bbsrc
biotechnology and biological sciences research council

About BBSRC

The Biotechnology and Biological Sciences Research Council (BBSRC) is one of seven Research Councils sponsored through the Government's Office of Science and Technology, and forms part of Research Councils UK (RCUK).

It invests around £300M each year in research that covers the whole of the microbial, plant and animal kingdoms. BBSRC is one of the few public bodies that supports basic research in the veterinary and plant sciences. The Council promotes and encourages Knowledge Transfer from, and commercialisation of, the research it funds.

BBSRC supports over 6000 scientists in universities and other research institutions across the UK. The Council also funds the training of over 2000 postgraduate students at PhD and Masters level.

BBSRC sponsors eight institutes (below) that provide specialist facilities for long-term and interdisciplinary research. Funding from other sources ensures a continuum of science from basic and strategic research through to applied research, often in partnership with industrial or other end users.

BABRAHAM INSTITUTE
research supporting biomedical, biotechnological and pharmaceutical sectors.
www.bi.bbsrc.ac.uk

INSTITUTE FOR ANIMAL HEALTH
working to improve the health and welfare of farm animals and to safeguard the human food chain.
www.iah.bbsrc.ac.uk

INSTITUTE OF FOOD RESEARCH
investigating food safety, diet & health, food materials & ingredients.
www.ifr.bbsrc.ac.uk

INSTITUTE OF GRASSLAND AND ENVIRONMENTAL RESEARCH
research on sustainable grassland systems and the wider managed environment.
www.iger.bbsrc.ac.uk

JOHN INNES CENTRE
plant and microbial research with strategic relevance for food, health, sustainable agriculture and industrial innovation.
www.jic.bbsrc.ac.uk

ROSLIN INSTITUTE
livestock genetics, breeding, welfare and biotechnology.
www.roslin.ac.uk

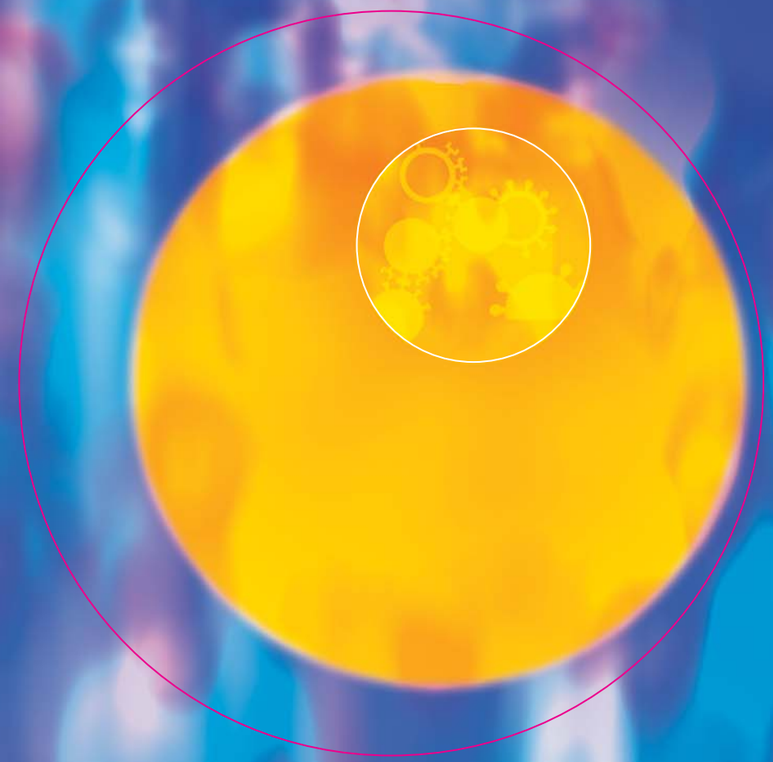
ROTHAMSTED RESEARCH
research on sustainable plant-based agriculture and the environment.
www.iacr.bbsrc.ac.uk

SILSOE RESEARCH INSTITUTE
bio-systems engineering research to benefit the agricultural, food, environmental and biomedical sectors.
www.sri.bbsrc.ac.uk

For further information on BBSRC please visit **www.bbsrc.ac.uk**

Bioscience for Society:
A Ten-Year Vision

"Towards predictive biology"



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> We are moving towards a more collaborative approach to research in the biosciences, such as that adopted by some of the physical science communities.

The Biotechnology and Biological Sciences Research Council (BBSRC)

BBSRC's principal aim is to foster a world-class biological science research community in the UK. Its mission is to fund internationally competitive research, to provide training in the biosciences, to encourage opportunities for knowledge transfer and innovation and to engage the public and other stakeholders in dialogue on issues of scientific interest and importance.

Innovation in the biological sciences impacts on everyone's lives – from the basic science that underpins healthcare through to safer, more nutritious foods, and a cleaner environment. Importantly, BBSRC-funded science also supports a number of key industrial stakeholders. Buoyant and prosperous bioindustries are essential if society is to gain the benefits from basic research.

An important feature of BBSRC-funded research is that it provides both generic 'enabling science' which can be taken up by other research communities – such as the environmental and clinical sciences, which are outside BBSRC's core remit – and also provides more directed research in areas of strategic importance such as animal health, food research and agriculture.

See back page for more about BBSRC.

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> Greater dialogue between researchers, those who use the outcomes of research and the wider public will help to ensure that the UK as a whole benefits from its world leading bioscience.

> We must attract and retain the best people in research, and as disciplinary boundaries disintegrate, it will be particularly important to foster biologists with greater numerical skills.

The Ten-Year Vision

In the next ten years it should become possible to model the behaviour of a minimal living cell (the "e-cell") in a computer *(in silico)*. This is a striking example of what we will be able to do as the biological sciences become more quantitative and 'data-rich' and, as a consequence, more predictive. This will be possible because of the exponential growth in the amount of experimental data available through national and international efforts – as well as all the data from genome sequences (over 20 thousand million bases of sequence data held in Genbank) ever increasing amounts are accumulating from studies into which genes are expressed under particular sets of conditions (the transcriptome), which proteins are produced (the proteome), and what metabolites are present (the metabolome) in diverse animals, plants and microbes.

This abundance of experimental data is changing the way biological research is undertaken, necessitating closer collaborations between biologists and bioinformatics experts. Groups of biologists are forming virtual centres in order to gain access to large-scale, expensive resources. We are moving towards a more collaborative approach like that adopted by some of the physical science communities, such as particle physics and astronomy.

Science at the centre...

The picture that is emerging for the biological sciences is shown in Figure 1. At its core are three interrelated areas - experimental data, models and tools - from which a more predictive biology is emerging at the centre. In turn, predictive biology is itself at the centre of a greater 'integrative' or holistic understanding of the biological sciences. The main result of advances in the biosciences is ultimately greater economic prosperity and improved quality of life for UK citizens.

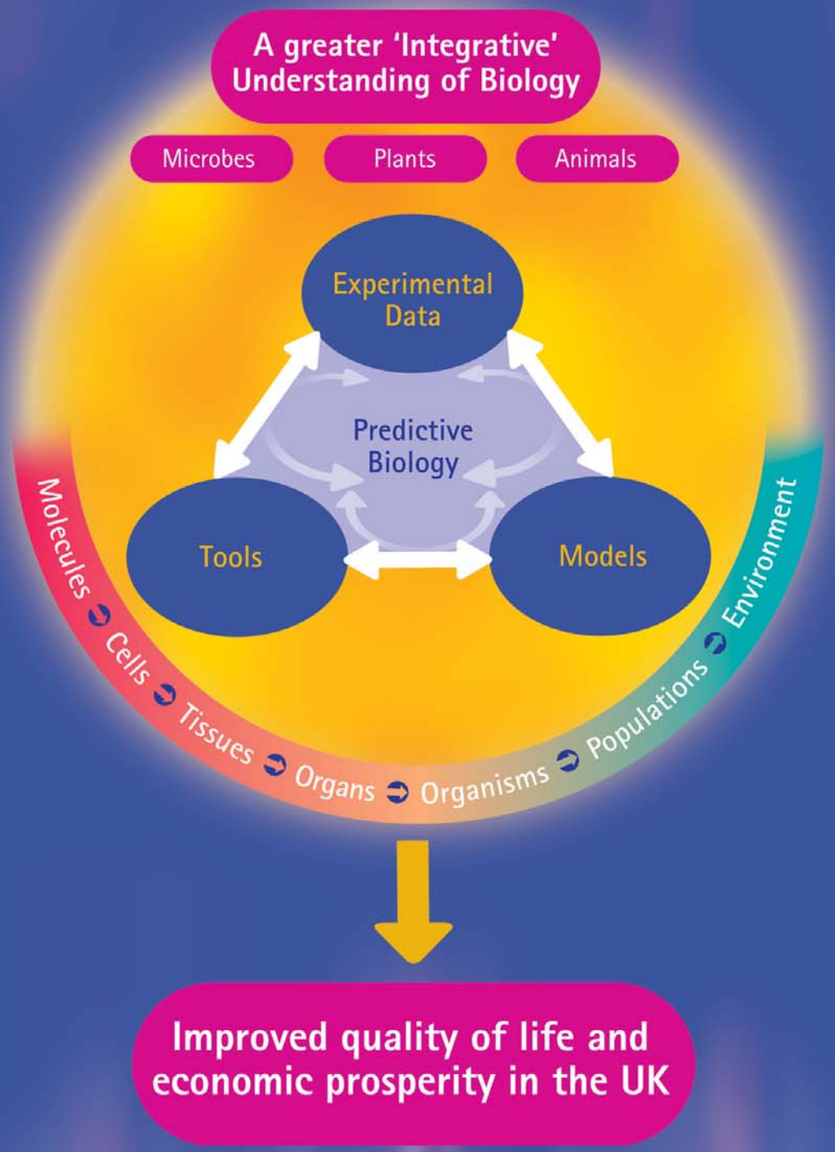
'Tools' recognises that advances in biological knowledge will depend increasingly on technology, computing and engineering to help address problems. Advances in real time bioimaging, cellular probes to study metabolism *in vivo*, microarrays, sensors, labs on chips and the next generation of super fast 'internet' networks (e.g. GRID) are just a few of the fields that must be developed further.

With these new tools, data mining and manipulation will permit more 'dry' *(in silico)* vs. 'wet' biological research. **Experimental data** and the development of mathematical **Models** are vital to a more predictive and quantitative biology and will facilitate research and predictive testing *in silico* - for example predictive toxicity of molecules or predicting the impact on biodiversity of changes in agricultural practice. This is not to suggest that 'dry' biology will replace observation and experimentation; on the contrary, it will help to extend and deepen our understanding of the 'wet' systems under study and permit the more intelligent framing of hypothesis driven research.

In the late 20th century, molecular biology and genomics revealed much about genes, gene products and other molecules in cells. A major challenge for the 21st century is to build on and expand the reductionist 'molecular' approach to develop a more holistic or integrative understanding of biology. Biology's evolution into a more predictive science will contribute significantly to the **Integrative Biology** of plants, animals and microbes. This will take us from the structure of individual molecules and how they assemble and interact in cells, through to how networks of cells function together in an integrated and dynamic way in tissues, whole organisms and populations. Integrative biology is distinctively BBSRC's *raison d'être*.

Organisms such as *Escherichia coli*, *Streptomyces coelicolor*, yeast, *Caenorhabditis elegans*, , *Arabidopsis thaliana* and the mouse will continue to be useful models of basic biological processes and to provide insights into the function of commercially important or less tractable organisms.

Figure 1.



Towards predictive biology

Over the last ten years the success of numerous genome sequencing projects has had a major impact on biology, and much effort is now focused on understanding protein function at different levels. It is therefore timely to assess where the biological sciences are going, the role of BBSRC and how the Council is preparing for the future.

This document outlines BBSRC's vision of the direction in which the biological sciences are developing in the 21st Century.[1] Biology has changed from being a descriptive science - whether of whole animals or plants in 19th century or at the molecular level in the 20th Century - to becoming a more data-rich and quantitative science. In 'Bioscience for Society: a ten-year vision', we have attempted to summarize this evolution of the biological sciences by the phrase 'Towards Predictive Biology'. This vision sees the opportunity to use the large amounts of data that we are now accumulating to better understand the function and behaviour of plants, animals and microbes at all levels from molecules to populations[1].

Predictive biology potentially offers better ways of mathematically modelling and making use of biological systems and processes, from biochemical pathways, cells, tissues and organs to whole organisms and populations. New medicines with greater efficacy and fewer side effects, lower chemical inputs for more sustainable agriculture, new catalysts and more efficient techniques for bioprocessing are just some of the expected benefits.

Greater understanding of how cells and tissues work will make it possible to model and then to understand how drugs act and how they are metabolised; this will lead to more effective and safer pharmaceuticals. A similar understanding of how drugs and other chemicals act on particular pathways, cells or tissues is an important prerequisite to replacing some of the current testing on animals.

Modelling the many factors that affect crop growth will permit more precise and smaller applications of fertilisers and pesticides; and modelling and manipulating ecological systems to disrupt pest or pathogen behaviour, or encourage natural predators, could reduce reliance upon chemical controls.

An ability to model new biochemical pathways will translate into innovative, more efficient, robust and sustainable techniques for industries that process biological material (i.e. food and drink processing) and that use biological systems in industrial processing or manufacture (i.e. biocatalysts, bioremediation).

[1] BBSRC's associated Strategic Plan 2003-2008 provides Strategic Objectives and key goals for taking this vision forward.

Science for Society

BBSRC's basic science will continue to enable developments that will ultimately benefit individuals, industry, the economy and society. For example, we can expect to see drug treatments and healthcare advice targeted to individuals on the basis of a person's genetic make-up. Novel and innovative biology-based technologies are needed to provide new options for more environmentally friendly agriculture, renewable raw materials for industry, and new strategies for combating devastating animal diseases such as foot and mouth. An understanding of the biology of ageing will offer new opportunities for lifestyle and healthcare interventions that will enable people to enjoy a healthier old age.

Greater dialogue between researchers, those who use the outcomes of research and the wider public will help to ensure that the UK as a whole benefits from its world-leading bioscience.

The basic science upon which this vision rests is extremely important, but it must be set against a moving background of wider issues, such as emerging and future Government policies, international developments in science, the activities of other research funders, and the increasing need to engage society in scientific developments. Some of these contextual matters are difficult to predict. BBSRC and the science community must be flexible enough to respond, and for this reason the vision is a 'live' document. BBSRC's aspirations and longer-term aims can only be achieved by continuing to invest in excellent science, training and career structures of scientists and by forging new partnerships, both nationally and internationally.

Achieving the vision

Investing in science and innovation...

BBSRC will continue to support excellent basic and strategic research through funding mechanisms that promote both 'big science' and foster individual creativity. The Council will support a broad and diverse research base in the biosciences and balance that against the need to prioritise areas of science that offer the greatest opportunity. BBSRC will, in partnership with Government and other Research Councils, invest in research infrastructure requirements and in particular take steps to ensure that data sets are developed and maintained for the long-term.

A key challenge is to ensure that BBSRC and the bioscience community seize the opportunities emerging from the science and training investment. BBSRC will continue to strengthen its portfolio of knowledge transfer activities. These range from industrially relevant training and promoting research collaborations with users to improving IP management, encouraging entrepreneurship and facilitating the formation of spin-out companies.

Interdisciplinarity...

The biosciences will become increasingly interdisciplinary. Many exciting scientific advances will emerge at the interfaces between biology, chemistry, physics and engineering. BBSRC will promote interdisciplinary research through Research Councils UK and other science funders.

People...

People are our most important resource. BBSRC will strive to enthuse young people with the excitement and opportunities of the biosciences, for example through schools-scientists links, in order to increase the proportion taking up careers in research. We must attract and retain the best people in research, and as disciplinary boundaries become less defined, it will be particularly important to foster biologists with greater numerical skills.

New partnerships ...

BBSRC alone cannot deliver this vision. New and stronger partnerships will be forged with Government Departments and the other Research Councils through Research Councils UK, particularly in the context of interdisciplinary science, and we will continue to explore mechanisms for effective public dialogue.

BBSRC will also seek strategic alliances internationally. As the questions in biology get bigger and more complex, international collaborations will give partner countries access to the infrastructure, specialised equipment and resources necessary to provide the answers; mirroring developments in the physical sciences.

Moving forward...

The UK leads Europe in the volume and impact of its science. The aspirations expressed in this document extend well beyond the ten-year horizon and are aimed at maintaining the UK's position in the 21st century - the century of biology. No one underestimates the challenges, but the opportunities are great.