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SCIENCE IN PARLIAMENT

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# BUILDING THE GLOBAL NUTRITIONAL SCIENCE COMMUNITY

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.

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- 1 Continually seek ways to enhance the Society's promotion of high quality nutritional science.
- 2 Support the interests and careers of the Society's membership.
- 3 Strengthen the Society's links with, and support to, other Societies, organisations and individuals in Europe, and beyond.
- 4 Work with those who are engaged in nutritional science in universities, industry, the public sector, and the non-profit sector to better understand, identify, and seek to meet, their needs and aspirations.
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Stephen Metcalfe MP,  
Chairman, Parliamentary and  
Scientific Committee

Welcome to the winter edition of Science in Parliament. This is a slightly unusual edition as it contains two multi-part articles.

The first deals with the recent historic decision to redefine four of the seven global standard units of measurement – the kilogram, the kelvin, the mole, and the ampere. Accurate and consistent measurement has been essential to all science and engineering. The new definitions of SI units will future proof the system as we explore even smaller or more remote objects, resulting in discoveries that will lead to technological developments that we cannot yet imagine.

The other multi-part article deals with the concerns of the research and innovation community about how to create an immigration system that will

support the continuing excellence of the UK research base after Brexit. In March 2017, when also chair of the Select Committee on Science and Technology, I produced a briefing paper on Science Priorities for Brexit. <http://www.scienceinparliament.org.uk/wp-content/uploads/2012/09/Science-Priorities-for-Brexit-Final.pdf> This clearly indicated that maintaining high quality collaboration and networks would be essential to maintain the UK's ambition to remain one of the best places in the world to do research, and to innovate and grow business. To deliver this, researchers must continue to be able to engage easily with the brightest minds and the best organisations and facilities wherever they are in the world.

In July 2018 the Select Committee produced a report on 'An immigration system that works for science and innovation'. The Government's response, published on 17 October, disappointed many of those who attended the Parliamentary & Scientific committee meeting held the same day on this topic. The panel members we had then have since produced statements, reproduced in this edition, reflecting what they would like to see in the forthcoming Immigration White Paper. As I

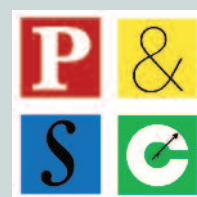
write in late November, this White Paper has not been published.

This edition also reproduces the inspiring address at the Annual lunch on 20 November which Sir Mark Walport gave about the work of UK Research and Innovation. It is immensely reassuring that UKRI has a Chief Executive of the calibre and insight of Sir Mark. As he concluded – it is in all our interests that UKRI is an enormous success – and we will all want to give him every support we can in that.

Of course, the dominating political issue continues to be Brexit. We have now been presented with the terms of Withdrawal and of the Future Relationship as agreed between the UK Government and the EU Council of Ministers and the Commission. There is still, however, the hurdle of Parliamentary approvals – both by the UK Parliament and the European Parliament – and much speculation on what that will bring. I am of course aware that many in the scientific community are desperately keen to avoid any outcome that could fracture or interrupt the continuity of the relationship with EU over research – a relationship that has brought much mutual benefit.



The Journal of the Parliamentary and Scientific Committee.  
*The Parliamentary and Scientific Committee is an All-Party Parliamentary Group of members of both Houses of Parliament and British members of the European Parliament, representatives of scientific and technical institutions, industrial organisations and universities.*



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.

## CONTENTS

### THE FUTURE OF MEASUREMENT

Dr Peter Thompson, Fiona Auty and Dr JT Janssen

### OVERSEAS DEVELOPMENT ASSISTANCE PROJECT DELIVERS HIGH TECH SKILLS IN AFRICA THROUGH RADIO ASTRONOMY

Professor Melvin Hoare

### AN IMMIGRATION SYSTEM FOR THE UK'S RESEARCH AND INNOVATION SYSTEM

Sergio Perez, Naomi Weir, Rt Hon Norman Lamb MP, Professor Richard Catlow FRS, Dr Louise Wren and Dr Hollie Chandler

### ANNUAL LUNCH OF THE PARLIAMENTARY AND SCIENTIFIC COMMITTEE

Sir Mark Walport, FRS, Hon FRSE, FMedSci

2	HOUSE OF COMMONS LIBRARY	22
	PARLIAMENTARY OFFICE OF SCIENCE AND TECHNOLOGY (POST)	22
	HOUSE OF COMMONS SELECT COMMITTEES	24
7	HOUSE OF LORDS SELECT COMMITTEES	27
	SCIENCE DIRECTORY	28

# THE FUTURE OF MEASUREMENT



Dr Peter Thompson, CEO, National Physical Laboratory



At a meeting in Versailles last month, a monumental change was agreed upon, a change that will underpin all measurement throughout the world. From 20 May 2019, four of the seven global standard units of measurement will be redefined, that is the kilogram (the standard unit of mass), the kelvin (the standard unit of thermodynamic temperature), the mole (the standard unit of amount of substance) and the ampere (the standard unit of electric current).

Measurement is at the heart of all science and engineering. It is only when we can measure something that scientists can study it and engineers can improve it. As we become more and more reliant on advanced science and engineering, having a global standard system of measurement is vital – not just for manufacturing and trade, but it affects our everyday lives too:

- Our medical care depends critically on measurements, for example from concentrations of chemicals in blood to the intensity of X-rays
- When satellite navigation systems guide us along a road they depend on time measured by ultra-precision clocks on satellites
- When we buy a part that ‘just fits’: a nut fits a bolt or a Lego® brick sticks perfectly to another brick

In all these situations, and thousands more, we are enjoying the benefits of a standardised global system of measurement.

The National Physical Laboratory (NPL) is the UK’s National Measurement Institute and is at the centre of the UK’s measurement infrastructure. We deliver world-leading measurement capability that is crucial to accelerating research and development. Our research

covers a variety of disciplines and areas ranging from new antibiotics to tackle resistance and more effective cancer treatments, to unhackable quantum communications and superfast 5G technological advances. Measurement underpins all these disciplines and it is our responsibility to not only ensure that all measurements made in the UK can be traced back to agreed international standards, but also to respond to the ever changing environment and advance our measurement capabilities for future applications like quantum technologies.

## WHAT IS THE INTERNATIONAL SYSTEM OF UNITS?

How do we know that ‘one metre’ in the UK is the same as ‘one metre’ in Japan? And how do we ensure that ‘one metre’ today is the same as it was 20 years ago? We do this by using the globally agreed *International System of Units*, known as the *SI* (from the French, *Système international d’unités*). The SI sets out what the agreed units of measurement are, how they are defined, and how they are realised in practice.

The widespread adoption of the SI allows science, industry and trade to measure physical objects and phenomena using

the same units, so that the results can be compared meaningfully, worldwide.

The SI was formally agreed in 1960 to replace the Metric System and is directed from the *International Bureau of Weights and Measures (BIPM)*, a laboratory situated in diplomatically-protected territory in Sèvres, just outside Paris. At BIPM, scientists from all over the world meet to agree upon definitions of precisely what we mean by each of the SI base units. These scientists often work at National Measurement Institutes which have responsibility for making the benefits of the SI available within individual countries. In the UK, this is one of the key roles of NPL.

Historically, units of measurement were defined by physical objects or properties of materials. For example, the metre was defined by the length between lines engraved on a metal bar and until next May, the kilogram is defined as the mass of a carefully specified metal cylinder. But physical representations can be unstable – they can change over time or in different environments, or they could be tampered with. So, over the years, the definitions have been improved to be more stable and reproducible, and to meet the

needs of today's research and technological applications.

During the last century, scientists have measured constants of nature, such as the speed of light and the Planck constant, with increasing accuracy and realised that they are more stable than any physical object. Scientists have utilised these properties to develop new definitions of the units that will meet the demands on the measurement system as science advances.

## "AU REVOIR" TO LE GRAND K

The kilogram is the last SI base unit to still be defined as an artefact, the International Prototype of the Kilogram (IPK), which is nicknamed 'Le Grand K'. It is a cylinder made from a platinum-iridium alloy and is nested under three glass cloches locked in a vault at BIPM.

Unfortunately, studies of closely-similar copies have revealed that the mass of the IPK is almost certainly



NPL's standard kilogram

changing...but only very minutely. This implies a tiny but known change in the values of all masses. For mass, and for all units, we need to rule out this type of problem.

At the moment, every measurement of mass must ultimately be traced back to the IPK. Currently, to realise the kilogram we compare the gravitational force on an object with the gravitational force on the reference mass which has a known weight. At NPL, like many other national measurement laboratories worldwide, we keep a copy of the IPK – ours is the eighteenth copy. The UK's kilogram is

checked against other copies that are held in the vault with Le Grand K and very occasionally those copies are compared against Le Grand K itself.

As of 20 May 2019, Le Grand K will be retired, thus removing the hierarchical system where every mass is traced back to the IPK. Instead, the kilogram will be defined using the Planck constant, a fixed numerical constant which will not change over time.

The UK has taken the lead through work carried out at NPL to design and develop the



Dr Ian Robinson (left) and Dr Bryan Kibble (right) working with the Kibble balance Mark II in the mid-90s at NPL.

instrument that has been used to measure the Planck constant. The Kibble balance, as it is known, was invented by Dr Bryan Kibble in 1975 at NPL. The image below shows Dr Bryan Kibble and Dr Ian Robinson working with the Kibble balance at NPL. This instrument can make extremely accurate measurements of the Planck constant. Although now based at Canada's National Research Council, NPL's Kibble balance instrument was used to measure the Planck constant with an accuracy of nineteen parts per billion: sufficient for the proposed redefinition of the kilogram.

Redefining the kilogram and the other SI base units is a truly worldwide endeavour that transcends politics and other worldwide challenges. In the articles that follow, some of my colleagues from NPL will tell you more about the history behind the SI and what these profound changes to how we define the SI will mean.

# A BRIEF HISTORY OF MEASUREMENT



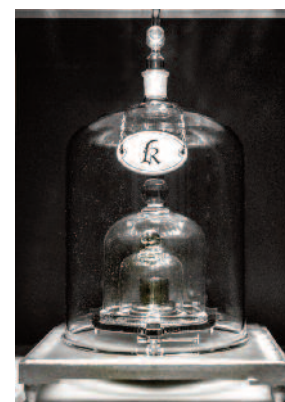
Fiona Auty, Head of Government Relations at NPL

Since civilisation began, we have measured – the Sun rising and setting gave us the length of day and night, and mapping the position of the stars helped us to navigate on land and at sea. Before we used money made of paper and coins, early trade in the form of bartering would have been based on some assessment of the amount of goods you could exchange.

The Ancient Egyptians invented one of the earliest rulers, the cubit rod. The length of a cubit is determined by the distance between the Pharaoh's elbow and the tip of his middle finger.

The Egyptians used the cubit rod to build some of the most remarkable buildings the world has ever seen. If you were to measure the pyramids you would find that they are whole numbers of cubits in width and height!

In England, in the 12th century, the yard was defined as the length from the tip of the King's nose to the top of his outstretched thumb. When Henry VII reigned however, he defined the yard as the length of his arm. As you can imagine, constantly changing the definition of the yard caused many problems!



The International Prototype of the Kilogram, Le Grand K

Trying to develop a measurement system became the pursuit of nations and rulers all over the world. In the UK, the first measurement standards for

food, drink and cloth, were set out in the Magna Carta in the 13th century to bring together rebel groups under the Crown.

But the system of measurement that we all know today was brought about by the French. Louis XVI, in the late 18th century, charged a small group of scientists to develop a new system of measurement.

Their work laid the foundation for the 'decimal metric system'. They planned to create standards of mass and length.

For mass, they proposed that the new kilogram be equal to the weight of one cubic decimetre of water. The idea was simple and it would mean that so long as someone had a metre rule, anyone could realise a kilogram.

However, there were problems... hotter water weighs less than colder water as it is less dense. Furthermore, impurities in the water affects the weight, as well as how far above sea level the measurement is made. In the following years, scientists perfected measuring a cubic decimetre of distilled water allowing a kilogram to be defined.

It was this community that eventually led to the signing of the Metre Convention on 20 May 1875 by 17 countries. Although it was called the 'Metre Convention', they actually agreed on three units – the metre and kilogram, defined by the physical artefacts that had been created, and the second which would be based upon astronomical time.

## SI TIMELINE

**20 May 1875:** The Metre Convention was signed in Paris by representatives of 17 nations, creating the International Bureau of Weights and Measures (BIPM).

**1889:** The first General Conference on Weights and Measures (CGPM) sanctioned the **new international prototypes of the metre and kilogram** made out of platinum-iridium.

**1948:** An international survey was launched to make recommendations for a single system of measurement units that can be adopted worldwide.

**1954:** The 10th CGPM approved the **introduction of the ampere, the kelvin and the candela** as base units for electric current, thermodynamic temperature and luminous intensity, respectively.

**1960:** The 11th CGPM adopted the name of the **International System of Units (SI)** based on six units: the metre, the kilogram, the second, the ampere, the kelvin and the candela. The new definition for the metre was introduced.

**1967:** The second was redefined as the 'atomic second' dependent on the properties of a caesium atom.

**1971:** A new unit was added to the SI: the mole as the unit for substance.

**1979:** The candela was redefined in terms of monochromatic radiation.

**1983:** The metre was redefined in terms of a fundamental constant, the speed of light.

**1990:** New practical conventions based on quantum phenomena were adopted for the ohm and volt.

**2007:** The 23rd CGPM recommended metrology laboratories pursue experiments to redefine the kilogram, the ampere, the kelvin and the mole in terms of physical constants.

**16 November 2018:** The 26th CGPM **agreed to redefine four of the seven base units - the kilogram, the ampere, the kelvin and the mole.**

**20 May 2019, World Metrology Day: The redefinition will come into force and from this point onwards the whole SI will be founded on a defined set of fundamental constants.**

Defining the metre was much more exciting. In 1791, the Academy of Sciences in Paris decided that the metre should be defined as one ten-millionth of the distance between the North Pole and the Equator. Basing the metre on the planet itself meant that no one country could argue for their own measure, transcending the politics of nations. In 1792, two explorers, Pierre Méchain and Jean Baptiste-Delambre, were commissioned to measure this distance, the quarter circumference of the Earth. They did it by measuring the distance between Dunkirk and Barcelona and extrapolating their results. It took them over six years, and in 1798 the metre was defined.

On 22 June 1799, two platinum standards, one for the kilogram and one for the metre, were deposited at the Archives de la République in Paris, marking the first step in the development of the present International System of Units.

In 1869, Napoleon III approved the creation of an international scientific commission to propagate the new metric measurement to facilitate trade and the comparison of measurement between states. Later that year, the French Government invited countries to join the commission. The first meeting of the newly-formed International Metre Commission took place in 1870.

In 1889, the delegates of the first General Conference on Weights and Measures sanctioned new international prototypes of the metre and kilogram, the same kilogram that remains today.

Using physical artefacts as measurement standards has its limitations; not least being that a physical artefact could be lost or damaged, the process of disseminating the same measurement throughout the world when you only have one original is also a logistical challenge.

The next big leap in measurement was triggered by the Cold War. The platinum metre rule enabled us to measure with an accuracy of one ten-millionth of a metre. But with the dawn of the space age, an error of this magnitude could mean missing the Moon. We needed to be able to measure with greater accuracy and precision.

It was Scottish scientist, James Clerk Maxwell, who first suggested that measurement standards should be tied to fundamental and unchanging laws of nature. In 1870, in a speech at the annual meeting of British Association for the Advancement of Science, Maxwell said:

*"If, then, we wish to obtain standards of length, time, and mass which shall be absolutely permanent, we must seek them*

*not in the dimensions, or the motion, or the mass of our planet, but in the wave-length, the period of vibration, and the absolute mass of these imperishable and unalterable and perfectly similar molecules."*

However, it wasn't until decades later that the science community pursued Maxwell's ideas.

Not long after the introduction of the international prototypes of the metre and kilogram, American physicist Albert Michelson proposed to use optical interferometers to measure the metre and define it in terms of wavelengths of light. An interferometer works by splitting and then recombining light to form a unique pattern called 'interference' which can be used to count wavelengths

of light. Therefore, a certain number of wavelengths of a particular light source could equal a metre.

On 14 October 1960 at a meeting in Versailles, the metre was redefined in terms of the number of wavelengths of light emitted from a krypton-86 lamp. It was at this same meeting that the International System of Units (SI) was adopted. The platinum-iridium bar that had been the

metre since 1889 was finally retired.

From 1960 to the present day, numerous changes to the SI have been made. The metre, the second and the candela (the unit for luminous intensity) have all been redefined in terms of physical constants of nature... Last month it was the turn of the remaining four SI units.

## THE REDEFINITION: THE SCIENTIFIC IMPACT



Dr JT Janssen, Director of Research at NPL

On 16 November 2018, at the 26th meeting of the *General Conference on Weights and Measures* (CGPM), Member States of the *International Bureau of Weights and Measures* (BIPM) voted to redefine four of the seven base units of the SI. This change has been eagerly awaited by the entire international metrology community and represents one of the most significant changes to the SI since its creation. Now all of the seven standard units of measurement are defined in terms of natural constants, guaranteeing their stability and universality. Making this revision across the whole SI is a profound change in approach, that will underlie all measurements in science and more widely. It marks the end of the link between the SI and artefacts, and the retirement of

the International Prototype of the Kilogram.

The new definitions will come into effect next year on World Metrology Day which takes place on 20 May 2019, 144 years after the Metre Convention was signed.

### WHAT ARE THE CHANGES?

The SI covers units for every type of measurement, but at the centre of the SI is a set of seven units known as the 'base units'. They are the kilogram (for mass), the metre (for length), the second (for time), the



ampere (for electric current), the kelvin (for thermodynamic temperature), the mole (for amount of substance) and the candela (for luminous intensity).

The seven base units have been chosen so that combinations of these can be used to express all other measurement units, known as

'derived units'. For example, the unit of force, the newton (N), is formed from base units with dimensions of mass, length and time: kilogram  $\times$  metre per second squared ( $\text{kg}\cdot\text{m}/\text{s}^2$ ).

The actual changes will impact four of the base units: the kilogram, ampere, kelvin and mole.

- The kilogram – will be defined in terms of the **Planck constant**
- The ampere – will be defined in terms of the **elementary charge**
- The kelvin – will be defined in terms of the **Boltzmann constant**
- The mole – will be defined in terms of the **Avogadro number**

### WHAT WILL THE CHANGES MEAN?

Redefining four of the standard units of measurement at one time is unprecedented! Although this is the biggest shake-up in measurement since the Metric System was introduced, beyond the world of metrology, it will largely go unnoticed. So what's the point?

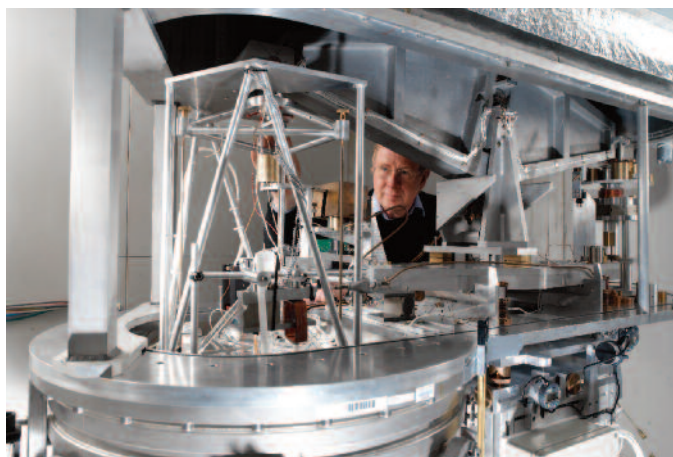
The redefinition of units is like replacing the weak foundations of a house with new foundations that are exactly the same size, but stronger. The difference isn't visible on the

surface, but substantial changes have been made to underpin the structure for the long term. Similarly, the changes in the SI will ensure that the SI definitions remain robust for the future, ready for advancements in science and technology.

Over the course of history, as our technological knowledge and demands have progressed, the definition of many of the units has changed. So don't panic – water is still going to boil at 100°C; you won't need to change the time on your watch; and (unfortunately) we're not suddenly going to lose weight! These changes will be used by scientists and engineers who are making measurements at the extremes, but in everyday life it will appear that not much has changed.

### THE KILOGRAM

The key change about the redefinition of the kilogram is that it will be possible to realise the kilogram at any place or time and by anyone. A number of approaches have been developed to respond to the challenge of redefining the kilogram. The Kibble balance method, which was invented at NPL, has become the favourite and has been pursued by laboratories in France, Canada and the USA.



Dr Ian Robinson working with the Kibble balance Mark II in vacuum in 2005 at NPL.

The Kibble balance method, named after the late scientist Dr Bryan Kibble who worked at NPL, operates by using a balance and a strong permanent magnet to compare mechanical and electrical power. Effectively, the experiment compares a force generated by the current in a coil sitting in a magnetic field with the weight of a mass. At the moment, Kibble balances are very expensive, large and difficult to operate. NPL is developing new 'mini' Kibble balances which will enable National Measurement Institutes across the world to realise the kilogram themselves.

At the moment, we can make the most accurate measurements at the kilogram scale, but we encounter larger uncertainties



NPL's 'mini' Kibble balance

when measuring smaller masses. Therefore, one of the industries where the redefinition will have a profound effect will be the pharmaceutical industry. NPL provides traceability for measurement of active components of drugs that can weigh from less than a millionth of a kilogram. Minimising the uncertainty in dosages of medication is crucial for patients.

#### THE AMPERE

The new definition of the ampere will significantly improve the accuracy with which electrical measurements can be made and it will open up multiple options for measurement laboratories to realise this unit of measurement.

The new ampere definition exploits the fact that electric current is made up of a flow of billions of identical charged particles called 'electrons'. We can create a standard ampere by using special nano scale electric circuits that control the flow of individual electrons.

Controlling the flow of single electrons could be key to developing certain kinds of quantum computers. **This next generation of technology will produce computers capable of calculations that are vastly beyond what is currently possible.**

#### THE KELVIN

The redefinition of the kelvin will lay the foundations for the development of novel and more accurate techniques for measuring temperature, especially when working in hostile environments with extremes of hot and cold temperatures.

Being able to measure temperature to a greater accuracy will provide new opportunities for innovation in areas such as advanced manufacturing and climate change. **The ability to identify and measure reliably very small changes across large time periods with greater accuracy will allow for more precise monitoring and better predictions for climate change.**

#### THE MOLE

The revised definition of the mole is simpler than the current definition, and it will help users of the SI to better understand the nature of the quantity 'amount of substance' and its unit, the mole. The new definition is based on a mole containing a fixed number of elementary entities, recognising the fact that atoms and molecules don't react together in terms of mass-based relationships, but instead in terms of amount of substance-based relationships. This fixed number is the numerical value of the Avogadro constant.

The new definition won't have an immediate effect on practical chemistry, but will pave the way for innovative new technologies to make increasingly more accurate chemical measurements. An example of where this matters is in air quality monitoring. **More accurate air quality measurements mean greater confidence in measured trends of pollutant concentrations in air.**

#### WHAT DOES THE FUTURE HOLD?

The new definitions of the SI base units are a major step to future proof the system so that we are ready for technological and scientific advancements ranging from 5G networks and quantum technologies, to innovations that we have not even dreamt up yet. These will all benefit from, and be accelerated by, this change in the SI. But this is not the end of the journey. We will always look to the future to see where improvements are needed and one such area will be in the measurement of time.

Metrology laboratories around the world are working on ever more precise atomic clocks and it could be that the definition of the second will change in the next decade. The current definition is based on a microwave transition in a Caesium atom. However, new optical transitions are being investigated which are much more precise and a new definition can be based on that in the future. This type of research involves intricate quantum effects which can be exploited for many more applications besides clocks. Examples are magnetometry, gravimetry, and quantum computing to name but a few. The revised SI will support the development of quantum technology – by establishing a new stable system of units, which itself is based on quantum phenomena, it will underpin advancements in quantum technologies, thus supporting the second quantum revolution.

# OVERSEAS DEVELOPMENT ASSISTANCE PROJECT DELIVERS HIGH TECH SKILLS IN AFRICA THROUGH RADIO ASTRONOMY



Professor Melvin Hoare, School of Physics and Astronomy, University of Leeds, principal investigator for the Development in Africa with Radio Astronomy project.

**The UK Government's Newton Fund and Global Challenges Research Fund are being used to train a first generation of Africans in the high tech skills associated with radio astronomy as the continent gears up to host the world's biggest radio telescope. Working closely with industrial partners in the space sector the Development in Africa with Radio Astronomy (DARA) project aims to help drive economic development in this new area.**

The Newton Fund uses the UK's Overseas Development Assistance budget to drive economic development in low and middle-income countries through scientific collaboration. Although most projects funded through this scheme concentrate on the traditional development priorities of health, food, energy, security, etc., one project is taking the novel approach of using astronomy to up-skill young people in Africa. Astronomy is one of those topics that stimulates the curiosity in many a young mind – the desire to find out answers to questions such as 'what is out there?', 'where do we come from?' and 'are we alone?'. The branch of astronomy that investigates the universe via radio waves also has many synergies with the techniques and technologies used in the space and communications sectors. Hence, there is an opportunity to use people's natural interest in astronomy to draw them in to a training programme that can equip them

well for the modern developed economy.

## THE DARA PROJECT

This is the premise behind the Development in Africa with Radio Astronomy (DARA) project. A bilateral Newton Fund project with South Africa it delivers training in radio astronomy to the citizens of eight African partner countries namely: Ghana, Kenya, Zambia, Namibia, Botswana, Madagascar, Mozambique and Mauritius. The DARA project has received about £4M to date of funding via the Science and Technology Facilities Council (STFC). The training is provided by a joint UK-South African team that includes staff from the universities of Leeds, Manchester, Oxford, Hertfordshire, Central Lancashire and Bristol. In South Africa, the lead partner is the South African Radio Astronomy Observatory (SARAO), with contributions from several South African universities as well. Academic and technical experts from these partners are carrying out a basic

training programme in radio astronomy that is delivered to ten trainees per year per country. The participants are selected to have a good degree in physics or related topic.

The programme is delivered over eight weeks of intensive contact time spread over the period of a year. Trainees first receive an introduction to astrophysics in their home countries. This is followed by practical training either at the Hartebeesthoek Radio Astronomy Observatory in South Africa, or at the newly commissioned 32 m radio telescope in Ghana (see Figure 1). Finally, the students undergo training in the data reduction techniques used in radio astronomy. This again is delivered in their home countries using clusters of computers provided by DARA and SARAO. The students are taught new computer skills by a team from the Centre for High Performance Computing in South Africa. For the students from Mozambique and



Figure 1: The newly commissioned 32 m radio telescope in Accra, Ghana. This forms the first element in the African VLBI Network.  
Credit: Andrews Dzodzomenyo

Madagascar English language training is also provided for the students ahead of the radio astronomy programme.

The basic training course puts those trainees who want to study radio astronomy further in a good position to apply for

Masters and PhD places overseas. The DARA project is funding several of these places at the UK partner universities, whilst others have won bursaries to study in South Africa. To counter any potential brain drain DARA PhD students are funded to return home each year and build links with key institutions so that they have jobs to return to. The scientific and technical collaborations that are building up between the UK, South Africa and the African partners will continue to help establish new research groups around the returning PhD students.

### WHY AFRICA?

Africa will host the mid-frequency part of the new global radio telescope project the Square Kilometre Array (SKA). The ultimate aim of the SKA is to build a network of about 2000 dishes each of 15 m diameter located all over sub-Saharan Africa. A dense core of dishes will be located in the Karoo Desert in South Africa's Northern Cape region. This was

selected as it is sparsely populated and surrounded by hills, which means it has very low levels of radio interference – the equivalent of light pollution for radio astronomy. An initial array of 64 dishes, in the form of the newly inaugurated MeerKAT array, has been built by South Africa. These will be joined by the first tranche of 133 SKA dishes by 2026. During the second phase it is planned to extend the network of dishes into the eight African partner countries where DARA is carrying out its training programme. Spreading the dishes out over thousands of kilometres is required to deliver the high spatial resolution, which when combined with the high sensitivity, will enable the ambitious science case of the SKA to be realised.

As a precursor to the full SKA, South Africa is constructing a more traditional network of individual radio telescopes in the eight African partner countries, in a project called the African Very-Long-Baseline-Interferometry



Figure 2: The May 2018 annual meeting of the DARA project that took place near Muldersdrift in South Africa. Credit: Patricia Grant

Network (AVN). These dishes will be linked together to provide very high spatial resolution radio images and will work together with similar arrays in Europe and Australia. The first of the AVN dishes was inaugurated last year in Ghana. This 32 m dish has been converted from a defunct telecommunications antenna by the South African SKA team.

## PARTNERSHIP WITH THE UK SPACE INDUSTRY

From the outset a key partner in the DARA project has been the UK SME Goonhilly Earth Station Ltd. (GES). They run a successful satellite communications business on the ex-British

Telecommunications site on The Lizard in Cornwall. The DARA team of UK universities was already working with GES to convert their old larger dishes into radio telescopes so there is synergy with what is happening in Ghana. The Goonhilly telescopes will to be used for hands-on student training and research as part of the e-MERLIN network of telescopes based at Jodrell Bank. Another of the large antennas at Goonhilly is being converted into the world's first private Deep Space Network dish.

During DARA's annual network meeting (Figure 2), business experts from GES, and our South African industrial partner, the South African National Space

Agency, are able to demonstrate to the trainees how the synergies between radio astronomy, space science and satellite communications can work to deliver jobs and wealth creation. Recently the current DARA Masters and PhD students gathered at Goonhilly so that they could see first hand how radio astronomy and the commercial satellite communications business can work hand-in-hand with each other (Figure 3). Many of the institutions developing around the AVN dishes have dual roles in both radio astronomy and space science applications.

With further funding from the UK's Global Challenges Research Fund, DARA is now funding small proposals drawn up by the African trainees to use radio astronomy for development and outreach. The outreach projects aim to encourage more school children in each of the African countries to consider studying STEM subjects to a higher level and hence equip more people with the kind of skills needed for the modern economy. The development projects encourage the DARA cohorts to think about how to use astronomy for economic and social development and are assisted by another of the DARA partners based in South Africa - the Office of Astronomy for Development run by the International Astronomical Union.

In the latest enhancement to DARA, an entrepreneur experienced in the space sector will provide business advice to any of the already 140 strong body of DARA trainees who seek to start their own business. A key aim of the DARA project is

that some of our trainees will apply their newly acquired experience and skills in research, computing, technology, digital signal processing, big data, etc. to developing high-tech industries thus fulfilling the criteria of the Overseas Development Assistance to help drive economic development in low and middle-income countries.



Figure 3: African students studying for a PhD or Masters in radio astronomy in the UK visiting Goonhilly Earth Station in Cornwall along with Prof Hoare and Ian Jones, CEO of GES Ltd. Credit: Toby Weller.

# AN IMMIGRATION SYSTEM FOR THE UK'S RESEARCH AND INNOVATION SYSTEM



Sergio Perez  
Director of the Science Policy  
Department of SRUK

Diego Sainz de la Maza  
Member of the Science Policy  
Department of SRUK

Javier Escudero  
President of SRUK

Rocío Gaudioso-Pedraza  
Vice-president of SRUK

## The Society of Spanish Researchers in the UK (SRUK)

Over two years have passed since the UK voted in the EU referendum and we do not stand in a much better-informed position now than we did in 2016. One of the biggest areas of concerns is the state of the freedom of movement that the EU has granted for the past decades to UK citizens to work in other countries of the EU and vice versa.

The uncertainty that the referendum unleashed over the post-Brexit immigration policy for EU workers has only intensified the closer we get to the exit date and is already affecting the attractiveness of the United Kingdom as a favourite destination to do science.

Currently, there are around 2.29 million EU workers in the UK<sup>1</sup>, and their importance in particular sectors of the British economy is unquestionable. One of these sectors is the Research and Development (R&D) UK sector. Nowadays, around 28% of academic staff in UK universities are non-UK nationals, and from them more than half (16% of the total) comes from the EU<sup>2</sup>. This figure increases to 22% in the most research intensive universities<sup>3</sup>. To these numbers, we need to add the number of PhD researchers, from which half of them come from outside the UK, with 14% of the total from the EU<sup>2</sup>. Little is known at the moment about what the future relationship between the UK and the EU will look like, so it is very difficult to predict whether the makeup of the research workforce will change, but here we show how without a clear immigration system the UK's attractiveness is being affected. The ability of the UK to keep

attracting the best and the brightest is dependent on a clear and straightforward immigration system, without which the UK might be on the path to lose its best researchers to other countries.

### HOW IS BREXIT PERCEIVED OUTSIDE THE UK?

At the Society of Spanish Researchers in the United Kingdom (SRUK, <http://sruk.org.uk/>) we have been monitoring the challenges and opportunities associated with Brexit and their impact on Spanish researchers, and hence other EU citizens, both in the United Kingdom and elsewhere. We have been particularly concerned about the effect of Brexit on the UK's reputation as a leading destination for international researchers. To investigate this, SRUK has run a large-scale international survey among Spanish researchers currently living outside the UK to understand their perceptions around Brexit<sup>4,5</sup>. The survey was responded by 284 participants, and it shows that Brexit has already affected the attractiveness of the UK as a destination for Spanish researchers. Specifically, over 75% of the respondents consider a post-Brexit UK less

attractive. Among the biggest concerns are international mobility, citizen rights and access to EU research funds.

Both mobility and access to funds are essential pieces of any R&D system, so to evaluate how important an easy immigration system and access to EU funds are for Spanish researchers, we asked them how attractive the United Kingdom would be after Brexit (compared to what their perspective was before the EU referendum) in four different scenarios, combining the possibilities of maintaining or not the access to Horizon Europe, as well as having or not an easy and straightforward immigration process for EU researchers and their families.

Although each and every one of these hypothetical situations result in a diminished attractiveness of the UK as a destination as a result of Brexit, the scenario where no access to Horizon Europe is kept and a hindered immigration process is implanted shows a remarkable detrimental effect on the attractiveness of the UK. Among the rest, a milder and expected outcome is observed if the UK maintains access to European funds and an easy immigration process is granted. Remarkably, the results show that less

respondents perceived as a negative scenario if the UK permits a straightforward immigration process and loses its access to Horizon Europe over the opposite possibility, suggesting that Spanish citizens value free movement of EU citizens more highly than the access to funds. We believe that an easy immigration system is essential to mitigate the negative perception of the UK in a post-Brexit scenario.

Besides, our results also point out that Brexit is regarded as a destabilizing process for the ongoing collaborations among different research groups and UK-based ones. Approximately half of our respondents that currently have British partners in their research consider that these collaborations will be affected. Remarkably, over 70% of the respondents consider that both collaborations and research visits will worsen after Brexit. Importantly, it is not all about the UK, our respondents also believe that the effect of Brexit within the EU R&D landscape will be negative, being the perception of the EU as an attractive destination and a reduction of excellent science the biggest areas of concern.

## OUR PRIORITIES FOR THE IMMIGRATION WHITE PAPER

Our surveys have helped us quantify the effect that Brexit is already having in the attractiveness of the UK's research and innovation system. The immigration white paper can contribute to reducing some of the uncertainty associated with Brexit if it proposes an easy and straightforward migration system for EU researchers and to sending a clear message to researchers both inside and outside the UK that is committed to remaining an attractive destination for skilled workers. Our survey shows that this is a clear priority for researchers over other elements

that are currently at stake in the Brexit negotiations. As a result, we believe that the first step to avoid a skills shortage after the exit date is to offer an appealing system to EU researchers and their dependants. A streamlined system that helps support research and innovation by supporting the people that make it possible is essential if the UK wishes to maintain its position as a global centre for excellent science and innovation and we urge the Government to consider this when designing

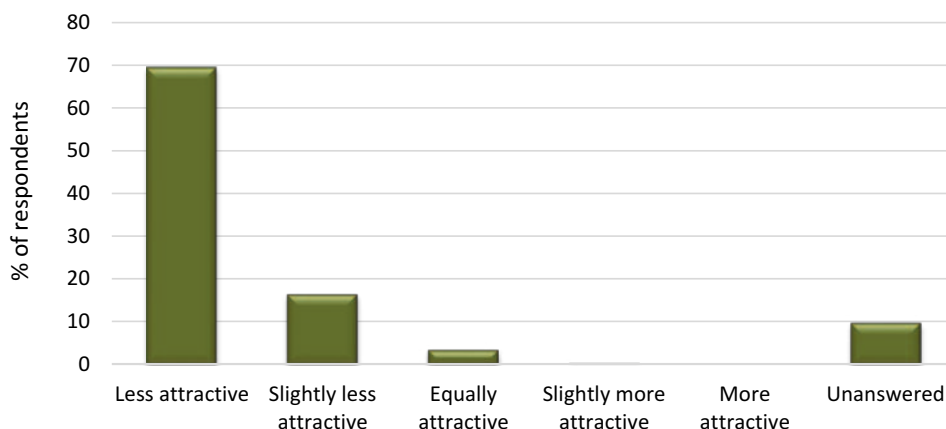
what a future immigration system should look like.

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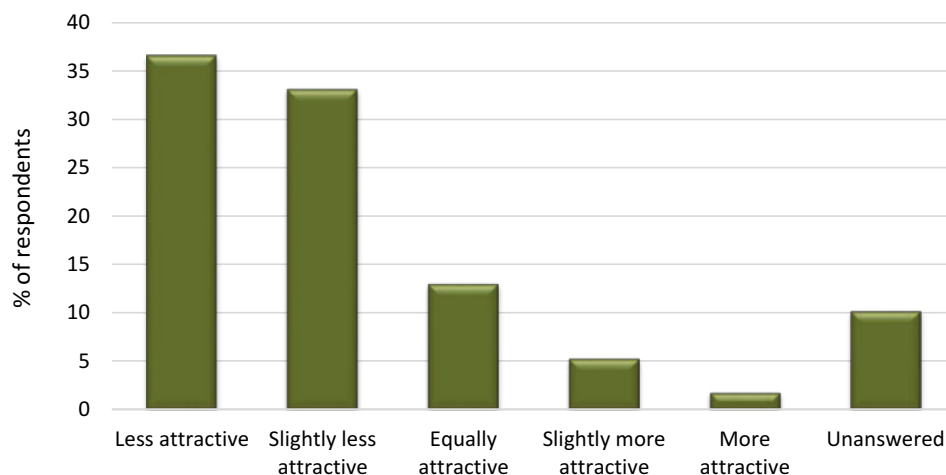
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### UK remains in Horizon Europe but the movement of EU workers and their families is hindered by bureaucratic means (need to apply for visa, lengthy process, etc.)



### UK does not have access to Horizon Europe but the movement of EU workers and their families is an easy and straightforward process



Results from the survey evaluating the importance of an immigration system over access to Horizon Europe funds. The survey was answered by 284 Spanish researchers living outside the UK. Full results in <sup>5</sup>

## Campaign for Science and Engineering (CaSE)



Naomi Weir  
Deputy Director, CaSE

**Immigration is a hot topic. And, to date, the immigration white paper has been a hot potato; passed from one Home Secretary and Immigration Minister to the next, leaked to the press before it was due last autumn, then via the Migration Advisory Committee and Number 10, and now expected later this year.**

In that time, the evidence base has developed. Some of this work was drawn together in recent Migration Advisory Committee reports, work by parliamentary committees, as well as from the sector, including CaSE. Our policy review sets out the types of people and types of movement essential for research and innovation and principles that should be central to any new system if it's to support a thriving environment for science and engineering in the UK. So, there is no lack of evidence or creative proposals.

However, we've also seen political mixed-messages and lack of transparency. This was typified in the drama over the tier 2 cap in the first half of this year. Thankfully, the cap has rarely been met. However, in the first six months of this year it was exceeded each month resulting in over 14,000 eligible applications being refused by the Home Office. This meant that skilled individuals, meeting all visa requirements, who have been offered a job by a company willing to sponsor them after undertaking a recruitment process that included checking if any UK residents were suitable for the role, were simply turned away. Some might call them the brightest and best.

CaSE has long campaigned for this policy to be abolished. And when the refusals began in December 2017, CaSE worked with MPs to ask Parliamentary Questions to understand the scale of refusals by occupation.

Following rebuttal, we resorted to an FOI request. We were the first to obtain the data, publishing it and kick starting an outcry against the policy. After significant pressure from CaSE and others the policy was changed, removing doctors and nurses from counting towards the cap, leaving room for other skilled workers. The damage to the UK's reputation should not be underestimated. It affected companies' productivity and ability to deliver on projects and, perhaps even more severely, thousands of skilled workers around the world are evidence to suggest that the UK is unwelcoming to talent from overseas. It is difficult to believe the Government saying they will welcome the brightest and best in future when they're already turning them away in the thousands.

I raise this here for two reasons. First, it is an example of damaging, disproportionate policy. And second, it is a case study of lack of transparency from the Home Office which contributes to distrust of the Government on immigration. These factors shape my concerns about the forthcoming white paper. However, if appropriately addressed we might end up with some reasonable proposals and a viable future migration system that supports science and engineering, and indeed the UK. I'll take each in turn.

It would be naive to say that coming up with a new immigration system is politically

or practically straightforward. It will always be a balancing act. Which is why one of the key principles by which we think any migration system should be measured is whether it is proportionate. Are the rules proportionate to risk? Are the restrictions proportionate to national interest? Is the cost proportionate for individuals, employers and the UK public purse?

A real risk in the current political climate is that we will end up with a system that is overly restrictive as a reaction to free movement and to 'prove a point' to an important but small section of Parliament and the public. Along with many aspects of public discourse at present, the options are often presented as being one extreme or the other. That might work for headlines, but it does not work for prudent policy making. From the outset our members have been clear that extending the current non-EEA migration system to encompass all migration would introduce substantial barriers to research and innovation. There are many other creative options that could meet some of the stated objectives of the Government and address some of the concerns raised by some of the public, while also taking into account the nuance in public opinion, the real impact choices on immigration will have on the economy, on businesses, on communities, on individuals and families, and on research and innovation too.

With the Prime Minister affirming that the UK will have a single migration system in future we want to ensure that the starting point for that new single system isn't the current non-EEA system. Instead, the Home Office should explore what building a system using the new, digital, EEA settlement scheme as a starting point could look like. Such a system could be first introduced to EEA migrants, and then, once the system is proven, rolled out with trade partners, Commonwealth countries and to all resulting in a single system that is fit for the future.

Now is a unique moment when we can test a new system without reducing security or increasing risk. Introducing a new, forward looking, light touch system that capitalises on capabilities afforded by new technology, would only be

increasing control and security compared to our current state of free movement. Further, the potential gains of showing political leadership and introducing such a new system could result in a system that costs less to run, improves control of our borders, is an attractive feature for doing business in the UK, and restores confidence in the UK as an outward looking nation.

It will not be a people pleasing White Paper. Its unlikely that anyone will be 100 per cent happy. But that should not be the objective of a future immigration system. There are difficult decisions to be made. But they must be made in light of evidence, including evidence on the nuance of public opinion, and must result in a proportionate new system.

Secondly, and more briefly, on transparency. In the past we have worked well with the Home Office, seeing productive policy change as a result. But in recent years we've seen a change tone. For instance, in 2015 the tier 2 cap was reached, the Home Office provided the refusal figures by standard occupational code when requested in response to a Parliamentary Question. Since December 2017, similar questions were given unsatisfactory answers. Even following a letter from the Chair of the Parliamentary Procedures Committee, the Home Office continued to refuse to provide Parliament with the figures when asked, hence we resorted to an FOI. It is concerning that the Government were reluctant to release this data, and that they would provide data through an

FOI that they were not willing to provide to Parliament.

Transparency is essential for accountability to the public and to Parliament. And to have any hope of informed debate and policies we need appropriate access to this kind of information. The lack of transparency must be addressed both to support the vital activity of Parliamentary scrutiny in the lead up to and during the passage of the White Paper, and if the resulting system is to support consensus building across fractured groups and attract support from the public and employers alike.

It has been a long time coming but, with so much at stake, I truly hope that the forthcoming White Paper on immigration will have been worth the wait.

## Rt Hon Norman Lamb MP, Chair, Science and Technology Committee.



Rt Hon Norman Lamb MP  
Chair, Science and Technology  
Committee.

Science in the 21st century is an unmistakably global endeavour. Universities UK report that, in 2012, 46% of UK research publications involved an international collaboration; a growth of 29.5% since 2003. In February, Sir Venki Ramakrishnan spoke eloquently at our summit on *Brexit, Science and Innovation* about why collaboration and mobility are so crucial to scientific progress: “when you have mobility”, he explained, “you have a much more rapid exchange of ideas and expertise. That allows you to remain at the cutting edge of, essentially, any science or technology”.

One of the UK's great strengths is its prime position at the cutting edge of scientific research; we are a science superpower with an illustrious history of ground-breaking scientific discoveries and an outstanding reputation for excellence and international collaboration. As we prepare to leave the European Union, we must ensure that international scientific collaborations, between the UK and the rest of the world, continue apace.

Disappointingly, there's still

little clarity on what a new immigration system for skilled EEA nationals will look like after the planned transition period. This uncertainty makes for a fundamentally unnerving time for EU researchers working, or considering working, in and with the UK. It also puts our scientific status and reputation at risk. The Science and Technology Committee, which I chair, has repeatedly voiced its concerns that curbing the movement of scientists, including researchers, students, technicians and laboratory assistants, into and

out of the UK, would harm one of this country's key strengths.

The Prime Minister has committed to ensuring the UK remains “open to the brightest and the best researchers to come and make their valued contribution.” While this is a welcome sentiment, it has yet to be translated into concrete action. I was disappointed that my Committee's call for an early UK-EU Science and Innovation Pact – one that built in the immigration arrangements needed to uphold the success

of our science community – was rejected by the Government.

Rather than simply wait for the forthcoming Immigration Bill, the Committee took the proactive step of deciding to develop our own immigration proposals and launched an inquiry into “an immigration system that works for science and innovation” in May. To produce a workable proposal, it was vital that we listened, and responded, to the concerns of the science community.

We therefore expanded the traditional inquiry format in two ways: in a Parliamentary first, we opened up the second half of our oral evidence session on the 19 June to contributions from the public gallery and via Twitter. After the evidence session, we also held a half-day workshop with stakeholders to gather their input and advice, all of which helped us refine our immigration proposals.

Throughout our inquiry, we received evidence on how the current non-EEA immigration system could be modified and improved, as well as proposals for inclusion in a brand-new immigration policy. A significant proportion of our subsequent Report highlights steps that the

Government could take now, unilaterally, while the Brexit negotiations are ongoing, to amend and enhance the current non-EEA immigration system. We believe this would give the science and innovation community confidence that the Government recognises, and is addressing, the limitations of the non-EEA immigration system for facilitating mobility and collaboration.

#### **Specifically, we called on the Government to:**

- revise, and clarify, the eligibility criteria further for the Tier 1 (Exceptional Talent) visa so that the pool of potential applicants is increased;
- re-instate the Tier 1 (Post-study work) visa route for graduates with a recognised degree from a UK higher education institution;
- remove the cap on Tier 2 (General) visas, reduce the cost of applying for a visa and review the operation of the shortage occupation list; and
- establish a “research activity” exemption for those wishing to apply for indefinite leave to remain in the UK but who need to spend more than



Panel at the PSC meeting on Immigration

180 days in any 12 months overseas for research purposes.

In the latter part of the Report, we presented our proposal for a new immigration system, initially focused on EEA nationals, that works for science and innovation.

#### **For temporary migration to the UK, we proposed:**

- Visa-free travel and permit-free work in the UK for up to 180 days for skilled workers. Eligibility would be verified at the border with proof of intent to leave within the 180-day period, and with a letter from the employer describing the nature of the skilled work.

#### **For longer-term migration to the UK, we outlined:**

- A five-year skilled work permit for those with either: an offer of employment, with minimum salary rates based on the ‘going rate’ for the job, reflecting regional and public/private sector differences in salary or; third party sponsorship (eg from a funding body).

The proposals represent an approach that we believe would deliver a stable, sustainable and enforceable immigration system; one that would be robust against abuse and avoid displacement and undercutting of the local labour market.

The conclusions drawn in the Migration Advisory Committee’s reports on both international students and EEA migration did not predominately align with ours. Amongst other things, the MAC rejected reinstating the post-study work visa, despite acknowledging that UK “post-study work options are less generous than those offered by a number of competitors”.

I want to finish, however, on a more optimistic note. I am encouraged by the sheer amount of interest and work that’s currently being undertaken on this matter by the science community. This was certainly



PSC meeting on Immigration on 17 October – Attlee Suite

evident at the Parliamentary and Scientific Committee's meeting in October.

While I was disappointed by the Government Response to our report, it is important to recognise that it does not dismiss the Committee's recommendations out of hand.

Though the Response mostly reiterates the steps the Government has already taken, it does state that the Government will "carefully consider" our recommendations and that they will "help" the Government to "design an immigration system which

ensures [it] is able to attract the necessary skills and expertise needed in the UK". During our *Brexit, Science and Innovation* debate in September, the Science Minister also stressed that he "had discussions with the Home Secretary on how to support the movement of those

engaged in science and research". I know that my Committee, alongside the science community, will be watching to see if the Immigration Bill does deliver an immigration system that works for science and immigration.

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## Royal Society – Professor Richard Catlow FRS



Professor Richard Catlow FRS,  
Foreign Secretary, Royal Society

**"There are clear messages from across the research community about what we need from the immigration White Paper for science to thrive.** At the heart of this is a welcoming system which both attracts and values talent. It is time that we bust the myth that salary is a proxy for skill and bear this in mind as we discuss the architecture of our post Brexit immigration system.

If the UK decided to apply immigration charges to EU nationals, based on the current system, an EU academic with a partner and two children

entering the UK on a 3 year Tier 2 visa would have to pay upfront costs, equivalent to 14% of their annual salary. That can't be right and will most definitely serve as a deterrent. This White Paper is an opportunity not just to prepare the country for a post Brexit era, but to fix the broken elements of the system which currently affects individuals from outside the EU.

We must also ensure that this system values all of the individuals who make excellent science a possibility. Not just the research group leaders or university professors, but the

expert technicians, early career researchers and PhD students who make truly exceptional science a reality.

The government have set an ambition to become the most innovative country in the world. Our immigration system will be a vital component of this. Getting it right will not just bring benefits to UK science, it will benefit individuals across the length and breadth of the country who stand to benefit from the discoveries and breakthroughs a thriving research and innovation system can bring."

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## The Wellcome Trust – Dr Louise Wren



Dr Louise Wren

**As researchers work together to tackle the complex problems of our time – from climate change and epidemics to the growing burden of dementia – it is hard to see how any one individual, team or country could take on these challenges alone.**

Wellcome is an independent charitable foundation that exists to improve health for everyone by helping great ideas to thrive. We believe that bringing people together from diverse backgrounds, often across borders, leads to new ways of thinking, better solutions and faster progress towards achieving our mission. In fact, mobile researchers have around 40% higher citation rates in scientific journals, and collaborative publications

generally have more impact.

UK-EU partnerships are critical for science: over half of the UK's collaborative papers are with EU partners. This year, an international survey of researchers from 109 countries found that Europe is a particularly interconnected research area – 82% of European researchers had trained or worked in more than one country, mostly within Europe.

We're already hearing from scientists that Brexit is affecting their work, their ability to take part in EU projects and their decision on whether to remain in the UK in the future. Last month, the Francis Crick Institute, the UK's biggest biomedical research lab, warned

that 97% of their scientists believe that a hard Brexit would be bad for UK science.

After Brexit, there should be a reciprocal agreement between the UK and EU to support full researcher mobility, maintaining many of the benefits that freedom of movement has delivered for many years. Reciprocal arrangements should be implemented in the UK through a quick and easy system for EEA nationals. This could be delivered in several ways, such as a bespoke science work permit like France's Talent Passport, or broader provisions to support the mobility of skilled workers. Critically, it must support the research workforce at all levels and career stages, from technician, to PhD student to

eminent professor, as well as including provisions for families.

The current immigration system is costly, burdensome and relies too much on salary and qualification to evidence skill. Expanding this to EEA nationals will not deliver the researcher mobility we need to produce the best science. As an example, a five-year UK visa for a researcher with a partner and three children currently costs over £11,000, and this is expected to increase once the NHS surcharge doubles next

year. In comparison, fees for the same researcher and family obtaining a four-year French Talent Passport costs approximately £1,040.

If the UK wants to continue to tackle global challenges and make scientific discoveries that will improve all of our lives, it must be easier, not harder, for researchers to travel and collaborate across borders. Ensuring the UK is welcoming to international talent has always been, and will always be, critical to its scientific success.



## The Russell Group – Dr Hollie Chandler



Dr Hollie Chandler  
Senior Policy Analyst  
The Russell Group

**The Russell Group represents 24 research-intensive universities who between them generate around £86 Billion for the UK economy each year. International staff and student are integral to our universities. Together, they employ nearly 45,000 members of staff from outside the UK and host over 200,000 students of other nationalities.**

EU nationals alone make up 23% of all academics at our universities and 28% of those on research-only contracts. The Settlement Scheme is important because it provides guarantees for these staff and EU students to be able to stay in the UK post-Brexit if they so wish. But what about future staff and students?

The current immigration system is already bureaucratic and costly for applicants and organisations sponsoring migrants coming to the UK from outside of Europe, including businesses, schools, charities and universities. Simply adding EU migrants into the mix will only exacerbate this problem.

Talented Europeans wanting to come here will be expected to wade through off-putting red tape and may be tempted to head elsewhere, especially to other countries in the EU where freedom of movement rules will still apply.

Instead of imposing barriers, the UK's future immigration system needs to facilitate migration of academics, research technicians and students also. That's why, we want the Immigration White Paper to set out ambitious reform to ensure the UK has a simple, streamlined immigration system that is easy for applicants to navigate and also takes some of the administrative burden off of organisations sponsoring migrants.

One idea that we've proposed is for a new Skills Permit. Open to all sectors, serving business as much as education, the Permit would be available to EU students or workers qualified to degree level or above who have a place to study or a job offer in the UK. They would have the right to come to the UK for up

to five years and transition between jobs or from study to work.

Building on the IT infrastructure built for the Settlement Scheme, those individuals on the Skills Permit would have a personal online account to update their details and by linking this record to other Government data sources, the Home Office could verify this information. This would of course, require investment in Home Office systems, investment that is going to be crucial to manage the UK's exit from the EU and successfully implement new immigration arrangements.

A light touch permit for skilled EU nationals and students would allow us to test a new approach that could in time be rolled out to other nations through trade deals. And, importantly, in the immediate term it would help the UK remain an attractive destination to EU talent and enable the UK to grow its knowledge economy.

# ANNUAL LUNCH OF THE PARLIAMENTARY AND SCIENTIFIC COMMITTEE 20 NOVEMBER 2018

## Address by Sir Mark Walport, FRS, Hon FRSE, FMedSci Chief Executive, UK Research and Innovation

It is a pleasure to join you all today and to update you on some of the key developments within UKRI, but before doing so, let me put this in context.

We are facing huge global challenges including: climate change, antimicrobial resistance, feeding a growing population, and increasingly scarce resources. These all pose a series of huge research and innovation questions. The major asset this country can provide in dealing with them is our people, because we are not over-endowed with natural resources. We really need research and the innovation that follows from it as a key part of the future of the United Kingdom.

2108 is an important anniversary year. It is, of course, the centenary anniversary of the end of the First World War. It is also the anniversary of an important report about the

machinery of government by Viscount Haldane. He laid out a framework for how research funding should work through two streams of funding. One through Government Departments to tackle the research and policy issues of these Departments, and the second directed to more general research questions. It is for the latter that he set out what has been interpreted as the 'Haldane Principle' - that is, when it came to choosing whether to fund researcher A or researcher B those decisions should be left to experts, and I don't think there is any argument about that. Importantly he also added that those who were tackling general research questions should talk to government Departments to find out what were the research questions that were troubling them.

Coming forward to 2015, which saw the genesis of UKRI in the report by Sir Paul Nurse, who picked up on these comments and said it would be important for this new organisation to consult very widely. This is one of the imperatives of UKRI, given the very complex pathways for research and innovation, and we are strongly committed to engaging effectively with academics, with business and with policy makers. This is sometimes framed as battles between 'top down' or 'bottom up', but the reality, whether you are seeking to sequence the human genome or find a new clean energy solution, is you have to talk to people who have ideas. These get distilled and it is collaboration that delivers.

Key to this is framing the right questions. What defines a first-class researcher is framing a



Sir Mark Walport

question that is interesting, where they don't know what the answer is, but where there is the opportunity of generating knowledge that could be useful and benefit society in all sorts of interesting ways.

UKRI is still a young organisation, but since our formation on 1 April we have achieved a great deal. We have an excellent Board, led by Sir John Kingman, an outstanding group of talented Executive Chairs and strong Councils.

Our system of Research Councils is admired throughout the world. In bringing them



Sir Adrian Smith FRS and  
Sir Mark Walport



closer together with Innovate UK and Research England, our first challenge was to ensure we didn't break what works well. There was no question of putting all the organisations into a mixing bowl and taking a big blender to them, and indeed the Higher Education and Research Act 2017 that set up UKRI made sure that could not happen.

In 2017, the Government's Industrial Strategy was launched. I was pleased at this because research and innovation have to be at the heart of any successful Industrial Strategy. No one could have anticipated 20 or 30 years ago the extraordinary and pervasive effect of information technology which now enables us to do things that were simply not possible then.

The Government has signalled its intent to capitalise on our strengths and is committed to increasing economy-wide investment on R&D to 2.4% of GDP by 2027, and 3% in the longer term.

If we are going to tackle the productivity challenge, the unevenness of the economy and spread excellence across the UK, then we need innovation to transform existing sectors and create new ones.

One of the challenges facing UK is that 80% of the economy is now in the services sector which, historically, has not done research and development in the same way as say the aerospace or pharma sectors. But it is essential that research and innovation is done in the service sector. There is also now a blurring of



boundaries. For example, one doesn't just buy a jet engine now, one buys power by the hour.

The Industrial Strategy Challenge Fund was established to support mission-led innovation and develop innovative ideas to transform existing UK industries and create new ones.

Through ISCF we already have some good success stories. An early example is the Faraday battery challenge. We have the Faraday Institution chaired by Peter Littlewood. This is a new £80 million research institute to drive and accelerate application-inspired discovery research in developing battery technologies and its translation. It brings together expertise from universities and industry to support research, training, and

analysis into electrochemical energy storage science and technology. This will be essential if we are to move away from fossil fuel-based motor vehicles.

A key aspect is the ability to scale up production, where late stage R&D is also important, so it's not just the early R&D to develop new products that matters, but the whole cycle.

One sector that quickly got its act together was the Creative Industries. A Clusters Programme will establish strong and sustained connections between the UK research base and the creative industries to provide a pipeline of collaborative R&D investment and activity. Clusters based across the UK - Bristol, Leeds, London, the South East, York, Cardiff, Belfast, Dundee and





Edinburgh – will address the challenges facing UK creative industries such as digital disruption, rapidly evolving business models, transformed user behaviour and expectations, and expanding global supply chains. We have also launched a new creative industries centre based at Royal Holloway to develop cutting-edge creative training and research programmes in immersive storytelling, to ensure the UK creative workforce is the most skilled in the world in the use of virtual, augmented and mixed reality technologies.

In my own area of medicine, there are very exciting developments. The Data to early Diagnosis Challenge, delivered by Innovate UK, will maximise the UK's potential to



diagnose diseases earlier and identify the best interventions for patients, as well as developing new treatments. A focus on digital pathology, radiology and diagnostics will advance the digitisation of diagnosis, increase the efficiency and quality of the review process and get new precision treatments to patients earlier. Five centres of excellence have been announced to support this work in London, Glasgow, Oxford, Leeds and Coventry.

Quantum technologies was singled out in the recent budget, with up to £70 million from the Industrial Strategy Challenge Fund, and £35 million to support a new national quantum computing centre.

These technologies have the potential to develop new knowledge that will bring new approaches to tackling global problems such as disease and climate change.

We also need to have robust monitoring and evaluation. It will be essential to evaluate the outputs, the outcomes and the impacts. It will be important to track all three, as impacts can take a long time to develop.

We aim to build excellence right across the UK. Evidence shows that regionally targeted R&D funding works best when it builds on established local excellence and capability, bringing together key local economic players such as universities, industry and local leadership.



Our £115m Strength in Places Fund was set up to support regionally-focused consortia to undertake R&D projects to drive significant local economic growth. We are in the final stages of agreeing the shortlist of projects and will be announcing this shortly.

Our Future Leaders Fellowship programme will develop, retain, and attract research and innovation talent in the UK. The second round of outline proposals is being considered, and the results of the first round will be announced early next year.

We have already started announcing the calls for our Strategic Priorities Fund awards. The first package has an environmental theme, focused on the UK's resilience to climate change, developing





digital environments, and promoting clean air to improve health outcomes.

But as well as focusing on regional development, we recognise that to retain its world-leading position, the UK needs to strengthen its partnerships with leading research and innovation nations.

Our £110m Fund for International Collaboration will invest in international infrastructure, and new joint research programmes enabled by government-to-government research pacts. Successful projects from the first round will be announced shortly.

But to be the outstanding organisation we set out to be and meet our objective to create the best environment for

research and innovation to flourish, we recognise that we need to enhance research culture as well as research funding. The culture within research and innovation is very important. There is a lot of focus on the culture within many organisations whether it be in business, the universities, the entertainment business, Houses of Parliament. It is an important issue for UKRI as well, because we want to enable everyone who has the interest and talent to contribute in all the various ways they can – that is a ‘systems engineering’ problem.

On the positive side of the balance sheet: we are a world leader in many areas of research, effective innovators and widely respected.



On the negative side, and in line with other global leaders in research and innovation, we have a hypercompetitive environment, as characterised in the excellent report on research culture led by Ottoline Leyser for the Nuffield Council on Bioethics.

Features of this include pressure to publish in “prestige” journals; rewards (such as promotion, prizes or academy fellowships) awarded on the basis of individual success rather than for teamwork (in stark contrast to the incentives and rewards for team work in industry); pressure to publish new and exciting ideas or findings at the expense of the overall state of knowledge and uncertainty, and an insufficient focus on diversity and the full breadth of talent.

Furthermore, there is too much bad behaviour across the sector: the publication of non-reproducible findings caused all too often by underpowered studies and data dredging; a failure to share data; bullying and harassment; and inadequate mentoring and career support caused by a narrow view of what constitutes success.

All of these are interrelated and we will need a “systems engineering approach” to tackle them, with respect to our own approaches to funding, to the researchers and innovators we employ directly and to our own staff generally.

So what are we doing about this? On equality, diversity and inclusion (EDI) – Jennifer Rubin, Executive Chair of ESRC, is leading and championing





work across UKRI. We have also appointed by open competition an independent, expert External Advisory Group for EDI, following an open call.

On diversity, we start with an abundance of evidence that the research and innovation community does not mirror the diversity in society at large at entry to university, and that this divergence increases at each stage of research and innovation careers.

Our Board is actively engaged in this challenge. It has agreed that we will commission two evidence reviews that will shed light on the nature and scale of EDI challenges across the research and innovation communities in the UK and internationally. These will also uncover the interventions and practices which have been

shown to be effective, and those that have not.

Similarly, we recognise that bullying and harassment is an acute problem in the sector, and one that we must address. The UKRI Board members have agreed to commission an evidence review to inform our approach to the prevention and handling of cases of bullying and harassment.

We have a range of options available to deal with bullying in the research community. These include collaborating with other funders and stakeholders to highlight and share best practice.

Equally it is important to ensure that the organisations that we fund (who are the employers of researchers and innovators), advocate and



communicate the right policies, and implement the processes and training in place.

We are most likely to succeed if we work closely with all of you and are open to new ideas. Our job is to catalyse new ideas, not simply to wait, but to help the research and

innovation community wherever possible.

I'm delighted to be here with all of you, many of whom I've worked with over a long period. It is in all our interests to ensure UK Research and Innovation is an enormous success.





# HOUSE OF COMMONS LIBRARY

The Science and Environment Section (SES) is one of eight teams in the Research Service in the House of Commons Library. 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. We also produce a series of briefing papers on topical issues, published on the internet and available in hard copy around the Parliamentary Estate.

The Library continues to produce material around the debate on Brexit. For example we have produced briefings on What if there's no Brexit deal?

We have also published, and continue to update, briefings on issues such as

- **New Nuclear Power**

Published Thursday, November 8, 2018

This summarises current progress on nuclear power, including conventional reactors, advanced designs, waste disposal and nuclear research.

- **Shale gas and fracking**

Published Tuesday, November 6, 2018

This provides an overview of hydraulic fracturing (fracking) for shale in the UK, including the UK Government support and proposals, opposition in the devolved Administrations, the regulatory regime (petroleum exploration and development licences, environmental, planning, health and safety), and wider potential implications of fracking on communities and mitigation of these.

- **Brexit: energy and climate change**

Published Thursday, September 6, 2018

This discusses key energy and climate change policy in the UK, the status of related Brexit negotiations and the possible impact of Brexit on these policy areas, including in relation to a no deal scenario.

- **Full-fibre networks in the UK**

Published Monday, September 3, 2018

This reviews the Government's policy for building a UK-wide full-fibre broadband network by 2033. It covers what is full-fibre broadband compared to superfast broadband and the Government's strategy for promoting full-fibre set out in its Future Telecoms Infrastructure Review (FTIR), published in July 2018.

- **Automated and Electric Vehicles Act 2018**

Published Wednesday, August 15, 2018

This paper explains the policy background to and contents and purpose of the Automated and Electric Vehicles Act 2018.

- **Distributed Ledger Technology**

- **In Vitro Fertilisation: 40th Anniversary**

- **NHS and Healthcare Data**

- **Security of UK Telecommunications**

- **Animal Sentience and Brexit**

- **Leaving the EU: Antimicrobial Resistance**

- **Antimicrobial Resistance and Immunisation**

- **Small Modular Nuclear Reactors**

- **Biometric Technologies**

We would be pleased to hear from anyone who wants to know more about how the Library works or how we can help with Parliamentary duties. Please contact Ed Potton ([pottone@parliament.uk](mailto:pottone@parliament.uk)) in the first instance. If you want to keep up to date with what we are up to, you can follow us @CommonsLibrary or visit [www.commonslibrary.parliament.uk](http://www.commonslibrary.parliament.uk).



## PARLIAMENTARY OFFICE OF SCIENCE AND TECHNOLOGY (POST)

POST is Parliament's in-house source of independent, balanced and accessible analysis of public policy issues related to science and technology. It is an office of both Houses of Parliament, overseen by a Board of MPs, Peers and external experts.

POST delivers a number of key services for Parliament:

### ADVICE

POST provides advice on research evidence relating to public policy issues.

### ANALYSIS

POST provides impartial summaries of academic and other rigorous research, placing findings in a policy context for parliamentary use.

These often take the form of POSTnotes, which are submitted to peer review from academia, industry, government and the third sector.

### BUILDING CONNECTIONS

POST holds a number of events each year that connect parliamentarians to leading experts from the research community and other sectors. POST helps identify experts for Members, library research services and select committees, for example, upon starting a new inquiry.

### PROFESSIONAL DEVELOPMENT

POST works with people in Parliament who want to develop their skills in using research evidence, and with members of the research

community who are keen to learn more about policy in general, and Parliament in particular.

## FELLOWSHIPS

POST manages a Fellowship Programme for PhD students and academics at any stage post-PhD, in collaboration with research funders and professional societies. These schemes bring researchers into Parliament to support and learn about the activities of POST, the committee offices and the libraries.

**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 so far in 2018 are:

589 - Trends in Agriculture

588 - Reducing UK Use of Antibiotics in Animals

587 - Flexible Electricity Systems

586 - Shift Work, Sleep and Health

585 - Sleep and Health

584 - Security of UK Telecommunications

583 - Developing Non-Academic Skills

582 - Unpaid Care

581 - Antimicrobial Resistance and Immunisation

580 - Small Modular Nuclear Reactors

579 - Persistent Chemical Pollutants

578 - Biometric Technologies

577 - Age of Criminal Responsibility

576 - Relationships and Sex Education

575 - Fire Safety of Construction Products

574 - The Microbiome and Human Health

573 - Health in Private-Rented Housing

572 - UK Fisheries Management

571 - The Ageing Process and Health

570 - Parental Alcohol Misuse

569 - Overseas Electricity Interconnection

568 - Science Diplomacy

## PLANNED WORK

POST carries out horizon-scanning to anticipate issues of science and technology that are likely to impact on policy.

At Board meetings, POST advisers present a shortlist of topics for discussion. If you would like to contribute or find out more at this stage please email POST

### Biology and health

- Antibiotic use in animals and resistance in human pathogens
- Causes of obesity
- Climate change and vector-borne disease
- Industry influence on public health policy
- Outward medical tourism
- Researching gambling

### Energy and environment

- Adaptation and mitigation in agriculture
- Assessing and restoring soil microbiomes
- Carbon capture, utilisation and storage
- Climate change and fisheries
- Climate change and wildfire frequency
- Developments in wind power
- Environmental gain
- Environmental principles: what works
- Food waste
- Insect population decline
- Natural hazard risk assessment
- UK emissions and 1.5 degrees

### Physical sciences and ICT

- Chemical weapons
- Cyber Security of consumer products
- Key EU space programmes

### Social sciences

- Approaches to dealing with stalking and harassment
- Approaches to reducing violent crime, focusing on early interventions
- Behaviour change in health and social care
- Research glossary
- Robotics and social care

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# HOUSE OF COMMONS SELECT COMMITTEES

## Current work and Inquiries

### SCIENCE & TECHNOLOGY COMMITTEE

The Science and Technology Select Committee exists to ensure that Government policy and decision-making are based on good scientific and engineering advice and evidence.

The Science and Technology Select Committee is unusual amongst departmental select committees in that it scrutinises the Government Office for Science (GO-Science), which is a "semiautonomous organisation" based within the Department for Business, Energy and Industrial Strategy. GO-Science "supports the Government Chief Scientific Adviser and works to ensure that Government policy and decision-making is underpinned by robust scientific evidence". The committee therefore has a similarly broad remit and can examine the activities of departments where they have implications for, or made use of, science, engineering, technology and research.

Norman Lamb MP was elected as Chair of the Science and Technology Committee on 12 July 2017.

Contact: Science and Technology Committee House of Commons, London SW1A 0AA Telephone: 020 7219 2793 Fax: 020 7219 0896 Email: [scitechcom@parliament.uk](mailto:scitechcom@parliament.uk)

### RECENT INQUIRIES

#### • Flu vaccination programme

Inquiry announced 1 March 2018 into the planning for the flu vaccination programme how advice is formulated, and cost-effectiveness issues are addressed, the reasons for different types of vaccines for different groups of the population, the effectiveness and take-up of the vaccination programme, and any plans for adjustments for the next flu season in terms of the vaccines uses and groups targeted.

**Report published 16 October.**

*Government response awaited*

#### • E-cigarettes

Inquiry announced 25 October 2017 into the health impacts and role of e-cigarettes as a smoking cessation tool.

**Report published on 17 August 2018.** This attracted considerable media coverage.

A Commons Statement on the report by the Chair on 6 September clarified some of its recommendations, including those that had not been accurately reported in the media.

*Government response awaited*

#### • An immigration system that works for science and innovation

Inquiry announced on 16 May following disappointing Government response (published on 21 March) to the Select Committee's report on Brexit, Science and Innovation.

**Report published on 19 July.** This was favourably referred to during a Commons debate on 6 September on Brexit, Science and

Innovation.

*Government response published on 17 October.*

#### • Galileo

Inquiry announced 23 October 2017 into UK access to Galileo, the European global satellite-based navigation system, and the implications for UK defence and industry

**Inquiry concluded**

#### • Research integrity

Inquiry on fraud, misconduct and mistakes in research, and the publication of research announced 13 September 2017.

**Report published on 11 June 2018.**

*Government response published 13 September*

#### • Biometric Strategy and Forensic Services

Inquiry announced 01 February 2018 into the reasons for the delay in producing a Biometric Strategy, the use of facial imaging technology, and developments affecting the Forensic Services.

Report published on 25 May. The Home Office published its long-awaited Biometrics Strategy on 28 June. This was disappointing and described by the Select Committee Chair, Norman Lamb MP, as 'simply not good enough ... and does not do justice to the critical issues involved.'

*Government response published on 15 October*

#### • Algorithms in decision-making

Inquiry announced 14 September 2017 into the increasing use of algorithms in public and business decision making

**Report published on 23 May 2018**

*Government response published on 12 September 2018*

#### • Genomics and Gene editing in the NHS

Inquiry announced on 14 September 2017 into of the mainstreaming of genomic medicine in the NHS

**Report published on 17 April 2018**

*Government response published in July 2018.* This addresses each of the Committee's recommendations and outlines the UK Governments plans to work with partners and stakeholders to create an ambitious vision for genomic medicine.

### WORK IN PROGRESS

#### • Energy drinks

Inquiry announced 8 March 2018 on the consumption of energy drinks. A study conducted by the Centre for Translational Research in Public Health has found that young people in the UK consume more energy drinks than those in other European countries, with consumption in the UK increasing by 185% between 2006 and 2015. A report by the European Food Safety Authority found that 68% of those aged 10-18, and 18% of those aged 3-10, were consumers of energy drinks.

*Report in preparation*

## • Digital Government

Inquiry announced 25 July 2018 into the progress of introducing Government digital services and how well protected these are from cyber attack.

The Government published its 'Digital Transformation Strategy' in February 2017, focusing on how digital technology can improve and redesign services as well as the internal workings of departments.

A June 2017 Report from the Institute for Government, Improving the management of digital government, stated that "the spread of new digital services for the public has been slower than planned" and that a cyber-attack that hit the NHS showed "the fragility of some of the systems being used in the public sector".

In March 2018, the Prime Minister announced that the data policy and governance functions of the Government Digital Service (GDS) would transfer from the Cabinet Office to the Department for Digital, Culture, Media and Sport (DCMS), effective from 1 April.

Oral evidence taking sessions in progress

## • Technologies for meeting Clean Growth emissions reduction targets

*Inquiry announced 23 October 2017*

The Government published its 'Clean Growth Strategy' in October 2017, setting out how it intended to meet the 'carbon budget' emissions reduction targets under the Climate Change Act. The Strategy lists four areas where progress is planned:

- 'Improving Our Homes';
- 'Accelerating the Shift to Low Carbon Transport';
- 'Delivering Clean, Smart, Flexible Power'; and
- 'Enhancing the Benefits and Value of Our Natural Resources'.

The Strategy emphasised the role that innovation can play in meeting the targets, with £2.5bn allocated for 'low carbon innovation' between 2015 and 2021. It also stressed that as well as cutting emissions, such innovation can "create jobs and help companies grow".

A wide range of technologies are being developed with the hope of contributing to emissions reductions including – but not limited to – small modular reactors, nuclear fusion, hydrogen and fuel cells, smart grids, negative emissions technologies and innovative construction materials or methods.

*Closing date for written submissions was 26 October*

## • Balance and effectiveness of research and innovation spending

*Inquiry announced 20 July 2018* inquiry into the balance and effectiveness of research and innovation spending following publication in May of UKRI's Strategic Prospectus. This will consider

- The effectiveness of public spending on R&D, including through mechanisms such as the Industrial Strategy Challenge Fund;
- The rationale needed for deciding on the balance of public R&D funding between:
  - individual research disciplines, research councils and cross-disciplinary schemes;
  - the two research funding streams of the 'dual support' system;
  - research and innovation;
  - pure and applied research;

- block funding, responsive mode funding and directed funding for the Industrial Strategy;
- the 'golden triangle' of London, Oxford and Cambridge, and the rest of the UK; and
- global challenges and other strategic/national priorities.

- The effectiveness of and balance between the different available UKRI/Government levers for encouraging innovation, including: R&D tax credits, the Small Business Research Initiative (SBRI), Innovate UK loans and grants, measures proposed in the 'patient capital' review, and other initiatives.

- The most appropriate phasing of the increase in R&D spending by UKRI over the next few years, in order to meet the Government's 2.4%/3.0% of GDP targets, and what if any changes will be needed in the forthcoming 2019 Spending Review to deliver these targets.

- Assumptions about the public/private mix in delivering the 2.4%/3.0% of GDP targets, the extent past patterns will be replicated in future and the levers that can be used to increase private sector spend on R&D.

*Closing date for written submissions was 28 September 2018*

## • Evidence-based early-years intervention

*Inquiry announced 26 October 2017* on the health impacts of adverse childhood experiences and examine the strength of the evidence linking adverse childhood experiences with long-term negative outcomes, the evidence base for related interventions, whether evidence is being used effectively in policy-making, and the support and oversight for research into this area.

*Report in preparation.*

## • Impact of social media and screen-use on young people's health

*Inquiry announced 21 February 2018*

The Royal Society for Public Health's 2017 report '#StatusofMind' called for action to promote the positive aspects of social media for young people, whilst mitigating the potential negatives.

The Youth Select Committee's 2017 report 'A Body Confident Future' examined negative and positive impacts of social media on body image. One recent US study reported that the presence of smartphones damages cognitive capacity. On the other hand, another study found no link between children's use of various screens and any harm to their health.

*Oral evidence taking sessions in progress*

## • Quantum technologies

*Inquiry announced 08 February 2018*

Quantum technologies have been selected by the Government as one of fourteen 'core industrial challenges' to be tackled through its Industrial Strategy Challenge Fund. The Industrial Strategy itself announced that the quantum technology sector will be allocated £20m of 'pioneer funding' and be the subject of a minister-led review. This follows the establishment of the National Quantum Technologies Programme in 2013, and a Government Office for Science report on quantum technologies in 2016.

*Report in preparation.*

## BUSINESS, ENERGY AND INDUSTRIAL STRATEGY

This Select Committee is appointed by the House of Commons to examine the administration, expenditure and policy of the Department for Business, Energy and Industrial Strategy (BEIS) and its associated public bodies. The BEIS Committee is chaired by Rachel Reeves MP.

Contact: Business, Energy and Industrial Strategy Committee, House of Commons, London SW1A 0AA Telephone: 020 7219 5777  
Email: [beiscom@parliament.uk](mailto:beiscom@parliament.uk)

### CURRENT WORK

#### • Gas storage

*Inquiry announced 17 October 2018 into issues around UK gas security and storage*

*Oral evidence sessions taking place*

#### • Carbon Capture, Usage and Storage (CCS)

*Inquiry announced on 29 May 2018 into CCS and efforts to kickstart this technology in UK*

*Oral evidence sessions taking place.*

#### • Geological Disposal Infrastructure

*Inquiry announced on 25 May 2018 into draft guidelines on nuclear waste disposal planning applications*

*Deadline for written submissions has passed.*

#### • Clean Growth Strategy

*Inquiry announced on 27 November 2017 following publication of the UK Government's Clean Growth Strategy*

*Oral evidence concluded*

### RECENT WORK

#### • Electric vehicles: developing the market and infrastructure

*Inquiry announced 21 September 2017 into electric vehicles, the challenges they represent and actions needed to support development.*

*Report published 19 October*

#### • Brexit and the implications for UK business: Pharmaceuticals inquiry

*Inquiry announced 19 September 2017 examining the potential impact of Brexit on the UK's pharmaceutical industry*

*Report published 17 May*

*Government response published on 16 July*

### ENVIRONMENTAL AUDIT COMMITTEE

The remit of the Environmental Audit Select 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.

The Chair of the Environmental Audit Select Committee is Mary Creagh MP.

Contact: Environmental Audit Committee, House of Commons, London SW1A 0AA Telephone: 020 7219 5776  
Email: [eacom@parliament.uk](mailto:eacom@parliament.uk)

## REPORTS ISSUED

### • 25 Year Environment Plan

*Inquiry announced on 1 February into the Government's long-awaited 25-year plan for the Environment*

*Report published on 24 July*

*Government response awaited.*

### • UK progress on reducing F-gas emissions

*Inquiry announced on 13 October 2017 about UK progress on reducing fluorinated gas emissions.*

*Report issued on 25 April 2018.*

*Government response awaited.*

## WORK IN PROGRESS

### • Sustainable seas

*Inquiry announced into the future of the sea, protecting marine life from climate change, overfishing and pollution.*

*Oral evidence sessions have taken place*

### • The Changing Arctic

*Inquiry announced 7 March 2018 into the rapid changes in the Arctic*

*Deadline for written submissions has passed.*

### • Nitrates

*Inquiry announced on 8 December 2017 on the scale of nitrate pollution in the UK and the solutions the Government should implement*

*Report in preparation.*

### • The Future of Chemicals Regulation after the EU Referendum

*Inquiry announced 29 September 2017 on The Future of Chemicals Regulation after leaving the EU Referendum*

## HEALTH COMMITTEE

The Health Committee is appointed by the House of Commons to examine the policy, administration and expenditure of the Department of Health and its associated bodies. The Committee chooses its own subjects of inquiry.

Dr Sarah Wollaston has been re-elected as Chair of the Health Committee for the 2017 Parliament.

Contact: Health Committee, House of Commons, London SW1A 0AA Telephone: 020 7219 6182 Email: [healthcom@parliament.uk](mailto:healthcom@parliament.uk)

### CURRENT WORK

#### • Antimicrobial resistance

*Inquiry announced on 24 May into the significant and increasing threat to public health in the UK and globally from antimicrobial resistance*

*Report published on Monday 22 October 2018.*

*Awaiting Government Response.*

#### • Brexit – medicines, medical devices and substances of human origin inquiry

*Report published on Wednesday 21 March 2018.*

*Government Response published on Friday 6 July 2018.*



# HOUSE OF LORDS SELECT COMMITTEES

## SCIENCE AND TECHNOLOGY COMMITTEE

### REPORTS ISSUED

#### Life Sciences and the Industrial Strategy

Report published 26 April 2018. This raises serious concerns about the Government's commitment to delivering its Industrial strategy in relation to Life Sciences which has so far been "wholly inadequate" and recommends there should be sweeping simplification of its implementation arrangements.

Government Response published 27 June 2018.

*Debated 23 October 2018.*

#### Off-site manufacture for construction

Report published 19 July 2018. This states that the construction sector as it currently operates cannot meet the UK's need for housing and may struggle to meet the need for infrastructure. Given that the UK already lags behind other countries in construction productivity, and is facing a labour shortage, the Government and the construction sector must urgently find solutions.

Government Response published 9 October 2018. *Awaiting debate*

### WORK IN PROGRESS

#### Forensic science

Inquiry announced 23 July 2018 into what new research programmes are needed in forensic science; the level of understanding within the criminal justice system and what routes are available to improve understanding; the performance of the market for forensic services in the UK; and the detection, recovery, integrity, storage and interpretation of evidence from digital devices and networks.

*The deadline for written submissions has passed. Oral evidence sessions taking place.*

### ARTIFICIAL INTELLIGENCE COMMITTEE

#### AI in the UK: ready, willing and able?

Report published on 16 April 2018. This said 'The UK currently enjoys a position as one of the best countries in the world in which to develop artificial intelligence, but this should not be taken for granted. We recommend the creation of a growth fund for UK SMEs working with AI to help them scale their businesses; a PhD matching scheme with the costs shared between the private sector; and the standardisation of mechanisms for spinning out AI start-ups from the excellent research being done within UK universities. We also recognise the importance of overseas workers to the UK's AI success, and recommend an increase in visas for those with valuable skills in AI-related areas. We are also clear that the UK needs to look beyond the current data-intensive focus on deep learning, and ensure that investment is made in less researched areas of AI in order to maintain innovation.

Government Response published on 28 June 2018.

*Report debated Monday 19 November 2018*

## EU ENERGY AND ENVIRONMENT SUB-COMMITTEE

### Brexit: food security

Inquiry announced 07 February 2018 to explore what impact Brexit could have on the price and availability of food in the UK

Report published 10 May 2018. This found that even in the 'best case scenario', with no tariffs and few customs barriers, international rules would oblige the UK to conduct more customs and borders checks than is currently the case. If an agreement cannot be negotiated by the time the UK leaves the EU the increase in tariffs could lead to significant price rises for consumers, whilst the additional customs workload could choke the UK's ports and airports and significantly disrupt food deliveries.

Government response published 19 July 2018.

*Awaiting debate.*

### Office of Nuclear Regulation's Brexit preparedness

Inquiry announced 05 July 2018 into the Brexit preparedness of the Office of Nuclear Regulation

Oral evidence concluded. Ministerial correspondence on-going.

### Food safety risk management post-Brexit

Inquiry announced 04 July 2018 into food safety risk management post-Brexit

Oral evidence concluded. Ministerial correspondence on-going.

### REACH regulations

Inquiry announced 22 June 2018 into what Brexit means for REACH Regulations

Report published 7 November.

*Awaiting Government Response and debate.*

### Air quality

Inquiry announced 08 June 2018 into the implementation of the EU air quality directive

Oral evidence concluded. Response from Minister received 11 October 2018

### Brexit: plant and animal biosecurity

Inquiry announced 16 March 2018 into the impact of Brexit on the UK's biosecurity.

Report published on 24 October 2018.

*Awaiting Government response and debate.*

## UK Research and Innovation

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UK Research  
and Innovation



Arts & Humanities  
Research Council



Engineering and Physical Sciences  
Research Council



Economic & Social  
Research Council

Innovate UK



Research  
England



Bioscience for the future



Medical  
Research  
Council



Science & Technology  
Facilities Council



Natural Environment  
Research Council

Operating across the whole of the UK with a combined budget of more than £6 billion, UK Research and Innovation brings together the seven Research Councils, Innovate UK and Research England.

We are an independent organisation with a strong voice for research and innovation, both to government and internationally, we are supported and challenged by an independent chair and board. We are principally funded through the Science Budget by the Department for Business, Energy and Industrial Strategy (BEIS).

Our mission is to be a trusted partner and to ensure research and innovation continues to flourish in the UK. We will support and help connect the best researchers and innovators with customers, users and the public. We will invest every pound of taxpayers' money wisely in a way that maximises impact for citizens, in the UK and across the world.



Arts & Humanities  
Research Council

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AHRC funds world-class, independent researchers in a wide range of subjects. Their research provides social and cultural benefits and contributes to the economic success of the UK but also to the culture and welfare of societies around the globe.

## Biotechnology and Biological Sciences Research Council



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



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

EPSRC

Engineering and Physical Sciences  
Research Council

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EPSRC funds engineering and physical sciences research, covering fields from healthcare technologies to structural engineering, manufacturing to mathematics, advanced materials to chemistry.

Innovate UK

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Innovate UK works with people, companies and partner organisations to find and drive the science and technology innovations that will grow the UK economy. They drive growth by working with companies to de-risk, enable and support innovation.



Medical  
Research  
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MRC is at the forefront of scientific discovery to improve human health. Their 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



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NERC is the driving force of investment in environmental science. Their 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  
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Research England is a new council within UK Research and Innovation. Taking forward the England-only responsibilities of HEFCE in relation to research and knowledge exchange, Research England will create and sustain the conditions for a healthy and dynamic research and knowledge exchange system in English universities.



Science & Technology  
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STFC is a world-leading multi-disciplinary science organisation. Their research seeks to understand the Universe from the largest astronomical scales to the tiniest constituents of matter, yet 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



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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.

AMPS

The Association of  
Management and  
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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.



**BIOCHEMICAL  
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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.



**British  
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NATURAL ENVIRONMENT RESEARCH COUNCIL

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British Antarctic Survey (BAS), an institute of NERC, delivers and enables world-leading interdisciplinary research in the Polar Regions. Its skilled science and support staff based in Cambridge, Antarctica and the Arctic, work together to deliver research that uses the Polar Regions to advance our understanding of Earth as a sustainable planet. Through its extensive logistic capability and know-how BAS facilitates access for the British and international science community to the UK polar research operation. Numerous national and international collaborations, combined with an excellent infrastructure help sustain a world leading position for the UK in Antarctic affairs. For more information visit [@basnews](http://www.bas.ac.uk)



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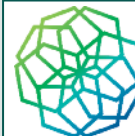
The British Ecological Society is an independent, authoritative learned society, and the voice of the UK's ecological community. Working with our members we gather and communicate the best available ecological evidence to inform decision making. We offer a source of unbiased, objective ecological knowledge,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



**BRITISH  
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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.



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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.



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The BSI is one of the oldest, largest and most active immunology societies in the world. We have over 5,000 members who work in all areas of immunology, including research and clinical practice.

The BSI runs major scientific meetings, education programmes and events for all ages. We disseminate top quality scientific research through our journals and meetings and we are committed to bringing the wonders and achievements of immunology to as many audiences as possible.



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The British Society of Soil Science (BSSS) or "BS cubed" as it is fondly known was founded in 1947 by a number of eminent British soil scientists. It was formed with the aims: to advance the study of soil; to be open to membership from all those with an interest in the study and uses of soil; and to issue an annual publication.

Nowadays BSSS is an established international membership organisation and charity committed to the study of soil in its widest aspects. The Society acts as a forum for the exchange of ideas and provides a framework for representing the views of soil scientists to other organisations and decision making bodies. It promotes research by organising several conferences each year and by the publication of its two scientific journals, the European Journal of Soil Science, and Soil Use and Management.



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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.



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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



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Ergonomics, also called Human Factors, sometimes abbreviated 'E/HF' is a science-based discipline about 'designing for people'. E/HF takes into account the physical and mental capabilities, aptitudes and abilities of people acting individually (a pilot, a surgeon or nurse, train driver) or collectively, with or without equipment (a theatre team, air traffic control) in the design of workplaces, equipment and ways of working to deliver the least harmful, safest, most efficient, most elegant possible outcomes'. E/HF uses science to improve the places in which we work, live and relax and the ways in which we interact with people, equipment and systems.



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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.



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**Science for Real- Science for  
Life-Science for Citizenship and Employability**

We build grass-roots partnerships between school and the wider world of professional science and engineering

- encountering science as a creative, questioning, collaborative human activity
- bringing school science added meaning and motivation, from primary to post-16
- locally, nationally, internationally (our UK-Japan Young Scientist Workshop Programme in since 2001)

Clifton Scientific Trust Ltd is registered charity 1086933



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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



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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. Our Fellowship programme, working in partnership with universities, research councils, 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 scientific credentials, update skills and redevelop confidence, in a suitably supportive environment.



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The Energy Institute (EI) is the chartered professional membership body bringing global energy expertise together. 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 250 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.



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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.



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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.



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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.



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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.



*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.



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**Advancing knowledge and setting standards in biomedical science**

With over 20,000 members in over 30 countries, the Institute of Biomedical Science is the leading professional body for biomedical scientists, support staff and students.

For over 100 years we have been dedicated to the promotion, development and delivery of excellence in biomedical science within all aspects of healthcare, and providing the highest standards of service to patients and the public. By supporting our members in their practice of biomedical science we set quality standards for the profession through: training, education, assessments, examinations and continuous professional development.



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IFST is the independent qualifying body for food professionals in Europe. Membership is drawn from all over the world from backgrounds including industry, universities, government, research and development and food law enforcement.

IFST's activities focus on disseminating knowledge relating to food science and technology and promoting its application. Another important element of our work is to promote and uphold standards amongst food professionals.



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IKE is the UK's professional body for innovators. It accredits and certifies 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.

## The Institute of Materials Finishing



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The Institute of Materials Finishing is the premier technical organisation representing industry, academia and individual professionals in both the UK's and global surface engineering and materials finishing sector.

We actively promote continual education and knowledge dissemination by providing both distance learning and tutored training courses, as well as a technical support service. We also provide bespoke courses that are tailored to an employer's specific needs. The Institute also publishes *Transactions of the Institute of Materials Finishing* and a bimonthly newsletter (*IMFormation*), as well as holding regular regional and international technical meetings, symposia and conferences.

## Institute of Measurement and Control



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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.

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The Institute of Physics is the professional body for physics in the UK and Ireland, inspiring people to develop their understanding and enjoyment of physics. We are a world-leading science publisher and proud to be a trusted voice for the physics community.

Our work includes supporting the teaching of physics, encouraging innovation in business and providing evidence-based advice to Government. Our members are from across the physics community – in academia, the classroom, and industry – and our reach extends to all who have an interest in physics and its contribution to our culture, society and economy.



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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.



## The Institution of Chemical Engineers

With over 44,000 members in 120 countries, ICChemE is the global membership organisation for chemical engineers. A not for profit organisation, we serve the public interest by building and sustaining an active professional community and promoting the development, understanding and application of chemical engineering worldwide.

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## Institution of Civil Engineers



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Established in 1818 and with over 86,000 members in 167 countries worldwide, ICE is a leading source of expertise in infrastructure and engineering policy and is widely seen as the independent voice of infrastructure. ICE provides advice to all political parties and works with industry to ensure that civil engineering and construction remain major contributors to the UK economy.



## 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.



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LGC is an international leader in the extended life sciences sector, providing reference materials, genomics reagents and instrumentation, as well as research and measurement services, to customers in the public and private sectors.

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 46 laboratories and centres across Europe and at sites in China, Brazil, India, South Africa and the US.



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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.



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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*



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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.



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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.



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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.



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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.



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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.



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.



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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.



The University of Nottingham

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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.



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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.



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Physiology is the science of how molecules, cells and organs work in the body. Representing over 3500 life scientists, The Physiological Society supports scientific research through its grants schemes, conferences and its three open access journals.

The Society also supports the teaching of physiology in schools and universities, and works to promote an understanding of physiology amongst policy-makers and the general public.



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Prospect is an independent, thriving and forward-looking trade union with 117,000 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.

QUADRAM  
INSTITUTE



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Opening fully in mid-2018, the Quadrant 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 Quadrant 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.



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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.



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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.

## 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.

## Royal Society of Biology

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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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SfAM is a UK organization, serving microbiologists internationally. It works to advance, for the benefit of the public, the science of microbiology in its application to the environment, human and animal health, agriculture, and industry. With Wiley-Blackwell, SfAM publishes five internationally acclaimed journals. Value for money and a modern, innovative and progressive outlook are its core principles. A friendly society, SfAM values integrity, honesty, and respect, and seeks to promote excellence and professionalism and to inspire young microbiologists.

## 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 of the UK's maritime engineering and business sector promoting and supporting companies which design, build, refit and modernise ships, and supply equipment and services for all types of commercial and naval ships, ports and terminals infrastructure, offshore oil and gas, maritime security and safety, marine science and technology, maritime autonomous systems and marine renewable energy.



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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.



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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



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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.



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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

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**Monday 21st January 2019**

**Evening Discussion Meeting and Dinner**

5.30pm – “E-Cigarettes”

**Monday 25th February 2019**

**Evening Discussion Meeting on Chemical and Biological Threats and Hazards, and Dinner.**

5.30pm – “What did we learn from Salisbury”

**Wednesday 13th March 2019**

**STEM for BRITAIN**

(All day event in Attlee Suite) – see notice on back page

**Evening Discussion Meeting with the Nutritional Society and Dinner**

**Monday 25th March**

5.30pm – “Nutritional Challenges for a growing and ageing population”

## ROYAL SOCIETY

Details of all events can be found on the events calendar at [events@royalsociety.org](mailto:events@royalsociety.org)

For scientific meetings queries:  
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## THE ROYAL INSTITUTION

Details of all events and booking information can be found at  
[www.rigb.org/whats-on](http://www.rigb.org/whats-on).

## ROYAL SOCIETY OF BIOLOGY

**11th March 2019**

The Inaugural Speaker’s lecture on science.  
(Details to follow)

**12th March 2019**

**Voice of the Future**

Details of all events can be found on  
[www.rsb.org.uk/events](http://www.rsb.org.uk/events)



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# PARLIAMENT SHOWCASES BRITAIN'S FUTURE

Scientists, Technologists, Engineers and Mathematicians

## STEM for BRITAIN

on

Wednesday 13 March 2019

Attlee Suite, Portcullis House

The annual poster competition and exhibition for early career researchers

[www.stemforbritain.org.uk](http://www.stemforbritain.org.uk)

