



Year in review

For the year ended 31 March 2017

THE
ROYAL
SOCIETY

Trustees

The Trustees of the Society are the members of its Council, who are elected by and from the Fellowship. Council is chaired by the President of the Society. During 2016/17, the members of Council were as follows:

President

Sir Venki Ramakrishnan

Treasurer

Professor Anthony Cheetham

Physical Secretary

Professor Alexander Halliday

Foreign Secretary

Professor Richard Catlow**

Sir Martyn Poliakoff*

Biological Secretary

Sir John Skehel

Members of Council

Professor Gillian Bates**

Professor Jean Beggs**

Professor Andrea Brand*

Sir Keith Burnett

Professor Eleanor Campbell**

Professor Michael Cates*

Professor George Efstathiou

Professor Brian Foster

Professor Russell Foster**

Professor Uta Frith

Professor Joanna Haigh

Dame Wendy Hall*

Dr Hermann Hauser

Professor Angela McLean*

Dame Georgina Mace*

Dame Bridget Ogilvie**

Dame Carol Robinson**

Dame Nancy Rothwell*

Professor Stephen Sparks

Professor Ian Stewart

Dame Janet Thornton

Professor Cheryl Tickle

Sir Richard Treisman

Professor Simon White

* Retired 30 November 2016

** Appointed 30 November 2016

Executive Director

Dr Julie Maxton

Registered address

6 – 9 Carlton House Terrace

London SW1Y 5AG

royalsociety.org

Registered Charity Number 207043

The Royal Society's Trustees' report and financial statements for the year ended 31 March 2017 can be found at:

royalsociety.org/about-us/funding-finances/financial-statements

Cover image

Dancing with stars by Imre Potyó,
Hungary, capturing the courtship dance
of the Danube mayfly (*Ephoron virgo*).

Contents

| | |
|---|-----------|
| President's foreword | 4 |
| Executive Director's report | 5 |
| Year in review | 6 |
| Promoting science and its benefits | 7 |
| Recognising excellence in science | 21 |
| Supporting outstanding science | 29 |
| Providing scientific advice for policy | 37 |
| Fostering international and global cooperation | 41 |
| Education and public engagement | 47 |
| Fundraising and development: support for the Royal Society | 55 |

President's foreword



V. Ramakrishnan

Venki Ramakrishnan,
President of the
Royal Society

This has been a year of major upheaval in the UK with our decision to leave the European Union. The Royal Society published a series of reports on the impact of the EU on UK science ahead of the referendum, and it is fair to say that for most scientists the evidence of benefit was quite clear. However, many factors influenced the vote and with the decision taken the onus has fallen on ensuring that UK science continues to flourish.

Within days of the vote I was speaking at an event in Parliament outlining the three key areas that needed to be addressed in the negotiations – mobility of and collaboration between scientists across borders; funding; and a regulatory environment that supports research and innovation. We continue to make that case and it is worth noting that Theresa May identified making the UK the best place for science and innovation as one of the Government's 12 priorities for Brexit.

Against the backdrop of Brexit the importance of science and innovation to the nation's general and economic welfare has risen high on the political agenda. The Royal Society has been working with others to make this case and in the Autumn Statement the Chancellor committed an additional £4.7 billion of investment in research over the next four years.

Science, research and innovation were also made the first pillar of the Government's Industrial Strategy green paper, published in January. Mirroring the views of the Royal Society, the green paper also highlighted the importance of skills and investment in infrastructure in delivering increasing productivity and driving growth across the country.

The year has also seen the passage of the Higher Education and Research Bill through Parliament. The Royal Society engaged constructively in scrutiny of these proposals to ensure that they were informed by evidence and did not jeopardise the many outstanding elements of the existing research system. I believe that the establishment of UK Research and Innovation will provide a strong and unified voice for science that can help tackle the considerable national and global challenges that lie ahead.

Tackling those challenges is what science is all about and, as the national academy of science in the UK, I am delighted that the contributions of our Fellows were recognised by the Nobel Prize committee. I want to offer my personal congratulations to Sir J Fraser Stoddart FRS who was awarded the Nobel Prize in Chemistry, and Professor Frederick Duncan M Haldane FRS and Professor David J Thouless FRS who were awarded the Nobel Prize for Physics.

Executive Director's report

It is important that scientists engage with different groups in society and with the public in general to find out about their experiences, listen to their views and to make science part of a wider conversation. This year has seen a step change in the way the Royal Society engages with the public in our policy work.

We launched our *GM plants: Questions and answers* project, where we commissioned Ipsos MORI to find out what people want to know about GM plants, and then drew on a panel of expert, independent scientists to respond. We also talked with the public about machine learning, through questionnaires and dialogue workshops, an online community and a series of sold-out public events. The results of this work, the first evidence about the UK public's views on machine learning, was published with our report *Machine learning: the power and promise of computers that learn* in April. The report probes important issues around machine learning and assesses the opportunities and challenges this technology presents. It was published at a critical time in the development and use of the technology, and the accompanying debate about how it will reshape the UK economy and affect people's lives.

Science is an inherently international activity. The Society is committed to working with partners to address global issues and challenges and as part of the Global Challenges Research Fund (GCRF), we have launched a new grants programme: Royal Society Challenge Grants. Working with our delivery partners, including the other national academies and Research Councils UK, we are addressing the global challenges directly relevant to developing countries. We are funding exceptional research programmes, promoting collaborative research in support of socio-economic development, using the strengths of the UK research base to build research capacity in developing countries and training research leaders in those countries.

In July 2016 we joined national academies across the UK and Europe in issuing a joint statement about the importance of the international nature of research. Alongside the statement, we launched a social media campaign under the hashtag *#ScienceIsGlobal*, which quickly reached 9.5 million people, with over 12,000 retweets and mentions from all over the world.

One of the Society's strengths is instigating collaborative projects to ensure that science and scientific evidence is considered broadly. Our *Science and the law* programme brings together scientists and members of the judiciary to ensure the best scientific guidance is available to the courts. The programme of seminars and meetings with senior judges has included events on memory, uncertainty and probability, mental capacity and pain, and future events include machine learning, substance addiction, human gene editing, robotics and causation. We are also working alongside the Judicial College, the Lord Chief Justice, the Lord President of Scotland and the Royal Society of Edinburgh to develop a series of easily understood guides or 'primers' on scientific topics designed to assist the judiciary when handling scientific evidence in the courtroom.

In October, I was delighted when we awarded the inaugural Royal Society Athena Prize to the London Mathematical Society in recognition of their advancement of diversity in science, technology, engineering and mathematics within the mathematical community. The Athena Prize was presented at our annual Diversity Conference, which explored how we can create and maintain inclusive environments within science to maximise innovation and creativity as well as career progression for all.



A handwritten signature in black ink that reads "Julie Maxton". The signature is written in a cursive, flowing style.

Dr Julie Maxton,
Executive Director
of the Royal Society

The Royal Society

The Royal Society of London for Improving Natural Knowledge, commonly known as The Royal Society, is a self-governing Fellowship of many of the world's most distinguished scientists drawn from all areas of science, technology, engineering, mathematics and medicine. It is the science academy of the UK and of the Commonwealth. The Society's fundamental purpose, reflected in its founding Charters of the 1660s, is to recognise, promote and support excellence in science and to encourage the development and use of science for the benefit of humanity.

Fellows are elected through a peer-review process on the basis of their excellence in science. At 31 March 2017 there were 1,441 Fellows and a further 166 Foreign Members, including 76 Nobel Laureates. It is from the eminence of its Fellowship and Foreign Membership and its independence from government that the Society derives its authority in scientific matters. Fellows and Foreign Members fulfil a range of responsibilities for the Society on a voluntary basis. Many others, scientists and non-scientists, also contribute to the work of the Society on a voluntary basis. The Fellowship is supported by staff based in London.

The six strategic priorities detailed in the Society's Strategic Plan 2012 – 2017 are:

- Promoting science and its benefits
- Recognising excellence in science
- Supporting outstanding science
- Providing scientific advice for policy
- Fostering international and global cooperation
- Education and public engagement.

The Society undertakes a very broad range of activities that provide public benefit either directly or indirectly. The Society is concerned with excellent science wherever and by whomever it is done and is committed to increasing diversity in science.

New strategy

As our current strategy ends in 2017, the new Strategic Plan 2017 – 2022 will form the core focus of the Society's activities over the next five years. It builds on the work undertaken to date and has been updated to reflect the changing scientific, political and social developments during the past five years, including the UK's decision to leave the European Union, and to strengthen the Society's response to future trends in science and emerging technologies. Since its formation, the Royal Society has played a key role in promoting science and the value of science around the world and this plan recognises that this role is as important now as it has ever been, setting out increased plans for international engagement.

The Society's strategic priorities for 2017 – 2022 emphasise its commitment to the highest quality science, to curiosity-driven research, and to the development and use of science for the benefit of society.

These priorities are:

- Promoting excellence in science
- Supporting international scientific collaboration
- Demonstrating the importance of science to everyone.

Promoting science and its benefits

Outstanding science, technology and innovation are essential to improving health and well-being and advancing our cultural, social and economic lives. Working across the full spectrum of scientific disciplines, the Royal Society supports scientists working in industry and academia to encourage the development and use of science for the benefit of humanity.

“[The meeting] succeeded in bringing together both academic and industrial people in an informal atmosphere ... it will help build working relationships.”

Anonymous feedback to the *Synthetic biology – does industry get it?* meeting.

Breakthrough science and technologies: transforming our future

The increasing importance of the knowledge-driven economy means that the flow of ideas and skills between the research base, industry, business and the wider community is crucial to future prosperity.

As a key component of our Science and industry programme, we have established a series of unique, high-level events at the Society to address the major scientific and technical challenges of the next decade.

After conferences in our *Breakthrough science and technologies: Transforming our future* series in 2015 on machine learning, robotics and autonomous systems, we held two further events in 2016/17 – *From satellite to soil: Connecting environmental observation to agri-tech innovations* and *Synthetic biology – does industry get it?* The talks and discussion have outlined the opportunities offered by these new technologies and the challenges faced in translating research advances into industrial applications, such as funding, regulation and skills.

Future conferences for 2017/18 are being planned on the topics of genome editing, energy storage and the ‘internet of things’.



Clockwise from top left
Dr Barbara Ryan, Group on Earth Observations, speaker at *From satellite to soil* on ‘Leveraging Earth observations for a food secure world’

Dr Jason Kelly, Founder, Ginkgo BioWorks, speaking at *Synthetic biology – does industry get it?*

Participants at *From satellite to soil*.



Meet the scientists: industry programme

Dr Moi Hoon Yap

Royal Society Industry Fellowship



Above

Dr Moi Hoon Yap,
Royal Society Industry
Fellowship holder.

The skin is our largest organ, and face skin is particularly important as it affects our perception and behaviour – research shows people with younger looking or better skin have more confidence than others.

With the growth of the cosmetic and skincare industries, the demand for an improved shopping experience is increasing and an emerging trend is the use of ‘try-on’ technology that utilises augmented reality on mobile applications.

During Dr Moi Hoon Yap’s Industry Fellowship she will be working with Image Metrics (IM), a leading provider of mobile applications for the cosmetics industry, responsible for developing the ‘Makeup Genius’ augmented reality app in collaboration with L’Oréal. This try-on app has over 20 million users worldwide and acts as a digital mirror to visualise the make-up products on the user’s face.

Building on Dr Yap’s background in face wrinkle detection and quantification and using approaches involving Hessian Line Tracking and a Multiscale Wrinkle Patterns algorithm, this project will develop a mobile application framework to automatically detect and quantify wrinkles thereby improving the realism of the try-on technology.

“A golden opportunity for knowledge exchange and to see the practicality of my research in the real world.”

Dr Moi Hoon Yap, Manchester Metropolitan University,
Royal Society Industry Fellowship holder 2016 – 2018.



Above

Professor Rebecca Fitzgerald (left) and Professor Chris Phillips (right) at *Labs to Riches*, 2017. See page 13 for further award winners.

Meet the scientists: industry awards

Professors Chris Phillips and Rebecca Fitzgerald Royal Society Innovation Award

Professors Chris Phillips and Rebecca Fitzgerald are developing their collaboration on the diagnosis of Barrett's Oesophagus. They won the Royal Society Innovation Award in 2017 – these awards support entrepreneurial researchers to take their next steps along the path to commercialisation.

“This award is invaluable for helping us in crossing the ‘valley of death’. Firstly, the freedom that we can spend it makes it a really effective lubricant in a complex enterprise like this that involves many parties; secondly, the fact that it constitutes the imprimatur of some of the nation's best scientific entrepreneurs really impresses investors.”

Professor Chris Phillips, Imperial College, London. Royal Society Innovation Award winner in collaboration with Professor Rebecca Fitzgerald, MRC Cancer Unit, University of Cambridge.

Oesophageal cancer has a mortality rate of 80% at five years. If the pre-cancerous condition Barrett's Oesophagus is detected early it can be monitored and treated before the cancer develops. However, existing cancer diagnostics rely on examination and grading by a specialist histopathologist.

The Phillips laboratory has developed ‘Digistain’ which computes a ‘nuclear-to-cytoplasmic ratio’ (NCR), an indicator of the extra DNA copies and nuclear size and shape disruption accumulated during the rapid cell division at the onset of cancer.

This is a reproducible, quantitative and objective method and is therefore expected to be more reliable for the early detection of cancer. The Fitzgerald laboratory has developed ‘Cytosponge’, a pill containing a compressed sponge attached to a string which expands in the stomach, collecting a sample of cells from the oesophagus lining when pulled back up.

Combining these two technologies provides a cost-effective, accurate and objective screen for Barrett's Oesophagus.

Industry awards overview

36

Industry Fellows supported

12

New Industry Fellows appointed

7

Translation awards made

2

Innovation awards made



Above

Left to right: Professor Mark Newton, University of Warwick with Professor Julie Macpherson, University of Warwick and HRH Prince Andrew, The Duke of York KG FRS.

Labs to Riches

In March 2017 we held our annual *Labs to Riches* event, promoting collaboration and translation by bringing together leading scientists and industrialists.

A Royal Society Innovation Award was given to Professor Julie Macpherson (left) with Professor Mark Newton for investigations of a new carbon material – boron doped diamond (BDD) as a pH and chlorine sensor for water safety.

Enterprise Fund: early-stage investments delivering societal benefit

The Royal Society Enterprise Fund was created with the aim of becoming a financially successful contributor to early-stage science-based companies in the UK and a role model for the translation of excellent science for commercial and social benefit. The Society entered into a Limited Partnership Agreement with Amadeus Capital Partners in 2014 to create the Amadeus RSEF LP. The fund invests alongside Amadeus IV Early Stage funds, enabling continued support of successful companies through their lifecycle. Investments have been focused on early-stage science-based companies in three sectors: Digital Health and Medical Technology, Artificial Intelligence (AI) and Machine Learning, and Cloud Computing and Cybersecurity. Despite being less than ten years old, the fund is already realising benefits from the fundamental science underpinning these companies:

- Congenica's genome analytics and interpretation software platform has already been used to interpret whole-genome sequencing data from hundreds of patients participating in Genomics England's 100,000 genomes project, helping us understand the basis for genetic disease and opening potential new avenues for treatment.
- Axol Bioscience have supplied differentiated human cells derived from healthy donors and patients of specific disease backgrounds. Primary cells are reprogrammed to induced pluripotent stem cells (iPSCs) and differentiated to cell types essential for the study of disease and the development of new treatments.
- OrganOx Ltd have developed a device to transport and store donor organs in a fully functioning state at 37°C, and published the first in-human application of their technology in the *American Journal of Transplantation* in 2016. Larger-scale studies are now underway in the hope that this technology will lead to an increase in the number of organs available for transplant and an improvement in the function of transplantable organs.

Science and the law: providing better understanding of science to the courts

Our *Science and the law* programme brings together scientists and members of the judiciary to ensure the best scientific guidance is available to the courts. In 2016/17 we held events on memory, uncertainty and probability, mental capacity and pain, and future events include machine learning, substance addiction, human gene editing, robotics and causation.

We are working alongside the Judicial College, the Lord Chief Justice, the Lord President of Scotland and the Royal Society of Edinburgh to develop a series of easily understood guides or ‘primers’ on scientific topics designed to assist the judiciary when handling scientific evidence in the courtroom. The first two primers on DNA analysis and gait analysis have been published and future topics will include statistics and collision analysis.

“The launch of this project is the realisation of an idea the judiciary has been seeking to achieve. The involvement of the Royal Society and the Royal Society of Edinburgh will ensure scientific rigour and I look forward to watching primers develop under the stewardship of leading experts in the fields of law and science.”

Lord Thomas, Lord Chief Justice of England and Wales.



Left
The Royal Courts
of Justice.

Pairing scheme

Scientists swap the lab bench for the green bench: our unique pairing scheme, run with support from the Government Office for Science, pairs scientists with parliamentarians and civil servants.



Right (top)
Dr Lily Asquith (left), Royal Society Dorothy Hodgkin Research Fellow, University of Sussex, at the Pairing scheme reception, attended by Caroline Lucas MP.

Right
Dr Lyndsey Butterworth (left), Research Associate at the Institute of Neuroscience, Newcastle University, with Chi Onwurah MP.

Diversity programme

Diversity is an essential tenet of modern society, but also provides a key part of the Royal Society's mission to recognise, promote and support increased excellence in science, technology, engineering and mathematics (STEM).

Some of the Society's activities and initiatives include the Athena Prize, our programme on unconscious bias, the Dorothy Hodgkin Fellowship, our annual diversity conference and campaigns like *Parent, Carer, Scientist*, celebrating the diversity of work life patterns of scientists.

Find out more at royalsociety.org/diversity

“Diversity makes us more successful, and it makes the country safer.”

Andrew Parker, Director General, MI5, speaking at *Diversity matters – the road to inclusivity*, our fourth annual Diversity Conference.

Right (top)

Bonnie Greer OBE, Chancellor of Kingston University (second right) pictured with Professor Uta Frith DBE FRS (third left) and conference participants, discussed barriers to accessing the Science, Technology, Mathematics and Medicine (STEMM) pathway at our Diversity Conference.



Right (bottom)

Awarding the inaugural Royal Society Athena Prize at the conference – the award recognises individuals or teams, working in UK academic and research communities, who have contributed most to the advancement of diversity in STEMM. In 2016 it was won by the London Mathematical Society for their Women in Mathematics Committee, which is leading the way in increasing the number of women in mathematics.



Out in STEM 2017

Our second LGBT history month event looked at inclusivity within tech communities. Sir Dermot Turing, Alan Turing’s nephew and one of his biographers, provided the keynote address, focusing on the law and the treatment of Alan Turing FRS.



Above (left and right)
Participants at *Out in STEM 2017*.

Left
Speakers at *Out in STEM 2017* including Sir Dermot Turing (second left).

Scientific meeting programme

Our discussion meetings bring together leading experts from all over the world to present and discuss new areas of research in all fields of science.

2,983 people attended our programme of 33 scientific meetings in 2016/17. This included 15 discussion meetings, 4 with an associated satellite meeting, and 14 Theo Murphy international scientific meetings. In addition, we held 16 Research Fellows international scientific seminars and one Bilateral international meeting.

Royal Society scientific discussion meetings 2016/17

Verified trustworthy software systems

Organised by Professor Philippa Gardner, Professor Mike Gordon FRS, Professor Greg Morrisett, Professor Fred Schneider and Professor Peter O'Hearn

4–5 April 2016

Integrating Hebbian and homeostatic plasticity

Organised by Professor Kevin Fox FMedSci and Professor Michael Stryker

19–20 April 2016

Quantum technology for the 21st century

Organised by Professor Sir Peter Knight FRS, Professor Ian Walmsley FRS, Professor Gerard Milburn, Dr Stephen Till and Dr Jonathan Pritchard

9–10 May 2016

Cometary science after Rosetta

Organised by Dr Geraint Jones, Dr Matt Taylor, Professor Alan Fitzsimmons and Dr Matthew Knight

14–15 June 2016

Membrane pores: from structure and assembly, to medicine and technology

Organised by Professor Robert Gilbert, Professor Hagan Bayley FRS and Professor Gregor Anderluh

27–28 June 2016

Ocean ventilation and deoxygenation in a warming world

Organised by Professor John Shepherd CBE FRS, Professor Andrew Watson FRS, Dr Peter Brewer and Professor Andreas Oschlies

12–13 September 2016

X-chromosome inactivation: a tribute to Mary Lyon

Organised by Professor Edith Heard FRS and Professor Neil Brockdorff FMedSci

3–4 October 2016

Enhancing photosynthesis in crop plants: targets for improvement

Organised by Professor Christine Foyer, Professor Alexander V Ruban, Professor Peter J Nixon and Professor Alfred William Rutherford FRS

10–11 October 2016

Royal Society scientific discussion meetings 2016/17 (continued)

New trends in evolutionary biology: biological, philosophical and social science perspectives

Organised by Professor Denis Noble CBE FMedSci FRS, Professor Nancy Cartwright FBA, Professor Sir Patrick Bateson FRS and Professor Kevin Laland

7–9 November 2016

The challenges of hydrogen and metals

Organised by Professor Anthony Paxton, Professor Michael Finnis and Professor Adrian Sutton FRS

16–18 January 2017

Extracellular vesicles and the tumour microenvironment

Organised by Dr Daniel Lambert, Dr David Carter, Dr Aled Clayton, Dr Andrew Devitt and Dr Stuart Hunt

23–24 January 2017

Breakdown of ergodicity in quantum systems: from solids to synthetic matter

Organised by Professor Sir Michael Pepper FRS, Dr Arijeet Pal, Dr Zlatko Papic, Dr Ulrich Schneider and Professor Steven Simon

6–7 February 2017

The origins of numerical abilities

Organised by Professor Brian Butterworth FBA, Professor Charles Gallistel and Professor Giorgio Vallortigara

20–21 February 2017

The Rhynie Chert: our earliest terrestrial ecosystem revisited

Organised by Professor Dianne Edwards CBE FRS, Professor Liam Dolan FRS and Dr Paul Kenrick

6–7 March 2017

Challenges for chemistry in molecular imaging

Organised by Professor David Parker FRS, Professor Nicholas Long and Professor Stephen Faulkner

21 March 2017

“The meeting was really enjoyable and the quality of the speakers was outstanding, and overall informative, rigorous, and inspiring.”

Feedback received from a participant at the scientific discussion meeting, *Membrane pores: from structure and assembly, to medicine and technology*, 27 – 28 June 2016.

“This was a particularly useful meeting, with long discussion sessions. I learnt an enormous amount and have already established novel collaborations.”

Feedback received from a participant at the Theo Murphy meeting, *Chemical biology approaches to assessing and modulating mitochondria*, 26–27 September 2016.

Theo Murphy meetings at the Kavli Royal Society International Centre 2016/17

Applying computational modelling to clinical neuroscience

Organised by Dr Randy McIntosh, Dr Karl Friston FRS, Dr Cathy Price, Dr Viktor Jirsa and Dr Petra Ritter

6–7 April 2016

Faulting, friction and weakening: from slow to fast motion

Organised by Dr Stefan Nielsen, Professor James R Rice, Dr Tom Mitchell and Dr Alexandre Schubnel

25–26 April 2016

New horizons for nanophotonics

Organised by Professor Yuri Kivshar, Professor Nikolay Zheludev, Professor Ortwin Hess and Professor Bill Barnes

23–24 May 2016

Bridging the gap: from massive stars to supernovae

Organised by Dr Justyn Maund, Professor Paul Crowther, Dr Hans-Thomas Janka and Professor Norbert Langer

1–2 June 2016

Into the genome: advances in the world of algal genomics

Organised by Professor Juliet Brodie and Professor Debashish Bhattacharya

8–9 June 2016

Nucleation: past and future challenges for experiment, theory and simulation

Organised by Professor Angelos Michaelides, Professor Daan Frenkel ForMemRS, Professor Fiona Meldrum and Dr Gabriele Cesare Sosso

5–6 September 2016

Chemical biology approaches to assessing and modulating mitochondria

Organised by Dr Michael Murphy

26–27 September 2016

Self-assembled peptides: from nanostructure to bioactivity

Organised by Professor Ian Hamley, Professor Dek Woolfson, Professor Louise Serpell, Dr Alberto Saiani and Professor Raffaele Mezzenga

24–25 October 2016

Theo Murphy meetings at the Kavli Royal Society International Centre 2016/17 (continued)

Mechanisms of asymmetric cell division

Organised by Dr Shukry Habib and Dr Paula Alexandre

14–15 November 2016

The offline brain: understanding memory consolidation and reconsolidation

Organised by Professor Edwin Robertson and Dr Lisa Genzel

30–31 January 2017

Reducing neonatal infectious morbidity and mortality: joining up our thinking

Organised by Dr Kirsty Le Doare, Dr Elizabeth Whittaker, Professor Beate Kampmann and Dr Christine Jones

13–14 February 2017

The terrestrial laser scanning revolution in forest ecology

Organised by Professor Mark Danson, Dr Mat Disney, Dr Rachel Gaulton and Professor Crystal Schaaf

27–28 February 2017

Evolution and functional biology of neuropeptide signalling: from genomes to behaviour

Organised by Professor Maurice Elphick, Dr Gáspár Jékely and Professor Lindy Holden-Dye

13–14 March 2017

Higgs cosmology

Organised by Professor Arttu Rajantie, Dr Malcolm Fairbairn, Dr Tommi Markkanen and Dr Astrid Eichhorn

27–28 March 2017

Research Fellows' international scientific seminars 2016/17

Dark energy in the laboratory

Organised by Dr Clare Burrage (University Research Fellow 2013–2017)

21–22 April 2016

Laterality: from genes to behaviour

Organised by Dr Silvia Paracchini (University Research Fellow 2011–2016)

28–29 April 2016

Orbital angular multiplexing in optical fibre communications

Organised by Dr Wlodek Forysiak (Industry Fellow 2012–2016)

3–4 May 2016

Imaging in graphics, vision and beyond

Organised by Dr Abhijeet Ghosh (Wolfson Research Merit Award 2013–2017)

5–6 May 2016

Structure and dynamics of the solar atmosphere: recent advances and future challenges

Organised by Dr Vasilis Archontis (University Research Fellow 2011–2016)

25–26 May 2016

Research Fellows' international scientific seminars 2016/17 (continued)
Frontiers of malaria research

Organised by Dr Julius Hafalla (University Research Fellow 2009–2016)
13–14 June 2016

Chirality and multiphoton nanophotonics from molecules to metamaterials

Organised by Dr Ventsislav Valev (University Research Fellow 2014–2019)
28–29 June 2016

Evolution of the biological pump

Organised by Dr Patricia Sanchez-Baracaldo (Dorothy Hodgkin Fellow 2012–2016)
20–21 September 2016

Uncertainty and action

Organised by Dr Benedetto De Martino (Sir Henry Dale Fellow 2014–2019)
17–18 October 2016

The transient and variable sky in the era of gravitational wave observations

Organised by Dr Alberto Sesana (University Research Fellow 2015–2019)
26–27 October 2016

'The Red Lotus Project': mathematical modelling of heat effects on slippery surfaces

Organised by Professor Darren Crowdy (Wolfson Research Merit Award 2013–2017)
1–2 November 2016

Storylines as an alternative way of representing uncertainty in climate change

Organised by Professor Theodore Shepherd FRS (Wolfson Research Merit Award 2012–2017)
23–24 November 2016

Prenylated Flavin: biochemistry and application

Organised by Professor David Leys (Wolfson Research Merit Award 2012–2017)
13–14 December 2016

Unifying scientific disciplines to understand and solve emerging membrane filtration challenges

Organised by Dr Ian Griffiths (University Research Fellow 2014–2019)
10–11 January 2017

Incorporating uncertainty into cardiac physiome simulations

Organised by Dr Gary Mirams (Sir Henry Dale Fellow 2014–2019)
15–16 February 2017

Cellulose: prospects and challenges

Organised by Dr Michael Ries (Industry Fellow 2013–2017)
15–16 March 2017

Recognising excellence in science

The Society recognises the excellence and creativity of scientists by election to the Fellowship and Foreign Membership and gives awards to those scientists who are making a major contribution to society.

New Fellows 2016

50 new Fellows, 10 new Foreign Members and 1 new Honorary Fellow were elected to the Society in April 2016, of which 15 were women. New Fellows were admitted in July 2016 at the Admissions Ceremony, during which they signed the Charter Book. A full list of those elected can be found on the following pages of this report.



Professor Christopher Abell FMedSci FRS



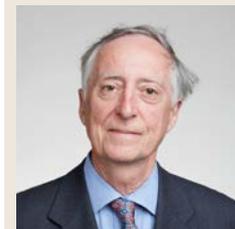
Professor Jas Pal Badyal FRS



Professor Steven Balbus FRS



Professor Polina Bayvel CBE FREng FRS



Professor Graham Bell FRS



Professor Martin Bridson FRS



Professor John Burrows FRS



Professor Katharine Cashman FRS



Professor Sarah Cleaveland OBE FRS



Mr James Collier FRS



Professor Alastair Compston CBE FMedSci FRS



Professor Brian Cox OBE FRS



Professor Jack Cuzick CBE FMedSci FRS



Professor William David FRS



Professor Christl Donnelly FMedSci FRS



Professor Marcus du Sautoy OBE FRS



Professor James Dunlop FRS



Professor Artur Ekert FRS



Professor Maria Fitzgerald FMedSci FRS



Professor Pratibha Gai FREng FRS



Professor Antony Galione FMedSci FRS



Professor Harry Gilbert FMedSci FRS



Professor Patrick Gill MBE FRS



Professor Dame Anne Glover DBE FRS



Professor Neil Gow FMedSci FRS



Professor Ian Graham FRS



Professor Richard Harvey FRS



Professor Adrian Hayday FMedSci FRS



Dr Ramanujan Hegde FRS



Dr David Hight FEng FRS



Dame Sue Ion DBE FEng FRS



Professor Eugenia Kumacheva FRS



Professor Corinne Le Quéré FRS



Professor Mark Lemmon FRS



Dr David Lodge FMedSci FRS



Professor Eleanor Maguire FMedSci FRS



Professor Lakshminarayanan Mahadevan FRS



Professor Gilean McVean FMedSci FRS



Professor Russell Morris FRS



Professor Luke O'Neill FRS



Professor Simon Peyton Jones FRS



Dr Jonathon Pines FRS



Professor James Prosser OBE FRS



Professor Sriram Ramaswamy FRS



Professor Caroline Series FRS



Professor Theodore Shepherd FRS



Professor Alison Smith OBE FRS



Professor David Wales FRS



Professor Philip Withers FRS

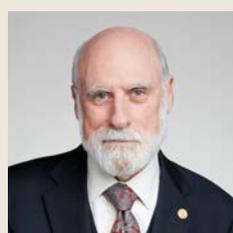


Professor Paul Workman FMedSci FRS

New Foreign Members 2016



Professor Robert Cava ForMemRS



Dr Vint Cerf ForMemRS



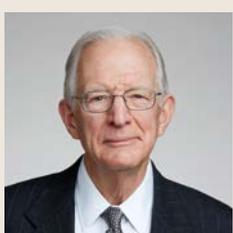
Professor Mark Davis ForMemRS



Professor Jennifer Doudna ForMemRS



Professor Gerd Faltings ForMemRS



Dr John Hayes ForMemRS



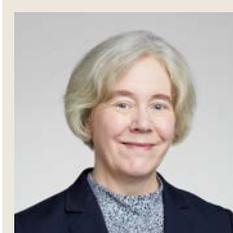
Professor Svante Pääbo ForMemRS



Professor Pasko Rakic ForMemRS



Dr Rino Rappuoli ForMemRS



Professor Ellen Williams ForMemRS

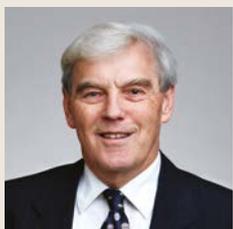
New Honorary Fellows 2016



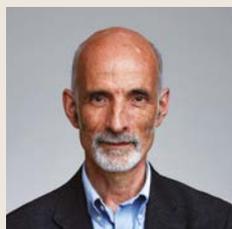
Lord Adair Turner FRS

Medals and Awards 2016/17

The Society's medals, awards and prize lectures provide a mechanism for the recognition and celebration of excellence within all aspects of science. The public recognition of leading scientists serves to inspire others to continue the advancement of science.



Copley A Medal
Dr Richard Henderson
FRS



**Croonian Medal
and Lecture**
Professor Jonathan
Ashmore FRS



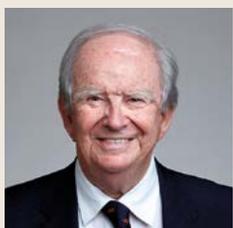
**Bakerian Medal
and Lecture**
Professor Andy Hopper
CBE FRS



Royal A Medal
Professor John Goodby
FRS



Royal B Medal
Professor Elizabeth
Robertson FRS



Royal C Medal
Sir John Meurig
Thomas FRS



**Armourers & Brasiers
Company Prize**
Professor Neil Alford
MBE FREng



Darwin Medal
Dame Caroline Dean
OBE FRS



Davy Medal
Professor Stephen Mann
FRS



Ferrier Medal
Professor Christine Holt
FMedSci FRS



**Francis Crick Medal
and Lecture**
Professor Simon Myers



**Kavli Education
Medal and Lecture**
Dr Becky Parker



**Kavli Medal
and Lecture**
Professor Henry Snaith
FRS



Leverhulme Medal
Professor Anne Neville



**Michael Faraday
Medal and Lecture**
Dr Nick Lane



**Milner Medal
and Lecture**
Professor Andrew
Zisserman FRS



Mullard Award jointly awarded to
Professor Steve Furber CBE FREng FRS and
Ms Sophie Wilson FREng FRS



Pfizer Award
Dr Amina Abubakar Ali



**Rosalind Franklin
Award and Lecture**
Professor Jo Dunkley



Rumford Medal
Professor Ortwin Hess



Sylvester Medal
Professor Timothy
Gowers FRS



**Wilkins-Bernal-
Medawar Medal
and Lecture**
Professor Jon Agar

Medals and awards

Copley Medal

Dr Richard Henderson FRS was awarded the Copley Medal, the world's oldest scientific prize, for his work on imaging techniques which have enabled scientists to understand the arrangements of atoms in important biomolecules.

Understanding the structures of proteins and biomolecules is vital for understanding essential processes in the body, and is a vital part of modern drug design to make more effective pharmaceuticals which better interact with target proteins in the body.

"The new structures provide important insights into the biological function of the assemblies and, by catalysing the subsequent development of new diagnostic or therapeutic tools, should help to improve the health and wealth of the country. It is a real thrill to be awarded the Royal Society's Copley Medal for my work in this area. Particularly as it's a prize that has been awarded to so many outstanding scientists since 1731. That's amazing." **Dr Richard Henderson FRS.**

"Dr Henderson's work has paved the way for the recent advances in electron microscopy that are revolutionising structural biology by making it possible to determine atomic structures of large macromolecules without the use of crystals. The award recognises not only his own groundbreaking work in electron microscopy but also his work in advancing and disseminating his ideas to the point where they have reached fruition and are now used prolifically across the world."

Sir Venki Ramakrishnan, President of the Royal Society.



Above
Dr Richard Henderson FRS.

"It is a real thrill to be awarded the Royal Society's Copley Medal for my work in this area. Particularly as it's a prize that has been awarded to so many outstanding scientists since 1731. That's amazing."



Above
Dr Amina
Abubakar Ali,
winner of the
Society's Pfizer
Award 2016.

The Royal Society Pfizer Award

The Society's Pfizer Award recognises research scientists who are making an innovative contribution to the biological sciences, including basic medical science, which contributes significantly to capacity building in Africa.

In 2016 it was awarded to Dr Amina Abubakar Ali for pioneering psychological research in East Africa and her work developing neurodevelopmental assessments which are now being used throughout Africa.

Nobel Prizes

In 2016/17 we celebrated the following outstanding achievements of our Fellows:

Sir J Fraser Stoddart FRS won the Nobel Prize in Chemistry 2016 for the design and synthesis of molecular machines. His pioneering work on the design and manufacture of an entirely new class of chemical compounds has great potential in the field of nanoscale engineering. He shares the prize with Jean-Pierre Sauvage and Bernard L Feringa.

"It is wonderful news that Royal Society Fellow, Professor Sir J Fraser Stoddart FRS, has been awarded the Nobel Prize in Chemistry this year. We offer congratulations to him and to Jean-Pierre Sauvage and Bernard L Feringa, who share the prize, on this great achievement. Their work demonstrates the potential for chemists to construct tiny molecules which behave like machines, moving in response to a stimulus. These minute machines have laid the groundwork for potential future applications in a range of fields, from health to the miniaturisation of smart devices." **Sir Martyn Poliakoff CBE FRS, Vice President and Foreign Secretary of the Royal Society.**

Professor Frederick Duncan M Haldane FRS and Professor David J Thouless FRS have won the Nobel Prize in Physics 2016 for theoretical discoveries of topological phase transitions and topological phases of matter. They share the prize with Professor J Michael Kosterlitz.

"I am delighted to hear that two Royal Society Fellows, Professors Haldane and Thouless, have been awarded the Nobel Prize in Physics this year. We offer our congratulations to them and to Professor Kosterlitz on this great achievement." **Professor Alex Halliday FRS, Vice President and Physical Secretary of the Royal Society.**

Supporting outstanding science

Through our funding programmes, we work in partnership with universities and industry, both within the UK and internationally, to support excellent scientists. Our Fellowships support scientists by providing the stability, freedom and flexibility needed for researchers to develop their ideas.

Our support for scientists

Early career Fellowships

298

University Research Fellows, for outstanding post-doctoral scientists with leadership potential, **45 new appointments**

151

Sir Henry Dale Fellowships, for post-doctoral scientists addressing an important biomedical question, **45 new appointments**

41

Dorothy Hodgkin Fellows, for outstanding post-doctoral scientists where career flexibility is essential, **13 new appointments**

40

new early career Fellows provided with mentors – **6 early career Fellows matched to mentors focusing on female research leaders**

100

scientists trained on media and communication skills, grant writing, engaging the public, and innovation and the business of science

Senior Fellowships

20

Research Professorships, providing long-term support for internationally recognised scientists of outstanding achievement, **6 new appointments**

7

Royal Society Leverhulme Trust Senior Research Fellowships, for scientists who would benefit from a period of full-time research without teaching and administrative duties

251

Wolfson Research Merit Award holders, to help recruit and retain outstanding scientists in the UK, **45 new awards**

Resources for research



© Thomas Demarczyk

8 research teams awarded up to **£250,000** in funding to refurbish laboratories used for the study of infectious diseases



© Robert Ingehart

7 Theo Murphy Blue Skies awards, providing researchers with an opportunity to pursue innovative research

138

research grants of

£15,000

awarded for early career scientists to purchase specialised equipment and consumables, and to support essential field research

19

research grants of

£150,000

awarded for our University Research Fellows and Dorothy Hodgkin fellows in the first year of their fellowship

Early career Fellowship

Amanda Sferruzzi-Perri,
Dorothy Hodgkin Fellow,
University of Cambridge.

“My research is focused on understanding the unique relationships between the mother, placenta and foetus which govern pregnancy success and lifelong health. I am particularly interested in identifying the signals secreted by the placenta that alter the metabolism of the mother in favour of foetal nutrient supply. I want to determine what role the signals play in regulating growth of the foetus, the health of the mother and the well-being of her child.

This research is important as impaired placental function disrupts the allocation of nutrients between the mother and her developing baby. This can lead to pregnancy complications, including gestational diabetes and abnormal birth weight, which have immediate and long-term consequences for maternal and offspring health.

The Dorothy Hodgkin Fellowship scheme appealed to me as it offers the option of claiming back time spent on parental/caring responsibilities. As the primary care-giver for our daughter, this enables me to balance my personal life with my ambition for a successful, independent research career.”

Early career Fellowship

Steven Spoel,
University Research Fellow,
University of Edinburgh.

“My laboratory studies how plants defend themselves against attack by pathogens that can cause devastation to food crops. These studies help us understand how plant and animal cells can better survive stresses (eg pathogen attack) by orchestrating dramatic reprogramming of gene expression to favour defence responses over normal cellular functions.

The University Research Fellowship (URF) has allowed me to set up an independent research group with a predominantly blue-skies research focus. As plant research is increasingly becoming an industrial focus, blue-skies academic plant science is under significant funding pressure. The final years of my URF partially alleviate this pressure by allowing us the freedom to move several of our key fundamental findings from plant cells into cell types that are considered more conventional models in biomedical sciences. Without URF funding this journey into more interdisciplinary science would be much more difficult to achieve.”

Early career Fellowship

Professor Rahul Raveendran Nair, Royal Society University Research Fellow at the University of Manchester.

“Realisation of scalable membranes with uniform pore size down to atomic scale is a significant step forward and will open new possibilities for improving the efficiency of desalination technology. This is the first clear-cut experiment in this regime. We also demonstrate that there are realistic possibilities to scale up the described approach and mass produce graphene-based membranes with required sieve sizes.”

Professor Rahul Raveendran Nair is a Professor of Materials Physics and Royal Society University Research Fellow based at the National Graphene Institute and the School of Chemical Engineering and Analytical Science at the University of Manchester.

He was awarded the University Research Fellowship in 2014 for exploration of new science and technology in novel layered materials, particularly graphene. One of his main research themes is graphene-based membranes and their applications. A group of scientists at The University of Manchester led by Professor Nair has built on previous research on graphene-oxide membranes developed at the National Graphene Institute, developing graphene-oxide membranes which are able to sieve common salts out of salty water, making it safe to drink. This research has attracted significant attention, as this technology has the potential to revolutionise water filtration across the world, in particular in countries which cannot afford large-scale desalination plants.

Senior Fellowship

Sir Andrew Wiles FRS, Royal Society Research Professor at the University of Oxford.

“Receiving the Royal Society Research Professorship enabled me to return to the UK, and allowed me to focus on research free from most administrative duties. This has given me the opportunity to devote myself to very long-term projects free from distraction. I feel that it is in this situation that I am most productive and in which I can contribute most to my field.

There are now a great many very talented young mathematicians in number theory, and particularly in the area of number theory in which I am working. However it seems to happen that periodically roadblocks appear that seem insurmountable and I most enjoy the challenge of tackling these questions, which most people tend to avoid. This is what I have been doing with the support of the Royal Society.”

A Royal Society Research Professor since 2009, Sir Andrew is a mathematician working in number theory, and is best known for his proof of Fermat’s Last Theorem.

Meet the scientists: Research Fellows

Rebecca Kilner

Wolfson Research Merit Award and Theo Murphy Blue Skies Award

“We were in a bit of a catch-22 situation: we needed more money to develop our idea, but our idea was too risky to be attractive to most funders. The Theo Murphy scheme offered the perfect way out of this dilemma.”

Rebecca Kilner, Wolfson Research Merit Award and Theo Murphy Blue Skies Award holder at the University of Cambridge. She received the Theo Murphy Blue Skies Award to investigate the role of microbes in animal evolution.

“I want to get a better idea about the role that microbes play in influencing animal evolution. Figuring out the answer to this problem could keep us busy for the next ten years. Right now, I want to gather enough data to make a compelling case for a larger grant to really develop our new idea about this. It will involve new techniques for our lab, and developing new protocols. With my teaching time bought out by this award, I now have the time to focus on this work.

This scheme gives us the security to fail when trying new techniques, so that we can find an approach that we know will work before applying for further funding.

I hope this research will give us new insights into the processes that generate biodiversity and therefore a better understanding about what needs to be done to conserve it. One of the joys of doing research is the unexpected direction of travel, and the unimagined destinations. I certainly didn't think we would be embarking on a project like this two years ago, so who knows where we will be in two years' time.”



Above

Rebecca Kilner, Wolfson Research Merit Award and Theo Murphy Blue Skies Award holder.



Above
Daniel Streicker,
Sir Henry Dale Fellow.

Meet the scientists: Research Fellows

Daniel Streicker
Sir Henry Dale Fellow

“This work directly addresses an important problem for all Latin American countries.”

Daniel Streicker, Sir Henry Dale Fellow based at the Institute of Biodiversity, Animal Health and Comparative Medicine, at the University of Glasgow. His main research focus is vampire bats in Peru and their role in spreading diseases to livestock. In 2016 he was awarded a Challenge Grant for a study of oral vaccination of vampire bats for rabies control in Latin America.

“Livestock is of strategic importance to economic development in Latin America and remains integral to the food security of local populations. Vampire-bat-transmitted rabies causes a lethal infection that threatens livestock production throughout the region and the burden of the disease is rising.

This research is evaluating oral vaccine delivery to wild bats by combining field experiments and statistical models. Specifically, we are using biomarkers to study ingestion of a ‘mock’ vaccine after topical application to bats and the degree of diffusion of vaccine to other bats through social grooming.

Mathematical models will be developed to estimate the vaccination coverage that could be attained with our delivery strategy and whether this would be sufficient to reduce the burden of rabies in humans and livestock.”

Meet the scientists: Research Fellows

Dr Paul Williams

University Research Fellow

“A defining moment in my career since taking up the University Research Fellowship was addressing the world’s media at a press conference in Vienna in 2013.”

“I told them about our new study into how aviation turbulence was becoming stronger because of climate change. An independent media expert has estimated that one billion people worldwide heard about this research, which is very gratifying.”

Dr Paul Williams, Royal Society University Research Fellow (URF) and Associate Professor in the Department of Meteorology at the University of Reading. He was awarded his Fellowship in 2009 and an extension of his Fellowship in 2014. He is now in his final year as a URF.

I study the atmosphere and ocean, focusing on the areas of fluid dynamics, climate change and computational modelling. I am interested in how waves, turbulence and jet streams are generated and how they will respond to climate change. I am also interested in improving computer simulations of the atmosphere and ocean, by designing better algorithms and adding random numbers to represent things like clouds and turbulent ocean currents. These are challenging scientific problems with important societal implications.

The aviation turbulence forecasting algorithm I co-developed is now being used operationally by the US National Weather Service. Every day, turbulence forecasts made with this algorithm are used in flight planning by pilots, aircraft dispatchers and air traffic controllers. These forecasts have improved the comfort and safety of air travel on the 700 million plane journeys made by Americans annually. Secondly, the time-marching algorithm I invented is now being used in dozens of atmosphere, ocean and climate models worldwide. It has significantly increased the accuracy and skill of these models. For example, it has improved simulations of regional climate, brought ocean simulations into better agreement with observations, improved the energy conservation in ice sheet simulations and improved the skill of medium-range weather forecasts.”



Above
Dr Paul Williams,
University Research Fellow.

Royal Society Publishing

Our journals



30 million

article downloads from our journals in 2016



7,000

submissions to our research journals received

38%

of all articles were published with immediate open access in 2016

2,800

articles published in 2016



Publishing photography competition

Our competition highlights the power of photography to communicate science and engage a public audience.

Left

Mark Cowan received a 'special commendation' for his photograph *Butterflies and caiman*.

Providing scientific advice for policy

We strive to ensure that policymakers have access to expert, independent scientific advice, while extending the reach, impact and influence of our policy work with UK, European and international decision makers.

Machine learning

In 2016/17 we have promoted the role of data science and digital technologies in advancing research, policy, industry and education – delivering work on cybersecurity, machine learning and data governance.

Our *Machine learning* project explores the opportunities that machine learning technologies present, their societal impact and the research challenges that will help shape the sector. This project has involved engagement with policy, industry and research audiences, public dialogue with Ipsos MORI and a series of sold-out public events.

A policy report with recommendations for government, industry and academia was published in April 2017, drawing from workshops with 200 practitioners in addition to over 1,500 wider contributors from public dialogues. Highlights of the programme of public engagement included an event at the Royal Festival Hall with Professor Brian Cox FRS – which over 2,000 people attended in person, and over 6,000 viewed online – sessions at the Northern Ireland Science Festival, New Scientist Live, Science Museum Lates and a programme of joint events with the British Academy on AI, Robotics and Society.

Cybersecurity

Progress and Research in Cybersecurity was published in July 2016. Our report makes recommendations on trust, resilience, research and translation – which together highlight the critical need for cybersecurity in an increasingly digital society. This will require an ambitious programme of research and innovation to generate new security approaches and products, as well as establishing clear standards and kitemarks to help users identify trustworthy digital products and services.

Data management and use

A joint project with the British Academy, *Data management and use*, is examining new uses of data and their implications, and reviewing the existing data governance landscape. The aim is to be able to connect debates across sectors and set out a shared vision for a digitally enabled society; a vision that can determine overarching principles for fair, well-managed data use. The project has been welcomed by the Government, with its Digital Strategy team committing to looking closely at its findings, published in summer 2017.

Genetic technologies

We are looking at a range of genetic technologies; at how they can and might be applied in agriculture, in industry, to conserve biodiversity and to improve human health. We are also considering the consequences of these technologies for our security, our culture and for the regulatory environment.

Building on our previous work on genetically modified (GM) plants, human gene editing and synthetic biology, Sir Venki Ramakrishnan, President of the Royal Society, gave a speech at the American Association for the Advancement of Science annual meeting in February 2017. This considered the range of technologies outlined above and provided a starting point for further debate and work in this area which is ongoing in 2017/18.

Research landscape

To maintain and support research excellence in the UK to 2035 and beyond, the Royal Society has started an ambitious programme of work to build understanding of the complex interactions of the culture of research.

One strand of this work is our *Changing Expectations* project, which aims to understand how best to steward research culture through a shifting research landscape. Through a national dialogue with the research community, by drawing on the experiences of our past and present, and exploring potential futures, *Changing Expectations* will investigate the evolving relationship between the research community and the wider research system.

“We face global problems – hunger, disease and environmental threats do not respect borders. So we should seek to address those global problems on a global stage. That means working together to ensure that the benefits of new technologies – and I personally believe that those benefits can be great – are as widely spread as possible.”

Sir Venki Ramakrishnan, President of the Royal Society, speaking at the American Association for the Advancement of Science (AAAS) conference in Boston, February 2017.

Education: broadening the curriculum

Our *Vision for science and mathematics education* recommended that all students should study science and mathematics to age 18. In 2016/17 our focus has been to keep this ambition on the political agenda, and as proposals for new, broader qualifications are discussed, we have recommended broadening the curriculum, so that all young people study science and mathematics up to the age of 18.

Schools that work for everyone

In December 2016 the Society responded to the Government's green paper, *Schools that work for everyone*, raising concerns that the proposals may only support a small proportion of disadvantaged pupils:

“New research commissioned by the Royal Society shows that in wholly selective local authorities, students receiving free school meals (FSM) achieve lower grades in GCSE mathematics. In these areas there are also fewer FSM students taking double or triple science GCSEs. These are subjects which open doors for young people.

Schools that work for everyone must place priority on ensuring that all young people receive high-quality science and mathematics education which equips students with the skills they need to prosper in a rapidly changing world. Irrespective of the role of selective schools in our education system, our schools must support students from every background to fulfil their potential.”

Professor Tom McLeish FRS, Chair of the Royal Society's Education Committee.

Future plans

In 2017/18 our science policy work will span across six themes, the research landscape, education, resilient futures, data, wellbeing, and new horizons.

How our some of our policy projects reached people



© asiseelt

Our work around the Higher Education and Research Bill reached **237,000** people via digital media including **864 blog views**, with **355 retweets**



© Sophonibal

29,700 unique page views of the *GM plants: questions and answers* report



23,100 views of our *What is gene editing and how does it work?* animation across YouTube and Facebook

Fostering international and global cooperation

Science is an international activity and we are strengthening links with academies, funders and governments in Europe, the USA and beyond as well as supporting other countries which are building their own scientific strength.

Our support for scientists

International Fellowships and awards

24

Newton International Fellowships awarded to post-doctoral researchers from around the world, to join UK institutions for up to 2 years (this does not include those funded by the Newton Fund, see below). This scheme is jointly run with the British Academy and the Academy of Medical Sciences and is funded by BEIS

217

International Exchanges grants made for new collaborations between scientists in the UK and 37 countries

7

International Scientific Seminars funded for Royal Society funded scientists to develop new collaborations

9

privately funded International Fellowships awarded to post-doctoral scientists from the USA, Israel, China and Italy

300

researchers selected to attend the Commonwealth Science Conference 2017

The Newton Fund – part of the UK's official development assistance to develop science and innovation partnerships for the economic development and welfare of partner countries

The Royal Society funds 3 programmes through the Newton Fund, in partnership with China, India, Mexico, Turkey, South Africa, Brazil, Malaysia and Thailand

27

additional Newton International Fellowships were awarded through the Newton Fund

28

Newton Advanced Fellowships awarded to mid-career scientists from partners countries for collaborations with leading UK research groups

51

Mobility Grants awarded to international researchers with funding towards UK visits to strengthen research capacity and collaborations

Global Challenges Research Fund (GCRF) – part of the UK's official development assistance

GCRF funding is available for research addressing a significant problem or development challenge and directly contributing to the sustainable and inclusive prosperity of people in developing countries

34

Challenge Grants awarded for work on research questions relating to global challenges

10

International Collaboration Awards made

3

University Research Fellowships funded through the GCRF

2

Dorothy Hodgkin Fellowships funded through the GCRF

Meet the scientists: International Fellowships

Dr Anand Prakash Maurya

Royal Society-SERB* Newton International Fellowship

“Antimicrobial resistance is becoming a global concern and one of the greatest threats to human health, and it is rising day by day. So, we need to address it urgently – if it is not addressed by 2050, it could kill more people than road traffic accidents or cancer.”

For the duration of his Fellowship, Dr Maurya is based at the University of Birmingham, conducting research into elimination of bacterial plasmids responsible for spread of antibiotic resistance genes, under the supervision of Professor Christopher Thomas.

“There were several reasons I applied for a Newton International Fellowship. Firstly, as this Fellowship is a collaboration between the United Kingdom and India, both the individual (me) and the countries benefit from it. The Fellowship is provided by the Royal Society which is one of the most prestigious scientific academies; this allows me to meet other researchers in my field, develop my research network and establish collaborations. Also, my Fellowship is enabling me to work with a world-leading expert, Professor Christopher Thomas, who is a pioneer in my research field.

Antimicrobial resistance is a growing challenge worldwide, for various reasons including overuse and use without prescription, as well as lack of proper control policy. The host laboratory for my Fellowship, Professor Thomas’s lab, has been pioneering a response which is called ‘plasmid curing’, or a ‘pCURE’ system. We are trying to manipulate plasmids and make an efficient plasmid (pCURE system) that can displace the bacterial plasmids that cause bacterial resistance. I am trying to make an efficient plasmid that will displace the resistance-causing plasmid from the gut microbiome.

My research could have great impact in future, as curing of plasmids is one alternative approach which could restore the ability to control infection by pathogenic strains. Plasmids are quite diverse and have a broad host range and complex organisation, so understanding their biology will help to underpin their exploitation.”



Above

Dr Anand Prakash Maurya, awarded the Royal Society-SERB Newton International Fellowship in 2016.

*Science and Engineering Research Board (of India).

**Above**

Dr Nadia Martinez Villegas, Newton Advanced Fellow and Associate Professor of Geochemistry at the Instituto Potosino de Investigacion Cientifica y Tecnologica in Mexico.

Meet the scientists: International Fellowships

Dr Nadia Martinez Villegas

Newton Advanced Fellow

“One of the things that is exciting about my work is the opportunity to discover how arsenic interacts with the ecosystem that survives in such a contaminated environment.”

Dr Nadia Martinez Villegas was awarded the Newton Advanced Fellowship in 2015 for a collaboration with Professor Bhaskar Sen Gupta at Heriot-Watt University.

“I study arsenic in the environment. There were unbelievably high concentrations of arsenic reported as having been found in the surface and groundwater of a particular semi-desert area in Mexico. I wanted to know the origin of that contamination, how it varied over space and time, and the extent and the impact of its pollution.

The support of the Newton Advanced Fellowship is helping me to better understand the chemistry of the contaminant, and in turn how we could help the people affected. The experience of Professor Sen Gupta in helping people to have access to safe water is enabling me to approach the social problematic of arsenic in my study area. Arsenic has contaminated water, soil and crops, as well as people, as measured by arsenic concentration in their hair. The lack of awareness and poverty in Cerrito Blanco, Matehuala, in the San Luis Potosi state in Mexico seem to combine to exacerbate the arsenic exposure problem.

We are looking to estimate the risks to the rural population exposed to arsenic, and the pollution of arsenic in agricultural soils. We are also looking to educate the population to avoid arsenic, to the extent it is possible to do so. Without the support of this Fellowship, I would not have had the opportunity to do this for my people, at least not at this stage of my scientific career.”

Meet the scientists: International Fellowships

Professor Gad Frankel

Royal Society International Collaboration Award

“Frequent episodes of diarrhoea lead to stunted growth and the associated delay in developmental milestones can have an impact even later in life. Our research aims to understand why these frequent episodes of diarrhoea cause such severe illness.”

Gad Frankel is Professor of Bacterial Pathogenesis at the Department of Life Sciences and the MRC Centre for Molecular Bacteriology and Infection (CMBI) at Imperial College London.

“We were attracted to the Royal Society International Collaboration Awards scheme to fund our Enterotoxigenic Escherichia coli (E coli), or ETEC, project as there was no need for extensive preliminary data and as we appreciated it will allow the exchange of personnel between the two laboratories.

Diarrhoeal disease is a major cause of illness around the world, but the worst affected are children in developing countries. In endemic low- and middle-income countries in Africa and Southeast Asia, strains of ETEC that produce the enterotoxin ST and LT cause 280 – 400 million cases of diarrhoea in children under five years of age and over 300,000 deaths annually.

Our research aims to understand why frequent episodes of diarrhoea cause such severe illness. Are there permanent changes in gut physiology as a result of fluid and salt loss during diarrhoeal episodes? Are there changes in the gut microbiome that now result in sensitivity to certain dietary factors? Do these changes in the microbiome increase the susceptibility to other infections? We will use mouse models that mimic the disease

seen in humans, and study the changes in the gut using advanced molecular and cell biology approaches. We anticipate that our work will lead to a greater understanding of the changes that occur in the gut that may also be seen in individuals that suffer from irritable bowel syndrome, Crohn’s disease and colon cancer.

At the CMBI at Imperial College we identified the Indian Institute of Science in Bangalore as an ideal strategic partner. In one-on-one meetings it quickly became apparent that our interest in understanding the complexities of diarrhoeal disease was complementary. We see engagement of young researchers working in our lab in a collaborative project between UK and India as an important added benefit. More generally, with changes in the economic climate of the UK and the growth of India as scientific force, our collaboration would showcase what is possible when these two historically linked nations attack a problem primarily relevant to the needs of developing countries, but also to the UK.”



Above

Professor Gad Frankel, awarded a Royal Society International Collaboration Award in 2016 for a collaboration with Professor Sandhya Visweswariah from the Indian Institute of Science in Bangalore.



Above

Sir Venki Ramakrishnan speaking at the opening ceremony of the Commonwealth Science Conference 2017. Image credit: National Research Foundation Singapore.

European Union: making the case for science

Ahead of the EU referendum in June 2016 and since its outcome we have worked to achieve the best possible outcome for science, collaborating with our sister and European academies, working with our Fellows, engaging in Parliamentary activities and collaborating with other organisations to support research and innovation in post-Brexit Britain.

In advance of the referendum we published three reports on the role of the EU within UK research to inform debate. Following the result we successfully argued for the Government to underwrite the value of any European grants awarded to UK researchers for the full award period. We welcomed the inclusion of science and innovation in the Prime Minister's 12 priorities for negotiations on leaving the EU and we launched a social media campaign, *#SciencelsGlobal*, to emphasise the importance of the international nature of research – to date it has reached more than 9.5 million people globally.

“One of the great strengths of UK research has always been its international nature, and we need to continue to welcome researchers and students from abroad. Any failure to maintain the free exchange of people and ideas between the UK and the international community including Europe could seriously harm UK science.

In the past, UK science has been well supported by EU funding. This has been an essential supplement to UK research funds. In the upcoming negotiations we must make sure that research, which is the bedrock of a sustainable economy, is not short-changed, and that the Government ensures that the overall funding level of science is maintained.

Many global challenges can only be tackled by countries working together and it is easier to work together when policy and regulation are consistent. In negotiating a new relationship with the EU we must ensure that we do not put unnecessary barriers in place that will inhibit collaborations.”

Sir Venki Ramakrishnan, President of the Royal Society, in response to the UK's decision to leave the European Union.

Commonwealth Science Conference: a unique opportunity to discuss common challenges

Building on the legacy of our 2014 Commonwealth Science Conference, we are working with the National Research Foundation of Singapore on the next Commonwealth Science Conference in June 2017.

The conference brings together leading scientists to showcase the best science from across the Commonwealth – providing opportunities for cooperation between researchers. It aims to inspire young scientists, students and pupils, build understanding about policy issues of common interest and encourage scientific capacity building. Areas covered include new technologies, the future of the oceans, emerging infectious diseases, sustainable cities and low-carbon energy.

Education and public engagement

Science is central to modern culture and the Society is committed to increasing opportunities for everyone to engage with science, both through the formal education system and in other ways.

How our activities reached people

Public engagement overview

43,700

people attended 65 Royal Society events during the year

19,000

of those attended events outside London including 12,000 visitors to our satellite Summer Science Exhibition in Manchester

Summer Science Exhibition 2016 – a week long festival of cutting-edge science



21 exhibits

of cutting-edge UK-based scientific research and technology showcased



14,000 visitors

across the week



▲159%

1,313 visitors

on preview night

Science matters series with Professor Brian Cox FRS – giving the public access to scientists who are experts on science and technology issues with global impact

3,700

tickets sold

6,300

watched livestreams

43,000

YouTube views

Questions asked by participants during our Science matters series:



What one change would have the single biggest impact to slow down climate change?

Have we gone past the 'tipping point' or can we save the planet?

How do we stop machines enslaving us?

Any recommendations for AI-proof careers?

Why is there so much scepticism behind GM crops?

How do we know science is real?

Experimental science

In March 2017 we launched a series of 24 experimental videos for schools with Professor Brian Cox, the Society's Professor of Public Engagement in Science, to increase teachers' confidence with experimental science and to relate the experiments to the real world. The complete series of *Brian Cox Schools Experiments* can be found on our YouTube channel.

People of science

Filming is underway for a series of *People of science* films featuring Professor Cox interviewing Fellows of the Royal Society about a figure from science who they admire. The first four films will be released on our YouTube channel in autumn 2017 featuring Bill Bryson FRS, Sir David Attenborough FRS, Dame Sally Davis FRS and Professor Uta Frith FRS.



Above
Professor Brian Cox FRS.



Left
Professor Uta Frith FRS (left) and Professor Brian Cox FRS (middle) during the filming for the *People of science* film series.

Summer Science Exhibition 2016

Our free, week-long festival celebrating the cutting-edge of UK science includes a packed programme of events alongside more than twenty exhibits featuring innovative research being done across the UK.



Images

Visitors at the Summer Science Exhibition 2016.

Partnership Grants scheme

Our Partnership Grants scheme provides grants for science, engineering and mathematics projects run at primary and secondary schools and colleges in partnership with a STEMM professional. In 2016/17 we awarded 37 grants to 15 successful primary schools and 22 successful secondary schools totalling £88,505.

Royal Society archives

Items from the Royal Society archives, including the Shelton chronometer used in James Cook's second voyage, feature in the video work *In Pursuit of Venus (infected)* by the 2017 Venice biennale representative of New Zealand, the artist Lisa Reihana.



Left
Partnership Grants
Conference 2017.

Below
*In Pursuit of Venus
(infected)* part of the
Lisa Reihana: Emissaries
exhibition at the 2017
Venice biennale. Photo
taken by Michael Hall.
Image courtesy of New
Zealand at Venice.

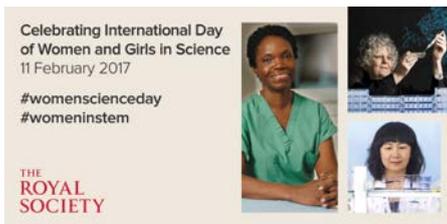


Our year in digital media

Digital overview



Twitter



1,600 retweets
for our tweet on Women in Science Day in February

“Science is global because it addresses challenges such as hunger, disease and environmental damage that do not respect borders.”

Venki Ramakrishnan, President of the Royal Society.

THE ROYAL SOCIETY #SciencelsGlobal



Number 1 for #AdaLovelaceDay – our tweet was the biggest supporting Ada Lovelace Day in October

9.5 million people reached by our #SciencelsGlobal campaign, with over **12,000 retweets** and over **15,900 mentions** across social media



5.3 million people reached by our #AndAScientist campaign, with over **2,000 mentions** across social media



7 million people reached by our campaign on Twitter to celebrate Commonwealth Day in March

Facebook



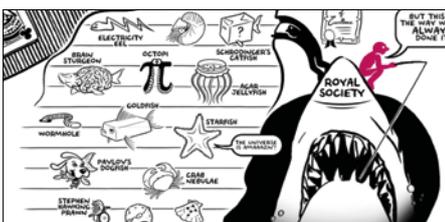
260,000 people were reached by our Facebook post celebrating the birthday of Alan Turing FRS in June

Facebook and YouTube



23,100 views of our *What is gene editing and how does it work?* animation across YouTube and Facebook

YouTube



81,000 views of our *Unconscious Bias* animation on YouTube



510,000 minutes watched of the *Brian Cox presents Science Matters – Climate Change* film on YouTube



100 films produced in the *Objectivity* series with Brady Haran, with over **100,000** subscribers

Our year in press

GM plants: Questions and answers report



© John Innes Centre

Over 100 pieces of coverage

for our **GM plants: Questions and answers report**, including *The Guardian*, *The Times*, *Financial Times*, *New Statesman*, *the Conversation*, *The Independent*, BBC news and Radio 4's *Today* programme

Royal Society Insight Investment Science Book Prize



200 mentions

of the **Royal Society Insight Investment Science Book Prize 2016** – broadcast highlights included *Newsnight*, BBC Radio 4's *Today* programme and BBC Radio 6. Print and online highlights included *The Guardian*, *Daily Mail* and *The New York Times*

Summer Science Exhibition 2016



Highlights of coverage

of our **Summer Science Exhibition 2016**, included BBC's *The One Show*, BBC London radio, Classic FM, *Time Out*, *The Daily Telegraph*, *The Times*, *The Guardian*, *Daily Mail* and *London Evening Standard*

Machine learning



© shuiz

Featured in media

including BBC *Breakfast*, BBC World Service, BBC Radio 4's *Today* programme, *The Guardian*, *Financial Times* and *New Scientist*

Fundraising and development: support for the Royal Society

Right

Andrea Wulf, winner of the Royal Society Insight Investment Science Book Prize 2016, for *The invention of nature*.

The Society has relied on the generous support of philanthropists throughout its history. This year the Society received funding from trusts, foundations, companies and individuals enabling the Society to deliver a wide range of programmes in support of its strategic aims. The following case studies illustrate the breadth of the activities for which the Society receives valued support.

The Royal Society Tata Programme for the Physical Sciences and Engineering

In June 2016 the Society launched a new partnership with the Tata group. The Royal Society Tata Programme for the Physical Sciences and Engineering expands the Society's University Research Fellowships (URF) programme with nine new URFs supported over ten years.

In addition to the new URFs, Tata is also supporting an annual *Meeting of Minds* event hosted by the Society. This event brings together the Royal Society Tata URFs and other Royal Society research fellows including Royal Society URFs, Dorothy Hodgkin Fellows, Industry Fellows and Newton International Fellows to inspire the cross-fertilisation of ideas and expertise, to encourage innovation across the disciplines.

The expanded programme would not have been possible without the support of Tata Sons Limited, Tata Consultancy Services and Jaguar Land Rover, and this represents the Society's largest corporate gift to date.



The Royal Society Insight Investment Science Book Prize

Insight Investment became a new corporate partner for the Society in 2016, thanks to their support of what is now known as the 'Royal Society Insight Investment Science Book Prize'. The Royal Society's prize for science books is the only major international prize to celebrate science writing for a general audience. The new agreement with Insight Investment has secured the prize for a further three years, during which it will celebrate its 30th anniversary in 2017.

The Royal Society Insight Investment Science Book Prize is essential to the Society's mission of promoting the value of science to a wide audience, beyond the scientific community, to encourage as many people as possible to engage with science.



Left
Professor Lisa Jardine
CBE FRS.

The Royal Society Lisa Jardine Research Awards

Professor Lisa Jardine CBE FRS spent a lifetime of research working in Renaissance and Early Modern disciplines, partly in the history of science, but most characteristically in interdisciplinary studies within the seventeenth and eighteenth centuries. Lisa was made an Honorary Fellow of the Royal Society in 2015 for her contribution to the history of science. She passed away in October 2015. Thanks to the support of Lisa's family and friends, the Society is able to fund the Royal Society Lisa Jardine Research Awards in her memory.

The awards will invest in the future of early career scholars providing access to the archive sources, with particular access to the Society's own archives. The Society is proud to be able to continue Professor Jardine's legacy and promote interdisciplinary scholarship.

Science on Stage

In February 2017 the Society secured funding to support the attendance of 12 UK teachers at the Science on Stage Europe festival and give them the opportunity to participate in the post-festival activities. The Society's ability to support the attendance of these teachers is due to the support of the Ogden Trust and seven of the Society's Fellows.

Science on Stage is Europe's biggest educational festival for STEM teachers. The Science on Stage festival provides a platform for science teachers to share inspirational high-quality activities and exchange ideas, projects and teaching concepts at stands, workshops and on stage.

Thank you

The Society is grateful for the outstanding level of support from all our donors listed below and those who have chosen to remain anonymous over the last financial year.

Companies

AstraZeneca UK Limited
Drapers' Company
GlaxoSmithKline (GSK)
Google Europe, Middle East and Africa
IBM United Kingdom Trust
Insight Investment
Jaguar Land Rover Limited
Lifschutz Davidson Sandilands
L'Oréal (UK) Limited
Rolls-Royce Group plc
Tata Consultancy Services Limited
Tata Sons Limited

Fellows and Foreign Members

Sir Geoffrey Allen FREng FRS
Sir Tom Blundell FMedSci FRS
Sir Walter Bodmer FMedSci FRS
Professor Harry Bryden FRS
Professor Robin Carrell FMedSci FRS
Sir John Enderby CBE FRS
Sir James Gowans CBE FMedSci FRS
Professor Ian Grant FRS
Professor Roger Heath-Brown FRS
Professor Volker Heine FRS
Professor Antony Hewish FRS
Sir Antony Hoare FREng FRS
Professor Judith Howard CBE FRS
Professor Eric Jakeman FRS

Professor Bruce Joyce FRS
Professor Steven Ley CBE FMedSci FRS
Professor Robert Lloyd FRS
Sir Ravinder Maini FMedSci FRS
Professor Michael Edgeworth McIntyre FRS
Dr Andrew McLachlan FRS
Professor Tom Meade FMedSci FRS
Professor James Naismith FMedSci FRS
Professor Jeremiah Ostriker ForMemRS
Professor John Pickett CBE FRS
Sir Martyn Poliakoff CBE FRS
Professor Susan Rees FRS
Professor Peter Richardson FRS
Professor Ian Smith FRS
Sir Jim Smith FMedSci FRS
Professor Veronica Van Heyningen
CBE FMedSci FRS
Professor Martin Vessey CBE FMedSci FRS
Professor Jeffrey Watkins FMedSci FRS
Professor Peter Wells CBE FMedSci FREng FRS
Professor John Willis FRS
Dr Ian Young OBE FREng FRS

Individuals

Mrs Natalia Benjamin
Mr Robert Dixon
Mr Alan Entwistle
Mrs Judith Gibson
Dr Malcolm Gray
Mr Matthew Gray
Mr John Hare
Mr John Hull
Mr Phillip Hyett
Mr Kamal Kharrazi
Mr Alexander Laws
Mr George Leach
Mrs Tania Little
Professor Sharon Long
Mr James Miller
Mrs Tracey Olsen
Mrs Helen Page
Dr Ann Shirley
Mr Robert Timperley
Mr Donny Tran
Mr Reinalt Vaughan-Williams
Lady Fiona Wilson
Mr Stefan Young
Mrs Shirley Zangwill

Trusts and Foundations and Livery Companies

The EPA Cephalosporin Research Fund
The Dana Foundation
Darwin Trust of Edinburgh
The Edina Trust
The Gatsby Charitable Foundation
The Goldsmiths' Company Charity
The Grantham Foundation for the Protection of the Environment
The Kavli Foundation
The Kohn Foundation
The Leverhulme Trust
The Ogden Trust
Queen Elizabeth Diamond Jubilee Trust
Society of Chemical Industry
Sino-British Fellowship Trust
The Woodward Charitable Trust
The Wolfson Foundation
K. C. Wong Education Foundation

Legacies

Mr Michael Crowley-Milling
Mr Felton Downes
Dr Marjorie Ann England
Mr George Hitchen
Mrs Janet Smith



The Royal Society is a self-governing Fellowship of many of the world's most distinguished scientists drawn from all areas of science, engineering, and medicine. The Society's fundamental purpose, as it has been since its foundation in 1660, is to recognise, promote, and support excellence in science and to encourage the development and use of science for the benefit of humanity.

The Society's strategic priorities emphasise its commitment to the highest quality science, to curiosity-driven research, and to the development and use of science for the benefit of society.

These priorities are:

- Promoting excellence in science
- Supporting international scientific collaboration
- Demonstrating the importance of science to everyone.

For further information

The Royal Society
6 – 9 Carlton House Terrace
London SW1Y 5AG

T +44 20 7451 2500

W royalsociety.org

Registered Charity No 207043

August 2017 DES5030