Welcome

Volume 68 once again provides a remarkable panorama of the diversity and outstanding scientific achievements of Fellows of the Royal Society. This volume includes one President of the Society (Aaron Klug), three Nobel Prize winners (Klug, Sherry Rowland and Ahmed Zewail), five Foreign Members (David Chandler, Erwin Hahn, Ilkka Hanski, Rowland and Zewail). The Memoirs themselves speak volumes about the distinction and originality of their work, as do all the others included in this volume.

Once again, there is a strong biomedical theme running through this volume with five Memoirs in the areas of medical sciences, physiology and pharmacology and three in cellular, molecular and structural biology. Reading these in parallel brings home forcefully the impact of basic biological science upon medical practice and vice versa.

News

The main news is that, as of 1 January 2020, all the Memoirs are now freely available to everyone as soon as they appear on the website. This significantly enhances access of the Memoirs for everyone, and we are very grateful to the Society for enabling this to happen. The Memoirs are a wonderful vehicle for conveying what we value about the sciences in general. The lives of the Fellows illustrate the diversity of background, nationality, upbringing and education which all contribute to the development of the talents of the individuals. We urge readers to spread the good news and encourage colleagues to use the material in the Memoirs to illustrate how real science works and the importance of the individuals’ personal contributions.

A second news item is that we have had a significant turn-over of membership of the Editorial Board. We are enormously grateful to those who have retired for their unstinting help and support in enabling the team to meet the challenges of making Biographical Memoirs complete so far as the coverage of Fellows is concerned. We have had nothing but very professional and creative interactions with these Board Members and we wish them well in the coming years. The new team is listed on the preliminaries of this book. We look forward to continuing the momentum we have generated over the last four years with a premier league group of colleagues.
INTERNATIONAL SCIENCE

Writing in the last week before the UK formally leaves the European Union is a poignant moment. A particularly notable feature of Volume 68 is how international the activities of the Fellows of the Society are, and how crucial that international dimension was in their success. Gustav Born grew up in Germany, but worked in the UK; Ben Burns worked in Canada; the five Foreign Members worked in the USA, Egypt and Finland; Robin Clark and Guy Dodson were born in New Zealand, but carried out their research in the UK. But in addition, all the Memoirs illustrate the essential role which international interchange of ideas, cooperation and collaboration plays in successful and ground-breaking science.

The Royal Society plays an essential role in keeping open channels of communication even when diplomatic relations are at a low ebb. On a personal note, I am forever grateful to the Society for the award of an Exchange Research Fellowship to the Soviet Union for the academic year 1968–1969. I arrived in Moscow one month after the invasion of Czechoslovakia, but this had no impact on the huge amount I and my colleagues in Moscow were able to achieve during that year and, even more important, the opportunity to make Soviet science better known in the West. There are many examples of the crucial role which international cooperation plays in the progress of science through the past volumes of the Memoirs. We are regularly asked to provide factually based evidence for the value of such collaborations and my answer is ‘read Biographical Memoirs’ and find out how the best scientists made their scientific breakthroughs. In many cases, the international dimension was crucial. The preservation of international collaboration in the years to come is a key priority which is fully appreciated by the Society.

Memoirs are published on the Biographical Memoirs website as soon as they are ready, before being collected into the annual printed volumes, so please look out for new essays throughout the year.

Biographical Memoirs Volume 68

There are 22 Memoirs in this first of two volumes of Biographical Memoirs for 2020, spanning a huge range of the sciences. The following notes are intended to act as a guide to the different disciplines represented, with brief summaries of the achievements of the Fellows, largely taken from the Memoirs’ synopses. These, and previous volumes, can be accessed on the Royal Society website.

Atmospheric science

Frank Sherwood ‘Sherry’ Rowland was a chemist who made substantial contributions in the fields of radiochemistry and atmospheric science. He is best known for his research on the stratosphere as, with Mario Molina, he wrote the seminal paper describing how chlorofluorocarbons deplete the stratospheric ozone layer, noting that any ozone depletion would be accompanied by a consequent increase in ultraviolet radiation at the earth’s surface. In 1995 he, along with Mario Molina and Paul Crutzen, was awarded the Nobel Prize for this ground-breaking work.

Cellular, molecular and structural biology

Guy Dodson’s scientific reputation is based on his seminal contributions to linking chemistry and biology through analyses of three-dimensional structures elucidated by crystallography.
He inspired and supported the development of new methods to determine structure, to relate structure to chemical mechanism and to embed structural insights into the lexicon of biological research. He is particularly remembered for his research into improving insulin therapy, based on modifications suggested by structural insights.

David Gadsby pioneered biophysical research that advanced our mechanistic understanding of ion-transporting proteins in biological membranes. His passion for hands-on DIY electrophysiology, his depth of analytical rigor, and his idiosyncratic scientific aesthetic expanded the edge of discovery in two areas: the electrical character of the Na\(^+\) pump, and the molecular workings of ‘CFTR’, the chloride ion channel whose mutations cause cystic fibrosis.

Aaron Klug made outstanding contributions to the development of structural molecular biology. An early interest in viruses resulted in his proposing a method for making three-dimensional maps of biological specimens from their projected electron micrograph images. For this development and its application to complex molecular assemblies, he was awarded the 1982 Nobel Prize in Chemistry. He applied X-ray crystallography and electron microscopy to determine the structures and thereby understand the functions of many biological assemblies, including viruses, transfer RNA, chromatin and zinc fingers.

**Chemistry**

Robin Clark was a distinguished physical/inorganic chemist who made major discoveries in the coordination chemistry of the early transition metals, especially of titanium and vanadium complexes with high coordination numbers and of the structures and physical properties of mixed valence, linear chain and metal–metal bonded compounds. He made seminal applications of microbeam Raman spectroscopy for the identification of pigments and other constituents of artworks and historical artefacts, thereby developing a basis for testing their provenance and the identification of forgeries.

Norman Greenwood was a member of the group of distinguished post-Second World War inorganic chemists who created modern inorganic chemistry. He was particularly recognized for his contributions to the chemistry of the main group elements boron, especially the metallaboranes, aluminium and gallium and for his contribution to the application of Mössbauer spectroscopy to inorganic systems.

Ahmed Zewail will be remembered for three main reasons: first, he was the individual who first demonstrated that the structure and dynamics of atoms in the transition state of chemical reactions could be determined through the judicious use of ultrafast lasers; second, he transformed both gas phase electron diffraction and transmission electron microscopy by improving their temporal resolution by some 10 orders of magnitude, while simultaneously retaining the spatial resolution of electron microscopy at the atomic level; third, he was the first US Science Envoy to the Middle East. He was the sole winner of the Nobel Prize in Chemistry in 1999.

**Ecology and environmental science**

Ilkka Hanski made seminal contributions to both empirical and theoretical ecology and evolutionary biology, in particular metapopulation biology. His most influential research was based on empirical work on the Glanville fritillary metapopulation in the Åland Islands, started in 1991, and continued until his death. His early research focused on ecological aspects of metapopulation biology, whereas his later work focused on genetic and evolutionary
processes. During the last years of his career, Hanski was a pioneer in the field of eco-evolutionary dynamics, showing how molecular-level underpinnings of trait variation can explain rapid evolutionary changes in natural populations.

**Paul Jarvis** was a plant ecologist and physiologist, who pioneered the scientific analysis of the exchange of water and carbon dioxide between forests and the atmosphere, and laid the foundations for decades of study on the interplay between forests and the climate system. He was one of the first to measure directly the photosynthesis and transpiration of forests, and leading from this, his analysis of the relationships between the physiology of plants and the weather has informed and inspired a generation of young scientists.

**Engineering**

**Sydney Andrew** was an outstanding chemical engineer. His career with ICI was notable. Early work when he was a plant manager led to the development of a systematic procedure for plant maintenance, the forerunner of ‘critical path scheduling’. He did pioneering work on the absorption of gases into liquids where the dissolved gas reacts with the liquid and he helped develop catalysts for the steam reforming of naphtha, leading to the installation of many plants to provide gas for domestic use.

**Howard Rosenbrock** was a major figure in automatic control. After R&D work in post-war industry, he moved to university research, where he made fundamental contributions to algebraic systems theory and to control design methods assisted by interactive computing. He established the Control Systems Centre at the University of Manchester Institute of Science and Technology, which became a centre of excellence under his leadership.

**Geology**

**Raymond Casey** was an internationally recognized expert in two entirely different fields—Geology and Philately. His doctoral thesis, begun at the age of 38 on Lower Greensand stratigraphy and palaeontology, was an outstanding study that led to major publications including a nine-part monograph of the ammonite faunas. In the late 1950s he also began to study faunas from Jurassic–Cretaceous boundary beds in eastern England. On the first visit to the Soviet Union he met Academician Dmitri Nalivkin in Leningrad, an eminent geologist and keen philatelist. This led to Raymond taking an enthusiastic interest in pre-revolutionary Russian postal history which, after his retirement, became his main research interest.

**Medical sciences, physiology and pharmacology**

**Gustav Born** made fundamental contributions to the study of blood platelets and their role in thrombogenesis. Working first on the biochemistry of these cells and their granules, he later devised an extremely effective method to measure their dynamic responses when stimulated to aggregate by pro-thrombotic stimuli. This Born Aggregometer revolutionized the study of platelets and the diagnosis of platelet-related disorders.

**Benedict Burns** was a pioneer of operations research and of the statistical analysis of neuronal activity. After the war he worked with G. L. Brown at the National Institute for Medical Research (NIMR) where he investigated the effects of agents that affected neuromuscular transmission. In 1950, at McGill University, he explored the properties of neural networks in neurologically isolated slabs of cerebral cortex and established the mechanisms responsible for maintaining rhythmic periods of excitation in isolated nerve networks. He subsequently provided evidence that self-re-exciting neural networks were
implicated in establishing the respiratory rhythm. In 1966 he returned to NIMR where he continued his investigations of visual perception.

Alan Cuthbert carried out ground-breaking work on epithelial ion transport. He used radiolabelled amiloride and benzamil to measure the sodium channel density in epithelia from frog skin and toad bladder, tissues that are good models for the distal section of the mammalian kidney tubule. Later, he focused on the ion transport deficits that underlie cystic fibrosis (CF), and was a member of the team that showed that the ion transport defect could be corrected in CF transgenic mice by gene therapy.

Patrick Mollison was a pioneer in blood transfusion, playing a major role in changing it from a risky procedure to one which is now extremely safe. His first major contribution was to devise a mechanism whereby blood could be stored for more than just short periods. He later took a special interest in haemolytic disease of the newborn (HDN), which was largely due to Rhesus incompatibility between mother and baby. He was also involved with work which eventually led to HDN becoming preventable with the use of anti-D treatment of mothers. He was physician to Her Majesty Queen Elizabeth and was present at the birth of all four of her children.

Edward (Os) Reynolds was the founding father of neonatal medicine in the United Kingdom. He brought to the field a new emphasis on scientific medicine and intellectual rigour with an adventurous investigative and collaborative spirit. He inspired a team of clinicians and scientists who contributed to major advances in our understanding of lung disease in preterm infants and of neurological insults arising in the perinatal period that have contributed to the markedly improved survival and developmental outcomes observed in the twenty-first century. The whole-body cooling, now widely utilized in the management of perinatal asphyxia, owes its introduction to the ground-breaking research utilizing magnetic resonance spectroscopy in animal and newborn studies initiated by him.

Psychology

Anne Treisman dedicated her career to the study of attention and perception. While still a graduate student, she modified and reformulated the leading theory of auditory attention. Her discoveries and insights into the role of visual attention in the perception of objects, to which she devoted her subsequent decades of research, have had a lasting influence, not only in experimental psychology but also in vision research, neuroscience and artificial intelligence.

Physics

David Chandler made significant advances in many areas of statistical mechanics theory—the structure and thermodynamics of simple liquids and nonpolar molecular liquids, the nature of hydrophobic hydration and hydrophobic interactions in aqueous systems, chemical reaction rates, quantum processes in liquids such as electron transfer and the solvation of an excess electron in water, ‘transition path sampling’ and the ‘dynamic facilitation’ theory of the properties of supercooled liquids and the glass transition.

Erwin Hahn was one of the most innovative physical scientists in recent history, impacting generations of scientists through his work in nuclear magnetic resonance, optics, and the intersection of these two fields. Starting with his discovery of the spin echo, a phenomenon of monumental significance and practical importance, Hahn launched a revolution in how we think about spin physics, with numerous implications following in many other areas of science.
Anthony Lane became one of the world’s leading theoretical nuclear physicists. His career in the Theoretical Physics Division at the Atomic Energy Research Establishment at Harwell was characterized by his outstanding successes in explaining experimental nuclear data. He pioneered the understanding of the important nucleon capture reactions by introducing new mechanisms of direct and semi-direct capture and, together with colleagues, he greatly advanced knowledge of nuclear analogue states, and the role of isospin in nuclear physics.

(William) James Stirling’s wide-ranging contributions to the development and application of quantum chromodynamics were central in verifying QCD as the correct theory of strong interactions, and in computing precise predictions for all types of collider processes. He published more than 300 papers on a vast range of phenomenological topics, including some of the most highly cited of all time in particle physics. At Durham he formed a famous long-standing collaboration that set the standard for determining the quark and gluon distributions in the proton.

ACKNOWLEDGEMENTS

First and foremost, we are enormously indebted to the authors of the Memoirs in this volume for their outstanding work in producing biographies of lasting value. These are authoritative and full of interest and pleasure for the insight they provide into a number of outstanding scientists. We are also grateful to the United States National Academy of Sciences (NAS) for allowing us to co-publish their Memoirs of David Chandler and Erwin Hahn. I am also personally indebted to the Editorial and Production teams at the Royal Society whose names and roles are listed on the title page. Their outstanding efforts have enabled us to continue the enhanced rate of publication of the Memoirs while maintaining the excellence of their content and high production values. Finally, the Editorial Board have been very helpful indeed in supporting the increased activity by suggesting Memoir writers, helping with refereeing and keeping a sharp eye on all aspects of the growth of Biographical Memoirs.

AUTHOR PROFILE

Malcolm Longair

Malcolm Longair CBE FRS FRSE is Jacksonian Professor Emeritus of Natural Philosophy and Director of Development, Cavendish Laboratory, University of Cambridge. He was appointed the ninth Astronomer Royal of Scotland in 1980, as well as Regius Professor of Astronomy, University of Edinburgh, and the director of the Royal Observatory, Edinburgh. He was head of the Cavendish Laboratory from 1997 to 2005. He has served on and chaired many international committees, boards and panels, working with both NASA and the European Space Agency (ESA). His main research interests are in high energy astrophysics, astrophysical cosmology and the history of physics and astrophysics. His current projects include a third edition of his book Theoretical concepts in physics to be published in Spring 2020, continuing to enhance the online digital archive of historic photographs illustrating the history of the Cavendish Laboratory and preparing for the move to the new Cavendish Laboratory in 2022.