Personal perspectives in the life sciences for the Royal Society’s 350th anniversary

2010 is the 350th anniversary of the Royal Society. The Philosophical Transactions of the Royal Society, first published in 1665, while being a few years younger than the society itself, is still the oldest scientific journal printed in the English-speaking world and the world’s longest running scientific journal in continuous production. Our authors have included many of the most outstanding scientists of the times including Isaac Newton, Michael Faraday and Charles Darwin, and the contents have communicated many of the major scientific findings of the past few centuries. Since 1887, the journal has been published as two separate publications, one serving the physical sciences and this one focusing on the life sciences.

The question of what we should do for the 350th anniversary of the society has preoccupied the editorial team since early 2008. One idea, quite common for scientific publishing anniversaries, was that we should identify key papers that had been published in the journal during its long history and republish them with commentary from a contemporary specialist, bringing the science up to date. Another idea was to focus specifically around a small number of contemporary controversies. However, we agreed that while the 350th anniversary is an important historical moment for the Royal Society, the moment was right to consider the state of the science and its future directions rather than simply to celebrate important historical findings. Our intention then was to produce an issue that would be forward-looking, providing a resource for the present and future more than a record of the past. We decided that a good way to do this would be to invite key thinkers on the contemporary topics of great interest and importance to review where their field was situated, give their perspectives and try to point to some promising as well as less promising routes for the future.

What are the contemporary topics of high interest and importance? There are various possible means to identify these, but our deliberations were given a helpful boost by a survey the Royal Society undertook in late 2007, asking fellows and university research fellows to briefly indicate what they thought were the ‘biggest gaps in knowledge’. The group polled is probably neither random nor well sampled but can at least be regarded as well informed and relevant for the task. Their responses were unsurprisingly divergent and also had a tendency to be either very specialized or very general. Rather alarmingly, or perhaps rather charmingly, many wrote about the current issues in their own particular research area. But there was also quite a strong convergence of views from across the wide range of specialisms sampled, towards just four or five major topics in the life sciences. Probably, the most common were the topics to do with complex biological systems, especially the brain and genetic control of organism function. Many respondents cited questions related to brain function; how the mind relates to the brain; human and animal cognition, consciousness and the emerging links to neurobiology. A related set of topics concerning the nature of intelligence, biological information processing and the way in which artificial intelligence systems can help us to understand complex biological processes were also common. A second set of topics raised by many concerned genome to organism processes, ways in which the emerging technologies associated with sequencing and bioinformatics might contribute to our understanding of the way that the genome controls the functioning of organisms. Also commonly raised was the long standing but still unresolved set of questions about the origins of life and the sources and maintenance of variability. Finally, and notably, the more commonly mentioned by the junior research fellows was a set of topics around environmental change, human population growth, sustainability and the future of life on Earth.

Using this set of topics as a starting point, we identified leading researchers working across the biological sciences, but especially in these areas. We invited them to consider the big questions in the broad field in which they work, to identify new or promising approaches as well as the aspects of research where they were sceptical about the current and conventional wisdom. Another non-random sorting then took place as different people accepted or declined the offer, but the final collection is pretty well balanced across the key topics.

The order in which the papers are presented starts with the set of issues and problems related to sustainable development in the face of environmental degradation, failing policies and changing human demography. A closely inter-related set of papers point to the intricate linkages between human societal norms and structures, and the continuing spiral of environmental degradation. Working our way out of this will require integrated solutions across the social, economic and environmental sciences. A poignant
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structured populations. These papers, each based on
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his general analysis of the evolution of cooperation,
significant areas that can inform contemporary debates
about the sustainability of human societies.
The urgency of the problem is highlighted by
Mooney who documents the degradation of biological
systems and of ecosystem services upon which we
depend. While the evidence of driving processes and
possible solutions is becoming clearer, there are
roadblocks to progress that seem to sit at the interface
of the science and policy worlds. May describes the
ecological issues relating to biodiversity loss in the
face of continuing pressures from land for food pro-
duction, energy, population trends and climate
change. How can all these different demands be
accommodated, and how much is the society willing
to accept technological solutions? Even if those solu-
tions do exist and function successfully in the
narrow context in which they are developed, what
might be their unintended side effects or wider
consequences?
Scientific progress will undoubtedly contribute new
solutions. These may come from new science and
technology or from new applications from established
disciplines. Loreau argues for a more coherent ecosys-
tem ecology that brings the intricate processes that
ecology has revealed to bear on resolving the ecosys-
tem service failures that result from environmental
degradation. Beddington assesses impending agricul-
tural and land-use demands with a look at new
 technologies, and Hill examines what quantitative gen-
etics, which essentially gave us the tools for the first
agricultural revolution based on selective breeding,
can deliver in the new genomics era.
Hill's paper neatly provides a link between the
environmental and the applied problems to the suite of
fundamentally interesting issues to do with the or-
gins of life and genetic diversity, the diversification
of life and the predictability of evolution. In this area,
there has been massive progress in recent times,
based partly on the new discoveries but also on new
technologies and experimental systems. One general
conclusion that emerges from this set of papers, most
appropriately in the current celebrations related to
Darwin's anniversary, is the progress in understanding
the shape of the history of life and the role of key
innovations in permitting adaptive evolution. Bell
addresses the tempo and mode of evolution, especially
the conflicting views on whether slow and gradual
evolution can really be the norm given the recent gen-
etic- and field-based evidence for strong selection and
rapid, major changes. Evolutionary novelty and its
potential to influence the nature of diversification
and the appearance of novelties is then detailed by
Barrett, for plant reproductive traits, and by
Cavalier-Smith for the major transformations in the
history of life. The major transitions that underpin
both these papers are discussed in more general
terms by Conway-Morris who presents the evidence
for randomness and open-endedness in evolution,
and concludes that it is more predictable than
generally supposed.
A human demographic shift of particular interest to
many is the current and future shifts to an ageing
population. Linda Partridge's paper provides the link
between evolutionary biology and emerging tech-
niques for medical intervention. An evolutionary
look at ageing clearly points to the multi-disciplinary
nature of the associated health problems. Of enormous
topical relevance, Watt then explains why stem cell
therapies may be of particular relevance across a
range of medical problems affecting both old and
young.
Frith then discusses the emerging links between
neuroscience and social cognition; surely a key area
for future research, where a common approach to
understanding the brain is to examine function
across a range of social processes and situations.
An alternative approach described by Hinton is to develop
computer systems based on biology to help us under-
stand the most complex processes such as visual
processing.
Finally, but by no means least, are two papers
taking different approaches to the emerging genomics
revolution where technologies are providing enormous
amounts of data to inform scientific understand-
ing of genetic control. O'Brien introduces us to some
of the many benefits from this new technology and
some emerging patterns; Brenner reminds us that
sometimes small reductionist experiments can provide
clearer clues to process than mass processing.
There is much to contemplate in these papers, and
many valuable insights. I thank all the authors for their
willingness to think deeply and broadly, and communi-
cate important and complex processes so clearly. A
measure of the success of this volume would be to
see the progress made in these the next time the so-
ciety or the journal has a major anniversary.
Thanks are also due to the Editorial team, especially
Claire Rawlinson and James Joseph, as well as the
members of the journal's Editorial Board for their
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