line of a powerful X-ray beam, and determine the amount of energies released by light emitted from the sample caused by incident X-ray beams, and all of this while working from the laboratory in Cape Town. The whole experience provided me with rare exposure to the world of X-ray crystallography, impacting my view of science in a spectacular way."* The GCRF START grant made her the first student to use the Diamond synchrotron from the University of Zululand.

Born in the DR Congo, Priscilla lived in Zimbabwe as a child, before moving to South Africa. She now has a NRF Postdoctoral Fellowship in Structural Biology at the University of Johannesburg.

"I have been able to learn and cultivate scarce, critical and sought-after skills here in Africa in the fields of bioinformatics and drug discovery, molecular biology and especially, structural biology. These include gene cloning, recombinant protein expression and purification, as well as characterisation of proteins. This has not been an easy task because I am from an under-represented group in science as a black female and have studied at a historically-disadvantaged and resource-constrained institution," she adds.

Another scientist challenging gender and cultural barriers is Zimbabwean, **Michelle Nyoni.** She is studying energy materials to improve the performance of Lithium-ion batteries for portable electronics, electric vehicles, small power grids and renewable energy sources. Her goal is to make them affordable and improve their environmental footprint to help tackle climate change. Michelle is a chemistry lecturer at the Chinhoyi University of Technology in Zimbabwe, a part-time PhD student in the Energy Materials Research Group at Wits University and runs her own consultancy bridging academia and industry in her spare time. Due to frequent load-shedding/power cuts, Michelle relies on a solar panel provided through the GCRF START collaboration to provide her with a reliable source of light to study at home in Zimbabwe.

While working in the farming sector in Zimbabwe, she realised that despite having abundant renewable sources of energy (wind and solar) they are hindered by the challenge of how to store it effectively. *"This is where the subject of batteries came into my life and where my current PhD research area fits in. I am investigating lithium vanadium phosphates as cathode materials for lithium-ion batteries. South Africa is one of the biggest vanadium producers in the world and Zimbabwe is*

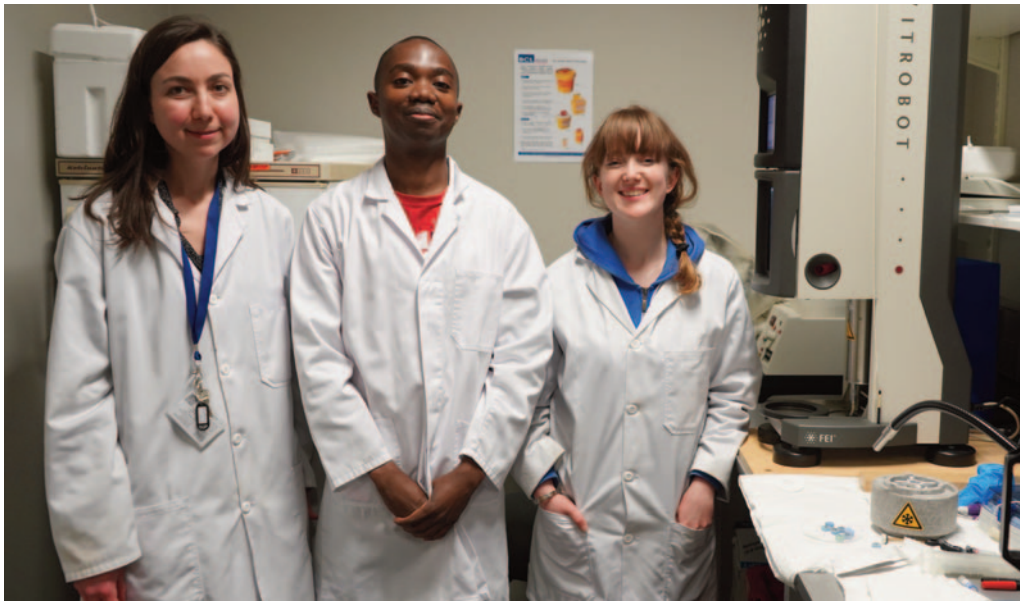
one of the biggest lithium producers in the world. Therefore, if the raw materials are locally available it will hopefully mean reduced cost of battery production," explains Michelle.

The young women collaborating with GCRF START represent the next generation of structural biologists and energy materials scientists in Africa and the start of a user community trained in world class synchrotron techniques to meet the ambition of a future African Light Source. Just one indicator of the programmes' success is how the tiny community of structural biologists in Africa has grown across South Africa to include a whole new generation of female scientists. Similarly, in energy materials, gender has traditionally been a barrier, so having young women entering materials science is great progress.

More about the GCRF START grant here: https://start-project.org/home/about/

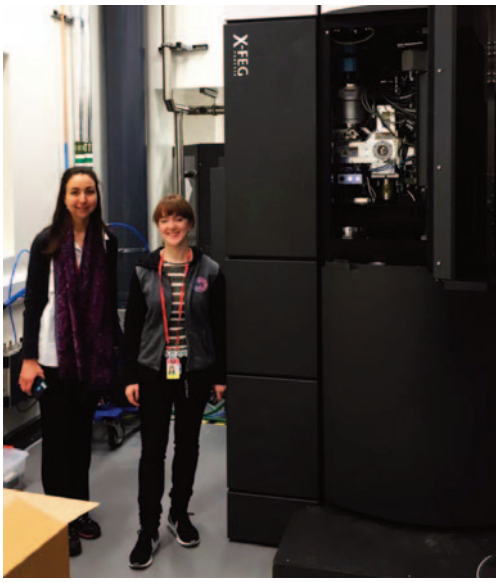
*UNESCO Just 30% of the world's researchers are women. While a growing number of women are enrolling in university, many opt out at the highest levels required for a research career. □

Aerial view of Diamond Light Source Ltd, Harwell Campus, UK. ©Diamond Light Source



Lizelle Lubbe (L) Melissa Marx (R) & A. Mulelu. Photo Credit Rebekka Stredwick©Diamond Light Source

Energy materials scientist Gugulethu Nkala ©Diamond Light Source



Dr Lizelle Lubbe & Melissa Marx at the Titan Krios III, Diamond Light Source, UK. Photo credit Dr Jeremy Woodward.©Diamond Light Source

COLLABORATION BETWEEN HUMAN AND VETERINARY MEDICINE WILL BE IMPORTANT IN TACKLING ANY FUTURE PANDEMIC DISEASE THREATS

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Currently a member of the UK Vaccine Network, a member of the Zoonoses and Emerging Livestock Systems Independent Programme Advisory Group (ZIPAG), an Independent Member of the UK Science Partnership for Animal and Plant Health, a Board Member of the International Veterinary Vaccinology Network, a Trustee for the Jenner Vaccine Foundation and a Member of the UK Zoonoses and a One Health Approach Advisory Group.

The current COVID-19 pandemic has reminded us all of the threat to humanity posed by zoonotic infections, that is those that can pass from animals into humans. These diseases make up 75% of the recent infections in humans and it is only a matter of time before the next zoonotic threat emerges. Indeed, it is reported that "there are over 150 zoonotic diseases worldwide, which are transmitted to humans by both wild and domestic animal populations, 13 of which are responsible for 2.2 million deaths per year". In recent years we have observed the global threat from zoonotic coronaviruses such as Severe Acute Respiratory Syndrome (SARS) which emerged in 2002, then 10 years later in 2012 the threat from Middle East Respiratory Syndrome (MERS) and just seven years after this the emergence of Coronavirus Disease in 2019 (COVID-19). Furthermore, as our population expands, the contact between human and wild animal habitats increases, introducing the risk of exposure to new viruses, bacteria and other disease-causing pathogens and thus the risk from future zoonotic diseases cannot be ignored. With this in mind we need to give some careful consideration to the lessons that we can learn from the recent coronavirus infections, including their control and how we can prepare for any future pandemic threats. In doing so we need to reflect on the contribution to our knowledge derived from both human and veterinary medicine.

It is important that information gained from veterinary vaccines should be recognised as part of a One Health approach to medicine, which has been defined as "the integration effort of multiple disciplines working locally, nationally and globally to attaining optimal health for people, animals and the environment". In this regard vaccination has a key role to play within this One Health agenda since it enables us to control disease transmission between animals and human, and in doing so have a significant impact on their shared environments. As a prophylactic measure vaccine can prevent the emergence of disease in the first place and as an intervention they can restrict its transmission and spread within a population. Indeed, several current veterinary vaccines are targeted towards livestock and companion animals and in order to prevent the disease in both animals and humans (for example avian influenza, bovine leptospirosis, rabies and Rift Valley Fever).

As we considered the possibility of tackling the SARS-CoV-2 virus, which causes COVID-19, back in early 2020 something that we did already know from veterinary science was that vaccines against coronavirus infections had been successfully developed over a number of years for livestock (cattle, pigs and poultry) and companion animals (cats and dogs) using both killed (inactivated) and live (attenuated) vaccine strategies. In addition, both Nucleic Acid vaccines based on DNA (similar to the Pfizer and Moderna mRNA vaccines) and Viral Vector Vaccines (similar to the AstraZeneca and Janssen adenovirus vectored vaccines) had both been successfully commercialised for many years against number of veterinary diseases. In fact, a range of viral vector vaccines have been available for multiple animal species since the 1990s and the first ever commercial DNA vaccine was developed in 2005 against a viral disease in salmon and in the same year another DNA vaccine was developed for horses. In addition to veterinary coronavirus vaccines being available, we also knew from veterinary medicine that the coronavirus spike protein was important in eliciting protective

immunity against infection and that virus neutralising antibodies could protect against a virulent disease challenge. Other lessons from animal coronavirus vaccines, that may well have an impact on future COVID-19 vaccine strategies, are protection can be provided by local mucosal responses to topical vaccination via a nasal route, protection can be passed on to offspring from a mother via maternal antibodies, inactivated coronavirus vaccines can elicit at least 12 months protective immunity against a controlled experimental virus challenge and that it is possible to broaden the anti-virus responses to viral variants by combining different virus strains within the same vaccine or by using a prime-boost strategy using different vaccine strains.

Having said this, we cannot fail to be impressed by the exceptional rapid response to the COVID-19 pandemic through the development and deployment of highly effective vaccines within 1 year of the virus genetic code being made available by researchers in China. However, we must be careful not to get too carried away by this success since human vaccines typically take much longer to develop, 10 to 15 years, and the circumstances surrounding this disease may not apply to all future pandemic threats. For example, we knew the vaccine target from previous work on coronaviruses, we had the genetic sequence available and we had vaccine delivery platforms ready to go as a result of years of scientific research. Indeed, the UK Vaccine Network established in 2015 had foreseen the risk posed by such zoonotic infections and had laid the groundwork for a response by funding vaccine platform technologies, developing vaccine process roadmaps and recommending the need for further vaccine manufacturing capability. This should in no way detract us from recognising the heroic efforts of all those involved in developing the COVID-19 vaccines in such a short timeframe and the insightful work of the UK Vaccines Taskforce in managing their sourcing and deployment. As the pandemic develops, we must recognise that there is now a growing need for new and improved vaccine technology platforms offering the opportunity for rapid product development, convenience of manufacture and ease of administration for future disease threats. In order to achieve this, we should utilize existing expertise on veterinary vaccines to evaluate target vaccine antigens in non-rodent animal species, which can often provide better disease models that can more closely mimic the disease in humans, and we should consider shortening the cycle from research to commercialization of human products by validating zoonotic disease vaccines within a relevant veterinary host species. Indeed, it is interesting to note that veterinary vaccines can generally be developed more rapidly than their human equivalents since researchers are able to test the efficacy of experimental formulations in the target animal species using controlled laboratory challenge studies at an early stage in their development. This approach is generally not considered to be ethically acceptable in humans until more is known about the effects of a new disease and its control, although it is interesting to note that the first human challenge studies with COVID-19 have now been approved within the UK. The trials will initially monitor up to 90 healthy 18- to 30-year-olds, who are at low risk of developing complications, after they are given the virus in a safe and controlled environment.

Another risk posed by COVID-19 is its ability to be transmitted from humans back into animals, a phenomenon known as Reverse Zoonosis or Zooanthroponosis. To date this has been known to occur in wild cats, domestic cats, dogs, ferrets, mink and primates. Furthermore, in the case of mink the virus has been shown to be capable of transmission back into humans. Following infection of these contact animals, experimental investigations have revealed that the virus has the ability to mutate in some cases and the potential to cause significant respiratory disease. As a result, vaccines are currently being developed for companion animals and endangered zoo species and animal vaccination is already being selectively rolled out in Russia. Whilst there is no immediate cause for alarm, this situation will require careful monitoring by veterinary scientists in the future if we are to fully understand and control these potential reservoirs of infection.

In conclusion, it is becoming increasingly evident that we should adopt a One Health approach to disease control in the future since it is clear that the health of humans is irrevocably linked to the health of animals and the environment in which they both co-exist. Thus, collaboration between animal and human health researchers offers the potential to advance the understanding of mutually relevant diseases and expand the translational approach to medicine. The World Health Organisation believe that we can achieve this by "designing and implementing programmes, policies, legislation and research in which multiple sectors communicate and work together to produce better public health outcomes". Utilising more relevant in vivo animal disease models and experience with veterinary vaccines can help to accelerate pre-clinical research for human vaccines, and thus shorten the cycle from research to commercialization by validating zoonotic diseases within animals. Any future pandemic preparedness strategy must recognise this and ensure that there is a close collaboration between human and veterinary medicine in the development of any research programme. □

HARNESSING GENOMICS FOR CONTROL OF INFECTIONS

Professor Judith Breuer MD FRCPath FMedSci, Professor of Virology, Institute of Child Health. Consultant Virologist Great Ormond Street Hospital For Children.

The widespread use of nucleic acid sequencing of the SARS-CoV-2 genome has had a huge impact on our understanding of the spread and control of the COVID-19 pandemic and has changed how we do public health for ever. So what is nucleic acid sequencing? Nucleic acid sequencing is the process by which the DNA or RNA nucleic acid base building blocks (there are five, known as G,C A T/U) which make up the genomes of all living organisms and the order in which they are strung together to code for structure of the organism, for example SARS-CoV-2, are identified. Mistakes in the nucleic acid sequence, made when the genome is copied to make, for example, a new SARS-CoV-2 virus, slightly change the genome sequence resulting in a "variant" genome.

So what have we learnt over the years from sequencing pathogens? At the simplest level we have known for many years that changes in parts of the genome that code for proteins which bind drugs can give us information about drug-resistance. Sequencing of the Human Immunodeficiency Virus (HIV) polymerase (pol) open reading frame (ORF) that codes for the reverse transcriptase and protease proteins, both of which are targets for antivirals, has been used for over 20 years to identify drug resistance and provide information on when to change treatment. Where resistance mutations are scattered in many genes, e.g. TB it makes sense to sequence the whole genome. Sequencing for drug resistance is also preferable where pathogen culture is difficult, e.g. TB , HCV or potentially dangerous (HIV). Another very specific therapeutic use of pathogen sequencing has been to inform the annual re-design of the influenza A and B vaccines. Variants occurring in those regions of Influenza A and B that code for proteins recognised by the immune system enable the viruses to "escape" immune control and cause new epidemics every year. To prevent this, influenza sequences, from all over the world representing the potential new epidemic strains are collated to help the influenza community decide on the content of the next vaccine.

Sequencing pathogens has also been used for many years to prove or refute putative outbreaks of infections occurring in hospitals and the community. Outbreaks tend to be recognised where there is an unusual clustering of cases of a pathogen occurring in the same locality and or time-frame, for example on the same ward or where there is an apparent increase of cases of an infection in the community. Where the pathogen genome sequences are identical or very similar, the information can help confirm that transmission from one person to another has occurred particularly if the clinical information fits. Even more usefully, where the pathogen genome sequences are quite different, this can rule out a transmission, allowing the clinical teams to focus their attention elsewhere. Where pathogen sequencing is routinely carried out and not just for outbreaks, it can also identify cases that are possibly linked to one another even if they were not originally thought to be part of a suspected outbreak.

While useful, before COVID 19, most pathogen sequencing for outbreak analysis in the past has been retrospective. By this I mean that the results were helpful for understanding what had happened, so called root-cause analyses, but in very few cases changed the management of the outbreak or influenced public health decisions. This situation changed with the advent of rapid methods for sequencing and the accompanying commitment to open databases of pathogen genome sequences. Deployment of rapid ebolavirus sequencing and analysis during the epidemics in West Africa in 2014-16, was able to distinguish viruses originating outside an area from the locally circulating variants. This in turn provided local public health agencies with the data they needed to limit spread of the virus and ultimately control the epidemic. The lessons learnt from Ebola and similar studies of Zika virus and Lassa fever virus outbreaks, provided the proof of concept that rapid sequencing for public health was achievable and formed the basis for standing up the COVID-19 (COG) UK Genomics consortium. Within COG-UK, standardised methods for sequencing SARS-CoV-2 were quickly made available to laboratories all over the UK who began to sequence cases and outbreaks occurring in their local hospitals and communities. The sequences were uploaded to a single database the Cloud Infrastructure for Microbial Bioinformatics (ClIMB) database

to provide open access information on which variants were circulating in the UK. The involvement of the UK Wellcome Sanger Institute enabled scale up sequencing of large numbers of community samples. The mechanisms for anonymising and sharing clinical data agreed through the public health agencies and the ethical framework provided by the Secretary of State's Control of Patient information (COPI) notice, set the stage for a unique opportunity to use genomic data in near real-time for the management of the COVID-19 epidemic.

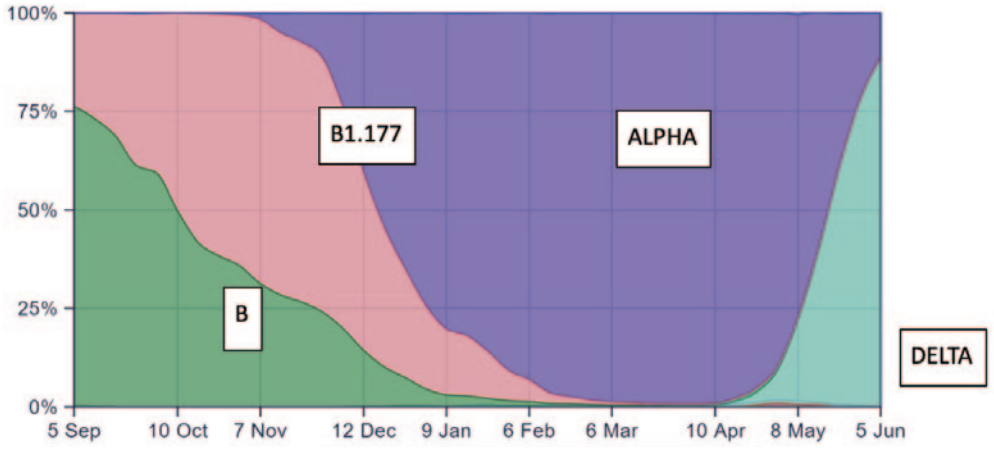
So 15 months on, what has this unique and bold experiment yielded? Early on, sequencing of clusters confirmed outbreaks associated with work places, nightclubs and pubs. However, the first insight that came directly from the sequence data was evidence that large numbers of variants spreading in the UK in 2020 before the first lockdown, arrived in the UK not from the Far East as had been anticipated, but from travellers returning from European holiday destinations following the February school holiday. These findings suggested not only that the virus must have been circulating quite widely in Europe from the start of 2020, but also pointed to the possibility that the UK may have been able to slow its own epidemic had it acted sooner to close its borders. This finding also overturned prevalent advice at the time that imported virus was not likely to contribute much to the spread of SARS-CoV-2 in the UK; large numbers of transmissions were shown to be due to the imported European strains. This first major finding has directly influenced UK policy on travel, including some of the restrictions still in place today.

Perhaps the largest impact of the COG-UK sequencing has been the early recognition and characterisation of new variants of concern (VOCs) and variants under investigation (VUIs). As described before, any virus that acquires mutations (mistakes) in its genome sequence is a variant. A variant under investigation (VUI) is one where the mutations acquired code for changes in the viral genome sequence that have been shown in laboratory experiments and epidemiologically to be associated with increased potential for disease severity, escape from host immunity or person to person transmission. Such mutations are particularly likely to affect the viral Spike protein which is the viral protein that binds to cells, the target of most immune responses and a major constituent of all SARS-CoV-2 vaccines. A VUI becomes a VOC when there is clinical and epidemiological evidence supporting greater transmissibility or disease severity. The first variant of concern B1.1.7 (Alpha) was recognised in November 2020. The rapid growth in numbers of this variant in the South East of England, despite the restrictions on population mixing imposed by the tier system, together with the unusual number of new mutations including some in the spike protein, flagged this as unusual. The large scale sequencing at the time, 5-10% of all positive COVID-19 tests, confirmed the Alpha variant as being more transmissible than the previously circulating variants and was soon followed by data indicating increased risk of hospital admission and mortality in the community. The finding led directly to the re-imposition of stringent lockdown measures in early January, a move which undoubtedly saved thousands of lives. Since then, several more VOCs have been identified (Figure 1), with the latest, Delta variant estimated to be 40-60% more transmissible than Alpha and now accounting for the majority of new cases. Once again, the sequencing is leading public health decision making with the possibility of current restrictions being extended to mitigate the impact of Delta on numbers of infections and hospital admissions. The variants have also provided crucial information for updating the vaccines to maintain optimal protection against circulating viruses.

So what of the future? Public health in the UK and probably worldwide has undergone a seismic shift in attitudes and practice. Where pathogen sequencing was seen as useful but peripheral to the main business of public health policy and planning, it is now centre stage. There is urgency to turn results round rapidly and to sequence as much as possible. Discussions are ongoing as to how to roll out real-time sequencing for other, if not all pathogens, to help control spread of infections, particularly those that are drug resistant, in hospitals as well as the community. The challenge now will be to incorporate pathogen sequencing into routine patient care. For that we need to establish networks of NHS labs that have the capability to sequence pathogens for patient management, something that the COG-UK Hospital Onset COVID Infection (HOCI) clinical trial has shown can be done. Importantly we also need the tools to marry sequence data with patient records to provide staff with information in a format that they can understand to improve management of infection in hospitals.

https://covid19.sanger.ac.uk/lineages/raw □

Figure 1 Proportion of variants in the UK 2020-2021



THE GOVERNMENT'S AMBITION TO RECOVER FROM THE COVID-19 PANDEMIC

Professor David Paterson
President, The Physiological Society
Head of Department of Physiology, Anatomy & Genetics at the University of Oxford

The Parliamentary and Scientific Committee, chaired by Stephen Metcalfe MP, met on Monday 17 May to discuss the role of science in delivering the Government's ambition to recover from the COVID-19 pandemic.

The Physiological Society sponsored the event and, as President, I was pleased to speak alongside representatives from the Department of Business, Innovation and Skills, AstraZeneca and the Confederation of British Industry (CBI). In my presentation, I highlighted the central role of physiological research in 'building back better' from COVID-19. Whether it is climate change, the ageing population or the pandemic itself, physiologists are working on the grand challenges facing the world today.

BUILDING BACK BETTER

The Government's *Build Back Better* plan was published alongside the spring Budget in March 2021 and outlines how they intend to rebuild the UK economy and tackle long-term problems facing the country.

While the vaccines success hopefully means we are reaching the end stages of the pandemic, there has been a heavy toll on lives and livelihoods. In the UK around 1 in 5 people have contracted the virus and there have been almost 130,000 deaths. According to the Office of Budget Responsibility, GDP fell 9.9 % in 2020, the largest decline in the G7.

If we learn the right lessons from the pandemic, then as the country recovers we have the opportunity to rebuild a better economy and society. That means tackling systemic problems such as inequality and listening to the science when it comes to dealing with long-term challenges such as climate change and our ageing population.

To achieve this, investment in science is vital. The Government has recognised the value of R&D throughout this crisis and it is now crucial that we cement this and make the 2020s an R&D decade.

The Physiological Society is aligning its approach to securing the future of physiology along three core themes: visibility, inclusivity and sustainability. These mirror the areas of focus I believe the Government must adopt if it wishes to succeed in cementing the UK as a science superpower.

VISIBILITY

Through the success of vaccinations, science is providing our escape from this crisis. Research and innovation are a visible part of public and political discourse in a way that we have not witnessed in our lifetimes. As Naomi Weir from the CBI noted at our event, in no other era of modern government would the Chief Medical Officer and Chief Scientific Adviser be household names.

While COVID-19 is our short-term priority, long-term societal challenges such as our ageing society have not gone away. Indeed, the correlation of severe implications from COVID-19 with age and frailty shows all too clearly why these issues are closely intertwined.

The demographic challenges facing the UK are stark. The number of people aged 65 and over will increase by more than 40% within 20 years, and the number of households where the oldest person is 85 and over is increasing faster than any other age group. Lifespan has outpaced healthspan and while we should celebrate that people are living longer, all too often they are living longer in ill health.

As we enter the fourth industrial revolution of precision medicine and genomics, the challenge becomes not prolonging lifespan but ensuring our healthcare systems are set up to maximise *healthspan*.

That means increasing the visibility across government, funders and public policy of the vital importance of understanding the physiology at play. Within R&D, we need to see more funding directed towards the biological processes

of ageing, and within public policy we need greater profile given to physiological age, considering healthy ageing across the whole life course. From understanding how maternal diet affects the body's response to stress through to how shift work affects blood glucose levels, greater visibility of physiological mechanisms will improve the quality of public health interventions and medical treatment that can help us live better for longer.

INCLUSIVITY

The UK's life science sector is incredibly important to the UK economy, generating £81 billion of turnover and employing a quarter of a million people. And it is set to expand - with the Association of the British Pharmaceutical Industry predicting that life sciences will add an extra £8.5 billion of growth to the economy and an extra 31,000 jobs by 2025. The UK should be proud of its success in this area, however our life sciences sector and associated investment is heavily concentrated in London and south east England.

To be a science superpower, the UK must harness ingenuity and intellect from across the country. In building back better, the Government must 'level up' to unlock potential in underrepresented regions of the country.

In a recent issue of our membership magazine, *Physiology News,* Parliamentary & Scientific Committee Deputy Chair Chi Onwurah MP wrote that "diversity is not a 'nice to have'; it is a moral and economic imperative. Without it, innovation is limited and valuable talent is excluded from the workforce."

In addition to geographic diversity, our research communities must become more inclusive of a wider range of voices and perspectives. All of us involved in science have a responsibility to redouble efforts to promote diversity – not only gender, but also race, religion, sexual orientation, disability, socio-economic status, age and other protected characteristics.

SUSTAINABILITY

As AstraZeneca's Steve Rees noted during the discussion meeting, the UK's fundamental science base is a big draw for pharmaceutical companies to base themselves in the UK. A thriving fundamental research base is essential for a booming life science economy - we cannot afford to let this go.

The UK Government's commitment to the UK as a science superpower looks beyond COVID-19 and is mentioned across Government – from *Build Back Better* to the integrated Review of the UK's defence capacity. It is clear that the UK Government is 'talking the talk' when it comes to prioritising science.

We now need to see them 'walking the walk' by ensuring the UK has a sustainable, reliable R&D funding model.

The UK punches above its weight in R&D, and we have witnessed the power of science during the pandemic, but it is not possible to turn science on and off like a tap. The delivery of COVID-19 vaccines in less than 12 months was made possible by at least a decade of underpinning science and mechanistic understanding.

The Conservative Party's manifesto commitment to reach 2.4% of GDP spend on R&D by 2027 is welcome - even if it will only take the UK up to the level of the OECD average - and represents a huge increase in public spending of up to £22 billion per year by 2024-25. However, recent cuts to official development assistance funding as well as uncertainty until the eleventh hour over where Horizon Europe fees will come from has given cause for concern. Two-thirds of the 2.4% will come from private investment, but as of yet there isn't a cohesive plan to achieve this and businesses look for certainty to invest.

Scientific research operates in a complex ecosystem and the COVID-19 pandemic has exposed stress points, particularly around the quality-related research (QR) funding model for English universities. Medical research charities account for half of publicly funded medical research in the UK but have been forced to cut on average 41% of research spend as philanthropic funding dries up. If the Government wants the UK to be a global science superpower it should consider that no major US competitor would want to be primarily accepting charitable funding based on the UK funding model.

We need confidence in public funding, clarity on plans to attract private investment and support for medical research charities to get them through this crisis. The Government also needs to combine funding commitments with a skills strategy that brings young people through the pipeline.

BUILD BACK STRONGER, SAFER AND MORE OPTIMISTIC

UK science has been a shining light during these dark last 18 months of the COVID-19 crisis. Government must not forget that in the months and years following the pandemic.

Science must retain and enhance the visibility it has garnered during this crisis. We all must ensure the research community becomes more inclusive and open to diversity, and Government must ensure R&D has a sustainable funding system.

COVID-19 has exacted a terrible toll in life and livelihoods. And this will not be the last pandemic. From climate change to our ageing society, the challenges we face in the years ahead are multiple and vast. The vaccination drive has shown what can be achieved when political will aligns with scientific prowess and public determination. By grasping the opportunity to put R&D at the heart of post COVID-19 recovery, policymakers can unlock the UK's potential. With our sights set on cementing our role as a science superpower, the UK can not only recover, but we can build a stronger economy, safer society and more optimistic future. □

CUTTING THROUGH THE NOISE: MOBILISING DATA AND GENERATING IMPACT DURING A GLOBAL PANDEMIC

Rob Davies, Head of CLOSER's COVID-19 Taskforce (UCL)

In May 2020, I highlighted the need to harness the power of longitudinal population studies to help understand the immediate and long-term impacts of the pandemic on individuals, families and communities and called for the creation of a new national birth cohort study to ensure that valuable data from a generation born during a global pandemic is not lost. As the UK moves into a new phase of its COVID-19 response I explore what happened over the past year and how our work ensured that longitudinal data and research will remain at the forefront of the country's response to the pandemic, now and in the future.

UNPRECEDENTED TIMES

Over the past 12 months something quite remarkable has happened – longitudinal studies that would normally carry out predominantly face to face data collection rapidly moved their operations online and ramped up the frequency of their surveys from years to months to capture the experience of their study participants and how the pandemic was affecting their lives. This phenomenal effort has ensured that data and evidence from longitudinal population studies have been at the forefront of the UK's response to COVID-19.

Findings from these studies have helped to understand the immediate health, social, economic and behavioural impacts of the pandemic at both a national and regional level, and across all generations and ages. Rich participant data has enabled the exploration of how people at different life stages are being affected by COVID-19 and how prior life experiences shape resilience or vulnerability to its effects. Valuable insights into how the pandemic has affected people's physical and mental health, their employment and finances and their children's education are shining a light on those who have been impacted the most and who needs more support.

MOBILISING DATA AND GENERATING IMPACT

CLOSER, the home of longitudinal research, brings together these national scientific assets to maximise their visibility, use and impact. Our world-class longitudinal population studies comprise of both national and regional studies from across the UK. They include the British Birth Cohort Studies, ONS Longitudinal Study, English Longitudinal Study of Ageing, Born in Bradford, Southampton Women's Survey, Avon Longitudinal Study of Parents and Children, Generation Scotland, Understanding Society (the UK Household Longitudinal Study), and more.

Created in May 2020, CLOSER's COVID-19 Taskforce mobilised data, research and policy specialists to capture and showcase the response of our studies, present a coherent narrative to policy and decision makers, develop resources for researchers, and make COVID-19 data more discoverable. Since its launch, CLOSER's bespoke online platform, the COVID-19 Longitudinal Research Hub, has established itself as a trusted source of information and insights across the research and policy landscapes. Our research tracker contains all the briefing notes, reports, academic publications and articles in one place and CLOSER Discovery - the UK's most detailed search engine for longitudinal data - includes COVID-19 data from seven longitudinal studies in unprecedented detail.

A NEW APPROACH FOR 2021: THE NATIONAL CORE STUDIES

CLOSER's message to policy and decision makers consistently emphasised that as we moved from the initial reaction to the pandemic into a new stage of the UK's response to COVID-19, it was vital that we did not lose sight of the potential long-term impacts of the pandemic on individuals and families. This required new investment on a scale not seen since the UK Millennium Cohort Study, created as part of the Government's plans to mark the turn of the 21st century.

In October 2020, the Government Chief Scientific Adviser, Sir Patrick Vallance, announced the commencement of the National Core Studies as part of the UK's response to the next phase of the pandemic. Focussing on areas where the UK must increase research scale

to respond to strategic, policy and operational needs and maintain resilience against COVID-19, this new approach comprised of six programmes: Epidemiology and Surveillance; Clinical Trials Infrastructure; Transmission and Environment; Immunity; Data and Connectivity; and Longitudinal Health and Wellbeing.

With a £9.6 million award from the National Institute for Health Research (NIHR) and UK Research and Innovation (UKRI), the Longitudinal Health and Wellbeing study aims to better understand and address the longer-term effects of COVID-19 on physical and mental health. Researchers will analyse data from more than 60,000 people drawn from a combination of national anonymised primary care electronic health records and longitudinal studies to help define what long COVID is and improve diagnosis.

GENERATION C: A NEW COHORT OF LONGITUDINAL STUDIES IS BORN

And there's more. Our calls for the need for new longitudinal studies are now being realised. Funded by the Economic and Social Research Council (ESRC), a £3m two-year feasibility study will aim to lay the groundwork for a full-scale Early Life Cohort Study that will follow participants throughout their lives. The study aims to recruit several thousand new babies, born across the UK between August-October 2021, and capture information about their economic and social environments, and their health, wellbeing and development during their first year of life. The feasibility study will be evaluated in early 2023, and if judged to be successful, commissioning of a new, larger main study is anticipated later that year.

But that's not all. With £4.6m provided by UKRI/ESRC for the first two years, the COVID Social Mobility and Opportunity Study (COSMO) is a major new longitudinal cohort study which will examine the short, medium and long-term impacts of the COVID-19 pandemic on educational inequality and social mobility. The study will take a representative sample of 12,000 young people in Year 11 across England, ask them about their experiences of the pandemic, as well as their future hopes and plans, and then follow them through the rest of their education and into the workplace.

And finally, after 20 long years, a new longitudinal birth cohort study launches onto the scene to provide vital evidence about the experiences of young children and their families growing up in the 2020s. Commissioned by the Department for Education (DfE), The Children of the 2020s will follow the lives of 8,500 babies born in England in April, May, and June 2021 from 9 months of age until their 5th birthday. The study will examine a range of factors that affect children's development and education in the early years, including the home environment, nurseries and preschool, the neighbourhood, early years services and the broader social and economic circumstances of the family, providing vital evidence into how best to support children in their early years.

WAS COVID-19 A DEFINING MOMENT FOR LONGITUDINAL RESEARCH?

A unique aspect of longitudinal population studies and key advantage compared to other studies is their ability to study change within individuals as a result of the pandemic. This is because they also have pre-pandemic measures of health and behaviours on the same people, with many having followed them throughout their lives. With this new investment these remarkable studies, unparalleled elsewhere in the world, will continue to follow the lives of their participants for many years to come, making it possible to not only track short-term impacts of the pandemic, but also the long-term change and impacts - over years and decades - on the lives of different generations. It was a defining moment; the longitudinal research community rose to the challenge, and the "jewel in the crown" of UK science and research will continue to shine brightly. □

COVID AND LONG COVID: WHAT'S THE DIFFERENCE?

Professor Charles Bangham FRS
Chair in Immunology at Imperial College London

WHAT IS THE DISEASE COVID?

Boris Johnson's experience of Covid was typical. After a few days of feeling mildly unwell with a fever, cough and headache, he began to recover. Then quickly, within a day, his condition worsened. It is this second phase of a characteristically biphasic disease that can be serious, with inflammation in the lungs and frequent clotting in the blood vessels, and this is the phase that has caused so many casualties. The PM then made a good recovery: his disease was milder than many, and indeed most people infected with the coronavirus SARS-CoV-2 have mild symptoms, and some are completely asymptomatic.

WHY IS IT SO UNPREDICTABLE?

Why do some people get such a severe disease, while others are even unaware they are infected? It is now widely understood that some pre-existing conditions, especially some diseases of the heart, lungs or kidneys, can predispose you to worse Covid. But in fact, virtually all viruses can cause an illness that varies widely in severity between people. Some will have a bad case of influenza whereas others have a trivial illness; I might develop severe Covid, while you have an asymptomatic infection. Each person reacts differently to each virus, and it is now known that this difference is largely due to a particular set of genes, which decide which foreign proteins we react to, and how strongly we react. Curiously, these are the same genes that determine

who can accept a transplant from whom - the tissue compatibility genes. Each person has their own particular combination of these genes, and it is this combination that partly determines the course and severity of an infection. But only partly: many other factors, of course, play a part.

WHAT IS LONG COVID?

In an insidious aftermath of an already potentially serious acute disease, about 10% of those infected with SARS-CoV-2 have symptoms that last more than 3 months, and this has become known as Long Covid [1] or post-Covid syndrome. This condition is still very little understood: why do some people develop it whereas others recover? What causes the persistent symptoms, and how long will they last? One of its most puzzling aspects is its variability, both between people and in one person over time. The commonest symptoms are fatigue, headache, palpitations and the so-called 'brain fog', but the symptoms often change from one day to the next: a person may have a severe headache one day, and the next day the headache is gone but they are breathless and have palpitations.

Because of this variability, some researchers have suggested that Long Covid is not a single disease, but rather a collection of diseases. But I favour the view that there is a common underlying mechanism. For example, we know that the lining of the blood vessels can be damaged by the coronavirus, causing vasculitis, and this is what seems to cause the widespread clotting that is a potentially dangerous consequence of the infection. Since the blood vessels supply all the organs in the body, it is easy to understand how vasculitis might produce such diverse effects. There is also intriguing recent evidence that parts of the virus – both its proteins and its RNA – might persist, in some people, for some weeks or months after they have recovered from the acute illness, raising the question whether these viral remnants can continue to cause symptoms. However, at present we are not sure whether either of these phenomena plays a part in Long Covid, and intense research is now underway to try and identify how the symptoms are caused and how they might be treated.

It is becoming clear that this mysterious and often distressing condition may impose a very great burden on the health of the population in the next few years. Some 4.5 million people in the UK have been infected with this coronavirus. Estimates of the proportion who go on to develop Long Covid vary widely, according to the definitions used and the details of the study, but most are in the range 5% to 20%. The average duration of Long Covid is also still uncertain. But even at the lower end of these estimates, the total number of people involved is of the order of tens of thousands.

COVID VACCINES AND VARIANT VIRUSES

Prevention of both acute Covid and Long Covid, as always in medicine, is better than cure: it is cheaper, quicker, more effective, and hugely reduces suffering. The efficacy of the Covid vaccines that have now been given to over 1.5 billion people globally is nothing short of astonishing: they are among the most efficient vaccines ever made. Rare but serious complications in an unfortunate few recipients continue to cause concern, and research is urgently needed to understand why some individuals have these adverse reactions, and how they may be treated. The ratio of the risks and benefits of the vaccines depend on the age and health of the recipient and the current incidence of the infection. But even when the incidence is low, the risks associated with the infection itself usually outweigh those from the vaccine, especially in those over 40 years old.

Will these vaccines retain their remarkable effectiveness against the new variants of the coronavirus that are emerging? To understand this, a little virology is needed. Like all similar viruses – those with an RNA genome like influenza virus – SARS-CoV-2 is in fact acquiring new mutations all the time: one new mutation appears about every 1 or 2 weeks, and each of the resulting viruses can be called a variant. It is this variability that makes it possible to trace the route that the infection has followed between people, by identifying the precise strain of the virus in each person, using DNA sequencing. The UK has been a world leader in this procedure, which is known as molecular epidemiology.

The great majority of these new mutations that arise don't change the behaviour of the virus - that is, its infectiousness or severity. Only a few mutations really matter, in particular those that change a small patch on the viral spike protein that enables the virus to stick to a cell and invade it. If a mutation makes the virus stick to the cell more tightly, it will make the virus more infectious, and so it will spread faster in the population. These more infectious variants, such as the the one designated B1.1.7 that was first identified in Kent, are referred to as variants of concern (VOC). The same mutations that increase infectiousness can also diminish the effectiveness of the immune response that was generated either by a vaccine or by infection with another strain – another 'variant' – of the coronavirus. But although the immune response can be less effective, there is good evidence that the existing vaccines still provide a useful measure of protection against the variants that have appeared so far, greatly reducing the incidence of serious disease and death. Perhaps most importantly, the virus does not have an unlimited capacity to mutate, at least not in the critical regions that change its behaviour, because many of the mutations would change the viral protein in such a way that it could not carry out its normal functions.

It is possible that a Covid vaccine booster will be needed at intervals in the future – perhaps every two to five years - and the vaccine may contain a mixture of different strains, to generate immunity to a wide range of variants, including the current variants of concern. Similar 'polyvalent vaccines' are already widely used, for example to immunize against different strains of bacterial meningitis, and they are highly effective. But it is not yet certain whether regular revaccination will indeed be needed, and if so how often it is given and what is the best composition of the vaccine. These points will become clear as we gain more knowledge from the current pandemic.

One lesson of the pandemic is clear: we must be prepared to make a rapid and decisive response to future epidemics with yet unknown viruses, and this preparedness requires real investment in infectious disease surveillance, vaccine and drug development and manufacturing capacity, and in the scientific research that has provided the bedrock for the extraordinary response that has been made to the coronavirus pandemic.

Prof Charles Bangham qualified in medical sciences at Cambridge and clinical medicine at Oxford. In 1995, he was appointed Chair of Immunology in the Faculty of Medicine in Imperial College London. He is founder and Co-Director of the Institute of Infection in Imperial College. Since 1987, he has conducted research on the immunology and virology of persistent viral infections, especially the human T cell leukaemia virus HTLV-1. Charles is a Wellcome Trust Investigator and a Fellow of the UK Academy of Medical Sciences and the Royal College of Pathologists. In 2019, he was elected a Fellow of the Royal Society.

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A TRANSFORMATIVE INDUSTRIAL OPPORTUNITY – ENSURING THE UK IS AT THE FOREFRONT OF THE TRANSITION TO SOLID STATE BATTERIES

Graeme Purdy, CEO, Ilika

Graeme was appointed to head up Ilika in May 2004, just before completion of the company's seed round of funding. He led the company through two successful rounds of venture funding before floating the company on AIM in 2010.Prior to joining Ilika, Graeme was Chief Operating Officer of a high-technology company in the Netherlands and before that worked internationally in a variety of technical and commercial roles for Shell. Graeme holds a Master's degree in Chemical Engineering from Cambridge and an MBA from INSEAD business school in France. Graeme is a Chartered Engineer and a Sainsbury Management Fellow.

International ambition for the transition to electric vehicles has never been higher. The Government's commitment to phase out sales of petrol and diesel cars by 2030 has set a high marker for UK ambitions. Predicted growth is huge with the Global Electric Vehicle Battery Market projected to reach $133.46 Billion by 2027, growing at a CAGR of 18.05% from 2020 to 2027.[1]

However, by the time the UK's government 2030 ban comes into force, another transition point for electric vehicles (EVs) will have begun - the move from conventional lithium-ion batteries (LIB) to solid state batteries (SSB). SBB will transform the driver's experience, promising a step-change with improved safety, faster charging times, increased range and a longer life. This improved performance, plus savings in manufacturing, means that SSB will use between 25%-65% less energy in EVs than LIB and have correspondingly lower greenhouse emissions per unit. The wide range estimate acknowledges the relatively early stage of the technology. Ilika has chosen to use oxide-based electrolytes for its SSB due to their additional environmental benefits at manufacturing level, which also translates into cost benefits.

SSB needs to be at the heart of UK policymaking as the Government plots out UK industrial ambitions in the Plan for Growth. Failure to get the right R&D support in now, will see many great, innovative UK companies fall behind as other countries – including US, Germany, France, Japan and China – put in place dedicated funding arrangements to bring the technology to maturity without delay.

The key to understanding the coming transition to SSB is energy density. Currently conventional LIB are the most widely used type of rechargeable battery in the world, due to their high energy density (270Wh/kg, 700 Wh/l) and long cycle-life (~1000 cycles).

However, LIB are reaching their theoretical limits, with only small increases in energy and power densities possible in the coming decade. SSB have the potential to exceed 400Wh/kg (1000Wh/l) over the next 3-5 years, surpassing LIB, and eventually reaching an energy density of 500Wh/kg. The technology S-Curve for Ilika's own Goliath SSB cells relative to LIB can be seen in the chart (M0, Gen 1, Gen 2 and Gen 3 are Ilika's developmental milestones):

FROM STEREAX TO GOLIATH

Ilika can demonstrate a track record of success with SSB. We developed Stereax, a range of miniaturised SSB for applications in implantable medical devices and Industrial Internet-Of-Things. We are currently commissioning the UK's first Stereax manufacturing facility, due for completion in Q3 of 2021.

In 2018, with Faraday Battery Challenge (FBC) support, Ilika began developing 'Goliath', a large format SSB for automotive applications. Scaling-up from Stereax brought a range of new challenges in materials and processing requirements. Out of these FBC supported programmes, we designed, built and commissioned a pre-pilot line capable of delivering 1kWh of single SSB cells per week. In achieving this we have developed materials and processes to create a foundation level prototype pouch cell suitable for both the automotive and consumer markets.

In addition to the cell level benefits, further benefits will be found at pack level as SSB enable the energy density gain to be combined with the reduced need for packaging and thermal management systems, thereby offering a smaller, higher energy pack when compared to standard LIB EV packs.

Beyond automotive and consumer appliances, this technology would be applicable to applications in aviation, maritime and agricultural machinery as well as the wider energy system.

PLANNING FOR GROWTH – SSB SUPPLY CHAIN VALUE AND JOBS FOR THE UK

Progress in the development of large scale SSB in the UK will be a key factor in how well the UK performs in capturing supply chain value. There is high level interest and substantial financial support in building giga factories for the UK. What is less well known is the fact that only one third of value is in the assembly of cells. Two-thirds of the value of the end product will be in the materials, processes and equipment required to produce those cells.[2] If the UK has ambitions to maximise value and create 3x the number of jobs then it should invest in the supply chain supporting the manufacture of cells. New materials, processes, equipment and skills will be required for the brave new world of SSB and these must be co-developed, alongside both the technology they support and the manufacturing capability needed to meet the needs of the waiting EV market. Time is of the essence – technology development and industrialisation must move forward together. The UK has been in a similar position before, having developed LIB at Oxford. However, this was most effectively exploited and commercialised abroad – a missed opportunity for the UK. Now China has already effectively secured its place as the dominant global manufacturer of LIB. Whilst Li-ion development continues both in and out of the UK, the technology is fast reaching its limitations. SSB offers the UK the chance to once again be at the forefront of battery technology, in a world market which is growing exponentially.

There is great interest around the world in solid state battery technology and the benefits it promises. Many countries have deployed billions of dollars in the search for what is often described as the 'holy grail' of batteries. There are many approaches to the challenges associated with the development of SSB and it is likely there will be no one clear winner, but different technologies will find their different niche applications and the market will be large enough to accommodate a number of approaches. Gigafactories in the UK and beyond will be able to licence a number of SSB technologies, but unless the supporting infrastructure exists locally, in terms of materials, processes, equipment, training and skills, then the UK will be reduced to importing cells for assembly only and may have to look overseas for expertise and trained employees and for its supply chain. Another missed opportunity.

A GOOD START, BUT MOMENTUM AND PROGRESS AT RISK

The decisions and funding Government makes on SSB development now will be decisive to the ambition of becoming a battery manufacturing centre of excellence. A good start has been made, including FBC funding for the UK Battery Industrialisation Centre to help de-risk high volume battery manufacturing. Companies such as BritishVolt and AMTE and others have ambitions to build UK gigafactories and the UK Govt has pledged substantial funds for creating these high volume manufacturing facilities.

The UK Govt has also deployed substantial funding into academic and early-stage battery research, through academic programmes such as the Faraday Institution and lower technology readiness level industrial programmes through the FBC. The central issue is whether this solid foundation of expertise and development can be retained and exploited from the UK. Much has been written about the innovation valley of death – the unsupported space between early-stage development and commercialisation where so many companies, largely innovative SME's, do not survive.

UK Government support for SSB development is limited compared to other countries and in fact it does not, as at the date of writing, warrant a specified fund of its own, unlike other countries. For example, Governments in Japan, China and Germany and the EU have funded SSB projects, and the Biden administration has set out ambitious electrification ambitions where extra support for SSB start-ups will be awarded. China is determined not to lose its preeminent position in manufacture and assembly and is giving support for SSB serious attention. At the start of this year the European Commission approved, under EU State aid rules, up to €2.9 billion euros of public investments in battery research and innovation, with at least €80m targeted at SSB technology and manufacturing.

Government ambitions for the UK to become a 'science superpower' depend entirely on it taking a committed, strategic approach to R&D in emergent industries. Failure to do so will place companies like Ilika on an unfair global playing field in

development of EV technologies which will underpin the automotive sector for decades to come.

Public funding received so far has been key to Ilika progressing its Goliath technology, and in return Ilika has been able to successfully leverage three times as much equity funding from the London capital market. Government funding can be seen as validation of a technology, offers the private investor a degree of comfort and effectively de-risks the investment, and thereby increases the R&D spend in the UK.

There is currently a lack of sustained, dedicated public funding for SSB development in the UK. For Ilika, its three-year FBC funded programmes come to an end this year, creating uncertainty, and risking a loss of momentum, skills and gained ground. The creation of the Advanced Research and Innovation Agency, focused on 'high risk, high reward' areas could provide an ideal solution, but the concern – with legislation still progressing through Parliament – is that the initial allocations for any project will come too late to provide a secure funding for UK companies.

Government should prioritise dedicated, long-term funding to secure battery manufacture and supply chains for the country. Technology development on this scale is a long journey and requires patience and commitment. British innovation in SSB technology, such as Goliath, is one of the best areas for Government focus, well-aligned with the ambitions in the R&D Roadmap, the Prime Minister's Ten Point Plan for a Green Industrial Revolution and Plan for Growth.

As we begin our transition from fossil-fuel calls we must plan for the transition from LIB to SSB as part of the central vision for achieving growth from research-led innovation in low-carbon technologies.

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AMERICA IS SEEING HUGE GROWTH IN SYNTHETIC BIOLOGY – THE UK MUST ENSURE IT DOESN'T MISS OUT

Dr Mark Kotter, CEO and Founder of bit.bio, stem cell biologist and a trained complex spine neurosurgeon

A NEW DAWN FOR SYNTHETIC BIOLOGY AND CELL THERAPY

Synthetic biology (synbio) companies are a new breed of biotechnology companies. Put simply synbio is building with biology. We examine the building processes in the natural world - plants, bugs, simple organisms - and harness them to create new products and new solutions.

Because of its nature, the majority of synbio companies are building businesses that will help contribute to global sustainable development goals such as those from the UN, and investors are taking notice. In the last six months, Gingko bioworks, who are producing bacteria with industrial applications, has announced a $17.5 billion dollar flotation. Then there's Sana biotech, creating engineered cells with plans for a £150m IPO.

Now, we are on the verge of synbio v2.0 where we move into the more complex but ultimately rewarding world of harnessing the power of mammalian cells including human cells. This is where my company, bit.bio is focused. We bring together coding and biology to reprogram human cells. Our cell coding technology, called opti-ox, is unique because it allows us to program cells - turning them from a stem cell into any other human cell type - with consistency and therefore scalability not previously possible.

Why is this important? Because with access to unlimited, reliable supplies of human cells, we can unlock a new era in healthcare. We can build models to study diseases on human cells rather than animals and these models are consistent, experiments are repeatable. Biotechs and pharmas can use cells to screen for potential new drugs which will give them a better shot of success at clinical translation. And probably the biggest prize of all, you remove the main bottleneck to the next generation of medicines - cell therapies.

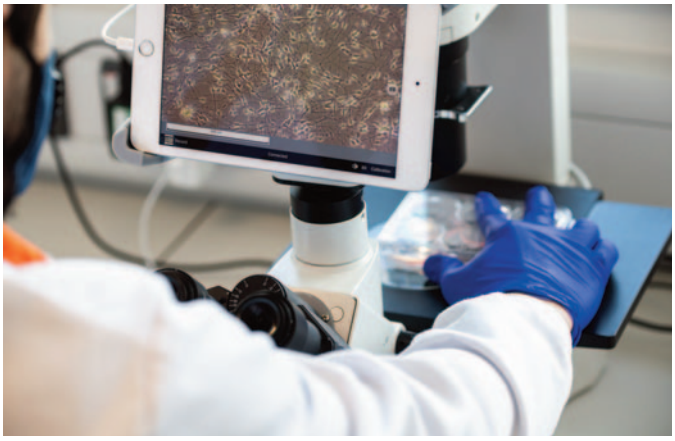
Additionally, the reason I am talking about mammalian cells and not just human cells is because we can use the same opti-ox technology to mass produce cell-based meat for human consumption. We can create the quantities of pig fat and muscle cells needed. This is

being done by our sister company which I am also a co-founder of, Meatable, based in the Netherlands.

So you can see how synbio really could help solve some of the major health issues that our Earth is currently facing, such as changes to healthcare, the ethical challenge of animal slaughter, the industrial use of antibiotics, and, as we have come to painfully realise, the increased chances of high density animal farming to trigger a global pandemic.

INDUSTRIAL SCALE SUPPLY OF HUMAN CELLS

At bit.bio, we represent the coming together of two fields:



coding (bit) and biology (bio). Bits are building blocks of code, just as cells are building blocks of life. Together, they illustrate what we do: precise reprogramming of human stem cells.

We think about cells like computers, that we can program with code. The DNA is the hard drive (ROM) which stores the operating system, containing all the programs of the cell.

When we talk about coding cells, we are engineering code into this operating system and that code gives the DNA the commands it needs to run specific programs.

Why is this important? Because every single human cell type is the result of a unique set of programs running. Control these programs and you can control a cell's identity with precision. The programs are combinations of different genes, turned up or down to different levels, interacting with one another called gene regulatory networks.

The bit part of our name refers to how we are using machine learning and partnering with the London Institute of Mathematics to hunt for these unique codes for every cell type. The bio is opti-ox - the gene engineering technology that puts the codes into the cell's DNA and runs them with no interference. The result is batches of human cells at scale with consistency not possible with other reprogramming techniques.

These cells will have an enormous impact across the biotechnology and pharmaceutical sectors, and it will hugely increase the efficiency of drug development and commercialisation – a key aim of the government's R&D Roadmap.

Indeed, bit.bio has a natural alignment with the government's Plan for Growth and R&D Roadmap, and can contribute to the UK becoming a life sciences superpower as part of a rich and diverse scientific research ecosystem.

Our work supports government ambitions for growth by building on the UK's science base and making real progress in synthetic biology. This is helping to deliver a more efficient and productive R&D ecosystem, and supporting upcoming government strategies to ensure innovation in the UK thrives.

GOVERNMENT PLAYS A LEADING ROLE

Due to an intensive R&D function, a need to demonstrate clinical proof of concept and to build our product pipeline, synthetic biology scale ups like bit.bio require long term commitment in terms of funding.

With this in mind, it is encouraging to see the UK Government recognise the unique growth story of many life science companies by making a number of tailored commitments to the sector. For example, this is evident in Build Back Better: Plan for Growth, the R&D Roadmap, the Life Sciences Industrial Strategy and the Life Sciences Investment Programme.

However, to transform the UK into a life sciences superpower, it requires an investment mindset with a bolder, long term vision for the sector. Synthetic biology in particular represents a huge prospect, with the United States seeing an explosion of investment and companies leveraging the technology.

Failure to grasp at this opportunity risks the UK falling behind in an area of science and innovation, already worth billions and anticipated to grow further still.

The pandemic has shown that investment in this critical field cannot come soon enough. The UK government is taking steps to ensure there is access to funding, but we must not be complacent.

SYNBIO NEEDS CAPITAL COMMITMENT

Like many others in the sector, bit.bio welcomes the UK government's Life Sciences Industrial Strategy which aims to ensure that the UK is creating a complete ecosystem that will keep us at the forefront of medical research and innovation. The Strategy also identified advanced therapies, including developing advanced therapies and advanced therapies manufacturing, as a key theme.

Establishing government backed growth funds through the British Business Bank and British Patient Capital such as the Future Fund: Breakthrough Capital - a new £375m UK-wide scheme which will encourage private investors to co-invest with government in high-growth, R&D intensive and innovative firms - is a step in the right direction and will help encourage further private sector and VC investment.

We will also be watching how the National Security and Investment Act 2021, expected to be commenced towards the end of this year, impacts investment into the life sciences sector. The Act, described by government as the "biggest shake-up of the UK's investment screening regime in 20 years", may inadvertently undo some of the good work of previously mentioned schemes.

Under the regime, mandatory notification to the Department for Business, Energy and Industrial Strategy (BEIS) ahead of transactions is required where an investor gains control in an entity in 17 specified "sensitive" sectors – synthetic biology being one of them.

I sympathise with government intentions and a high level of scrutiny on transactions with a national security risk is vital. However, in its initial definition of synthetic biology, the government, according to the BIA, captured most companies in the sector, the vast majority of which will have no implication on national security.

We remain hopeful the government will narrow the definition of synthetic biology further, ahead of secondary legislation being published later this year. BEIS have already shown their willingness to proactively consult with the sector, so an extended line of communication with the BIA and synbio companies can resolve this issue before the regime is implemented later this year.

The UK government has outlined its vision to keep us at the forefront of medical research and innovation, and for the UK to become a life sciences superpower. The desire to reshape the UK's approach to regulation, detailed in the independent report from the Taskforce on Innovation, Growth and Regulatory Reform, is a welcome next step. In particular, the report's proposal to establish a new UK Clinical Trials Regulatory landscape could move the UK into being a regulatory environment of choice for a clinical study.

bit.bio will continue to contribute to this aim by building on the UK's world-renowned science base, delivering a revolution in R&D and making real progress in the development of cell therapy through access to unlimited supplies of human cells. This is all within reach and the government of today should be able to look back in ten years time and know they did everything they could to help us succeed. □

NEW OPPORTUNITIES FOR DRUG DISCOVERY

Steve Rees OBE
VP Discovery Biology, Discovery Biology, Discovery Sciences, R&D, AstraZeneca, Cambridge, UK

Advances in science and technology are revolutionising our understanding of disease, leading to the creation of many new types of medicine to treat and, in the future, maybe cure disease. It is an exciting time to be a research scientist and through the continued attraction of skilled scientists, the investment in fundamental research across the academic sector, the creation of a research infrastructure to enable the establishment and growth of new businesses, and the support of the pharmaceutical industry, the UK has a huge opportunity to maintain its place as a world leader in scientific innovation and medicine discovery and development.

NEW TECHNOLOGIES TO UNDERSTAND DISEASE

The science of genomics involves sequencing DNA to identify changes in genes that are associated with disease. The cost of sequencing the human genome has fallen to just £600, leading to the affordable sequencing of millions of people to identify the genetic cause of disease. The early impact of this technology has been seen in cancer. By sequencing tumour tissue we now know that diseases such as lung cancer are a collection of maybe 40 or more diseases each with different causes, often requiring different treatments. This knowledge is leading to the development of medicines for specific types of cancer with the medicine being targeted to the right patient through the use of new diagnostic technologies. Through sequencing tumour tissue it is also possible to understand mutations in cells that lead to resistance to medicines and to develop new treatments for the drug-resistant cancer. Sequencing technologies are now helping us better understand all diseases and leading to the ability to apply this precision medicine approach elsewhere. Key to the success of this endeavour are initiatives such as the UK Biobank that allow access to the patient medical history alongside the DNA sequence which means that changes in the gene sequence can be matched to the onset and progression of disease.

Transcriptomics and proteomics allow the study of the messenger RNA (mRNA) and protein levels in cells and tissue and how these change in disease, across different patient populations and upon treatment with medicines. These technologies generate huge amounts of data; advances in data science and artificial intelligence has made it possible to extract knowledge from these data to allow the scientist to understand what disease looks like at a cellular level to develop new hypotheses for the treatment of disease.

THE CHANGING FACE OF MEDICINE

Most medicines available today are small chemicals that bind to proteins to activate or inhibit their function, or monoclonal antibodies that bind to proteins again to inhibit their function. The next decade will see a transformation in the types of medicine to treat and in some cases maybe cure disease. The development of vaccines to SARS-CoV2 has been an unprecedented achievement and heralds huge opportunities for the creation of future vaccines, equally remarkably the vaccines developed by Moderna and Pfizer/Biontech are mRNA vaccines. mRNA, the genetic material that translates the instructions contained within the DNA into proteins which function in the body, is a compelling therapeutic modality because of its ability to drive high-efficiency, dose-dependent, protein expression. Combined with state-of-the-art drug delivery systems, such as lipid nanoparticles, this offers opportunities for the delivery of a wide range of next generation medicines to patients. For example, in collaboration with Moderna AstraZeneca is developing an mRNA medicine designed to stimulate the formation of new blood vessels to protect heart muscle cells in patients with heart failure or after a heart attack.

Another exciting new type of medicine are antisense oligonucleotides (ASO) and small inactivating RNAs. These are small sequences of DNA or RNA that specifically bind to mRNA to prevent it making protein. These medicines can potentially be created to interfere in the production of any protein. One of our molecules, in collaboration with Ionis Pharmaceuticals, targets the mRNA for APOL1. Several variants of the APOL1 gene evolved in sub-Saharan West Africa providing protection from Trypanosoma infections, but people carrying two copies of these variants have an increased risk for developing chronic kidney disease (CKD). APOL1 knockdown through ASOs is being explored with the aim of being a precision medicine in CKD providing a novel treatment for patients with APOL1-mediated CKD. These medicines are in the clinic today; ASO medicines have been approved by the US Food and Drug Administration (FDA) for the treatment of Duchenne muscular Dystrophy and spinal muscular atrophy.

In contrast to inhibiting protein function, PROTACs are a new type of chemical that promotes protein degradation. Discovered recently it is anticipated that degrading rather than inhibiting the target protein will lead to increased effectiveness in disease. PROTACs that degrade the oestrogen receptor and the androgen receptor are in phase 1 clinical studies as novel treatments for breast and prostate cancer and are being explored in many diseases.

There is huge excitement about the potential of cell and gene therapies to cure disease. Clinical studies are in progress to treat cancer with CAR-T cells. These medicines involve taking T-cells, a key cell-type in the immune system, from patients and engineering them in the laboratory to recognise tumour cells. Upon re-introduction into the patient these cells are able to kill tumour cells to treat cancer. The first two CAR-T therapies were approved by the FDA in 2017. Gene therapy medicines are also reaching patients with the potential to cure disease. Very recently the first patient in the UK was treated with Zolgensma a treatment for the muscle wasting disease spinal muscular atrophy (SMA) and works by introducing into patients a correct copy of the missing gene SMN1 to restore normal function. Elsewhere there is huge excitement about the potential of CRISPR to correct gene defects in patients. In the first clinical studies, patients with the blood disorders Sickle Cell Disease or β-thalassemia have been treated with CRISPR to delete a gene to allow the expression of foetal haemoglobin.

Whether mRNA, ASO, PROTACs, cell or gene therapy these new technologies offer the potential for a revolution in medicine to treat and potentially cure both common and rare diseases.

THE OPPORTUNITY FOR PRECISION MEDICINE

The last decade has seen a revolution in diagnostic technologies to enable the targeting of the right medicine to the right patient. Diagnostic tests typically involve taking blood, urine or tissue samples from patients and testing for the presence of so-called protein or DNA biomarkers that are predictive of disease. This approach ensures that the right medicine, or combination of medicines, are given to the right patient to ensure effective treatment.

The COVID-19 pandemic has accelerated this revolution; qRT-PCR tests to detect the viral genome and lateral flow tests to detect viral proteins have been developed and executed at an unprecedented scale. There is now the opportunity to use these technologies to detect the early onset of many diseases to enable better treatment. It is well established that the earlier a cancer diagnosis the greater is the chance that the patient will survive the cancer and the greater the likelihood that the patient will not require hospitalisation. There is a huge opportunity ahead for the creation of cost-effective point-of-care diagnostics for the regular screening of people to detect disease before disease symptoms arise. This will require a new approach to healthcare but has the potential to truly lead to a revolution in medicine as the early detection of disease often leads to cure rather than treatment.

SUPPORTING MEDICINES DISCOVERY IN THE UK

The development of new technologies to understand and treat disease offers huge hope for the future; in six of the last seven years the FDA has approved over 40 new medicines, a level rarely achieved. The UK is well positioned to lead in medicines discovery and manufacture. Doing so requires that the UK trains and remains attractive to the best scientific talent and that the government continues to support academic research through ensuring funding agencies like UKRI have secure, long term funding settlements. We need to bring industry and public funders of research closer together; creating more opportunities to collaborate and shaping initiatives such as the Advanced Research and Invention Agency (ARIA) so that research is informed by the scientific challenges faced in industry. We need an investment environment that supports innovative businesses. Tax incentives for R&D are important if the UK is to remain globally competitive. We also need a venture capital ecosystem that matches places like Boston, US, with investors who understand the biotech sector. Finally, the government must ensure it can attract the next wave of innovative medicines manufacturing investment into the UK, including the next generation medicines such as cell and gene therapies and high skilled jobs and supply chains associated with them. □

THE UK NATIONAL QUANTUM TECHNOLOGIES PROGRAMME

Roger McKinlay, Challenge Director Quantum Technologies, Innovate UK.

INDUSTRIAL ENGAGEMENT

Background

Just as one would judge an artist and a photographer through examples of their work, so the current portfolio of industrial projects in the UK National Quantum Technologies Programme (UKNQTP) speaks more than any progress report or strategic plan. The collection not only demonstrates the potential of this truly transformative technology – one could rank its impact alongside stone, steel and steam – but it also introduces companies which one day could be household names.

The NQTP currently has over 40 such projects underway – launched under the banner of the Industrial Strategy Challenge Fund (ISCF) within Innovate UK - and will have approximately 80 by the autumn.

These projects are creating products, not just demonstrating ideas. The SPLICE project (led by QLM Technology Limited) has created a camera that can "see" methane using a process called time correlated single photon counting. Partners in the project include the Universities of Bristol and Sheffield, Bay Photonics in Torbay, the National Physical Laboratory (NPL) and BP.

The SPIDAR project led by Toshiba in the UK uses quantum imaging for LIDAR - "Light RADAR" – with applications in autonomous vehicles.

Pioneer Gravity is a project led by a survey company, RSK Environment Limited. The partners include the Universities of Southampton and Birmingham, UniKLasers Ltd of Edinburgh and QinetiQ. The project is assessing the use of cold-atom sensors to detect underground infrastructure by measuring gravity.

Perhaps the widest-known application of quantum technologies is computing. Rigetti UK, the UK subsidiary of a pioneering US quantum computing company, is leading a computing project with the University of Edinburgh, Phasecraft (a UK quantum computing software company), Oxford Instruments and Standard Chartered Bank.

Like all in the portfolio, these are collaborative projects led by companies but drawing on the UK's outstanding universities and research organisations. Companies are pulling the science to market. Some market opportunities are very close with products already existing. Others – and quantum computing falls into this bracket – are five years or more away.

This is part of a long-haul but with large prizes to be won. Venture Capital companies – often criticised for being short term – are prepared to invest longer term if the prize is large enough. This is proving to be the case with quantum technologies.

Grant Funded Projects

The quantum ISCF projects were all launched relatively recently. £20M (Wave 2) of funding was announced in 2018 with a further £153M (Wave 3) announced in 2019. The first projects, three years is a typical project duration, are coming to an end. The second tranche of Wave 3 projects are currently being selected and will be launched in the autumn.

These projects are funded with grants against which companies have to provide a match. Grant funding was the ideal vehicle for ISCF, the objective being to increase R&D activity and spend. This mechanism suits young companies and the funding is highly catalytic. The principal return is not in money pledged up-front or in industry matched funding but in new money, private funding raised on the back of the grant.

Well Launched

The speed at which projects have started and the demand – the competitions have been two to three times over-subscribed – bears testament to the ground laid by the NQTP. The national programme was launched in 2014 with the formation of four academic hubs. Commercialisation was the aim from the start and the Engineering and Physical Sciences Research Council (EPSRC) ensured that some funding was ring-fenced to be spent by the hubs on companies rather than researchers. This encouraged the formation of spin-out and start-up companies in advance of the launch of the ISCF programme.

As the figure shows this EPSRC "funding universities to work with companies" is balanced by the ISCF "funding companies to work with universities". Launched before the formation of UKRI, it is good example of the complementary capabilities of a Research Council and Innovate UK. The investments have also been in skills, notably Centres for Doctoral Training. Infrastructure has featured from the outset with the creation of the Quantum Metrology Institute at NPL and more recently the launch of the National Quantum Computing Centre.

The Defence Science and Technology Laboratories and

have been supportive of the programme from the start and the MOD and GCHQ are key partners.

The Outputs and Outcomes

What are the outputs of such extensive activity? There is no single NQTP funding stream or budget and each of the funded programmes must satisfy the terms under which it has been funded. Of course, there are outputs which can be measured – papers, patents and products – but the sum is greater than the parts. As in any business, true "value" lies in the future value of what exists now. The ecosystem which these programmes have created is the envy of many countries and the UK national programme is much emulated.

Success breeds success and the UK is creating and attracting outstanding talent. Much value lies in the key relationships: universities with companies, supplier with supplier, developer with customer, hardware with software and even competitor with competitor. The UK is doing well at attracting overseas companies and foreign direct investment. Like many deep technologies, quantum is proving to be "sticky". The UK is arguably the best country in the world to start a quantum business and companies already in the UK see many reasons to stay.

However, there is no room for complacency. Several countries are investing more than the UK is and we are not alone in spotting the potential of the technology.

The Money Talks

Perhaps the strongest indicator of success is private investment. At the time of the Parliamentary and Scientific Committee briefing in April 2021 (when this presentation was made) the £100M of grants allocated by the Quantum ISCF Programme had already attracted £100M of private investment. Grants are not paid at the start of a programme but are drawn down as costs are incurred. Thus, in terms of cash, companies are raising new money faster than the grants are leaving the UKRI bank account. By mid-June 2021, this figure had risen to over £400M following major fund raising by two of the grant recipients.

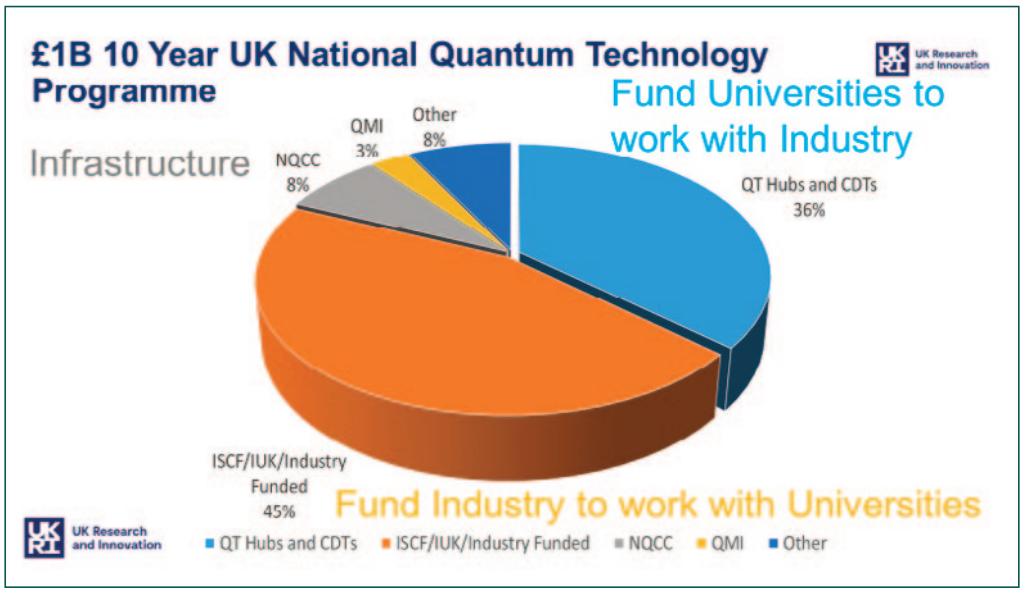
The mechanism is straightforward and effective. A grant-funded collaborative project transforms the appearance of a new company in the eyes of a potential investor. Not only does the company have funding but there is also evidence of collaboration with potential suppliers, peers and customers. One might call it evidence of a "strategy in action". Strategic grant-funded projects catalyse company growth.

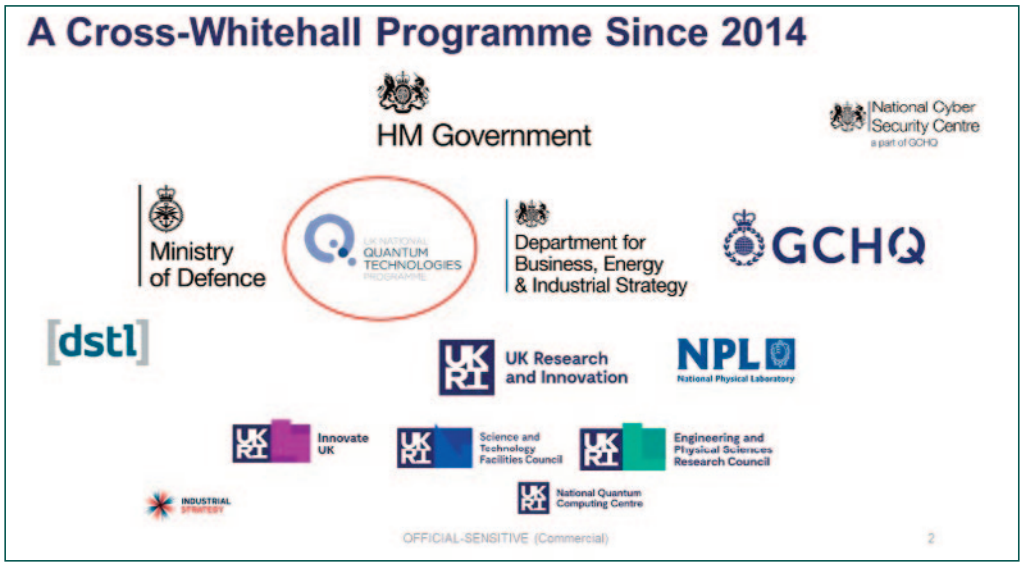
In the future other forms of government assistance will be needed. The British Business Bank and National Security Strategic Investment Fund are also active in this sector. However, it must be stressed that for serving the objectives of both the NQTP and ISCF, grants are proving very effective.

A Model for Deep and Transformative Technologies

The NQTP should be considered as a model for Cross-Whitehall working. The diagram shows the partners involved. It is a light structure which may have to become more formal as the rate of government spending increases, as it will have to if the UK is to keep up with international competition. However, for seven years it has served well in building the foundations on which industrial successes are already appearing.

It is early days for quantum technologies and ongoing research is needed. The science is still advancing and will do for many years. What the quantum ISCF projects are demonstrating is that the UK has established an ecosystem within which value is being created. Many countries currently announcing large quantum science and technology programmes do not have the talented companies, institutions and individuals needed to productively spend their funding. The success of the UK is not going unnoticed. Retaining what we have created will be the next major challenge. □





NATURE-BASED SOLUTIONS - JOINTLY ADDRESSING CLIMATE CHANGE AND THE BIODIVERSITY CRISIS

Professor Rick Stafford, Bournemouth University

Dr Daniela Russi, British Ecological Society

A recent joint report from IPBES and IPCC[1] has highlighted once again the urgent need to address both climate change and biodiversity loss to prevent devastating and irreversible environmental change. Nature-based solutions are a great way to address them together, which can complement traditional conservation measures and the necessary drastic and rapid reduction of cutting greenhouse gas emissions.

Nature-based solutions (NbS) are initiatives that boost biodiversity and simultaneously provide other environmental and human benefits. While these benefits can include factors such as increased human well-being or water purification, NbS also provide climate change mitigation, by sequestering carbon from the atmosphere, and climate change adaptation benefits (for example, preventing flooding or coastal erosion).

Forests are probably the best known climate-focussed NbS, with trees known to absorb large quantities of carbon dioxide, but NbS can be implemented in all kinds of habitats, from ponds and lakes through to grassland and arable agriculture.

A recent report from the British Ecological Society[2] analysed the potential of NbS across all main UK habitats. More than one hundred experts contributed to the report, providing a comprehensive summary of available scientific evidence and policy recommendations from the ecological community. The report suggests that while a wide range of habitats are important, protecting and restoring peatlands and creating more and better connected native woodland are priority actions to capture new carbon and prevent the release of carbon stores, as well as protecting and improving biodiversity.

Peatlands are the most carbon-dense terrestrial system and host a high level of biodiversity. However, a large share of the UK's 2.6 million hectares of peatland have been degraded and are currently a carbon emitter. The share of UK land covered by woodland is one of the lowest among European countries (12%, as compared to between 28 and 36% in Germany, France, Spain and Italy). Woodlands can provide solutions to multiple societal needs, including timber production, carbon drawdown, improved mental health and prevention of flooding in lowlands through tree plantation in uplands.

Since the report's release, DEFRA has published the Peatland Action Plan and Woodland Action Plan, echoing many of the report's recommendations, such as protection and rewetting of peatland, to turn it from a producer of carbon in its damaged state to a sequesterer of carbon, banning the use of peat based compost, restoring the 'Great North Bog', as well as trebling the rate of tree planting by 2024 with a majority of native tree species. Picking the right areas for tree planting is vital, as planting trees in the wrong areas, such as on shallow peat or on species-rich grasslands, can be counterproductive for carbon capture or biodiversity.

The marine environment is also covered in the report, and shows major Blue Carbon potential. Areas such as seagrass and saltmarsh sequester significant amounts of carbon per hectare, but are in decline. Saltmarsh can be created through managed realignment programmes such as those recommended in existing shoreline management plans, which also help with adaptation

to sea-level rise. The majority of the UK's seagrass beds have been destroyed over the last century, but with improved coastal water quality, there is a real chance to restore these habitats, and pilot projects to do so are already beginning.

The real potential for marine systems, however, is the carbon sequestered and stored in the ocean sediments. While the sequestration rate is low per unit area, the huge area of seabed (almost three times the size of the land area of the UK, and over 25 times the area of the UK including overseas territories) mean potential carbon sequestration in the marine environment can be very high. Carbon enters the sediment through particles sinking from the ocean surface. These particles can include plankton, fish and even fish faeces, with around 1% of carbon photosynthesised by marine algae and plankton captured. This amount of captured carbon equates to around 15% of current carbon emissions from fossil fuel globally. Activities such as bottom trawling for fish can disturb this sediment and potentially release this carbon back into circulation. Clearly damaging activities need to be prevented in carbon hotspots, through banning bottom trawling in marine protected areas, but policies to boost fish and marine mammal numbers can also increase ocean productivity by efficient nutrient cycling into surface waters, potentially resulting in more carbon sinking to the ocean floor. Understanding the full potential of ocean NbS is a clear research priority, and effective protection will be key to maximising their benefits.

Smaller changes can also make a difference. For example, green spaces and trees in urban areas do sequester carbon, and can also cool the environment – an important natural adaptation benefit, with an increased frequency of heatwaves – and provide areas for exercise, relaxation and improved mental and physical well-being. Planting hedges and hedgerows trees and creating field margins to support wild species on agricultural land can boost biodiversity, deliver important ecosystem services like pollination and pest regulation, capture carbon, improve water infiltration into the soil and stop soil erosion.

Agroforestry (the practice of combining woody vegetation like trees or shrubs with crops and/or animal production systems) is also a NbS, as it provides many benefits from carbon capture through to reduced risk of flooding, increased biodiversity and landscape diversity, while it also offers complementary sources of income for land owners.

Given the huge potential of NbS on the land and in the sea, it is important to think how to establish and best protect these areas. Good hierarchical governance structures are likely to be key. Such structures incorporate local community level support, as well as regional and national stakeholders, alongside strong government direction and support.

While private finance and investment opportunities exist and are growing, government-led finance and incentives will be key to their success. This will require earmarking public funding for NbS across a wide range of policies, including climate, agricultural, forests and biodiversity policies. For example, the Environmental Management Schemes, which will begin piloting in 2022 and be launched in 2024, represent a good opportunity to finance different NbS in agricultural landscapes, such as for example creating hedgerows, protecting species-rich grassland and using agroforestry. Incentives needs to be accompanied by information services for land-owners and managers to help them choose the right NbS for their context.

It will also be important to encourage private companies to invest in NbS, e.g. through changes in regulations (e.g. biodiversity net gain regulations), the creation of new markets for certified products from NbS with a premium price (e.g. nuts and fruits from agroforestry) and the development of public-private partnerships that can create the right conditions for the private sector to invest in NbS.

Not only NbS are a great way to tackle the climate and biodiversity crisis, while providing a wide range of environmental, health and social benefits, but in many cases they provide sound economic sense. While it is impossible to capture the full economic benefit of all services provided by NbS, current partial valuations do demonstrate investment in NbS is highly cost effective. For example, a recent study commissioned by the RSPB to Cambridge Econometrics has estimated that investing in peatlands has a cost-benefit ratio of 1:4.6.[3] This is an underestimation of the multiple benefits provided by peatland restoration, as it only includes carbon storage and recreational expenses.

In addition, the restoration, protection and management of NbS also provide good job opportunities and careers for green recovery from the pandemic. For example the previously-mentioned report by Cambridge Econometrics estimated that peatland restoration can create three temporary jobs for every 100 hectares of habitat during the restoration phase and seven job per year to maintain the restored peatlands.

It is important to highlight that NbS will not be sufficient on their own to address the biodiversity and climate crises. Traditional conservation measures, like e.g. protected areas, and a drastic decrease of carbon emissions across all economic sectors will still be needed to meet climate and biodiversity targets. However, NbS can provide an important contribution to these measures and play an important role to tackling the climate crisis and reverting biodiversity loss, while creating synergies among environmental and socio-economic policies and ensuring a better and greener future post-COVID.

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1 https://www.ipbes.net/events/launch-ipbes-ipcc-co-sponsored-workshop-report-biodiversity-and-climate-change

2 The report can be downloaded at https://www.britishecologicalsociety.org/policy/nature-based-solutions/read-the-report.

3 https://www.rspb.org.uk/our-work/policy-insight/wildlife-and-the-economy/

THE EARL OF SELBORNE 1940-2021

On 12 February 2021 the world of science lost a long-standing friend and staunch proponent with the death of John Roundell Palmer, the 4th Earl of Selborne GBE FRS DL, at the age of 80.

He had a long and very distinguished career and throughout his life he dedicated much of his time to supporting the environment, taking a particular interest in agriculture and ecology, before developing his expertise into science more broadly.

He was educated first at St. Ronan's School, Hawkhurst, and then at Eton and Christ Church, Oxford, where he graduated with a Bachelor of Arts in 1961, proceeding to complete a Master of Arts. But it was in the world of science for which John came to be remembered.

He served in the House of Lords for nearly 50 years having succeeded to his grandfather's title in 1971 (for his own father had been killed in the War in 1942) and in that whole time was the only person to Chair the House of Lords Committee on Science & Technology *twice* (most recently in 2014-2017 having first joined it in 1993) which was a rare honour and a reflection of the esteem in which he was widely held. In addition over the years he sat on a very wide range of public bodies and committees.

When the 1999 House of Lords Act removed so many hundreds and hundreds of Peers, John was one of those few elected to remain and went on to be an even more active Member of the House. Sitting for most of his life on the Conservative Benches he decided, late in life, to re-designate himself as Non-Affiliated and sat on the Crossbenches until he resigned from the House on 26 March 2020 two days after his 80th Birthday. [A By-election to fill his vacancy was finally held in June 2021 when Lord Sandhurst was elected to replace him.]

In his early years in the House in the 1970s and 1980s and into the 1990s he was much involved with agricultural issues as reflected in his memberships of the Apple and Pear Development Council, his Chairship of the Hops Marketing Board and of the Agricultural and Food Research Council and of the Joint Nature Conservation Committee. He was also a member of the NEDC Food Sector Group.

Beginning in the 1990s he broadened his activity to include the environment and business. He was a member of the Royal Commission on Environmental Pollution from 1993 to 1998 and on the business and philanthropic side he was from 1989 a master of the Worshipful Company of Mercers, a director of Lloyds Bank from 1994 and of its successor Lloyds TSB Group from until 2004.

John was President of a number of important societies: the Royal Agricultural Society of England from 1987–88, the Royal Institute of Public Health and Hygiene from 1991-1997 and of the Royal Geographical Society from 1997–2000.

From 1996–2006 he was the Chancellor of the University of Southampton and between 2003–2009 he was Chair of the Trustees of the Royal Botanic Gardens in Kew.

Lord Selborne served the University of Southampton well and he is remembered there with affection for having dedicated much of his time to supporting the environment and taking a particular interest in ecology.

In 1991, he became a fellow of the Royal Society. He was also a fellow of the Linnean Society, vice-patron of the Royal Entomological Society, and patron of the Institute of Ecology and Environmental Management.

As a member of the House of Lords, Lord Selborne served on and then chaired (on two separate occasions) the Science and Technology Committee. In 1991 he became a Fellow of the Royal Society. He was also a Fellow of the Linnean Society and Vice-Patron of the Royal Entomological Society. Lord Selborne was appointed a KBE in 1987 and a GBE in 2011, both for services to science.

Countless science organisations found John to be supportive of their work. For example, although not a vet, John had an extensive influence on the veterinary profession. In a different area he is remembered with great affection by the Nutrition Society for having written the Forward to their most recent textbook.

He was a kindly man and struck some people as unjustifiably self-effacing. Though quietly spoken he had a distinctive sense of humour that was often on display in his later years during his accomplished Presidency of the Foundation for Science and Technology, over whose meetings and discussion dinners at the Royal Society he presided with such assurance.

His longevity on the political stage also brought with it surprises for some. For example, on one occasion when a Chief Executive arrived late to as FST meeting because he was flying on from the event direct to Ethiopia John "launched into a lengthy story of when he met Haile Selassie as if it was yesterday. That Christmas we met again at the Parliamentary Science Reception and, without prompting, he remembered me and asked how my visit to Ethiopia had been. What a wonderful man."

Right up until he was 80 and despite failing health he would travel up to London from his local station at Alton in Hampshire (shared with the picturesque Watercress Line steam railway) to attend the House.

He was indeed a lovely man and he is already much missed.

In 1969 he married Joanna van Antwerp James and they had four children (3 boys and a girl). Our thoughts are with them and it is hoped that a memorial service or event of some kind later this year will be held to honour the Earl of Selborne and details will be given in a future issue of *Science in Parliament*.

Dr Stephen Benn

HRH PRINCE PHILIP THE DUKE OF EDINBURGH 1921-2021

There have been many things that people only learned about the extraordinary life of HRH Prince Philip, the Duke of Edinburgh, after his death at the age of 99 on 9 April 2021, only two months before he would have been 100. Acres of newsprint and dozens of photographs were produced in its wake and there are so many different aspects of his life and career upon which so much has already been written.

He was the longest-serving consort of a reigning British monarch and the longest-lived male member of the British royal family, and only retired from his royal duties on 2 August 2017, aged 96, having completed 22,219 solo engagements and 5,493 speeches since 1952.

Over his lifetime Prince Philip was a patron, president or member of over 780 organisations, as well as Chair of The Duke of Edinburgh's Award, the self-improvement program he created for young people aged 14 to 24.

Philip's connection to Parliament was real. From July 1948 he was actually a member of the House of Lords (as a Royal Duke) until July 1999 when his membership was relinquished following the House of Lords Act 1999. He is believed to have been the oldest living member of the Privy Council at the time of his death.

It is right and proper to record in *Science in Parliament* the particular interest he took in science and engineering and the special connexion that he had with the P&SC.

Prince Philip became an Honorary Member of the P&SC in 1958 and remained as such until he handed this role on to his daughter HRH The Princess Royal in 1994. During that period he attended 6 annual lunches and gave speeches at 3 of them. He acted, in effect, as the Honorary President.

His interest in science dated back at least to 1951 when he was appointed President of the British Association for the Advancement of Science. He was President of the Royal Zoological Society from 1960 to 1977 and remained a life member. From 1965 to 1975 he was President of the Council of Engineering Institutions that became the Royal Academy of Engineering in 1992. He remained a life member and was instrumental in setting up the Royal Academy of Engineering. His many other involvements with science and engineering included being Patron of the Institute of Mathematics when it was formed. During this period he was (like another British consort in the 19thC) very much in tune with the mood of modern technological change and the importance of science.

The Parliamentary & Scientific Committee will also always remember the kindness and generosity of the Duke of Edinburgh when he agreed to host a Reception at Buckingham Palace in November 2014 to commemorate the 75th Anniversary of its deliberate founding in 1939 at the start of WW2.

It was a memorable evening for all who were there. Already well into his 90s he addressed the assembled gathering with his trademark wit and verve and after his formal welcome toured the room making a point of talking to everyone present from the eldest P&SC grandees to the newest – including the young members of the string quartet that had provided the music during the evening.

The Duke of Edinburgh will be remembered with respect and affection by many in the world of science & engineering.

Dr Stephen Benn

HOUSE OF COMMONS SELECT COMMITTEES

BUSINESS, ENERGY AND INDUSTRIAL STRATEGY COMMITTEE

The Business, Energy and Industrial Strategy Committee scrutinises the policy, spending and administration of the Department for Business, Energy and Industrial Strategy and its public bodies, including Ofgem, the Financial Reporting Council and the Committee on Climate Change.

The Committee regularly holds accountability evidence hearings with Government Ministers and with bodies such as the Financial Reporting Council, the Committee on Climate Change and Ofgem. The BEIS Committee also hears from a range of stakeholders in the course of its work, receiving evidence from academics, business groups, NGOs and charities to its inquiries.

Membership:

Darren Jones MP, Labour, Chair
Alan Brown MP, Scottish National Party
Judith Cummins MP, Labour
Richard Fuller MP, Conservative
Nusrat Ghani MP, Conservative
Paul Howell MP, Conservative
Mark Jenkinson MP, Conservative
Charlotte Nichols MP, Labour
Sarah Owen MP, Labour
Mark Pawsey MP, Conservative
Alexander Stafford MP, Conservative

Inquiries:

- Net zero and UN climate summits - Opened 6 March 2020. Government response published 17th May 2021.
- The impact of coronavirus on businesses and workers - Opened 13 March 2020. Government response published 19th May 2021.
- Delivering audit reform - Opened 18 March 2020.
- Work of the Department and Government Response to coronavirus - Opened 14 April 2020
- Post-pandemic economic growth - Opened 3 June 2020.
- Post-pandemic economic growth: Industrial Strategy – Opened 23rd July 2020.
- Post-pandemic economic growth: Levelling up local and regional structures and the delivery of economic growth – Opened 24th July 2020.
- ONE WEB – Opened 16th September 2020.
- Freed Labour in UK value chains – Opened 18th September 2020. Government response published 10th June 2021.
- Decarbonising heat in homes – Opened 2nd October. Accepting written evidence until 13th November 2020.
- Business and Brexit preparedness – Opened 17th November 2020.
- Mineworkers' Pension Scheme – Opened 18th March 2021. Deadline 12th April 2021.
- Findings of the Report of Climate Change Assembly UK – Opened 19th April 2021
- Liberty Steel and the Future of the UK Steel Industry – Opened 27th April 2021

For further details: Tel: 020 7219 5777
Email: beiscom@parliament.uk

ENVIRONMENTAL AUDIT COMMITTEE

The remit of the Environmental Audit Committee is to consider the extent to which the policies and programmes of government departments and non-departmental public bodies contribute to environmental protection and sustainable development, and to audit their performance against sustainable development and environmental protection targets.

Unlike most select committees, the Committee's remit cuts across government rather than focuses on the work of a particular department.

From its beginning in 1997, in carrying out its environmental 'audit' role the Committee has had extensive support from the National Audit Office, providing seconded staff and research and briefing papers.

Membership:

Rt Hon Philip Dunne MP, Conservative, Chair
Duncan Baker MP, Conservative
Dan Carden MP, Labour
Sir Christopher Chope MP, Conservative
Barry Gardiner MP, Labour
Rt Hon Robert Goodwill MP, Conservative
James Gray MP, Conservative
Helen Hayes MP, Labour
Ian Levy MP, Conservative
Caroline Lucas MP, Green Party
Cherilyn Mackrory, Conservative
Jerome Mayhew MP, Conservative
John McNally MP, Scottish National Party
Dr Matthew Offord MP, Conservative
Claudia Webbe MP, Independent
Nadia Whittome MP, Labour

Inquiries

- Preparation for COP26 - Opened 17 March 2020.
- Greening the post-Covid Recovery - Opened 13 May 2020. Government response published 22nd June 2021.

- Energy Efficiency of Existing Homes - Opened 18 May 2020. Government response published 13th May 2021.
- Biodiversity and Ecosystems – Opened 13th July 2020
- Fixing Fashion follow up – Opened 6th October 2020
- Technological Innovations and Climate Change: Tidal Power – Opened 9th November 2020
- Green Jobs – Opened 17th November 2020.
- Water Quality in Rivers – Opened 8th December 2020.
- Next steps for deposit return schemes – Opened 12th February 2021.
- Technological Innovations and Climate Change: Community Energy – Opened 19th February
- Sustainability of the built environment – Opened 25th March 2021
- Technological Innovations and Climate Change: Supply chain for Battery Electric Vehicles – opened 4th May 2021

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SCIENCE AND TECHNOLOGY COMMITTEE

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The work of many Government departments makes use of — or has implications for — science, engineering, technology and research. The Science and Technology Committee exists to ensure that Government policies and decision-making are based on solid scientific evidence and advice. It is chaired by Greg Clark MP.

The Committee has a similarly broad remit and can examine the activities of government departments that make use of science, engineering, technology and research (otherwise known as science for policy). In addition, the Committee scrutinises policies that affect the science and technology sectors, such as research funding and skills (often referred to policy for science).

Membership:

Rt Hon Greg Clark MP, Conservative, Chair
Aaron Bell MP, Conservative
Dawn Butler MP, Labour
Chris Clarkson MP, Conservative
Katherine Fletcher MP, Conservative
Andrew Griffith MP, Conservative
Mark Logan MP, Conservative
Rebecca Long-Bailey MP, Labour
Carol Monaghan MP, Scottish National Party
Graham Stringer MP, Labour
Zarah Sultana MP, Labour

Inquiries

- UK Science, Research and Technology Capability and Influence in Global Disease Outbreaks.
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- Commercial genomics - Opened 9 April 2020.
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- The role of technology, research and innovation in the COVID-19 recovery – Opened 24th July 2020.
- Coronavirus – Lessons Learnt – Opened 6th October 2020.
- The Role of Hydrogen in Achieving Zero – Opened 4th December 2020.
- UK space strategy and UK satellite infrastructure – Opened 24th June 2021.

HEALTH AND SOCIAL CARE COMMITTEE

The Committee scrutinises government and in particular the work of the Department of Health and Social Care. It is chaired by Jeremy Hunt MP.

The Committee also scrutinises the work of public bodies in the health system in England, such as NHS England and Improvement, Public Health England and the Care Quality Commission, and professional regulators such as the General Medical Council and the Nursing and Midwifery Council. They do so by holding inquiries on specific topics and accountability hearings with the Secretary of State, and Chief Executives of relevant public bodies.

Membership:

Rt Hon Jeremy Hunt MP, Conservative, Chair
Paul Bristow MP, Conservative
Rosie Cooper MP, Labour
Dr James Davies MP, Conservative
Dr Luke Evans MP, Conservative
Barbara Keeley MP, Labour
Taiwo Owatemi MP, Labour
Sarah Owen MP, Labour
Anum Quaiser-Javed MP, Scottish National party
Dean Russell MP, Conservative
Laura Trott MP, Conservative

Inquiries

- Social care: funding and workforce - Opened 10 March 2020. Government response published 17th February 2021.
- Safety of maternity services in England – Opened 24th July 2020.
- Workforce burnout and resistance in the NHS and social care – Opened 30th July 2020. Published 8th June 2021.
- Coronavirus – Lessons Learnt – Opened 6th October 2020.
- Coronavirus – Recent developments –Opened 5th January 2021.
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- Treatment of autistic people and individuals with learning disabilities – Opened 3rd February 2021.
- Department's White Paper on health and social care – Opened 25th February 2021. Published 14th May 2021.
- Supporting those with dementia and their carers – Opened 12th May 2021.

For further details: Tel: 020 7219 6182
Email: hsccom@parliament.uk □

HOUSE OF LORDS SELECT COMMITTEES

SCIENCE AND TECHNOLOGY COMMITTEE

The Science and Technology Committee has a broad remit "to consider science and technology". It is chaired by Lord Patel.

The Committee scrutinises Government policy by undertaking cross-departmental inquiries into a range of different activities. These include:

• public policy areas which ought to be informed by scientific research (for example, health effects of air travel),

• technological challenges and opportunities (for example, genomic medicine) and

• public policy towards science itself (for example, setting priorities for publicly funded research).

In addition, the Committee undertakes from time to time shorter inquiries, either taking evidence from Ministers and officials on topical issues, or following up previous work.

Members

The Lord Patel KT, Crossbench, Chair
The Baroness Blackwood of North Oxford, Conservative
Viscount Hanworth, Labour
The Lord Holmes of Richmond MBE
The Rt Hon. the Lord Kakkar, Crossbench
The Lord Krebs, Crossbench
The Baroness Manningham-Buller LG DCB, Crossbench
The Lord Mitchell, Labour
The Baroness Rock, Conservative
The Lord Sarfraz, Conservative
The Baroness Sheehan, Liberal Democrat
The Baroness Walmsley, Liberal Democrat
The Baroness Warwick of Undercliff, Labour
The Lord Winston, Labour

Inquiries

- Ageing: Science, Technology and Healthy Living - Opened 25 July 2019 Government response published 15th March 2021.
- The science of COVID-19 Opened 7 May 2020.
- The Contribution of Innovation Catapults to Delivering the R&D Roadmap – Opened 11th November 2020. Government response published 6th April 2021.
- Role of batteries and fuel in allowing Net Zero – Opened 3rd March 2021.

For further details: Tel: 020 7219 5750
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PARLIAMENTARY OFFICE OF SCIENCE AND TECHNOLOGY (POST)

POST is a bicameral body that bridges research and policy, providing reliable and up-to-date research evidence for the UK Parliament. It is overseen by a Board of MPs, Peers and external experts.

POST briefings are impartial, non-partisan, and peer-reviewed. Timely and forward thinking, they are designed to make scientific research accessible to the UK Parliament. All this research is published on the UK Parliament website.

POSTnotes are four-page summaries of public policy issues based on reviews of the research literature and interviews with stakeholders from across academia, industry, government and the third sector. They are peer reviewed by external experts.

POSTnotes are often produced proactively, so that parliamentarians have advance knowledge of key issues before they reach the top of the political agenda.

Those produced in 2020 and 2021 were:

646: Regulating Product Sustainability
645: Low-carbon hydrogen supply
644: Effective Biodiversity Indicators
630: Digital sequence information
643: Developing essential digital skills
642: Sustainable cooling
641: Living organ donation
640: Childhood Obesity
639: Distance learning
638: Food and drink reformulation to reduce fat, sugar and salt
637: AI and healthcare
636: Woodland creation
635: Screen use and health in young people
634: Mental health impacts of COVID-19 on NHS staff
633: Interpretable machine learning
632: Heat networks
631: Edge computing
630: Digital sequence information
629: Cloud computing
628: Remote sensing and machine learning

627: Managing land uses for environmental benefits
626: A resilient UK food system
625: Marine renewables
624: Food fraud
623: Natural mitigation of flood risk
622: Online extremism
621: Infrastructure and climate change
620: 3D bioprinting in medicine
619: UK insect decline and extinctions
618: Bioenergy with carbon capture and storage (BECCS)
617: Climate change-biodiversity interactions
616: Low-carbon aviation fuels
615: Climate change and aviation
614: Brain computer interfaces
613: Non-custodial sentences
612: Autism
611: Human Germline Genome Editing
610: Misuse of Civilian Drones

POSTbriefs are responsive policy briefings based on mini-literature reviews and peer reviews. Those produced in 2020 and 2021 were:

41: Biodiversity indicators
40: Proposals to increase UK recycling of plastic food packaging
39: Outward medical tourism
38: Understanding research evidence
37: Key EU space programmes
36: Understanding insect decline: data and drivers
35: Evaluating the integration of health and social care

POST has also introduced some rapid response articles that summarise the research around COVID-19:

COVID-19 vaccines safety and blood clots
COVID-19 glossary
What is the real-world impact of COVID-19 vaccines on community transmission?
COVID-19 vaccines: effectiveness against the B.1.617.2 variant and latest updates from trials
COVID-19: Current understanding
COVID-19: Behavioural and social interventions
COVID-19: Insights from behavioural science
COVID-19: School closures and mass gatherings
Vaccines for COVID-19
Models of COVID-19: Part 1
Models of COVID-19: Part 2
Vaccines for COVID-19
COVID-19 misinformation
Face masks, face coverings and COVID-19
Models of COVID-19: Part 3
COVID-19 therapies
Mental health and well-being during the COVID-19 outbreak
Light switches and clusters: social distancing strategies for COVID-19
Contact tracing apps for COVID-19
COVID-19 and international approaches to exiting lockdown
COVID-19 in children
Immunity to COVID-19
Antibody tests for COVID-19
COVID-19 and social distancing: the 2 metre advice
COVID-19 Vaccines: July update on research
Effects of COVID-19 on the food supply system
COVID-19 in children – July update
Child and adolescent mental health during COVID-19
COVID-19, children and schools
COVID-19: July update on face masks and face coverings for the general public
Immunity to COVID-19: August update
Influenza immunisation programme, NHS winter pressure and COVID-19
COVID-19 vaccines: Immunisation and prioritisation of eligible groups
COVID-19 and the disadvantage gap
Long-term health effects of COVID-19
Contact tracing apps for COVID-19: September update
Interpreting COVID-19 test accuracy
Mental health impacts of COVID-19 on NHS healthcare staff
The latest in COVID-19 testing: developing new technologies
Impact of COVID-19 on different ethnic minority groups
COVID-19 and occupational risk
Test, trace and isolate programmes for COVID-19
Test, Trace and Isolate: Behavioural aspects
COVID-19 vaccines November update: progress of clinical trials
Technology and domestic abuse
Mass testing for COVID-19 using lateral flow tests
Regulatory approval of COVID-19 vaccines in the UK
Monitoring wastewater for COVID-19
Monitoring COVID-19 vaccine safety in national immunisation programmes
COVID-19 and the digital divide
Manufacturing COVID-19 vaccines
SARS-CoV-2 virus variants: a year into the COVID-19 pandemic
Mass testing for COVID-19: January update on lateral flow tests
The performance of COVID-19 vaccines in clinical trials and in real world conditions
COVID-19 in pregnant women and newborn babies
Changing the UK COVID-19 vaccine dosing schedule
Latest evidence on impacts of COVID-19 in children: March 2021

POST has also recently asked its COVID-19 Expert Database of 5500 experts what their main short-, medium- and long-term concerns are related to COVID-19 and what data they want to see the Government release. 17 articles covering different sectors are all available on the POST website here: https://post.parliament.uk/category/horizon-scanning/2020/. The evidence gaps identified through this work and that of parliamentary staff have been published as Parliament's first Areas of Research Interests: https://post.parliament.uk/covid-19-areas-of-research-interest/

Ongoing and future projects approved by the POST Board.

BIOLOGY AND HEALTH

In production

Disorders of consciousness
Researching gambling
Influence of industry on public health policy

Testosterone and sports performance
Mental health impacts of COVID-19
Living organ donation
Developments in vaccine technologies
Childhood obesity
Preventing zoonotic diseases

ENERGY AND ENVIRONMENT

In production
Blue Carbon
Delivering the local nature recovery network
Energy sector digitalisation
Genome editing and the future of food
Managing soils for carbon and plant productivity
Pesticides and health
Reducing agricultural pressures on freshwater ecosystems
Food waste
Sustainable cooling
Coastal management
Environmentally efficient residential buildings
Net zero and decarbonising construction

DIGITAL AND PHYSICAL SCIENCES

In production

Space defence
Smart cities
Digital skills for life

SOCIAL SCIENCES

In production

The impact of early childhood education and care on children's outcomes
Distance learning
Remote and flexible working

The POST Board oversees POST's objectives, outputs and future work programme. It meets quarterly.

Officers

- Chair: Adam Afriyie MP
- Vice-Chair: Professor the Lord Winston, FmedSci, FRSA, FRCP, FRCOG, FREng
- Secretary: Claire Quigley

House of Commons

- Rt Hon Greg Clark MP
- Alan Whitehead MP

House of Lords

- Lord Oxburgh, KBE, FRS
- Lord Haskel
- Lord Patel KT, FMedSci, FRSE

Non-parliamentary

- Professor Elizabeth Fisher, FMedSci
- Paul Martynenko, FBCS
- Professor Sir Bernard Silverman, FRS, FAcSS
- Professor Dame Sarah Whatmore, FBA

Ex-officio

- Oliver Bennett MBE, Head of the Parliamentary Office of Science and Technology
- Penny Young, House of Commons Librarian and Managing Director of Research & Information
- Farrah Bhatti, Principal Clerk, Committee Office, House of Commons
- Edward Potton, Head of Science and Environment Section, House of Commons Library
- Nicolas Besly, Clerk of Select Committees, House of Lords

Head of POST

- Oliver Bennett MBE

PARLIAMENTARY OFFICE OF SCIENCE AND TECHNOLOGY

Houses of Parliament
Westminster
London SW1A 0AA □

HOUSE OF COMMONS LIBRARY

The House of Commons Library is an impartial research and information service for Members of Parliament of all parties and their staff. This service supports MPs in their work scrutinising Government and legislation, and supporting constituents.

The Library provides confidential, impartial and bespoke briefing to Members of the House of Commons and their offices on a daily basis supporting the full range of parliamentary work, from policy development to constituency issues.

The Commons Library publishes a range of products including research briefings, shorter insight articles and briefings for non-legislative debates, all of which are available online for MPs and the general public. These briefings include in-depth and impartial analysis of all major pieces of legislation. The briefings also cover areas of policy, frequently asked questions and topical issues. You can find the briefings on the Commons Library website (https://commonslibrary.parliament.uk) where you can also sign up for personalised alerts for new or updated briefings in subject areas.

A recent focus of briefing has been Coronavirus and a webpage provides access to all the relevant material published by the Commons Library as well as the Lords Library and POST (see https://commonslibrary.parliament.uk/coronavirus/). This includes:

A series of briefings on Coronavirus restrictions:
https://commonslibrary.parliament.uk/coronavirus/coronavirus-restrictions/

A series of briefings on Vaccination:
https://commonslibrary.parliament.uk/coronavirus/coronavirus-vaccination/ including:

UK Vaccination Policy
Published 21 January 2021, CBP-9076

Coronavirus: Covid-19 vaccine roll-out - Frequently Asked Questions
Published 22 June 2021, CBP-9081

The Science and Environment Section (SES) is one of eight teams in the Research Service in the House of Commons Library. In recent months they have published, and continue to update, briefings on issues as varied as:

The UK Space Industry
Published 23 April 2021 CBP-9202
This briefing paper gives an overview of the UK space industry, including an introduction to the space sector and key UK Space Agency programmes. It also covers space policy and progress made towards developing the regulatory framework for UK space launches.

Gigabit-broadband in the UK: Public funding
Published 30 April 2021 CBP-9207
A briefing on the UK Government's current and past funding programmes for gigabit-broadband roll-out.

Gigabit-broadband in the UK: Government targets and policy
Published 30 April 2021 CBP-8392
This briefing provides information on the Government's gigabit-capable broadband targets and policy to support the roll-out of broadband by industry.

Building telecommunications infrastructure
Published 30 April 2021 CBP-9156
This briefing explains the rules and permissions needed to build broadband and mobile infrastructure including proposals for reforms to make building infrastructure easier.

Advanced Research and Invention Agency Bill 2019-21
Published 6 May 2021 CBP-9176
A briefing on the Government Bill to establish a new research funding agency specifically aimed at providing long-term support for high risk 'blue-skies research'.

Plastic waste
Published 12 May 2021 CBP-8515
A briefing on plastic waste in the UK, including statistics on plastic waste, information on UK Government and devolved Government plans and ambitions to reduce avoidable plastic waste and examples of voluntary initiatives from the plastics industry, environmental groups and retailers.

Coronavirus variants and surge testing in England (Insight)
Published 20 May 2021
An article covering virus variants, how they are assessed and managing 'variants of concern'.

Telecommunications (Security) Bill 2019-21
Published 21 May 2021 CBP-9063
An overview of the provisions in the Bill and of the debate and amendments made during the Committee stage.

Climate change: an overview
Published 27 May 2021 CBP-8666
A collection of climate change-related parliamentary briefings and publications.

Gigabit broadband: How is the rollout going? (Insight)
Published 2 June 2021
An article looking at where in the UK gigabit broadband is available, progress between September 2020 and January 2021, and take up rates.

Tree planting in the UK
Published 2 June 2021 CBP-9084
A briefing on tree planting policies that aim to increase tree cover in the UK, improve biodiversity, reduce climate emissions and provide income from agroforestry.

World Oceans Day 2021
Published 3 June 2021 CDP-2021-84
A briefing for a general debate held on World Oceans Day.

General debate: Misuse of Drugs Act
Published 16 June 2021 CDP-2021-90
A briefing for a general debate held on the Misuse of Drugs Act 1971.

□

UK Research and Innovation

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UK Research and Innovation

Arts and Humanities Research Council | Biotechnology and Biological Sciences Research Council | Economic and Social Research Council
Engineering and Physical Sciences Research Council | Innovate UK | Medical Research Council
Natural Environment Research Council | Research England | Science and Technology Facilities Council

Website: www.ukri.org

Big challenges demand big thinkers - those who can unlock the answers and further our understanding of the important issues of our time. Our work encompasses everything from the physical, biological and social sciences, to innovation, engineering, medicine, the environment and the cultural impact of the arts and humanities. In all of these areas, our role is to bring together the people who can innovate and change the world for the better. We work with the government to invest over £7 billion a year in research and innovation by partnering with academia and industry to make the impossible, possible. Through the UK's nine leading academic and industrial funding councils, we create knowledge with impact.

Arts and Humanities Research Council

Website: www.ahrc.ukri.org

AHRC funds outstanding original research across the whole range of the arts and humanities. This research provides economic, social and cultural benefits to the UK, and contributes to the culture and welfare of societies around the globe.

Biotechnology and Biological Sciences Research Council

Website: www.bbsrc.ukri.org

BBSRC invests in world-class bioscience research and training. This research is helping society to meet major challenges, including food security, green energy and healthier, longer lives and underpinning important UK economic sectors, such as farming, food, industrial biotechnology and pharmaceuticals.

Economic and Social Research Council

Website: www.esrc.ukri.org

ESRC is the UK's largest funder of research on the social and economic questions facing us today. This research shapes public policy and contributes to making the economy more competitive, as well as giving people a better understanding of 21st century society.

Engineering and Physical Sciences Research Council

Website: www.epsrc.ukri.org

EPSRC invests in world-leading research and postgraduate training across the engineering and physical sciences. This research builds the knowledge and skills base needed to address scientific and technological challenges and provides a platform for future UK prosperity by contributing to a healthy, connected, resilient, productive nation.

Innovate UK

Website: www.gov.uk/government/organisations/innovate-uk

Innovate UK drives productivity and economic growth by supporting businesses to develop and realise the potential of new ideas, including those from the UK's world-class research base. They connect businesses to the partners, customers and investors that can help them turn these ideas into commercially successful products and services, and business growth.

Medical Research Council

Website: www.mrc.ukri.org

MRC is at the forefront of scientific discovery to improve human health. Its scientists tackle some of the greatest health problems facing humanity in the 21st century, from the rising tide of chronic diseases associated with ageing to the threats posed by rapidly mutating micro-organisms.

Natural Environment Research Council

Website: www.nerc.ukri.org

NERC is the driving force of investment in environmental science. Its leading research, skills and infrastructure help solve major issues and bring benefits to the UK, such as affordable clean energy, air pollution, and resilience of our infrastructure.

Research England

Website: www.re.ukri.org

Research England creates and sustains the conditions for a healthy and dynamic research and knowledge exchange system in English universities. Working to understand their strategies, capabilities and capacity; supporting and challenging universities to create new knowledge, strengthen the economy, and enrich society.

Science and Technology Facilities Council

Website: www.stfc.ukri.org

STFC is a world-leading multi-disciplinary science organisation. Its research seeks to understand the Universe from the largest astronomical scales to the tiniest constituents of matter, and creates impact on a very tangible, human scale.

Association of the British Pharmaceutical Industry

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The Association of the British Pharmaceutical Industry (ABPI) represents innovative research-based biopharmaceutical companies, large, medium and small, leading an exciting new era of biosciences in the UK. Our industry, a major contributor to the economy of the UK, brings life-saving and life-enhancing medicines to patients. Our members are researching and developing over two-thirds of the current medicines pipeline, ensuring that the UK remains at the forefront of helping patients prevent and overcome diseases. Topics we focus on include:

- All aspects of the research and development of medicines including clinical research and licensing
- Stratified medicine
- Vaccines, biosimilars, small and large molecules, cell therapy and regenerative medicine

Contact: Dr Jane Gate, Executive Director
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AIRTO, the Association of Innovation, Research and Technology Organisations, comprises approximately sixty principal organisations operating in the UK's Innovation, Research and Technology (IRT) sector. The IRT sector has a combined turnover of £6.9Bn, employs over 57,000 people and contributes £34Bn to UK GVA. AIRTO's members work at the interface between academia and industry, for both private and public sector clients. Members include independent Research and Technology Organisations, Catapult Centres, Public Sector Research Establishments, National Laboratories, some university Technology Transfer Offices and some privately held innovation companies.

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Branch Office Address:
Merchant Quay,
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Website: www.amps-tradeunion.com

We are a Trades Union for Management and Professional Staff working in the pharmaceutical, chemical and allied industries.

We have produced a training programme funded by the EU on diversity and helping women managers remain in the workplace after a career break. This training programme is aimed at both men and women and is intended to address the shortfall in qualified personnel in the chemical and allied industries.

We are experts in performance based and field related issues and are affiliated to our counterparts in EU Professional Management Unions.

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AWE plays a crucial role in our nation's defence by providing and maintaining warheads for the UK's nuclear deterrent and delivers advice and guidance on a 24/7 basis to UK government in the area of national security.

We are a centre of scientific, engineering and technological excellence, with some of the most advanced research, design and production facilities in the world. AWE is contracted to the Ministry of Defence (MOD) through a Government-owned-contractor-operated (GOCO) arrangement. While our sites and facilities remain in government ownership, their management, day-to-day operations and maintenance of Britain's nuclear stockpile is contracted to a private company: AWE Management Limited (AWE ML). AWE ML is a consortium comprising three partners: Jacobs Engineering Group, the Lockheed Martin Corporation and Serco Group plc.

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The Biochemical Society works to promote the molecular biosciences; facilitating the sharing of expertise, supporting the advancement of biochemistry and molecular biology and raising awareness of their importance in addressing societal grand challenges. We achieve our mission by :

- bringing together molecular bioscientists;
- supporting the next generation of biochemists;
- promoting and sharing knowledge and
- promoting the importance of our discipline.

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The British Ecological Society is an independent, authoritative learned society, and the voice of the UK's ecological community. Working with our members we gather and communicate the best available ecological evidence to inform decision making. We offer a source of unbiased, objective ecological knowledge, and promote an evidence-informed approach to finding the right solutions to environmental questions.

British In Vitro Diagnostics Association (BIVDA)

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BIVDA is the UK industry association representing companies who manufacture and/or distribute the diagnostics tests and equipment to diagnose, monitor and manage disease largely through the NHS pathology services. Increasingly diagnostics are used outside the laboratory in community settings and also to identify those patients who would benefit from specific drug treatment particularly for cancer.

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The British Pharmacological Society is a charity with a mission to promote and advance the whole spectrum of pharmacology. It is the primary UK learned society concerned with drugs and the way they work, and leads the way in the research and application of pharmacology around the world.

Founded in 1931, the Society champions pharmacology in all its forms, across academia, industry, regulatory agencies and the health service. With over 3,500 members from over 60 countries worldwide, the Society is a friendly and collaborative community. Enquiries about the discovery, development and application of drugs are welcome.

Tracey Guise, Chief Executive Officer
British Society for Antimicrobial Chemotherapy (BSAC)
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BSAC is a learned society whose members are among the world's leading infectious disease physicians, pharmacists, microbiologists, and nurses.

With more than 45 years of leadership in antibiotic research and education, BSAC is dedicated to saving lives by fighting infection. It does this by supporting a global network of experts via workshops, conferences, evidence-based guidelines, e-learning courses, and its own high-impact international journal.

BSAC also provides national surveillance and susceptibility testing programmes, an outpatient parenteral antimicrobial therapy (OPAT) initiative, research and development grants, and the secretariat for the All-Party Parliamentary Group on Antibiotics.

BSAC has members in 40 nations and active learners in more than 135 countries.

SCIENCE DIRECTORY

British Society for immunology

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The British Society for Immunology's mission is to promote excellence in immunological research, scholarship and clinical practice in order to improve human and animal health. We are the leading UK membership organisation working with scientists and clinicians from academia and industry to forward immunology research and application around the world. Our friendly, accessible community of over 3,500 immunologists gives us a powerful voice to advocate for immunological science and health for the benefit of society.

BRITISH SOCIETY OF SOIL SCIENCE

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The British Society of Soil Science (BSSS) was founded in 1947 and is an established international membership organisation and charity committed to the study of soil in its widest aspects. The society brings together those working within academia, practitioners implementing soil science in industry and all those working with, or with an interest in soils.

We promote research and education, both academically and in practice, and build collaborative partnerships to help safeguard our soil for the future. This includes hosting the World Congress of Soil Science 2022 in Glasgow, where those with an interest in soil science can meet to discuss the critical global issues relating to soil.

Brunel University London

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Brunel University London is an international research active university with 3 leading research institutes:

Institute of Energy Futures: Led by Professor Savvas Tassou, the main themes of the Institute are *Advanced Engines and Biofuels, Energy Efficient and Sustainable Technologies, Smart Power Networks*, and *Resource Efficient Future Cities*.

Institute of Materials and Manufacturing: The main themes of research are *Design for Sustainable Manufacturing, Liquid Metal Engineering, Materials Characterisation and Processing, Micro-Nano Manufacturing*, and *Structural Integrity*. The Institute is led by Professor Luiz Wrobel.

Institute of Environment, Health and Societies: Professor Susan Jobling leads this pioneering research institute whose themes are *Health and Environment, Healthy Ageing, Health Economics Synthetic Biology, Biomedical Engineering and Healthcare Technologies*, and *Social Sciences and Health*.

Brunel University London offers a wide range of expertise and knowledge, and prides itself on having academic excellence at the core of its offer, and was ranked in the recent REF as 33rd in the UK for Research Power (average quality rating by number of submissions) and described by The Times Higher Education as one of the real winners of the REF 2014.

Cavendish Laboratory

UNIVERSITY OF CAMBRIDGE

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The Cavendish Laboratory houses the Department of Physics of the University of Cambridge.

The research programme covers the breadth of contemporary physics

Extreme Universe: Astrophysics, cosmology and high energy physics

Quantum Universe: Cold atoms, condensed matter theory, scientific computing, quantum matter and semiconductor physics

Materials Universe: Optoelectronics, nanophotonics, detector physics, thin film magnetism, surface physics and the Winton programme for the physics of sustainability

Biological Universe: Physics of medicine, biological systems and soft matter

The Laboratory has world-wide collaborations with other universities and industry

Chartered Institute of Ergonomics & Human Factors

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Our vision is integrated design to improve life, wellbeing and performance through science, engineering, technology and psychology. The Institute is one of the largest in the world representing the discipline and profession of Human Factors and Ergonomics. We have sector groups in most industries from defence to aviation and pharmaceuticals that provide expert advice to industry and government. We accredit university courses and consultancy practices and work closely with allied learned societies.

The Cosmetic Toiletry & Perfumery Association | ctpa

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CTPA is the UK trade association representing manufacturers of cosmetic products and suppliers to the cosmetic products industry. 'Cosmetic products' are legally defined and subject to stringent EU safety laws. CTPA is the authoritative public voice of a vibrant and responsible UK industry trusted to act for the consumer; ensuring the science behind cosmetics is fully understood.

CLIFTON SCIENTIFIC Trust

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The Council for the Mathematical Sciences

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The Council for the Mathematical Sciences is an authoritative and objective body that works to develop, influence and respond to UK policy issues affecting mathematical sciences in higher education and research, and therefore the UK economy and society by:

- providing expert advice;
- engaging with government, funding agencies and other decision makers;
- raising public awareness; and
- facilitating communication between the mathematical sciences community and other stakeholders

THE FRANCIS CRICK INSTITUTE

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The Francis Crick Institute is a biomedical discovery institute dedicated to understanding the fundamental biology underlying health and disease. Its work is helping to understand why disease develops and to translate discoveries into new ways to prevent, diagnose and treat illnesses such as cancer, heart disease, stroke, infections, and neurodegenerative diseases.

The Crick was formed in 2015, and in 2016 it moved into a brand new state-of-the-art building in central London which brings together 1500 scientists and support staff working collaboratively across disciplines.

Daphne Jackson Trust

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Founded in 1992 in memory of the UK's first female Professor of Physics, the Trust is the UK's leading charity dedicated to realising the potential of scientists and engineers returning to research after career breaks for family, caring and health reasons. Recently, we have expanded our remit to incorporate the social sciences and arts & humanities. Our Fellowship programme, working in partnership with universities, UKRI, charities, learned societies and industry, enables individuals to undertake part-time research in universities and research institutes. Fellowships comprise a research project alongside an individually tailored retraining programme, with additional mentoring and support, enabling recipients to re-establish their research credentials, update skills and redevelop confidence, in a suitably supportive environment.

energy institute

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The Energy Institute (EI) is the chartered professional membership body bringing together expertise for urgent global challenges. Our ambition is that energy, and its critical role in our world, is better understood, managed and valued. We're a unique network with insight spanning the world of energy, from conventional oil and gas to the most innovative renewable and energy efficient technologies. We gather and share essential knowledge about energy, the skills that are helping us all use it more wisely, and the good practice needed to keep it safe and secure. We articulate the voice of energy experts, taking the know-how of around 20,000 members and 200 companies from 120 countries to the heart of the public debate. And we're an independent, not-for-profit, safe space for evidence-based collaboration, an honest broker between industry, academia and policy makers.

EngineeringUK

Suzanne King
Policy and Voice Manager
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EngineeringUK is an independent organisation that promotes the vital role of engineers, engineering and technology in our society. EngineeringUK partners business and industry, Government and the wider science and technology community: producing evidence on the state of engineering; sharing knowledge within engineering, and inspiring young people to choose a career in engineering, matching employers' demand for skills.

fera

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Fera provides expert analytical and professional services to governments, agrichemical companies, food retailers, manufacturers and farmers to facilitate safety, productivity and quality across the agrifood supply chain in a sustainable and environmentally compatible way.

Fera uses its world leading scientific expertise to provide robust evidence, rigorous analysis and professional advice to governments, international bodies and companies worldwide. Our food integrity, plant health, agri-tech and agri-informatics services ensure that our customers have access to leading edge science, technology and expertise.

First Group

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FirstGroup are the leading transport operator in the UK and North America and each day, every one of our 110,000 employees works hard to deliver vitally important services for our passengers. During the last year around 2.2 billion passengers relied on us to get to work, to school or college, to visit family and friends, and much more.

GAMBICA

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GAMBICA is the voice of the laboratory technology, instrumentation, control and automation industries, providing influence, knowledge and community. We offer members a common platform for voicing their opinions and representing their common interests to a range of stakeholders. GAMBICA seeks to spread best-practice and be thought leaders in our sectors.

The Geological Society

serving science, profession & society

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The Geological Society is the national learned and professional body for Earth sciences, with 12,000 Fellows (members) worldwide. The Fellowship encompasses those working in industry, academia and government, with a wide range of perspectives and views on policy-relevant science, and the Society is a leading communicator of this science to government bodies and other non-technical audiences.

IBMS Institute of Biomedical Science

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Advancing knowledge and setting standards in biomedical science

With over 20,000 members in 61 countries, the Institute of Biomedical Science (IBMS) is the leading professional body for scientists, support staff and students in the field of biomedical science.

Since 1912 we have been dedicated to the promotion, development and delivery of excellence in biomedical science within all aspects of healthcare, and to providing the highest standards of service to patients and the public.

By supporting our members in their practice, we set quality standards for the profession through training, education, assessments, examinations and continuous professional development.

Institute of Food Science + Technology ifst

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We are the UK's leading professional body for those involved in all aspects of food science and technology. We are an internationally respected independent membership body, supporting food professionals through knowledge sharing and professional recognition.

Our core aim is the advancement of food science and technology based on impartial science and knowledge sharing.

Our membership comprises individuals from a wide range of backgrounds, from students to experts, working across a wide range of disciplines within the sector.

IKE

Institute of Innovation & Knowledge Exchange

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www. InnovationInstitute.org.uk

IKE is the UK's professional body for innovators. It accredits and certificates innovation practices. We influence the inter-relationship between education, business, and government through research and collaborative networks. Our Innovation Manifesto highlights our commitment to support the development of innovative people and organisations. IKE runs think-tanks, conducts research, develops new business models and tools and supports organisations to benchmark their innovation capabilities.

Institute of Marine Engineering, Science and Technology (IMarEST)

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Established in London in 1889, the IMarEST is a leading international membership body and learned society for marine professionals, with over 15,000 members worldwide. The IMarEST has an extensive marine network of 50 international branches, affiliations with major marine societies around the world, representation on the key marine technical committees and non-governmental status at the International Maritime Organization (IMO) as well as other intergovernmental organisations.

Institute of Measurement and Control

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Reg Charity number: 269815

The Institute of Measurement and Control is a professional engineering institution and learned society dedicated to the science and application of measurement and control technology for the public benefit. The InstMC has a comprehensive range of membership grades for individuals engaged in both technical and non-technical occupations. Also, it is licensed by the Engineering Council to assess and register individuals as Chartered Engineers (CEng), Incorporated Engineers (IEng) and Engineering Technicians (EngTech).

The InstMC works to develop the knowledge and skills of individual engineers, fostering communication and advancing the science and practices within the industry.

IOP Institute of Physics

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The Institute of Physics (IOP) is the professional body and learned society for physics in the UK and Ireland. The IOP's mission is to raise public awareness and understanding of physics, inspire people to develop their knowledge, understanding and enjoyment of physics and support the development of a diverse and inclusive physics community. As a charity, the IOP seeks to ensure that physics delivers on its exceptional potential to benefit society.

IPEM Institute of Physics and Engineering in Medicine

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Website: www.ipem.ac.uk

IPEM is a registered, incorporated charity for the advancement, in the public interest, of physics and engineering applied to medicine and biology. Its members are medical physicists, clinical and bio-engineers, and clinical technologists. It organises training and CPD for them, and provides opportunities for the dissemination of knowledge through publications and scientific meetings. IPEM is licensed by the Science Council to award CSci, RSci and RSciTech, and by the Engineering Council to award CEng, IEng and EngTech.

IChemE ADVANCING CHEMICAL ENGINEERING WORLDWIDE

The Institution of Chemical Engineers

The Institution of Chemical Engineers (IChemE) advances chemical engineering's contribution worldwide for the benefit of society. We support the development of chemical engineering professionals and provide connections to a powerful network of around 35,000 members in 100 countries.

We support our members in applying their expertise and experience to make an influential contribution to solving major global challenges, and are the only organisation to award Chartered Chemical Engineer status and Professional Process Safety Engineer registration.

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Kuala Lumpur | London | Melbourne | Rugby | Singapore | Wellington

IET The Institution of Engineering and Technology

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The IET is a world leading professional organisation, sharing and advancing knowledge to promote science, engineering and technology across the world. Dating back to 1871, the IET has over 163,000 members in 127 countries with offices in Europe, North America, and Asia-Pacific.

LGC

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LGC is a global leader in the life sciences tools sector, including human healthcare and applied markets (food, agbio and the environment). LGC provides a comprehensive range of measurement tools, proficiency testing schemes, supply chain assurance standards and specialty genomics tools (oligos, PCR tools, NGS reagents), underpinned by leading analytical and measurement science capabilities. Under the Government Chemist function, LGC fulfils specific statutory duties as the referee analyst and provides advice for Government and the wider analytical community on the implications of analytical measurement for matters of policy, standards and regulation. LGC is also the UK's National Measurement Laboratory for chemical and bio-measurement.

With headquarters in Teddington, South West London, LGC has laboratories and sites across Europe, the US, China, Brazil, India, and South Africa.

L'ORÉAL UK AND IRELAND

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L'Oréal employs more than 3,800 researchers world-wide and dedicates over €877 million each year to research and innovation in the field of healthy skin and hair. The company supports women in science research through the L'Oréal UNESCO For Women In Science Programme and engages young people with science through the L'Oréal Young Scientist Centre at the Royal Institution. L'Oréal also collaborates with a vast number of institutions in the UK and globally.

The Linnean Society of London

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As the world's oldest active biological society, the Linnean Society is an essential forum and meeting point for those interested in the natural world. The Society holds regular public lectures and events, publishes three peer-reviewed journals, and promotes the study of the natural world with several educational initiatives. The Society is home to a world famous library and collection of natural history specimens. The Society's Fellows have a considerable range of biological expertise that can be harnessed to inform and advise on scientific and public policy issues.

A Forum for Natural History

London School of Hygiene & Tropical Medicine

London School of Hygiene & Tropical Medicine
Contact: Professor Peter Piot, Director
Keppel Street, London, WC1E 7HT
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www.lshtm.ac.uk

The London School of Hygiene & Tropical Medicine (LSHTM) is a world-leading centre for research and postgraduate education in public and global health with over 4,000 students and more than 1,300 staff working in over 100 countries across the world – including at two MRC Units in The Gambia and Uganda which joined LSHTM in 2018. Our depth and breadth of expertise encompasses many disciplines, and we are one of the highest-rated research institutions in the UK.

Marine Biological Association

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Since 1884 the Marine Biological Association has been delivering its mission *'to promote scientific research into all aspects of life in the sea, including the environment on which it depends, and to disseminate to the public the knowledge gained.'* The MBA represents its members in providing a clear independent voice to government on behalf of the marine biological community. It also has an extensive research programme and a long history as an expert provider of advice for the benefit of policy makers and wider society.

Institution of Mechanical Engineers

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The Institution provides politicians and civil servants with information, expertise and advice on a diverse range of subjects, focusing on manufacturing, energy, environment, transport and education policy. We regularly publish policy statements and host political briefings and policy events to establish a working relationship between the engineering profession and parliament.

Met Office

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The Met Office doesn't just forecast the weather on television. Our forecasts and warnings protect UK communities and infrastructure from severe weather and environmental hazards every day – they save lives and money. Our Climate Programme delivers evidence to underpin Government policy through the Met Office Hadley Centre. Our Mobile Meteorological Unit supports the Armed Forces around the world. We build capacity overseas in support of international development. All of this built on world-class environmental science.

Microbiology Society

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The Microbiology Society is a membership charity for scientists interested in microbes, their effects and their practical uses. It is one of the largest microbiology societies in Europe with a worldwide membership based in universities, industry, hospitals, research institutes and schools.

Our principal goal is to develop, expand and strengthen the networks available to our members so that they can generate new knowledge about microbes and ensure that it is shared with other communities. The impacts from this will drive us towards a world in which the science of microbiology provides maximum benefit to society.

NPL National Physical Laboratory

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The National Physical Laboratory (NPL) is the United Kingdom's national measurement institute, an internationally respected and independent centre of excellence in research, development and knowledge transfer in measurement and materials science. For more than a century, NPL has developed and maintained the nation's primary measurement standards - the heart of an infrastructure designed to ensure accuracy, consistency and innovation in physical measurement.

Natural History Museum

Advancing the science of nature

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We challenge the way people think about the natural world – its past, present and future

We use our unique collection and unrivalled expertise to tackle the biggest challenges facing the world today.

We are leaders in the scientific understanding of the origin of our planet, life on it and can predict the impact of future change.

We study the diversity of life and the delicate balance of ecosystems to ensure the survival of our planet.

We help enable food security, eradicate disease and manage resource scarcity.

We inspire people to engage with science to solve major societal challenges.

University of Northampton

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The University of Northampton is an institution committed to science education through initial teacher training, a STEM Ambassador network which works within the community and teaching and research to doctoral level. We are an Ashoka U 'Changemaker Campus' status university recognising our commitment to social innovation and entrepreneurship.

SCIENCE DIRECTORY

The University of Nottingham
UNITED KINGDOM · CHINA · MALAYSIA

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With 43,000 students and campuses in Nottingham, China and Malaysia, The University of Nottingham is 'the nearest Britain has to a truly global university'. With more than 97 per cent of research at the University recognised internationally according to the Research Excellence Framework 2014, the University is ranked in the top 1% of the world's universities by the QS World University Rankings.

THE NUTRITION SOCIETY
Advancing Nutritional Science

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The Nutrition Society is a not for profit, membership organisation which is dedicated to delivering its mission of advancing the scientific study of nutrition and its application to the maintenance of human and animal health. Highly regarded by the scientific community, the Society is one of the largest learned societies for nutrition in the world and anyone with a genuine interest in the science of human or animal nutrition can become a member.

The Physiological Society

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As the largest network of physiologists in Europe, with academic journals of global reach, we continue our 140-year tradition of being at the forefront of the life sciences.

We bring together scientists from over 60 countries, and our Members have included numerous Nobel Prize winners from Ivan Pavlov to John O'Keefe.

prospect

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Prospect is an independent, thriving and forward-looking trade union with over 120,000 members across the private and public sectors and a diverse range of occupations. We represent scientists, technologists and other professions in the civil service, research councils and private sector.

Prospect's collective voice champions the interests of the engineering and scientific community to key opinion-formers and policy makers. With negotiating rights with over 300 employers, we seek to secure a better life at work by putting members' pay, conditions and careers first.

QUADRUM INSTITUTE

Quadram Institute
Science • Health • Food • Innovation

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Opening fully in mid-2018, the Quadram Institute will be an interdisciplinary research centre capitalising on the academic excellence and clinical expertise of the Norwich Research Park. Its mission is to understand how food and the gut microbiota link to the promotion of health and preventing diet and age related diseases. The Quadram Institute brings together fundamental and translational science with a clinical research facility for human trials and one of Europe's largest gastrointestinal endoscopy units. This will synergise interactions between basic and clinical research, delivering a step change in the understanding of the role of food in health.

Royal Academy of Engineering

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As the UK's national academy for engineering, we bring together the most successful and talented engineers for a shared purpose: to advance and promote excellence in engineering. We have four strategic challenges: drive faster and more balanced economic growth; foster better education and skills; lead the profession; and promote engineering at the heart of society.

Kew
ROYAL BOTANIC GARDENS

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RBG Kew is a centre of global scientific expertise in plant and fungal diversity, conservation, and sustainable use, housed in two world-class gardens. Our scientific vision is to document and understand global plant and fungal diversity and its uses, bringing authoritative expertise to bear on the critical challenges facing humanity today.

Kew's strategic priorities for science are:

1. To document and conduct research into global plant and fungal diversity and its uses for humanity.
2. To curate and provide data-rich evidence from Kew's unrivalled collections as a global asset for scientific research.
3. To disseminate our scientific knowledge of plants and fungi, maximising its impact in science, education, conservation policy and management.

These priorities enable us to curate, use, enhance, explore and share Kew's global resource, providing robust data and a strong evidence base for our UK and global stakeholders. Kew is a non-departmental government body with exempt charitable status, partially funded by Defra.

Ri The Royal Institution
Science Lives Here

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The Royal Institution (Ri) has been at the forefront of public engagement with science for over 200 years and our purpose is to encourage people to think further about the wonders of science. We run public events and the famous CHRISTMAS LECTURES®, a national programme of Masterclasses for young people in mathematics, engineering and computer science, educational activities at the L'Oréal Young Scientist Centre and policy discussions with science students. And through the Ri Channel we share the stories behind cutting-edge science with people around the world.

THE ROYAL SOCIETY

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The Royal Society is the academy of science in the UK and the Commonwealth comprising 1400 outstanding individuals representing the sciences, engineering and medicine. The Society has played a part in some of the most fundamental, significant and life-changing discoveries in scientific history and Royal Society scientists continue to make outstanding contributions to science across the wide breadth of research areas. Through its Fellowship and permanent staff, it seeks to ensure that its contribution to shaping the future of science in the UK and beyond has a deep and enduring impact, supporting excellence in science and encouraging the development and use of science for the benefit of humanity.

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The Royal Society of Biology is a single unified voice, representing a diverse membership of individuals, learned societies and other organisations. We are committed to ensuring that we provide Government and other policy makers – including funders of biological education and research – with a distinct point of access to authoritative, independent, and evidence-based opinion, representative of the widest range of bioscience disciplines. Our vision is of a world that understands the true value of biology and how it can contribute to improving life for all.

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The Royal Society of Chemistry is the world's leading chemistry community, advancing excellence in the chemical sciences. With over 50,000 members and a knowledge business that spans the globe, we are the UK's professional body for chemical scientists; a not-for-profit organisation with 170 years of history and an international vision of the future. We promote, support and celebrate chemistry. We work to shape the future of the chemical sciences – for the benefit of science and humanity.

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*Sf*AM utilises the expertise of its international membership to advance, for the benefit of the public, the application of microbiology to the environment, human and animal health, agriculture, and industry. Our values include equality, diversity and inclusivity; collaboration to amplify impact; scientific integrity; evidence-based decision-making and political neutrality. With Wiley-Blackwell, *Sf*AM publishes five internationally acclaimed journals.

Society for Underwater Technology

Society for Underwater Technology
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The SUT is a multidisciplinary learned society that brings together individuals and organisations with a common interest in underwater technology, ocean science, and offshore/subsea engineering. The society was founded in 1966 and has members from over 40 countries, including engineers, scientists, other professionals and students working in these areas.

Society of Chemical Industry

SCI: where science meets business

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Established by Royal Charter in 1881, SCI is a unique multi-disciplinary community. Set up by a prominent group of forward thinking scientists, inventors and entrepreneurs, SCI continues to be a multi-science and industry network based around chemistry and related sciences. Our charitable objective is to promote links between science and industry for the benefit of society. Our passion is invention and creation.

We deliver our charitable objective by:

- Supporting the commercial application of science into industry
- Tackling global challenges across Agrifood, Energy, Environment, Health and Materials

Society of Cosmetic Scientists

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Advancing the science of cosmetics is the primary objective of the SCS. Cosmetic science covers a wide range of disciplines from organic and physical chemistry to biology and photo-biology, dermatology, microbiology, physical sciences and psychology.

Members are scientists and the SCS helps them progress their careers and the science of cosmetics ethically and responsibly. Services include publications, educational courses and scientific meetings.

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The Society of Maritime Industries (SMI) is the voice and champion of the UK maritime engineering, marine science & technology and business service sectors.

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The **UK Innovation & Science Seed Fund** is a leading patient capital investor with more than £330 million private investment leveraged to date. The Fund works to build technology companies from the earliest stage by working closely with its partners led by STFC, BBSRC, NERC and Dstl, with the National Research and Innovation Campuses they support, and with entrepreneurial science-led teams. UK Innovation & Science Seed Fund is also closely aligned with the Catapults and InnovateUK, helping to commercialise key technological advances in industrial biotech, agricultural technology, healthcare, medicine, clean energy, materials, artificial intelligence, software and space.

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Understanding Animal Research is a not-for-profit organisation that explains why animals are used in medical, veterinary, environmental and other scientific research. We aim to achieve a broad understanding of the humane use of animals in medical, veterinary, scientific and environmental research in the UK. We work closely with policymakers to ensure regulation is effective and are a trusted source of information for the national and international media. We are funded by our members who include universities, professional societies, trade unions, industry and charities.

University of Essex

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Established in 1964, the University of Essex is ranked as one of the Top 20 universities in the Research Excellence Framework and is awarded Gold in the Teaching Excellence Framework. It is home to world-leading expertise in analytics and data science, with research peaks spanning the social sciences, sciences, and humanities. Pioneers of quantitative methods and artificial intelligence techniques, Essex is also in the UK top 10 for Knowledge Transfer Partnerships, and works with businesses to embed innovation into operations, through KTPs, knowledge exchange and contract research.

Universities Federation for Animal Welfare

UFAW Established 1926

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Registered in England Charity No: 207996

UFAW, the international animal welfare science society, is an independent scientific and educational charity. It works to improve animal lives by:

- supporting animal welfare research
- educating and raising awareness of welfare issues in the UK and overseas
- producing the quarterly scientific journal Animal Welfare and other high-quality publications on animal care and welfare
- providing advice to government departments and other concerned bodies.

The Welding Institute

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The Welding Institute is the leading institution providing engineering solutions and knowledge transfer in all aspects of manufacturing, fabrication and whole-life integrity management.

Industrial membership provides access to innovative problem-solving from one of the world's foremost independent research and technology organisations.

Non-Corporate services include membership and registration, education, training and certification for internationally recognised professional development and personnel competence assurance.

TWI provides Members and stakeholders with authoritative and impartial expert advice, knowhow and safety assurance through engineering, materials and joining technologies.

SCIENCE DIARY

PARLIAMENTARY AND SCIENTIFIC COMMITTEE – ALL-PARTY PARLIAMENTARY GROUP

Email: office@scienceinparliament.org.uk
www.scienceinparliament.org.uk
follow us on Twitter @ParlSciCom

DISCUSSION AND OTHER MEETINGS 2021

Monday 13th September
Discussion Meeting on Mathematical Modelling and Algorithms
Sponsored by the Institute of Mathematics and its Applications
5.30pm to 7.00pm

Tuesday 12th October
Discussion Meeting on Brain Gain: How world-leading UK neuroscience research can meet tomorrow's societal challenges
Sponsored by the British Neurological Association
5.30pm to 7.00pm

Monday 8th November
Discussion Meeting on COP 26
Sponsored by the National Physical Laboratory
5.30pm to 7.00pm

Tuesday 16th November
Annual Luncheon
Cholmondeley Room, House of Lords
12.30pm – 2.00pm

Monday 29th November
Discussion Meeting on topic to be advised
Sponsored by the Nuffield Council
5.30pm to 7.00pm

Monday 6th December
Discussion Meeting and STEM for Britain 2021 Awards Ceremony
Attlee Suite, Houses of Parliament
10.00am – 1.00pm

The dates of the 2022 Discussion Programme and other meetings will appear in the Autumn journal.

ROYAL SOCIETY

Details of all events can be found on the events calendar at events@royalsociety.org
For scientific meetings queries:
scientificmeetings@royalsociety.org

THE ROYAL INSTITUTION

Details of all events and booking Information can be found at www.rigb.org/whats-on

ROYAL SOCIETY OF BIOLOGY

For further details please contact Karen Patel or Dr Stephen Benn at events@rsb.org

ROYAL SOCIETY OF CHEMISTRY

For further details please contact Events@rsc.org

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NEW ALL PARTY PARLIAMENTARY GROUP

THE NUTRITION SOCIETY

NUTRITION: SCIENCE AND HEALTH

AIMING TO:

Raise parliamentary awareness and stimulate informed debate around regional, national and global nutrition issues; champion nutrition science to support evidence-based policy making on nutrition and health challenges, and deliver a programme of events encompassing issues that scope disease prevention, healthy ageing, food security, sustainable diets, and animal nutrition.

The Nutrition Society invites MPs and members of the House of Lords to become founding members. If interested, please email **appg@nutritionsociety.org**

THE NUTRITION SOCIETY
Advancing Nutritional Science

The scope of the APPG meetings include, but are not limited to:

- the human health benefits of a sustainable diet
- enabling tomorrow's doctors: Nutrition in medical education
- emerging nutrition deficiencies in the UK
- delivering global change in nutrition and health
- transforming health outcomes (in relation to obesity, cardiovascular disease, diabetes) via National Food Policy
- sport and performance nutrition
- nutrition and health claims.

To find out more, please visit:
https://www.nutritionsociety.org/nutrition-science-and-health-all-party-parliamentary-group-appg

STEM for BRITAIN

STEM for BRITAIN 2022

P & S C

The Parliamentary & Scientific Committee's STEM for BRITAIN 2022, hosted by Stephen Metcalfe MP, will take place in the Houses of Parliament on Monday 7th March, during British Science Week

Applications are invited from Monday 13th September from early-career research scientists, engineers, technologists and mathematicians who wish to exhibit posters in one of the following five areas:

• Biological and Biomedical Sciences • Chemistry • Engineering • Mathematics • Physics

The closing date for applications is Monday 6th December 2021.

A wide range of important scientific, engineering and mathematics institutions and organisations are lending their support to this event, including the Royal Society of Biology, the Institute of Physics, The Physiological Society, the Royal Society of Chemistry, the Royal Academy of Engineering, the Council for the Mathematical Sciences, Dyson Ltd, the Institute of Biomedical Science, the Clay Mathematics Institute, the Nutrition Society, the Heilbronn Institute, United Kingdom Research and Innovation, Society, the Biochemical Society, and the Society of Chemical Industry.

This reflects the importance we all attach to the encouragement of researchers at this stage in their careers.

Prizes will be awarded for the posters presented in each discipline which best communicate high level science, engineering or mathematics to a lay audience.

The Westminster Medal for the overall winner will be awarded in memory of the late Dr Eric Wharton, who did so much to establish SET for Britain as a regular event in the Parliamentary calendar.

From Monday 1st September full details of the competition and exhibition including the application form can be found on the STEM for Britain website at: www.stemforbritain.org.uk.