

DELIVERING EXCELLENCE WITH IMPACT

BBSRC Delivery Plan 2008-2011

Executive Summary

Bioscience is at the forefront of tackling some of the biggest challenges facing humankind and the planet, including climate change, food security, renewable energy and the ageing population. A strong and versatile UK science base will be essential in addressing these challenges, and BBSRC will continue to drive forward the UK's world-leading bioscience by increasing support for inspiration-led research, further developing infrastructure, facilities and training in the biosciences, and empowering scientists to translate research in to practical application that have benefits across society and economy, within and beyond the UK. We will continue to encourage innovative working practices in bioscience, exploiting the opportunities afforded by rapid technological advancement and the availability of large quantities of data. In particular we will seek to embed integrative and systems approaches that harness the power of mathematics, physics and engineering to generate new understanding of biological processes and enable effective and responsible intervention and utilisation of knowledge.

BBSRC's [budget](#) will rise from £386M to £471M by 2010-11.

We will:

Ensure the continued health and international competitiveness of UK bioscience, by:

- investing c£115M in [systems/predictive biology](#) including [tools and resources](#) to effect further change and consolidate advances made under SR2004.
- continuing to give priority to [responsive mode funding](#), and providing £80M for FEC, to support investigator-inspired research that is the lifeblood of innovation.

Drive a step-change in the economic and social impact of our funding, by:

- increasing interactions with business by redirecting £50M to research directly relevant to industry; providing at least £34M for [complementary and collaborative activities](#) with the Technology Strategy Board.
- operating at least four [Research Technology Clubs](#) by 2011, in partnership with over 40 companies.
- providing up to £15.5M to strengthen business awareness and focus on academic research through [entrepreneurship and commercialisation](#).

Provide the skilled people upon which our science base and bioindustries depend, by:

- increasing by a third, to £62M, our funding for fellowships, training and skills development to help deliver the [skilled workforce](#) needed in a knowledge-based economy and to retain and attract inward investment from high-tech companies.
- awarding all our PhD studentships as flexible 4-year Doctoral Training Grants, allowing students to do challenging research and develop specialist and transferable skills, with stipends tracking inflation.
- virtually doubling our funding for [Fellowships](#) to £10M, to develop talented early career bioscientists; and enable mid-career scientists to embrace interdisciplinary research.

Tackle major policy and societal long-term and multidisciplinary challenges, by:

- investing £38M for capacity building in [renewable bioenergy](#), and £22M on underpinning food security during [environmental change](#), including £7M to help secure agriculture and animal health in the developing world;
- investing £44M on understanding the biology of [ageing](#) for healthier and longer lives; and £15M for [nanotechnology](#) with benefits in healthcare, drug delivery and diagnostics.

Secure national research capability and unique facilities in key strategic areas, by:

- continuing to support, especially through research institutes, crucial capability and facilities in: [sustainable agriculture and land use](#); [animal health and welfare](#); and [biomedical/diet and health](#) by providing a further £13.5M of resource and capital to [build sustainability and by modernising governance](#) in BBSRC-sponsored institutes,
- major capital commitments of £150-200M, focusing particularly on animal health and welfare through the redevelopment of the Institute for Animal Health around its new science strategy, and the embedding of The Genome Analysis Centre (TGAC) as a major new national facility for bioinformatics and sequencing.

Introduction - Vision and strategic aims

Vibrant and excellent bioscience research is essential if the Government's overarching ambition for science and innovation is to be achieved. It helps drive the economy, improves life experiences for UK citizens and makes this country an attractive location in the international research market. Bioscience generates new knowledge, and provides skilled people, for multi-billion pound industries and services including pharmaceuticals, biotechnology, healthcare, environment and food/farming. The pharmaceutical industry alone employs 73,000 people, creates another 250,000 jobs in related industries and generates a trade surplus of £3.4Bn.

UK bioscience is an important national asset. But sustained investment in research, skills and facilities, and continued transformation to multidisciplinary ways of working are needed to maintain its world-leading position in the face of increasing global competition.

Bioscience is progressing from a largely descriptive science to one that is more and more data-rich and increasingly quantitative and predictive. **This century's BIG challenges in bioscience, such as understanding ageing, diet and health, food security, sustainable land use, impacts of climate change, infectious disease and renewable bioenergy, can be effectively addressed only at the 'systems level'. This requires multidisciplinary teams, where high-throughput data collection, data interrogation and predictive modelling are integrated to develop and refine scientific understanding and to inform experimental design.**

BBSRC's major strategic objective, now and in the next decade, is to drive and support this revolution in bioscience to ensure that the UK research base is fit for purpose to deliver scientific excellence leading to strong economic and social impacts. This is reflected in our new Strategic Plan 'The Age of Bioscience', launched in January 2010, which recognises that bioscience will be at the forefront of tackling some of the biggest challenges currently facing humankind and the planet. A strong and versatile UK science base is essential to address these challenges, and the Strategic Plan cements BBSRC's commitment to excellent, **world-class bioscience**. From the molecular to the systems level, we will continue to fund the best research, people and institutions across our remit. Building on investments from the 2004 Spending Review, our strategic aims are to:

- **Ensure the continued health and international competitiveness of UK bioscience** through embedding systems/predictive biology capability, and by protecting investment in responsive mode grants to fund the best science from the best people.
- **Provide a step-change in the economic and social impact of the research that we fund** ensuring it drives innovation particularly through collaborative and complementary activity with the Technology Strategy Board
- **Address major policy and societal long-term challenges by supporting multidisciplinary science** through cross-Research Council and multi-agency programmes on renewable bioenergy; global food security; living with environmental change; the biology of ageing for healthier lifespans; improved global security (through agricultural contributions to alleviating poverty in developing countries); and harnessing the benefits of nanotechnology.
- **Ensure that the UK has the skilled people that are the lifeblood of our science base and bioindustries.**
- **Secure our national research capability and facilities in strategically important areas of research** through sustainable and well governed sponsored institutes

During the years 2008-09 to 2010-/11, BBSRC's budget will rise from £386M to £427M, £452.5M and £471M respectively. Below we set out our spending plans to meet our strategic

aims. **Annex 1** provides an overview of projected funding against major science themes and mechanisms.

Research priorities

BBSRC will continue support for excellent bioscience across its broad remit, where the following offer exciting opportunities for new research and capacity building.

Cross-Research Council multidisciplinary activities

Energy - Renewable Bioenergy

The Stern review¹ in 2006 highlighted the severe economic and social consequences if action is not taken to mitigate and adapt to climate change. There is an urgent need for renewable low-carbon energy sources, including more diverse and cost effective biofuels. UK bioscience in universities and the BBSRC-sponsored institutes is well placed to deliver these, from lab to field to biorefinery: we lead the world in the biochemistry of photosynthesis, have the best plant molecular biology community in Europe and with strengths in microbial physiology, metabolism and biotransformations are competitive across a broad front with the USA.

In 2006 BBSRC reviewed the science requirements for bioenergy and will **commit £38M by 2010-11 to bring together the UK research community and expand capacity**. As part of this commitment, in early 2009 the Council established a £27M "virtual" BBSRC Sustainable Bioenergy Centre (BSBEC), with programme grants to five lead institutions and a number of other academic partners, comprising funding of £20M from BBSRC and industrial contributions with a total value of £7M from a wide range of companies. This will increase the number of top plant and microbial scientists with specialist skills and expertise, and will bring the research community together as well as increase engagement with the emerging industrial base.

A Bioenergy "champion" has been appointed to coordinate and build on the activities of BSBEC in developing BBSRC's wider portfolio of bioenergy research. Alongside our existing responsive-mode strategic priority in this area, we will explore further opportunities to promote research into longer-term alternatives to petrochemicals and to address gaps in the portfolio, such as the exploitation of algae as a source of biofuels and the biological production of hydrogen by bacteria. We will promote engagement in a new programme on Biorefineries (see page 19); and will explore the long-term potential for harnessing UK expertise in photosynthesis, and other relevant fields, for more direct conversion of solar energy, which would have potential applications in both bioenergy and food security. In 2010 BBSRC and the US National Science Foundation (NSF) will hold an intensive week long facilitated workshop - an "Ideas Lab" - to bring together leading researchers across all disciplines to foster new ideas, collaborations and proposals on novel mechanisms to enhance photosynthesis.

Bioenergy and industrial biotechnology is one of the three major strategic research priorities identified out in BBSRC's new Strategic Plan. During 2010-11 BBSRC will review its industrial biotechnology portfolio and develop a strategy for its future support for this area.

Economic and social impact: We will provide a much-needed focus for UK activity in bioenergy that will increase national capacity and research volume significantly, helping the UK meet policy goals and industrial needs. Outcomes are expected to include: energy crops better tailored for biomass production and biorefineries and with reduced environmental footprint; greater understanding of societal attitudes to bioenergy crops and their impact, e.g. on wildlife; new knowledge of plant growth and carbon partitioning; higher yields from advanced bioprocessing that increase economic viability of bioenergy and transport biofuels.

¹ http://www.hm-treasury.gov.uk/Independent_Reviews/stern_review_economics_climate_change/sternreview_index.cfm

Living with Environmental Change (LwEC)

This interdisciplinary research programme will increase the UK's ability to cope with, and reduce the costs of, environmental change. Research Councils, working with key policy partners, will address the sustainability of natural resources, ecosystem services, economic growth and social progress.

We place high priority on mitigating and adapting to the impact of environmental change. Our main interest is in sustainable agriculture and land use, which will be crucial to the UK's future food and water security. For example, changes will significantly affect the types of crops grown in the UK - e.g. we will need those that are productive despite a changed climate, scarcity of natural resources and new pests/diseases.

BBSRC spends around £39M a year on research for sustainable farming and food production² where £5M of this is focused on climate change. **We will commit £22M to increase this research, primarily through existing strengths in sustainable agriculture and animal health in our institutes** (see page 15). In particular:

- BBSRC will seek to implement the recommendations of its review of research relating to environmental change primarily through its Living with Environmental Change responsive-mode strategic priority.
- Under the auspices of the wider LWEC Partnership, BBSRC is leading a c£10M initiative of research into the health of bees and other insect pollinators, funded jointly with DEFRA, NERC, the Scottish Government and the Wellcome Trust.
- BBSRC will fund new research to develop predictive models of how farming systems respond to environmental change and new farming practices, so that knowledge about effects on food production, livestock diseases, wildlife and land use can inform national preparedness and minimise economic and social costs.
- The outcomes of scoping workshops held in 2009/10 will be used to develop other activities, under LWEC Objective C, relevant to the effects of environmental change on aspects such as soil-water relations and populations of crop and livestock pests and disease vectors, and their impacts on food production.
- Further workshops will be held to scope additional topics at the interface between LWEC Objective C and the new multi-funder Global Food Security programme (page 8). Possible topics include the potential role of farming practices in mitigating greenhouse gas emissions; and systems approaches to the impacts of climate change on agriculture, bringing together climate, biological and economic modellers.
- BBSRC will also contribute up to £2M to the LWEC-accredited Environmental and Social Ecology of Human Infectious Diseases initiative, led by MRC and funded jointly with ESRC and NERC (see also page 8)
- Through a new collaborative scheme, BBSRC and the Scottish Government's Rural and Environment Research and Analysis Directorate (RERAD) will co-fund research into food security and living with environmental change.

Economic and social impact: We will build on our sustained investment to date, by focusing on research that addresses a central pillar of the Stern review, namely basic research to mitigate and adapt to environmental change, with associated economic benefits, rather than on significantly increasing investment in areas already well funded. Anticipated outcomes are: more sustainable food/farming systems that produce less greenhouse gases; crops better suited to future UK climate, and new strategies against emerging pests and diseases of crops and livestock.

² Pollock report http://www.bbsrc.ac.uk/about/pub/reports/sustain_ag16_10_02.html

Ageing Research: Lifelong Health and Wellbeing

HM Treasury identified the *rapid increase in the old age dependency ratio as the 'baby boom' generation reaches retirement age* as a key policy challenge for which sustained investment in research will be necessary.

One approach that we are pursuing aims to minimise the need for health and social care, by achieving 'healthy ageing'. We have built up our annual investment in research on ageing to £12M a year over several years, through responsive mode priorities, focused initiatives³ and our world-leading Systems Biology Centre in Newcastle⁴.

Working through RCUK we will further expand ageing research, committing more than £44M by 2010-11, to include the initiative in Lifelong Health and Wellbeing (with MRC and others). We will continue to work with other funders and stakeholders to build capacity and collaboration both nationally and internationally.

Our research will increase understanding of developmental origins of good health, investigate ageing as a risk factor in frailty and loss of homeostasis and unravel the impacts of diet, exercise and health.

Our priorities include:

- supporting our £10M Research Technology Club programme on Diet and Health, co-sponsored with industry (see page 19) together with ongoing diet and health research at universities and the Institute of Food Research
- Scoping a potential Research Technology Club for research into healthy ageing
- Supporting collaborations between UK and US scientists through the partnering award scheme with the US National Institute on Aging, and exploring further opportunities to network the two 'ageing research' communities
- Working with UK Sport to impact on the UK Olympic effort and contribute to the understanding of exercise and health across the lifespan

Economic and social impact: We will build on our strong investment record to provide more focused and coordinated ageing research at the national level. We will generate new knowledge of factors that affect health (for better or worse) both early (*in utero*) and later in life, that will inform strategies for improving 'healthspan'. Our research will also facilitate interventions to improve physical and mental wellbeing in the aged. Eventual outcomes could have enormous social and economic impacts such as novel drugs and treatments to slow or modify the ageing process.

Global Security/ Global Uncertainties

The cross council Global Uncertainties programme has recently refocused its priorities on six core themes, concerned explicitly with aspects of national and international security. BBSRC funds research directly relevant to security issues surrounding misuse of microbes and the identification/control of plant and animal diseases (naturally occurring or deliberately released). We also fund research to improve detection and identification of biological agents and to understand their dispersal and, in the case of animal disease, to improve vaccines.

More broadly, bioscience has a major role to play by addressing those threats that arise from unsustainable agriculture in developing countries and contribute to poverty, food insecurity and political instability - see section on Global Food Security below (page 8).

³ Including multidisciplinary cross-Council initiatives such as the New Dynamics of Ageing Initiative, SPARC (Strategic Promotion of Ageing Research Capacity), the joint call with MRC, EPSRC and ESRC for Centres, and most recently a scheme for collaborative research on the biology of ageing with the USA.

⁴ Centre for Integrative Systems Biology in Ageing and Nutrition: <http://www.cisban.ac.uk>

We will commit £7M on research relevant to security by placing particular emphasis on animal and plant diseases. Building on our successful initiative – Sustainable Agriculture Research for International Development⁵ – funded jointly with DfID we will make full use of the strong UK base in plant science and animal health. This complements our ongoing annual spend of many millions of pounds in universities and institutes on basic underpinning bioscience such as molecular cell biology and microbiology. Our top priorities include:

- Leading a joint programme with DfID and others on animal health research for international development⁶. Awards totalling £13M have been announced under this programme.
- Maintaining national capacity in plant disease research through institute programmes and building on the Crop Science and Rural Economy and Land Use initiatives
- Maintaining national capability (especially through the Institute for Animal Health, IAH) to develop novel diagnostics for animal diseases, building on the DIID Foresight project⁷
- Contributing up to £2M to the first transnational call of the ERA-net on Emerging and Major Infectious Diseases of Livestock (EMIDA)
- Leading a joint £1.7M initiative with Defra, MRC and the Wellcome Trust on combating swine influenza
- In line with the ‘one biology, one health’ agenda (see page 12), contributing up to £2M to the Environmental and Social Ecology of Human Infectious Diseases initiative, led by MRC and funded jointly with ESRC and NERC (as described on page 6)

Economic and social impact: BBSRC’s baseline impact in this area is already high, largely through animal health and welfare research at IAH. The institute has contributed substantially to the mitigation of losses from animal disease and played a major part in the near eradication of Rinderpest, with net economic benefit of around \$1Bn per annum. Our priorities will boost global security by helping to alleviate poverty and assure food supply. Outcomes will be new control strategies for plant and animal disease based on better understanding of host/pathogen interactions. Through this research the UK will be better able to respond to new threats from biological agents (natural or manmade) – e.g. avian influenza. Better vaccines will result from the work on host/pathogen interactions, and industry/society will benefit from new tools and genetic resources to accelerate crop and livestock improvement.

Global Food Security

The UN Food and Agriculture Organisation predicts that global demand for food will rise by 50% by 2030 and 70% by 2050⁸. To meet this increasing demand, agriculture will need to produce more food from the same or less land, using less water, energy and other inputs, and reducing waste and adverse environmental impacts.

Food security is a key priority in BBSRC’s forward strategy, building on our long-standing support for plant and animal sciences. BBSRC is **leading a major new multi-agency programme in Global Food Security**, to address the long term need to significantly increase global food production by 2050 in a sustainable way, and taking account of the need to improve food quality and promote healthy diets. International partnerships are actively being explored to achieve this.

⁵ SARID initiative http://www.bbsrc.ac.uk/science/initiatives/sus_ag_dfid.html

⁶ Combating infectious diseases of livestock for international development (CIDLID) initiative <http://www.bbsrc.ac.uk/funding/opportunities/2008/combating-infectious-diseases-livestock.aspx>

⁷ http://www.foresight.gov.uk/Previous_Projects/Detection_and_Identification_of_Infectious_Diseases/Index.htm

⁸ OECD-FOA Agricultural Outlook 2009 - 2018 (FAO, 2009)

Our priorities include:

- Leading a multi-partner programme on Global Food Security via a Programme Development Board, including the development of a Strategic Plan for the Programme
- Launching a further joint initiative with DfID (and potentially the Indian Government and others) to fund research that counters the effects of abiotic and/or biotic stresses on crop production in Sub-Saharan Africa or South Asia.
- Joint with the US National Science Foundation (NSF), holding an intensive week long facilitated workshop - an "Ideas Lab" - to bring together leading researchers across all disciplines to foster new ideas, collaborations and proposals on novel mechanisms to enhance photosynthesis. (see also page 5)
- Supporting our £6M Crop Improvement Club, co-sponsored with the Scottish Government and industry, to accelerate the development of improved crop varieties higher yields and consistent, high quality products (see page 19).
- Committing £10M over five years to the Technology Strategy Board's innovation platform in Sustainable Agriculture and Food Agri-food, in which BBSRC is a partner.

Economic and social impact: We will build on our longstanding investment in plant and animal sciences and explore mechanisms to accelerate the translation of this research into practical applications relevant to sustainable food production. We will also continue to support fundamental research which underpins food security, including long-term challenges such as an increased understanding of photosynthesis or nitrogen fixation, which have the potential to offer a step change in crop production with applications in food security and bioenergy. Through national and international partnerships we will ensure that the skills and knowledge generated through UK bioscience help to address the challenge of achieving global food security.

Nanotechnology

Nanotechnologies will revolutionise society with potential step-changes in electronics, optics, computing and healthcare. Bioscience will make an enormous contribution to nanotechnology, which continues to be a priority for BBSRC.

We will protect our current annual investment of £5M in bio-nanotechnology, where £1M will be earmarked to strengthen our portfolio, boost science networks and forge partnerships with industry. We will take every opportunity to gear this money by working closely with the TSB and looking for benefits in the areas of Healthcare (bio-active molecules in the diet, tissue engineering and drug delivery applications); Diagnostics (new sensors for improved detection of biomolecules, e.g. security applications); and Energy and Environment (reconstructing biomolecular systems (e.g. photosynthesis) and underpinning bioscience of nanotoxicology research).

Economic and social impact: Nanotechnology is a genuinely interdisciplinary, 'disruptive' technology in which a growing UK industry is heavily dependent on knowledge transfer from the science base. Applications include understanding the uptake of nanoscale food bioactives; nanofabrication of engineered tissues through understanding nanoassembly processes; nanoscale devices for improved sensitivity and specificity of detection of biomolecules and cells for security applications.

BBSRC research priorities

In addition to the above and central to our remit, are priorities of particular importance to UK bioscience and bioindustry.

Excellent bioscience in Responsive Mode

Inspiration-led research underpins the health and global competitiveness of UK bioscience and provides the 'seed-corn' for innovation. Its support through responsive mode grants enables funding for the best ideas from the best people, providing BBSRC and the research community with the vital agility to move rapidly into emerging areas of science.

In 2008, following extensive consultation with the academic community, BBSRC restructured its research committees. Four new research committees were created to replace the former seven, and a mixed economy of peer review membership was established, comprising core committee members and a pool of reviewers to be called on flexibly for their specific expertise. Policy and research priorities that overarch all of BBSRC's activities are used to provide strategic focus for the community, and highlight notices are used to increase numbers of responsive mode grant applications in areas where there is a particular strategic need. We continue to maintain specific mechanisms for assisting new investigators and for Industrial Partnership Awards that have significant industrial co-funding, and have launched a revised scheme to support strategic longer/larger grants (LOLAs) in multidisciplinary science. These changes were presented through a series of Roadshows across the UK,

Reflecting the importance of inspiration-led bioscience, and despite increasing costs and competing priorities, **we will seek to maintain success rates in responsive mode during 2010/11 at not less than 20%**. We will increase our support for investigator-led research through responsive mode, initiatives, research clubs, training and other priority areas, including an additional £80M for FEC .

Economic and social impact: The health of a nation's science base contributes directly, and significantly, to its economy and quality of life. This is a founding principle of the Government's 10-year Science and Innovation Investment Framework. It is impossible to predict the future economic and social impact of inspiration-led research, which often has lead times in decades rather than years. But there are clear examples, such as antibiotics, DNA fingerprinting, magnetic resonance imaging, biopharmaceuticals and the 'green revolution' where excellent basic and curiosity-driven bioscience has had major economic and social impact.

Embedding Systems Biology

Systems/predictive biology continues to be central to the international competitiveness of UK bioscience and for attracting inward investment. In SR2004 we funded six new flagship centres:

- Imperial College London – host/pathogen interactions
- University of Newcastle – ageing and nutrition
- University of Manchester – yeast as model for biomedical research
- University of Oxford – cell networks/pathways
- University of Nottingham – virtual root
- University of Edinburgh – RNA metabolism, circadian rhythms

We also committed £23M (with £2.8M from EPSRC) for the major new Systems Approaches to Biological Research (SABR) initiative, and invested in substantial European collaboration through the ERASysBio initiative. We will develop further partnerships with European counterparts.

We have developed an international partnership scheme in the area of systems biology with Japan. These partnerships awards, funded jointly by BBSRC and the Japan Science and Technology Agency (JST), seed long term sustainable collaborations between British and Japanese scientists.

Due to BBSRC's funding of £100M (including investment in tools and resources, see below) the UK is now the leading European player in systems biology and competitive with the USA. We will maintain the current high level of investment in systems biology whilst further increasing that available for tools and resources. Total funding to 2010-2011 will be in the order of £115M to drive forward the process of change in UK bioscience and promote new ways of working. Guided by our Systems Biology Roadmap (developed jointly by bioindustry and the research base), we will:

- Use large grants and institute programmes to form networks with mathematicians, physical scientists and engineers that break down barriers between disciplines.
- Embed systems approaches as 'normal business' in responsive mode funding, initiatives and institute programmes and engage communities that are under-represented in the current BBSRC systems biology grant portfolio. For example we have provided support to the four joint centres for Integrative Mammalian Physiology⁹ to promote awareness, training and utilisation of systems approaches.
- Increase the involvement of industry and academics that have little contact with biologists, such as engineers, through Industry Interchange and Discipline Hopping schemes.
- Develop and implement mechanisms for additional training in systems biology. For example, we will launch a new initiative to develop an e-learning platform in systems biology (eLSA - eLearning for Systems Approaches) which will provide a web portal for courses in mathematics underpinning systems biology, basic systems biology and intermediate/ advanced systems biology for all BBSRC supported students research assistants, investigators and institute staff free of charge for a period of up to three years. We will also encourage our Centres to conduct further courses to induct biologists into systems biology approaches, e.g. through summer schools and problem-solving events

Increasing investment in Tools and Resources

Tools, technologies, resources and infrastructures are essential for a healthy, world-class bioscience research base; and their provision is central to our vision of systems/predictive bioscience. Whilst not all of the tools and resources required are directly applicable to systems biology this area is a powerful driver for major advances in computational, modelling and high-throughput technologies.

BBSRC runs two funding streams to deliver tools and resources for the biological sciences. These pump-prime early stage/high-risk technology, provide interdisciplinary funding to develop/adapt technologies for bioscience and help to establish/maintain databases, gene banks, mutant lines and culture collections of importance to the bioscience community. The funding streams complement our investment in technology development research made through responsive mode. We will further strengthen investments in T&R, with a budget for 2010-11 of up to £12.3M, by focusing on:

- **Technological challenges:** overcome bottlenecks in bioimaging, computational analysis, biobased tools (e.g. RNAi) and bioanalytical techniques for both academic and industrial use. We will help drive commercial exploitation where appropriate.

⁹ A £12M cross-funder programme led by BBSRC in partnership with HEFCE, MRC, the Scottish Funding Council, the British Pharmacology Society's Integrative Pharmacology Fund, and the Department for Business, Innovation and Skills: <http://www.bbsrc.ac.uk/business/collaborative-research/industry-clubs/mammalian-biology.aspx>

- **Bioresources:** building on our Bioinformatics and Biological Resources pilot, we will provide regular funding for development and support of databases and biological collections.
- **Data sharing:** establish a data sharing culture, facilitate development of standards and provide tools for data mining, curation and annotation; drive greater use of e-science infrastructure/high performance computing. This will include monitoring compliance with BBSRC's Data Sharing Policy, launched in 2007

Economic and social impact: Over the last four years, due substantially to BBSRC funding, the UK has become the leading European nation in systems/predictive biology; and UK researchers are 'partners of choice' for international collaborations. We will maintain the momentum to drive change, establish new ways of working and equip researchers with the requisite tools and resources for contemporary bioscience. Major industries, such as pharmaceuticals and biotech, recognise the enormous economic potential of systems approaches, e.g. to generate leads for novel drugs and bioprocesses, and are enthusiastic proponents of UK capacity building.

Other strategic areas

Synthetic biology: BBSRC will continue to develop this emerging, interdisciplinary area which builds on biomimetic and biomodification approaches. We have established networks (funded with EPSRC, AHRC and ESRC) as a platform for pump-priming and exploratory studies, and encourage applications to our responsive mode. In partnership with other stakeholders, including both UK and European funding agencies, we will develop this area more fully.

Post-Cooksey review: delivery of medical research is changing in the UK following the Cooksey Review and the establishment of OSCHR. BBSRC's remit does not cover human medical research but much of the underpinning cell and systems biology that we fund is highly relevant. We are keen to maintain the excellent MRC/BBSRC interface to ensure co-ordination of activities, and will work with OSCHR as appropriate to ensure alignment of strategic priorities and that there are no unintended gaps.

One biology, one health: Building on our investment in Animal Health research, BBSRC will continue to support fundamental and comparative studies of human, animal and microbial biology to improve animal and human health.

Stem cells: BBSRC has a long and strong track record in funding stem cell research, which is why the UK has a world-class research community today. We will expand UK capability further, primarily through responsive mode, and will support with other funders excellent science to underpin the progress of stem cells towards clinical application (see also Public Engagement, below). We will continue to sponsor and host the UK National Stem Cell Network (UK NSCN) to co-ordinate activities on behalf of the UK government for the benefit of the UK (and international) stem cell and regenerative medicine research community in both public and private sectors. We will also contribute to cross-Council co-ordination activities, including other government departments and TSB, involving an analysis of the UK national portfolio of research in stem cells.

3Rs: we will continue to support research and training for **the reduction, refinement and replacement (3Rs) of animals in research**. Building on our SR2004 investment of £8M in four vet schools for research on animal welfare, we will collaborate and disseminate best practice to the wider scientific community (a final dissemination event is planned for 2011). We increased our funding for the National Centre for 3Rs (NC3Rs) during SR2004 and with MRC, the Wellcome Trust and others we adopted the NC3Rs Non-Human Primate Guidelines and published the joint funders' expectations with regard to responsibility in the use of vertebrate animals in bioscience research, which we will continue to promote. We

have also supported joint calls and workshops with NC3Rs in the areas of tissue engineering solutions to replace animal experiments and replacing animals protected under the Animals (Scientific Procedures) Act 1986 with invertebrate models. We will continue to work with NC3Rs and other funders to promote best practice in animal research and will further increase funding by £1.7M bringing it to a total of c£3.1M by 2010-11.

Infrastructure

BBSRC will continue to fund critical UK capability, for example BBSRC-sponsored institutes (page 15), Systems Biology centres (page 10) and Bioenergy Centre (page 5). Within RCUK we will participate in the European Strategy Forum on Research Infrastructure (ESFRI) and the European Roadmap for New Large-Scale Research Infrastructures.

Through interactions with partner organisations we ensure that UK researchers retain access to facilities overseas, and we support this by travel and partnership schemes (page 26). Our main priorities are to:

- Progress the redevelopment of IAH Pirbright facilities for exotic diseases of farm animals towards its scheduled completion in 2013/14
- Contribute to the revision and prioritisation of the UK Large Facilities Roadmap. BBSRC's input will include proposals for:
 - Relocation of IAH Compton facilities to new facilities at Pirbright to support research into viral diseases of poultry that have significant economic and social impact within the UK such as high level containment facilities for avian flu work and other major disease threats (see also page 19).
 - Develop ELIXIR (the European Life Sciences Information Resource), with EBI, RCUK and the Wellcome Trust. This is a distributed facility based around a hub at EBI in Cambridge, with nodes in all EU member states. The preparatory phase has been funded by the EU (start in 2008), and £10M has been provided by BBSRC for additional computer storage facilities for the hub. The proposed start date for facility construction is 2011-12.
- Lead for RCUK and BIS in updating the ESFRI Roadmap to reflect UK priorities.
- Establish The Genome Analysis Centre (TGAC), which was launched in June 2009, as a national facility for the development and application of sequencing in animals, plants and non-medical microbes, including expertise in bioinformatics

Other cross-Research Council programmes/activities

Skills, training and careers

BBSRC places great emphasis on research skills, training and careers, where we see major positive economic and social impacts. For this reason, our plans are described later, in the section on Economic Impact.

Public engagement

We aim to embed public engagement in our decision-making, promote dialogue and consultation, and increase openness and transparency. We will:

- Continue to work with other Research Councils and through RCUK to improve the effectiveness and impact of public engagement activities at a national level. For example, in 2009 BBSRC led the RCUK Darwin Today public exhibition and events programme on behalf of RCUK, touring over 30 venues during 2009 providing access to an estimated over half a million people. Our new exhibition 'Questioning evolution? Evolving answers!' will be touring the UK throughout 2010, visiting a total of 15 venues.
- Continue to contribute to the development and delivery of the RCUK Science in Society programme, and to work with the Beacons for Public Engagement as appropriate.

- Respond to the recommendations of the BBSRC and MRC-commissioned national Stem Cell dialogue (Sciencewise). The dialogue, which reported in December 2008, built on existing RCUK public engagement on stem cells, including a travelling exhibition, discussion meetings and publications.
- Contribute to RCUK public dialogue on energy research, and develop a public engagement programme around bioenergy, focused on the work of the BBSRC Sustainable Bioenergy Centre. A new communications and public engagement group, chaired by BBSRC Bioenergy champion, has been established to take this programme forward.
- With EPSRC, develop activities to promote public engagement with the emerging area of Synthetic Biology. This will build upon the findings of BBSRC's commissioned review of the ethical and social challenges (Balmer and Martin 2008). A public dialogue on synthetic biology, commissioned by BBSRC, EPSRC and Sciencewise-ERC and conducted by the British Market Research Bureau (BMRB) is due to report in Summer 2010.
- Promote public awareness of advances in the biosciences and their potential applications and implications (including further promotion of our 'Bioscience for Life' campaign), and to provide opportunities for public dialogue in order to identify public views, aspirations and concerns which BBSRC can then address in its policymaking and funding decisions.
- The Bioscience for Society (BSS) strategy panel will continue to provide high-level advice to BBSRC on priority issues in areas such as public confidence, transparency and accountability, and foresight on emerging scientific and societal issues. We will improve further the interaction between BSS and the other strategy panels.
- Ensure synergy between Swindon Office and BBSRC Institute activities in public engagement. This will add value to activities by sharing of resources and joint-working, focusing initially on co-ordinated approaches to work to engage young people with bioscience research and its impact.
- Continue to encourage and equip BBSRC-supported scientists to engage with the public(s), including through new specialist training courses, the first of which (in bioenergy) will be piloted during 2010.

Sustainability

Full Economic Costing

We share the Government's view that the UK's world-class Science and Engineering Base must be sustainable including the regular renewal of infrastructure and having the adaptive capacity to respond to new needs opportunities. The aim is that *'by the beginning of next decade research councils should meet close to 100% full economic costs (FEC) of the research they fund'*¹⁰. Demand for grants in the biosciences is high and research is increasingly costly. By 2011, our university grants portfolio will be based on paying 80% FEC, which equates to an annual increase of around £80M. This addition, coupled with Science Research Investment Fund capital grants based on research council funding, will bring grant payments to around 90% FEC.

Full economic costing of institute programmes has highlighted shortfalls in areas that did not benefit from increases in dual support funding. Further investment is needed for institute sustainability and to preserve national capabilities as outlined below.

Securing key national capability and facilities

BBSRC-sponsored institutes cover three strategic areas of research - **Sustainable Agriculture and Land Use (SALU)**, **Animal Health and Welfare (AHW)** and **Biomedical/Diet and health**. They conduct mission driven, multidisciplinary research that is typically more strategic and longer-term than that in universities. Institutes provide unique facilities and important concentrations of multidisciplinary skills/capability. Their work has significant impact on key areas of public policy, including food security, emerging diseases, sustainable natural resources (water, soil, air), bioenergy and diet and health. It is essential that the UK retains the skills base and research capability in these areas, particularly as we face climate change, rapid population growth, increasing demand for food, emerging and re-emerging infectious diseases, diminishing natural resources and increasing pressure on land.

Over the past decade, BBSRC has restructured its institutes to maintain crucial capabilities and facilities and to support long-term sustainability. We are introducing new governance arrangements that ensure full clarity of responsibility. We are also focusing institute research and enabling greater dynamism and flexibility by replacing single core grants by a few large five-year institute strategic programme grants (ISPGs) for each Institute. An 'Institute Integration Award' provides each Institute Director with flexibility to make strategic choices and to help preserve key expertise, long-term experiments, important data sets and some fixed infrastructure costs e.g. animal facilities. Beginning in 2010 we will be actively reviewing the institutes in the four-yearly Institute Assessment Exercise (IAE).

BBSRC invests around £130M a year in its institutes. We will provide an additional £13.5M resource and capital funding to build sustainability and secure national facilities, particularly for AHW and SALU.

In addition, **The Genome Analysis Centre (TGAC)** has been established in Norwich by BBSRC with support from the East of England Development Agency EEDA and Local Authorities. This national facility will provide modern sequencing technologies and expertise in bioinformatics to the plant and agricultural communities for the provision and analysis of genomic data for plants, animals and non-medical microbes, and of potentially complex ecosystems such as the microbiology of soils.

¹⁰ (10-year framework, 3.19)

BBSRC's main investments in its institutes are:

Animal Health and Welfare

This area is currently covered by two institutes, one of which currently operates at two sites:

- **IAH – Pirbright site:** exotic viral diseases (foot and mouth, bluetongue). New, world-class facilities completed by 2013/14.
- **Institute for Animal Health (IAH) – Compton site:** endemic disease, (TB, *Salmonella*); unique resources for immunology in cattle (MHC herd) and chicken (for avian flu work). It is planned to transfer to a single site at IAH-Pirbright. The new combined single IAH site will focus research on viral diseases of livestock that have economic impact on the UK herds and flocks and/or have the potential to threaten human health by transfer from animals to humans (zoonoses) such as avian 'flu.
- **The Roslin Institute:** applying basic animal sciences to human and veterinary medicine, the livestock industry and food security

IAH receives most of its funding from BBSRC, including a £2M increase following the last Institute Assessment Exercise. Significant funding is also received from Defra but this has been falling in recent years. To preserve capability and achieve sustainability, BBSRC has committed to substantive additional investment. This will help to meet high running costs of containment facilities and ensure the highest standards of biosecurity.

In addition, BBSRC invests in Roslin-NPU covering livestock genetics/genomics and prion diseases (scrapie and BSE). On 1st April 2008, Roslin-NPU transferred to the University of Edinburgh to form a new flagship centre (£55M new build, mostly funded by BBSRC) focused on using genomics to understand the shared biology of humans and animals. BBSRC previously made a £2M phased increase for sustainability for the centre, which includes national capability in prion disease.

New capital developments

BBSRC is committed to the redevelopment of the Institute for Animal Health as a modern and flexible, single-site national facility for animal health research focusing on viral diseases. The redevelopment of the IAH at its Pirbright site requires an initial capital investment of over £100M. We plan to follow this with the transfer of relevant science, and reprovision of the associated facilities, currently located at the Compton site to Pirbright. BBSRC is seeking a proportion of these costs from the Large Facilities Capital Fund.

BBSRC has also made £30M interim capital investments in facilities at Compton and Pirbright to underpin high quality research and national capacity in the period leading to the redevelopment at Pirbright.

Sustainable Agriculture and Land Use

Three institutes cover this area:

- **Rothamsted Research:** sustainable plant-based agriculture and the environment. Including bioenergy, climate change, soils pests and diseases and crop genetics.
- **John Innes Centre (JIC):** world-class basic plant and microbial science.
- **Institute of Biological, Environmental and Rural Sciences (IBERS):** sustainable grassland systems, biorenewables and the wider managed agri-environment. Integrating agricultural, grassland, rural, environmental and biological science disciplines

On 1st April 2008, the former Institute of Grassland and Environmental Research (IGER) in Wales transferred to Aberystwyth University and merged with two university departments to form the Institute of Biological, Environmental and Rural Sciences (IBERS). This will be

followed by a further link between IBERS and Bangor University to form an Institute for Sustainable Land Use. BBSRC will invest capital in new laboratories and this is expected to attract significant further investment from the Welsh Assembly, EU and HEFCW to establish a sustainable, well focused organisation with greater critical mass.

Rothamsted and the North Wyke site in Devon (formerly part of IGER) also joined together, continuing the long tradition of research in SALU at these institutes. The larger Rothamsted has a turnover of around £48M. The unique Rowden Plots will be developed as a national facility for farm-scale agro-ecological systems research, overseen by a new science board, and providing access to universities and other research providers. This will complement the larger long-term field experiments at Rothamsted's main site in Hertfordshire.

Biomedical including Diet and Health

This area is covered by two institutes:

- ***Babraham Institute*** – Cutting-edge science in cell signalling and gene regulation underlying normal cellular processes and development
- ***Institute for Food Research*** – nutrition, food composition and safety, with highly policy relevant topics such as food-borne zoonoses (including food poisoning) and food allergies. Brings together synergistic interactions between food science, food technology, food safety, and diet and health research.

In line with other institutes remaining under BBSRC sponsorship, the governance arrangements for the Babraham Institute will be redefined. A vibrant and sustainable institute is important to maintain the attraction of the campus to the rapidly growing community of 30+ early stage biotech companies on the site many of which draw on Babraham's research facilities and the support provided by the institute's commercial subsidiary, Babraham Biotechnologies Limited.

We are continuing to develop a strategic partnership between IFR and the University of East Anglia (UEA) to form a major new Centre in Diet, Food and Health. This development is part of a wider Science and Enterprise vision for the Norwich Research Park involving interdisciplinary working and closer collaborations across IFR, JIC and the newly established TGAC with UEA and the Norfolk and Norwich University Hospital.

The revised governance arrangements for IFR are under development with a view to implementation during 2010. To assist with progress towards sustainability and increased running costs a small additional sum will be invested across this sector by 2010-11.

Economic Impact (EI)

Competitive advantage and innovation can derive very directly from advances in basic and strategic bioscience. For example, BBSRC's earlier investment of £86M in biomolecular sciences not only generated exciting new science and knowledge but also helped development of eight companies, enabling them to raise £330M in investment and contributing to revenues of up to £900M.

Over many years, BBSRC has led several innovative approaches to maximising the economic and social impact of research. For example, we pioneered the successful Biotechnology Young Entrepreneurs Scheme and Business Plan Competition, the latter now being delivered RCUK-wide. Over SR2004 we more than doubled support for collaborative R&D with industry, but there is much more to do to address the Warry Report¹¹, help to increase the impact of Research Council science, to embed awareness and commitment to EI throughout our research community and organisational structures.

Working within RCUK, we have established an **economic impact baseline** from earlier investments, with a range of key metrics to monitor, measure and demonstrate future progress. We are also working to develop a strategy to identify, collect, maintain and manage information on economic impact generated by BBSRC funding.

In the following sections we outline our plans for significantly raising the economic impact of our funding through **four pillars of activity**:

- i. Increasing Collaborative Research with Business
- ii. Encouraging Entrepreneurship and Commercialisation
- iii. People and Knowledge Flow
- iv. Boosting Skills and Training

Increasing Collaborative Research with Business

Baseline

Research conducted collaboratively with bioindustries has greater relevance and is more likely to generate economic impact more speedily than that conducted without an industrial partner. Over SR2004, our investment in collaborative research with users rose to more than £10M a year, where it contributed to the 2008 baseline that includes:

- Eight percent of papers published by BBSRC institutes are joint with industry;
- BBSRC has initiated two Research Technology Clubs with a total investment of £17.7M and involving 30 companies;
- £3.6M support from BBSRC for a collaborative programme in Applied Genomics helped 6 companies to raise a total of £500M investment.

Future plans.

We will increase both the depth and breadth of our interaction with users. A major element will be **directing a total of around £50M over the 2007 spending review period, towards industrially relevant research.** In this we will work closely with the Technology Strategy Board (TSB), providing at least £34M (of the £50M) for complementary and collaborative activities.

Our **Research with Industry Strategy**, developed in recent years with guidance from our Bioscience for Industry Strategy Panel and extensive discussion with industrial stakeholders,

¹¹ Warry Report: <http://www.dti.gov.uk/files/file32802.pdf>

identified emerging areas of bioscience, aligned with BBSRC strategic priorities, most likely to raise industrial competitiveness over the next decade. We have used this to inform co-funding of programmes with the TSB, and we will evolve the strategy in concert with the Board to help guide our future complementary and collaborative activities.

Research Technology Clubs

UK bioindustries have shown considerable interest in the **Research Technology Club (RTC)** model to stimulate industrially-relevant areas, whereby the companies contribute collectively to a common pot with BBSRC, identify generic research challenges which offer the opportunity for both high-quality research and industrial applicability, and seek bids from universities and institutes in those areas. A key feature of an RTC is its management, where Knowledge Transfer Networks (KTNs), funded by TSB, help enable effective networking between industrial and academic members of the club. We also target PhD studentships to these areas to ensure skilled personnel are available.

BBSRC is planning substantial investment with company partners in RTCs. Three Clubs are currently operational in the areas of biopharmaceutical Bioprocessing ('BRIC'), Diet and Health ('DRINC') and Biorefining ('IBTI'). These have 17, 13 and 10 company members respectively. Phase 2 of BRIC has recently been announced, and a further club, in Crop Improvement ('CIRC'), was launched in 2010. Through these clubs, which all involve KTNs in their management, **we will invest some £16M in complementary activity with TSB by 2010-2011.**

We are also **exploring possible new RTCs and other innovative ways of working with business through discussions with companies.** Areas under discussion include 'Healthy Ageing' and 'Animal Health', and the widening of CIRC to support research into a wider range of crops. We will work with TSB in defining and developing future RTCs.

There is also a need to translate technologies arising from RTCs into commercial application, where TSB involvement could make a significant contribution through, for example, Collaborative R&D programmes and KTPs. We are collaborating with the TSB and EPSRC to test the concept of Innovation and Knowledge Centres (IKCs) in the biosciences. We are supporting, with EPSRC and TSB, an IKC in Regenerative Medicine at the University of Leeds and will co-fund further IKCs in areas of mutual interest. We also look forward to working with TSB in reviewing needs of sectors in which the Board has not previously been active, e.g. the agri-food sector, and BBSRC is a partner in a Technology Strategy Board innovation platform in Sustainable Agriculture and Food, alongside Defra. We will continue to explore other cooperative work with TSB to improve translation of science into practice through Innovation Platforms, KTNs and other routes.

Encouraging Entrepreneurship and Commercialisation

Baseline

A culture of innovation and enterprise within the bioscience research community and a readiness to pursue the successful application of research outputs are essential if we are to realise the full economic impact of research funding and training. Commercialisation by which the outcomes of research activity are brought to the marketplace through the development of new products, processes, services or technologies is an important mechanism through which this impact can be achieved. BBSRC provides considerable support for entrepreneurship and commercialisation where benefits of past investments include:

- Thirteen major university bioscience departments, receiving £36M of BBSRC funding, have created 37 spin-out companies over the last ten years. Associated IP has generated licensing income exceeding £3M over the past three years;
- Over a similar period, BBSRC-sponsored institutes generated 17 spin-out companies with £5M income from IP;

- Increased commercial awareness at the postgraduate level through the Biotechnology Young Entrepreneurs Scheme. Forty three percent of 'graduates' of this scheme take employment in the commercial sector;
- Eighteen projects from a sample of 26 that received our Follow-on Funding led to commercialisation: with 9 start-ups and 4 licensing deals and a total of £1.6m attracted in external equity funding.

Future plans

We will further increase our activities to encourage entrepreneurship and commercialisation. When taken together the measures outlined below will foster a greater EI culture and awareness as well providing support for researchers to pursue the commercial potential of their ideas.

We will **increase the number of participants in the Biotechnology Young Entrepreneurs Scheme** (Biotechnology YES) to over 350 a year. This competition provides commercial awareness for early-career bioscientists. Entrants work in teams to develop business plans for hypothetical biotechnology companies and bid for funding to commercialise their ideas. The scheme will be reviewed in 2010 in order to evaluate its impact and inform the future development of the competition beyond its 15 year anniversary this year.

We consider it vital to provide support so that the commercial potential of research may be demonstrated. We will **double support for proof-of-concept studies via the Follow-on Fund** to around £2.9M a year. Potential outcomes include: improved products and processes, increased licensing income and collaborative research with industry, and the creation of new enterprises. We will work with other Research Councils and TSB to consider how Follow-on funding can be made even more effective.

Once commercial potential has been demonstrated it is important to deliver economic impact through the most appropriate business model. To encourage well structured start-ups BBSRC launched the Bioscience Business Plan Competition in 1999. This has now been developed and operates across all disciplines through RCUK. **We will maintain close involvement with the RCUK Business Plan Competition, encouraging applications from the bioscience community.**

Our Enterprise Fellowships Scheme aims to circumvent the time pressures on leading researchers which can prevent them from exploring the full commercial potential of their ideas. The Fellowships free-up an academic's time to develop a commercial proposition and also provide training in commercial awareness. We will **increase the number of Enterprise Fellows we support by 50%**, to 15, with the aim of enhancing collaboration with industry, supporting new enterprises, and increasing licensing opportunities.

We will work through RCUK, and bring together BBSRC Senior Management and counterparts in universities, to effect a **culture change in universities around the concept of excellence WITH impact.** The BBSRC Excellence with Impact scheme, which will conclude in 2011, is one way in which we are helping to drive this culture change in university departments. This competition will reward bioscience departments which have achieved the greatest impact from their research and also culture change in how the wider impact from bioscience research is recognised and supported. Our prestigious Innovator of the Year award, which celebrates the success of BBSRC-supported scientists in delivering economic and/or social impact from their excellent research, will also run again in 2010-11.

We will develop a distinct funding stream and assessment process for knowledge exchange and commercialisation activities at BBSRC institutes. This new approach will enable institutes to take a longer term and more strategic approach to the successful application of the intellectual assets of the institute so as to maximise public benefit and impact

We will develop closer relationships with our academic community, including partnerships with key HEIs, which will help us to deliver impact in areas of strategic importance through shared strategies for research, training and infrastructure investment.

Facilitating People and Knowledge Flow

Exchange between the science base and industry is mutually beneficial, giving academics an insight into the bioindustry environment and providing industry scientists with direct access to leading research groups. Examples of current activity include:

Baseline

- 24% of BBSRC-funded PhD students move directly into industry upon completion.
- BBSRC's Industry Interchange Awards scheme has supported 15 scientists to move between the science base and industry and vice versa.
- BBSRC is an active partner in the Royal Society Industry Fellowships Scheme

Future plans

We will further promote people and knowledge flow by maintaining support for the Royal Society Industry Fellowships, and developing the activities described above in two main areas

First, **we will increase the number of Industry Interchange Awards we make by 50%**, with outcomes expected to be: increased level of research contracts and collaborations, industrial contribution to training programmes, and academic contribution to product development;

Second, **we will continue to work with the Technology Strategy Board** to double our funding of Knowledge Transfer Partnerships (KTPs) for new PhD graduates and postdoctoral researchers. We will aim to allocate £400k p.a. from 2010-11 to enable postgraduate and postdoctoral researchers to be mentored and supported as they extend their expertise from an academic to an industrial setting, building on BBSRC funded research.

Skills and Training

Skills and trained individuals make a major contribution to the economy and society across the board. Bioindustries, particularly the pharmaceutical and biotechnology sectors, have stated publicly that a prime reason for locating and investing in the UK is the quality of research and the availability of skilled people.

To help industrial scientists update their skills we provide, through our Modular Training Programme, pump-priming support for short courses that meet the training needs of industry. This scheme is highly supported where we have recently increased activity by 40%, and we will maintain this over the period to 2011.

We will continue to promote training and skills in *in vivo* sciences, recognised as a skills gap by the bioscience industries, for example through promoting sustainability of the centres for Integrative Mammalian Biology.

To reflect the importance of skills and training we will increase our funding for training and fellowships by around a third: from £46M in 2007-08 to over £61M by 2010-11.

Baseline

UK bioindustries are significant stakeholders in BBSRC's postgraduate training; industry representatives sit on BBSRC's Studentships and Fellowships Panel, and we run two funding competitions which allocate CASE studentships directly to industry. Over the last spending review period our skills and training baseline shows that:

- We awarded around 100 CASE studentships a year, enabling companies to influence the research areas in which they need students to be trained
- In 2006-07 we supported around 540 CASE PhD students at over 200 different UK companies.
- One third of the studentships funded from Doctoral Training Grants need to be collaborative with industrial partners.
- Of BBSRC funded students 24% enter employment in industry and commerce whilst 17% find employment in government or other public sector bodies. Around 4% go into school teaching or teacher training.

Future plans: Postgraduate Training

PhD Studentships

Our PhD studentships are a crucial investment across the breadth of our science to ensure the flow of highly qualified individuals into the economy.

Research students must be able to work across traditional disciplinary boundaries, understand the social context and ethical responsibilities of their research, and be equipped with wider professional skills. For these reasons, **BBSRC will now fund all studentships as flexible 4-year Doctoral Training Grants to ensure that students have time to undertake challenging research projects and to develop a broad range of skills.** In addition, we will **increase student stipends in line with inflation** to attract high-calibre students into research careers. To cover the move to 4-year awards and the growth in stipends we will increase investment from £39M to c£51.3M per annum by 2010-11.

We will work through RCUK to provide evidence that demonstrates the economic and social impact of our investment in training. We will develop and sustain the skills pipeline, taking account of industrial needs, such as those expressed in the recent ABPI report¹².

UK bioindustries are significant stakeholders in BBSRC's postgraduate training; industry representatives sit on BBSRC's Bioscience Skills and Careers Panel (BSC) and our Training Awards Committee (TAC). We run two funding competitions which allocate CASE studentships directly to industry, and fund studentships in projects selected by our Industry Research Clubs. To develop our postgraduate training further we will:

- **Double our funding in targeted priority areas to £8M per annum** to invest flexibly in targeted training, for example in connection with our bioindustry research clubs, advanced training partnerships, or through targeted Research Experience Placements for undergraduates. This will enhance training in strategically and economically important areas of UK bioscience.
- **Award up to 75 CASE studentships a year to our major industrial partners** as 4-year PhDs to help industry train the researchers it needs
- **Award up to 45 four-year studentships annually to companies, primarily SMEs** to provide students with valuable experience of the challenges facing smaller bioscience companies. We will continue to work with RDAs to encourage SME involvement.
- **Award up to 40 new Strategic Skills Awards in 2010-11 to cover more of the cost of *in vivo* research training.** We are working with MRC and the British Pharmacological Society to address the issue of the very high cost of training in this area.

Future plans: Postdoctoral Researchers

We invest significantly in the research staff employed on BBSRC grants. These postdoctoral researchers play a vital role in the success of UK bioscience and it is crucial that research

¹² 'Sustaining the Skills Pipeline' (2005): <http://www.abpi.org.uk/Details.asp?ProductID=285>

careers attract and retain the best people. Although we are not the employers where grants are held at universities, we must ensure that our funding represents a good long-term investment in the science skills base.

To help achieve this, BBSRC has been working through RCUK to **establish a new Code of Practice for the employment of researchers** and to provide **dedicated funding to universities and other research organisations to support staff development of researchers on BBSRC grants**. The *Concordat to Support the Career Development of Researchers* was launched in June 2008.

Future Plans: Fellowships

Our Fellowships support the very best researchers, enabling them to realise their potential and conduct world-leading research. We take a strategic approach, with schemes for early-career researchers from around the world; for mid-career scientists developing new interdisciplinary directions; and for leading scientists who are opening new avenues of research.

To develop our fellowship programme further we will:

- **Increase our fellowships budget from £5.3M to c£10.0M** to account for the move to full economic costing
- Focus investment on our prestigious **David Phillips Fellowships** to support talented early career bioscientists; and on the **Research Development Fellowships** for mid-career researchers
- Award **targeted Professorial Fellowships** in order to bring world-class senior scientists to work in the Diamond Light Synchrotron. The first Diamond Fellowship was awarded in 2009.
- Work with the Royal Society to provide opportunities for all our junior fellows to attend the prestigious Royal Society ***Innovation and the Business of Science course***, developed in conjunction with Imperial College Business School.

In 2008, a new fellowship scheme was developed - the Industrial Impact Fellowship - to support the movement of experienced R&D leaders from industry to work alongside major BBSRC-funded programmes of work in universities and institutes. The scheme awarded its first fellowship in 2009, and will make further awards during 2010.

Impact on public policy

BBSRC-funded bioscience generates new knowledge and provides evidence and skilled people that underpin responses to a range of major public policy challenges both within and beyond the UK, including climate change, ensuring food security and providing a safer and healthier diets, developing renewable bioenergy and transport fuels combating infectious disease of plants and animals (including humans), improving animal welfare in farming and the laboratory, and improving health and quality of life into old age as lifespans increase and society ages.

Engagement with policy makers in these areas (through, for example, mechanisms such as the multi-agency Global Food Security programme, led by BBSRC) ensure a co-ordinated approach to meeting these challenges and help to increase the impact of BBSRC-funded bioscience on public policy.

Examples of our science into policy include:

- **Influencing global policy on climate change** - as a result of international research involving BBSRC funded UK scientists, the concept of locking-up carbon in soil and trees was included in the final version of the Kyoto Protocol agreed in Bonn in 2001.
- **New variant CJD** - the link between vCJD and BSE was confirmed by BBSRC scientists. This was crucial in designing policies to reduce the risk of people eating meat that might contain the BSE agent.
- **Swine 'flu** - a technology developed with BBSRC funding at the John Innes Centre allowed the rapid screening of candidate vaccines during the 2009 H1N1 swine flu virus outbreak, producing a candidate vaccine in just 14 days.
- **GM crops** - BBSRC funded researchers were a key part of the Government's farm-scale evaluations of GM crops. The results of these trials have informed UK and EU policy on the environmental controls and monitoring of GM crop varieties.
- **Animal welfare** – BBSRC research has determined the environmental features required to minimise stress in animals during livestock transport; contributing to EU legislation and allowing the design of transporters that enhance animal welfare.
- **Combating disease** - research and predictive modelling at the BBSRC Institute for Animal Health on the livestock disease bluetongue prevented an outbreak in 2008, saving the UK an estimated £485M and 10,000 jobs. The Institute continues to play a crucial role in the diagnosis and monitoring of major diseases such as Foot-and-Mouth and Bluetongue and provides epidemiological data that helps to inform UK biosecurity policy and strategies for disease containment, control and eradication.
- **Fertilisers** - Scientists at **Rothamsted Research** have developed mathematical models of nitrogen flow that are being used to produce fertiliser-use recommendations and to help farmers to manage nitrate loss.

Our priority areas of research will continue to make a significant contribution in major policy areas (e.g. food security, environmental change, bioenergy and ageing) through involvement in cross-Council programmes, modernising bioscience with systems/predictive biology, securing key national facilities and capability, and through our emphasis on boosting skills and training. Anticipated outcomes include:

- Progress towards a sustainable supply of sufficient, affordable, nutritious and safe food
- Reduction in the adverse effects of climate change on UK farming and food security
- More sustainable agriculture, making efficient use of natural resources such as soil and water, whilst reducing waste and adverse environmental impacts

- Better able to respond to economic threats from diseases of plants and animals as a result of increasing trade, global travel and terrorism
- The development of renewable sources of petrochemical replacements as feedstocks for industry and low carbon energy
- An underpinning knowledge base to help tackle obesity, diet-related causes of diabetes, cardiovascular disease and some cancers
- An increased understanding of the factors that affect health (for better or worse) both during early development and later in life, that will inform strategies for improving 'healthspan' during ageing, with the potential to reduce the need for medical and social intervention.

Long-term policy challenges

The Government has identified five overarching long-term policy challenges¹³

- Demographic and socio-economic change
- Intensification of cross-border economic competition
- Rapid innovation and technological diffusion
- Continued global uncertainty
- Pressures on natural resources and global climate

These far-reaching challenges require sustained cross-Government and cross-Research Council investment to provide the knowledge base, technical capability and skills to address them. RCUK has published a broad overview¹⁴ of how UK research and skills will play a significant part in helping to tackle each of the five challenges. The specific and important contribution from BBSRC-funded bioscience is set out at **Annex 2**.

In addition, BBSRC plans to pilot a new PhD professional placement scheme, which will aim to provide BBSRC-funded PhD students with the opportunity to gain experience of working in a range of professional areas, including public policy.

¹³ http://www.hm-treasury.gov.uk/spending_review/spend_csr07/spend_csr07_longterm.cfm

¹⁴ <http://www.rcuk.ac.uk/cmsweb/downloads/rcuk/news/csrchallenges.pdf>

International

International collaboration is essential to ensure that the UK remains a world-leader and that academic research, industrial R&D and the UK economy benefits from the increasing scientific activity across the globe¹⁵. Our International Strategy, published in 2007 sets out delivery of these aims through three inter-related areas:

Promoting the movement of people

UK bioscience and bioindustries benefit from the flow of scientists between countries. We will continue to ensure that UK researchers can work with the very best laboratories overseas.

We promote international engagement in many ways, including schemes for grantholder travel to develop international links and fellowships for those outside the UK. We also, with MRC, pay the UK subscriptions to the Human Frontiers Science Program (HFSP) and the European Molecular Biology Organisation (EMBO) which offer prestigious opportunities for fellowships in leading teams across the world. We will:

- streamline access of UK researchers to international schemes and ensure greater harmony across RCUK international work
- fund UK researchers to visit other countries and access new skills and facilities
- support exchanges through contributing to HFSP and EMBO
- raise awareness of international opportunities to our community and contribute to implementing GSIF and RCUK International Strategies
- ensure that our Fellowships and PhD studentships attract the highest calibre people.

Enabling international research and collaboration

BBSRC does not fund research proposals from overseas, but we support international collaborations at the level of individual researchers, centres or partnerships with other funding bodies. As well as funding travel, we welcome bids from researchers to hold workshops enabling new collaborations to be developed. Our Partnership Award schemes allow UK laboratories to lead on interactions over four years with counterparts in Japan, China and India, and have now expanded to the USA.

We have increased the opportunities for collaborative research projects with funding agencies in partner countries, such as a joint partnership call with Japan in systems biology, and a partnering scheme with the US National Institute on Aging to support collaborative research on the biology of ageing. In 2010 BBSRC and the US National Science Foundation (NSF) will hold an "Ideas Lab" - to bring together leading researchers across all disciplines to foster new ideas, collaborations and proposals on novel mechanisms to enhance photosynthesis.

Institutes of BBSRC also play a key role in forging international links in key strategic areas. In early 2010 a UK-Brazil partnership in sustainable agriculture was established when Embrapa - the agri-business research arm of the Brazilian Government - announced Rothamsted Research as its first UK base as part of its Labex ("Laboratory Exterior) programme.

A key pillar of the RCUK International strategy is to establish a formal Research Council presence in China, USA and India, in order to deepen mutual understanding of funding systems and widen the possibilities for co-funding; these are now operational.

¹⁵ www.bbsrc.ac.uk/international

The European Research Area (ERA) aims to reduce fragmentation and overlap across EU research programmes. We have worked with a range of stakeholders and partners to develop the Seventh Framework Programme (FP7) and beyond to maximise benefits for UK bioscience. We manage the UK Research Office in Brussels (which celebrated 25 years in 2010) on behalf of RCUK, to help UK researchers access information and guidance on participation in FP7.

Other opportunities to realise the aims of the ERA include co-funding research with other funders in member states (through the ERA-NET scheme or bilaterally); allowing researchers to take their grants with them across Europe and through the schemes of the European Science Foundation, of which BBSRC is a member organisation. Specifically we will:

- fund our community to develop collaborative activity, e.g. through workshops and partnering awards.
- co-fund research with partners in EU and elsewhere and raise awareness of this important opportunity in the UK
- support joint research through HFSP and through ERA-NET, ESF schemes and bilaterally
- help RCUK to enhance recognition and impact of Research Councils overseas
- lead (with French partners) on the emerging EU Joint Programming Initiative on Agriculture, Food Security and Climate Change

Discharging our global responsibilities

BBSRC research contributes to Millennium Development Goals in tackling major challenges such as climate change, food security, renewable energy and the threat of pandemics. We have a good record in co-funding research with DfID and we will extend this to other areas (see below and page 8). We will continue to work with RCUK and industry to offer Dorothy Hodgkin Awards enabling students from developing countries to undertake PhDs in the UK. BBSRC is a founding member of the UK Collaborative for Development Science, and we help to ensure that coordination is reflected in GSIF and other forums. We will:

- work within the UK Collaborative on Development Sciences for closer coordination between DfID, the Research Councils and other stakeholders
- establish further co-funding with DfID and others - including international funding partners where relevant - in strategic areas such as animal health research (see page 8) and crop production (see page 9), both of which will contribute to addressing the challenges global food security and international development
- lead a multi-agency programme on Global Food Security programme, bringing together the UK's main public funders of food-related research and training to address the challenge of providing the world's growing population with a sustainable, secure supply of good quality food from less land and with lower inputs (see page 8)
- explore opportunities for further international partnerships, particularly in relation to global food security, building on recent activities including: a UK-China workshops (led by RCUK Beijing) which produced a range of potential partnerships and input to strategic planning for Global Food Security; a BBSRC scoping mission (assisted by the UK Science and Innovation Network, BIS/FCO) to Thailand and Vietnam to explore partnerships in food security; and round-table discussions with counterpart funders in India (in association with the UK-India Science and Innovation Council) where talks included the potential for India to co-fund joint UK-India research projects on crop stress (see page 9)

Announced commitments

We have already announced several future commitments, which deliver our strategic aims. These include major investments in the UK science base such as:

- £37M for the EBRC development in association with the University of Edinburgh.
- £100M investment by the Department of Business, Innovation and Skills and BBSRC in the IAH Pirbright site, as part of the redevelopment of the institute as a modern and flexible, single-site national facility for animal health research focusing on viral diseases.
- £20M for UK bioenergy research which more than doubles the budget for research into green bioenergy. In 2009 BBSRC announced the launch of a £27M "virtual" BBSRC Sustainable Bioenergy Centre (BSBEC), with programme grants to five lead institutions and a number of other academic partners, comprising funding of £20M from BBSRC and industrial contributions with a total value of £7M from a wide range of companies.
- £23M for new Research and Technology Clubs with industry.
- £10M to increase data storage and handling capacity of the European Molecular Biology Laboratory's European Bioinformatics Institute (EMBL-EBI), as the first step in developing the EBI as the central hub of the emerging European Life-Science Infrastructure for Biological Information (ELIXIR)
- BBSRC will provide the majority of the £13.5M investment in the establishment of TGAC, and will underwrite its running costs for several years.

A fuller list with details is at **Annex 3**.

Efficiency and Effectiveness

Administration

BBSRC will aim to contribute £80.7M in Value for Money (VfM) efficiency savings to the overall RCUK Efficiency Programme by 2010-11. **This includes further reducing the proportion of funds spent on administration to remain within the BIS 2010-11 target for Research Councils of 2.91%.** The breakdown of these savings is:

- Reprioritisation of programmes - £34.5M
- Reduction of administration costs - £2.2M
- Improved asset utilisation - £20M
- Greater co-funding - £24M

In addition we will make a significant investment in the RCUK Shared Services Centre (SSC). This will include £27.7M on the implementation costs of the central project team as well as a further £2-3M on internal BBSRC implementation costs over the CSR2007 period. The approved Business Case demonstrates that the SSC should deliver £10.8M procurement savings to BBSRC and sponsored institutes by 2011. These savings are in addition to the projected VfM efficiency savings.

Our programme is to:

- Work with RCUK to realise peer review efficiency savings
- Review our committee structures for awarding responsive mode grants
- Implement new governance arrangements for all BBSRC-sponsored institutes
- Secure further efficiency saving through sharing of support services with universities
- Continue an energy efficiency programme to reduce cost and carbon emissions
- Continue implementation of the 10-year estates strategy, including backlog maintenance
- Release funding for the estates strategy through disposal of surplus facilities

Performance Management and Metrics

BBSRC will continue to work through the RCUK Performance Evaluation Group to refine its Performance Management System, including further development of output metrics in line with the BIS Economic Impact Reporting Framework, and to develop internal monitoring of progress against Delivery Plan commitments, particularly in relation to economic impact, where our Economic Impact baseline document provides further information on progress.

BBSRC also maintains an ongoing programme of research evaluations to ensure the quality of research outputs and outcomes.

Longer-term issues – beyond this Comprehensive Spending Review

There are some significant longer-term issues that span well beyond 2011 but which BBSRC is already considering in its planning. These are reflected in our new Strategic Plan, which will inform BBSRC's priorities and high-level strategic direction over the period 2010 - 2015 and beyond. Examples include:

- **Bioinformatics and e-Infrastructure:** assuming that the development project for ELIXIR (see page 13) proceeds as planned, the UK will need to negotiate with EMBL regarding the support for the core of the facility in the UK, since it is effectively an upgrade to the EBI. The main infrastructure costs at Hinxton are likely to be a substantial new computing facility and further building space.
- **Tools and resources:** sustained long-term investments will be essential to ensure that the necessary tools and resources are available to and embedded in bioscience research in order for the UK to maintain its leading international position.
- **Integrative and systems biology:** further expanding training provision in mathematical, computational and systems biology will be of particular importance in achieving BBSRC's long-term goal of embedding integrative and systems approaches to bioscience.
- **Global Food Security:** UK bioscience will play a major role in addressing the challenges of global food security. BBSRC will need to work with stakeholder, including other funders, industry, policy makers and international partners, to support the research, skills and infrastructure required to begin to tackle these challenges. This will include investment in major long-term research programmes that have the potential for significant impacts on sustainable food production (e.g. improving the efficiency of photosynthesis,)
- **Institutes:** BBSRC will continue its programme of investment in its institutes, which provide key national facilities, central to the UK science base. This will include the completion of the redevelopment of IAH, and the continued development of TGAC.
- **Industrial Biotechnology:** given the breadth of this field it will be important for BBSRC to focus its investments in areas where we can have most impact and leverage. BBSRC's is in the process of reviewing its Industrial Biotechnology portfolio and developing a strategy for future investment in this area.
- **High quality research:** In order to maintain flexibility and the ability to respond to emerging areas, a continuing commitment to responsive mode funding will be essential, balanced with an appropriate degree of focus in areas where bioscience can contribute directly to solutions to major societal challenges such as food security, renewable energy and the ageing population.
- **Framework 8:** BBSRC will continue to represent the interests of UK bioscience in the development of Eighth Framework Programme (FP8).

Commitment Information

| Commitments £M | CSR2007 | | | |
|--|--------------|--------------|--------------|--------------|
| | 2007-08 | 2008-09 | 2009-10 | 2010-11 |
| Administration/Programme & SSC costs | 17.8 | 17.9 | 15.4 | 14.7 |
| Institute Programme Costs (1) | | | | |
| - National Research Capacity | 59.8 | 62.9 | 66.4 | 72.9 |
| - Other programmes | - | - | - | - |
| International subscriptions | 1.3 | 1.3 | 1.3 | 1.3 |
| Postgraduate training | 40.5 | 43.7 | 47.0 | 51.1 |
| Fellowships | 5.8 | 6.7 | 8.9 | 10.5 |
| Grants | 220.0 | 205.5 | 219.5 | 223.5 |
| Capital (2) | 60.3 | 59.5 | 68.2 | 51.6 |
| KT Transfer, Science & Society & Other | 14.5 | 20.9 | 24.8 | 31.3 |
| Total Commitments | 420.0 | 418.4 | 451.5 | 456.9 |
| BBSRC DEL Allocation CSR2007 | | 427.0 | 452.6 | 471.1 |

Notes: (1) From 1 April 2008, the institutes at Aberystwyth and Roslin become part of universities. The 2007/08 commitment has been adjusted to bring the figures onto the same basis.
(2) Excludes BIS and Defra shares of the Pirbright Project.

Table 1: Projected BBSRC expenditure over the CSR period for major 'mechanisms' of funding

| Expenditure | | CSR2007 | | | |
|--|----------------|----------------|----------------|----------------|--|
| £M | 2007-08 | 2008-09 | 2009-10 | 2010-11 | |
| Administration/Programme & SSC Costs | 17.8 | 17.9 | 15.4 | 14.7 | |
| Institute Programme costs | | | | | |
| - National Research Capacity | 65.8 | 65.9 | 69.4 | 75.9 | |
| - Other Programmes | | | | | |
| International subscriptions | 1.3 | 1.3 | 1.3 | 1.3 | |
| Postgraduate training | 40.5 | 43.7 | 47 | 51.1 | |
| Fellowships | 5.8 | 6.7 | 8.9 | 10.5 | |
| Grants | 196.9 | 219.2 | 229.5 | 236.8 | |
| Capital | 60.3 | 59.5 | 68.2 | 51.6 | |
| KT Transfer, Science & Society & Other | 11 | 12.4 | 17 | 21.4 | |
| Total Expenditure | 399.4 | 426.6 | 456.7 | 463.3 | |
| CSR07 DEL Allocation | | 2008-09 | 2009-10 | 2010-11 | |
| Near Cash | | 362.1 | 379.6 | 391.1 | |
| Non cash | | 17.1 | 19.4 | 20.5 | |
| Capital Grants | | 28.9 | 34.2 | 39.6 | |
| Capital Grants | | 18.9 | 19.4 | 19.9 | |
| Total DEL Allocation | | 427.0 | 452.6 | 471.1 | |
| BBSRC Expenditure | | | | | |
| Near Cash | | 332.1 | 354.3 | 361.1 | |
| Non cash | | 24.3 | 20.9 | 21.9 | |
| Capital Grants | | 83.9 | 86.7 | 84.5 | |
| Capital Grants | | (13.7) | (5.2) | (4.2) | |
| Total DEL Expenditure | | 426.6 | 456.7 | 463.3 | |
| Difference | | | | | |
| Near Cash | | 30.0 | 25.3 | 30.0 | |
| Non cash | | (7.2) | (1.5) | (1.4) | |
| Capital Grants | | (55.0) | (52.5) | (44.9) | |
| Capital Grants | | | 32.6 | 24.6 | |
| Total Under/(Overspend) | | 0.4 | (4.1) | 7.8 | |

Figure 1: Projected expenditure (£M) by main funding mechanisms from 2007/08 baseline over the CSR period.

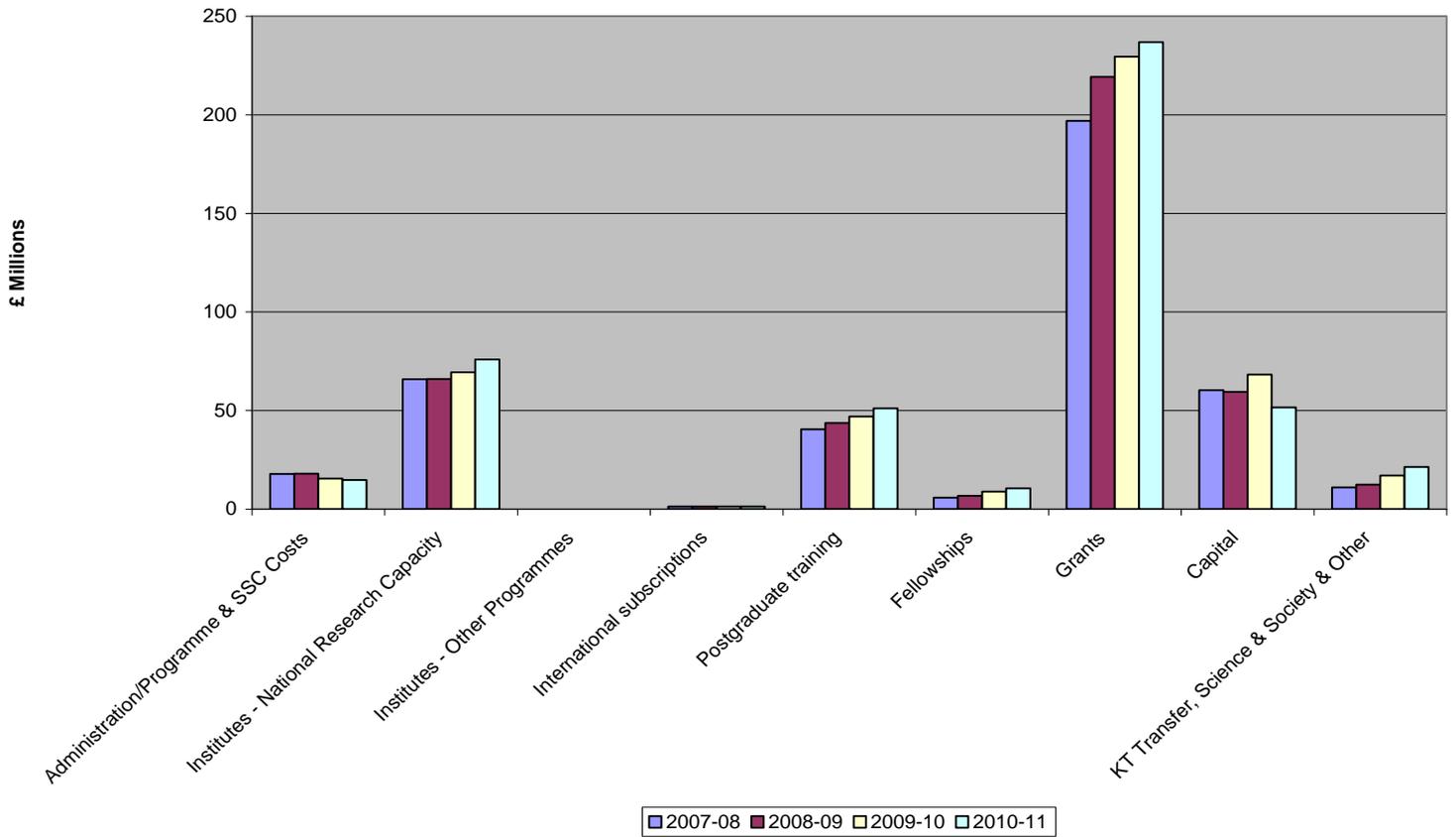


Figure 2: Projected expenditure (£M) by main funding mechanisms (excluding grants) from 2007/08 baseline over the CSR period.

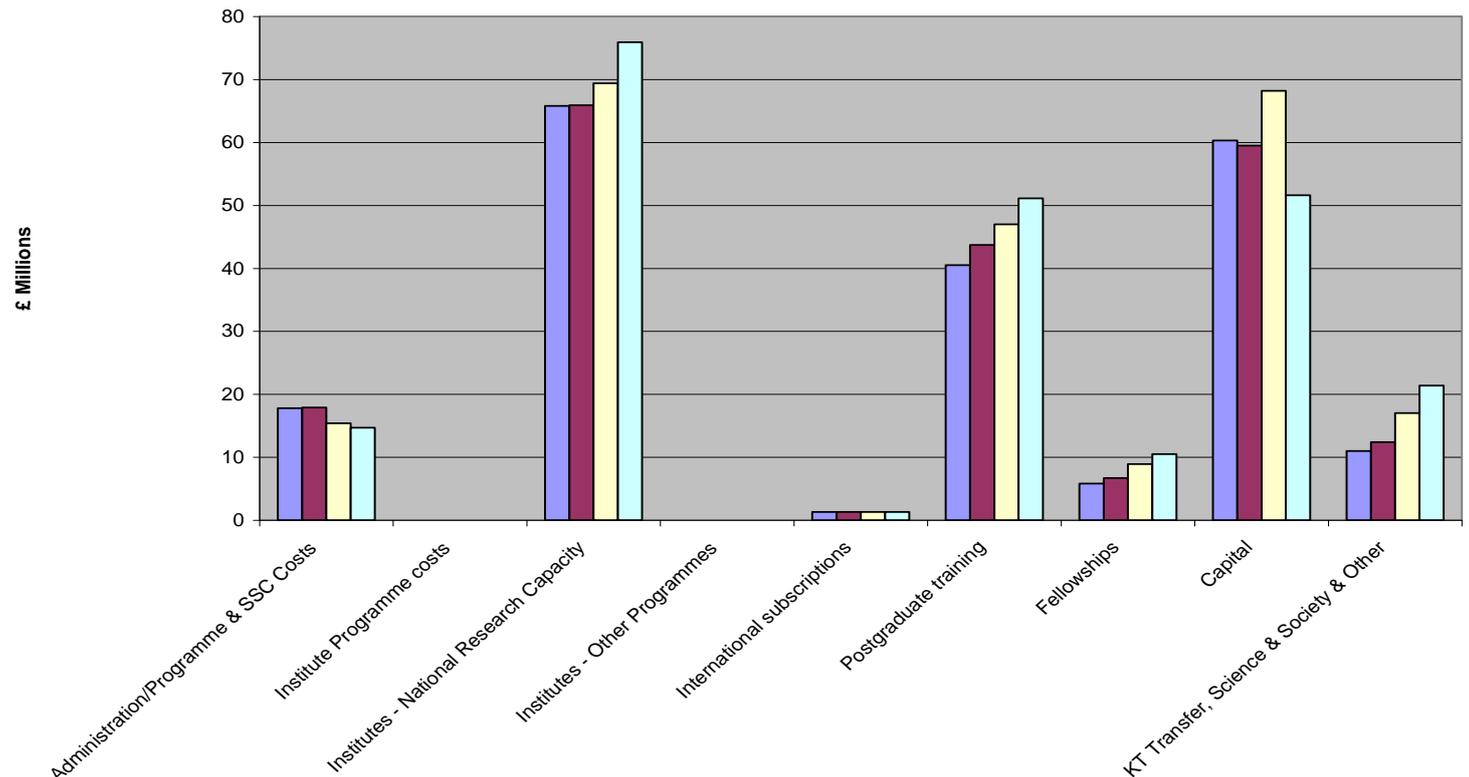
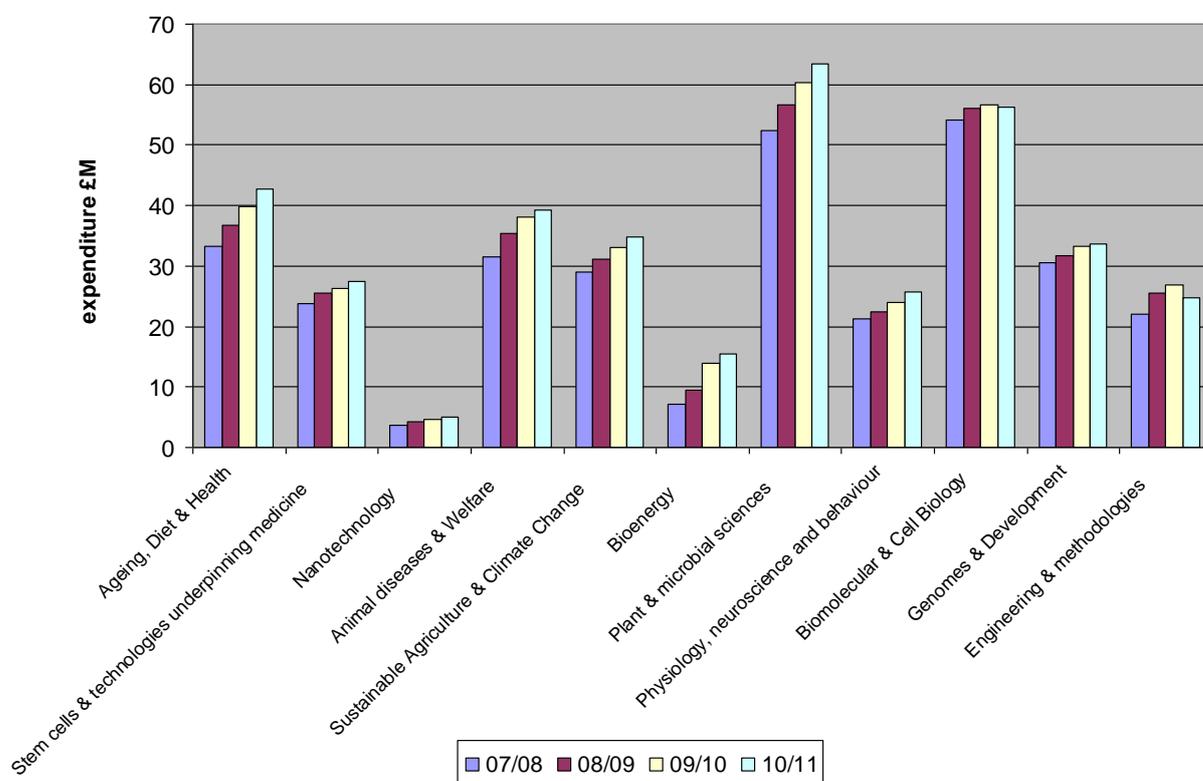


Table 2: Summary of projected BBSRC research expenditure over the CSR period by main science themes

| £M | CSR2007 | | | |
|---|--------------|--------------|--------------|--------------|
| | 2007/08 | 2008/09 | 2009/10 | 2010/11 |
| Ageing, Diet and Health | 33.2 | 36.8 | 39.8 | 42.8 |
| Stem cells and technologies underpinning medicine | 23.9 | 25.5 | 26.2 | 27.4 |
| Nanotech | 3.8 | 4.3 | 4.7 | 5.1 |
| Animal diseases and welfare | 31.5 | 35.3 | 38.1 | 39.3 |
| Sustainable Agriculture and climate change | 29.0 | 31.1 | 33.0 | 34.8 |
| Bioenergy | 7.2 | 9.4 | 13.9 | 15.6 |
| Plant & microbial sciences | 52.4 | 56.7 | 60.4 | 63.3 |
| Physiology, neuroscience and behaviour | 21.4 | 22.4 | 24.0 | 25.8 |
| Biomolecular and cell biology | 54.2 | 56.0 | 56.6 | 56.3 |
| Genomes and development | 30.5 | 31.8 | 33.3 | 33.6 |
| Engineering & methodologies | 22.0 | 25.4 | 26.9 | 24.8 |
| Other Expenditure (Including International Subscriptions; Institute Capital; Administration & SSC: Science & Society) | 90.4 | 91.9 | 99.9 | 94.7 |
| Total Expenditure | 399.4 | 426.6 | 456.7 | 463.3 |

Projected BBSRC research expenditure (£M) by main science themes from 2007/08 baseline over the CSR period.



BBSRC funded bioscience contribution to the five long-term policy challenges

1. Demographic and socio-economic change, with rapid increases in the old age dependency ratio on the horizon and rising consumer expectations of public services.

The UK population is projected to increase from an estimated 61.4M in 2008 to 71.6M in 2033¹⁶. Over this period, the proportion of the population aged 75+ will increase from 7.8% to 12.2% and aged 85+ will increase from 2.1% to 4.6% with the ratio of the population within working age to pensionable age falling from 3.23 to 2.78. This will bring an associated strain on the economy and health system, especially as the ageing population is in poor health.

BBSRC funds research into the biological process of healthy ageing, including a major Systems Biology Centre in ageing research at Newcastle University, with the ultimate aim of understanding how and why cells age. The Council has supported around fifty research projects under two major initiatives in recent years, with significant advances in, for example, our knowledge of the ageing immune system and why elderly people are more prone to infections such as 'flu. In another example with very practical outcomes, research has also shown how muscle and tendon weakness associated with old age, which makes the elderly prone to falls, can be reversed by regular exercise.

Working with other Councils such as ESRC, EPSRC and MRC, BBSRC is participating in the cross-Council programme 'New Dynamics of Ageing'. The Councils have also recognised ageing research as a priority for the CSR period, and have launched the cross-Councils initiative in 'Lifelong Health and Wellbeing' where the BBSRC emphasis will be on developing understanding in areas such as:

- Developmental origins of optimal health (how impacts on foetal and infant development can affect health throughout life)
- Ageing as a risk factor in frailty and homeostasis (how cells and tissues are affected by ageing)
- Diet, exercise and health in ageing
- Underpinning research to identify interventions in ageing

In collaboration with UK Sport, BBSRC is encouraging research on physiological and psychological aspects of athletic performance to impact on the UK's Olympic challenge for 2012 and after. This will contribute to an understanding of the effects of exercise across the lifespan

BBSRC is working with ESRC to develop new approaches to understand the factors that influence health dietary choices

Ongoing research funded by BBSRC in universities and at the Institute of Food Research (IFR) on diet and health throughout the lifespan will contribute to improving the prospects for better health in the ageing population.

¹⁶ ONS, <http://www.statistics.gov.uk/pdfdir/pproj1009.pdf>

BBSRC funded bioscience contribution to the five long-term policy challenges**2. The intensification of cross-border economic competition, with new opportunities for growth, as the balance of international economic activity shifts toward emerging markets such as China and India.**

The rapidly growing economies of countries such as China and India not only present a threat of competition to UK business but also potentially a huge market for UK goods and services.

The Government recognises that science and innovation are the key to the future competitiveness and increased productivity in the UK. UK bioscience is now the most highly cited in the world. The healthy bioscience research base and skilled people that BBSRC funding generates underpin some of the most important sectors of the UK economy and helps them to compete in the global market.

The pharmaceutical industry employs 73,000 people and creates another 250,000 jobs in related industries, generating a trade surplus of £3.4Bn. The industry invests over £3Bn in R&D in the UK, nearly a quarter of all industrial research in the UK. The biotechnology sector is second only to the USA, with numbers of drugs in clinical trials equalling the rest of Europe combined. The UK food sector is the UK's largest manufacturing industry with turnover in excess of £70Bn.

In order for the UK to remain at the top of the league in biosciences research, we need to collaborate with the best around the world and encourage the best bioscientists to come to the UK. For example, BBSRC's systems biology initiative has drawn leading overseas scientists to positions in UK universities, and the Fellowships programmes and those funded in collaboration with international organisations, such as EMBO and the Human Frontiers Science Program, are used by many postdoctoral research bioscientists to move to the UK (e.g. almost one third of international EMBO Fellows move to the UK). BBSRC is also active in promoting links between the best UK laboratories and leading researchers overseas, where the Council supports schemes to foster research partnerships with Japan, China, India and the USA. Joint research with China and India has included major collaborations on genome projects for rice and brassica.

RCUK has launched offices in China, USA, and India. These continue to promote links with UK research and help build further international collaborations for mutual benefit. BBSRC works with key partners such as BIS and the Science Innovation Network, UKCDS, the British Council and the Royal Society to further develop international activities.

BBSRC funded bioscience contribution to the five long-term policy challenges**3. The rapid pace of innovation and technological diffusion, which will continue to transform the way people live and open up of new ways of delivering public services**

In an increasingly knowledge-driven economy, a strong and sustainable research base is essential for economic growth and social prosperity. The primary role of the Research Councils is to support the generation of new knowledge and supply highly trained people to meet the needs of UK employers, but they also have an important role in driving knowledge transfer to improve access to the knowledge provided by the research base.

BBSRC has a good track record in promoting knowledge transfer and innovation from the bioscience it funds. The Council is active in encouraging collaborations with industry as evidenced by industry partnership awards which have now grown to £7M per annum.

The Council is also active in identifying emerging technologies where industry can derive real benefit from ideas emerging from the science base. For example £14.5M Bioprocessing club (with 17 companies) a £12M club in Diet and health (with 13 companies), a £7M Biorefining Club (with 10 companies) and a £6M Crop Improvement Club (with 13 companies). The Council expects the total awards made through this mechanism then active by 2010/11 to be around £30M.

BBSRC plays a key role in providing trained scientists into the economy, with over 2000 studentships supported at any one time. The need to ensure students possess the broad range of skills to compete at the cutting-edge of biology has meant lengthening postgraduate training towards 4 years. The Council is increasingly targeting training to areas of real need/opportunity and taking account of industry views (for example, as expressed in an ABPI report¹⁷) e.g. *in vivo* physiology, bioprocessing.

We will examine the training potential of grant applications requesting postdoctoral staff, in order to ensure that the 2000 BBSRC-funded postdoctoral scientists gain useful and relevant experience.

¹⁷ 'Sustaining the Skills Pipeline' (2005): <http://www.abpi.org.uk/Details.asp?ProductID=285>

BBSRC funded bioscience contribution to the five long-term policy challenges

4. Global uncertainty with ongoing threats of international terrorism and conflict and the continued imperative to tackle global poverty

Much of the basic research that BBSRC funds can contribute indirectly to combating bioterrorism by virtue of the fact that it increases our understanding of biological systems, particularly in the fields of microbiology and plant and animal diseases. However, there are four broad areas of activity in which the research is of more direct relevance:

- *Diagnostics – detection and identification of biological agents and chemicals*

Although most infectious diseases of agricultural plants and livestock rarely pose a direct threat to people (with some notable exceptions - e.g. anthrax, TB) they do provide an opportunity for 'economic terrorism' by the deliberate introduction of disease agents in the environment.

BBSRC-sponsored institutes, such as the Institute for Animal Health (IAH) and Rothamsted Research, have research and expertise in the identification of plant and animal pathogens. In particular, the IAH Pirbright Laboratory is an international reference laboratory for several important infectious diseases of livestock, including Foot and Mouth Disease (FMD), African Swine Fever and Bluetongue. The IAH also works on avian influenza. Diagnostics (and the underpinning science) is also covered by the remits of a number of BBSRC's responsive mode grant-awarding Committees and includes research on the 'hardware' at the biology/engineering interface such as biosensors to monitor/detect biological or chemical agents.

- *Dispersal and persistence of biological and chemical agents*

BBSRC-funded research on the natural spread and persistence of plant and animal pathogens in the environment has direct relevance to the response to bioterrorism. Rothamsted Research has for some years worked on the understanding of airborne dispersal of fungal pathogens, and much of the institute's work is about improving the understanding and forecasting of crop pests and diseases; work also includes the fate of pesticides in the environment. Similarly there is work at IAH and elsewhere on the epidemiology of the infectious diseases of livestock

- *Basic biology of disease mechanisms*

A significant proportion of BBSRC-funded research aids the response to terrorism indirectly by increasing our knowledge of basic biology. Furthermore, some institute research programmes and grants through the responsive mode Committees are specifically targeted at understanding more about disease processes in plants and animals (including basic biology of human systems), immunology or investigating new targets for antimicrobials.

- *Decontamination - bioremediation*

Biotechnology has the potential to provide clean-up solutions for environmental contamination whether that be the result of industrial activity, accident or terrorism. BBSRC funds multidisciplinary projects (principally through responsive mode) in the areas of bioavailability of pollutants and biotechnological solutions to environmental pollution.

BBSRC activities of relevance to tackling global poverty include:

- research on pests and diseases of crops and livestock of importance in the developing world
- co-funding of research with the Department for International Development (DfID)
- co-ordination with other funders through the UK Collaborative on Development Sciences

BBSRC funded bioscience contribution to the five long-term policy challenges

5. Increasing pressures on our natural resources and global climate, requiring action by governments, businesses, and individuals to maintain prosperity and improve environmental care.

Economic expansion and global population growth is driving widespread human-induced environmental change on an unprecedented scale, not least through the impact of climate change. The prognosis is for a warming world, placing pressures on natural resources such as food supply, water, clean air and biodiversity.

BBSRC is the only Research Council to fund research aimed at increasing the long-term sustainability of agriculture and land use, including tackling the threats from current and emerging pests and diseases of crops and livestock. The Council invests around £70M per annum in this research mainly through its sponsored institutes. The institutes are a critical national resource of research capability and expertise, where they undertake the necessary longer-term and more strategic research not typically found in the HEI sector.

In addition to the investment through institutes, BBSRC has been a key player in the cross-Council Rural Economy and Land Use (RELU) programme and has recently launched two new initiatives on crop science and bioenergy. The former of these focuses on translation of basic knowledge in plant science into new crops better suited for a changing environment (e.g. drought tolerant). The latter initiative is aimed at keeping the UK amongst the leaders in bioenergy research in Europe by exploiting strengths in plant and microbial science and building up our national research capability.

Over the CSR period, the cross-Council research programmes in Energy and Living with Environmental Change are priorities for BBSRC. Our particular contributions will be in bioenergy and sustainable agriculture, respectively.

Details of BBSRC's announced commitments relevant to the CSR period

- BBSRC has formally announced its commitment to the £55M EBRC development in association with the University of Edinburgh. BBSRC's share of the expenditure is £37M and this is all due to be spent during the CSR 2007 period.
- BBSRC has committed to the redevelopment of the Institute for Animal Health as a modern and flexible, single-site national facility for animal health research focusing on viral diseases. In July 2009 the Government and BBSRC announced £100M of funding for redevelopment of the IAH at its Pirbright site.
- In addition, BBSRC has announced commitments to investment in facilities totalling £102M. This includes laboratories for the new organisation to be formed from the transfer of IGER to the University of Wales Aberystwyth (£15M), a new laboratory facility at Babraham (£23M) and a new laboratory facility at Rothamsted (£5.5M). BBSRC announced in February 2006 the Strategic Grant funding for its sponsored Institutes for 4 years from 2006/07. For year one of CSR 2007 this equates to £67.3M, rising to £68.7M in year two.
- In January 2007, the Tools and Resources Development Fund was reopened with a stated budget of £3-4M available.
- In March 2007 Alistair Darling, then Secretary of State for Trade and Industry, and BBSRC announced a new initiative to invest an extra £20M in UK bioenergy research, which would more than double the budget for research into green bioenergy. The initiative by BBSRC would take total public funding to £36M over the next five years and support the build up of research capacity into how bioenergy can help replace fossil fuels with renewable, low-carbon alternatives. As part of this commitment, in early 2009 the Council established a £27M "virtual" BBSRC Sustainable Bioenergy Centre (BSBEC), with programme grants to five lead institutions and a number of other academic partners, comprising funding of £20M from BBSRC and industrial contributions with a total value of £7M from a wide range of companies.
- BBSRC has announced commitments to four industry "clubs". It announced in 2005 a £9M commitment to a £14M club in Bioprocessing, co-sponsored with EPSRC and 18 companies, with BBSRC committing £3M in each of 2006, 2007 and 2008. In April 2007, a £10M partnership was announced with the food industry including a £1M contribution from industrial partners, for an industry club to develop products to deliver enhanced health benefits for consumers. More recently we have announced a £5M commitment (of which £1M from industrial partners) to a Biorefineries club looking at producing chemicals and polymers from renewable sources, and a £6M commitment, in partnership with the Scottish Government and a consortium of leading companies, to a Crop Improvement Club to accelerate the development of improved crop varieties higher yields and consistent, high quality products. Following the success of BRIC an additional £10M will also be committed to Phase 2 of BRIC (BBSRC £6M, EPSRC £3M, Industry £1M).
- In November 2008 BBSRC announced £3.5M funding in partnership with EPSRC and TSB to support and Innovation and Knowledge Centre in regenerative Therapies at Leeds University.
- In September 2009 BBSRC announced that it would commit £10M funding over five years to the TSB's Sustainable Agri-food Innovation Platform.
- In July 2007 BBSRC announced it was prepared to commit up to £1M towards the cross-funder UK Clinical Research Collaboration (UKCRC) Translational Infection Research Initiative, aiming to boost capacity for translational and applied research on infections in the clinical and public health contexts.
- In 2009 BBSRC announced support for two consortia totalling £1.7M under the BBSRC led initiative (with MRC, Wellcome Trust and Defra) 'Combating Swine Influenza' initiative to investigate the recent swine influenza outbreak.

- BBSRC announced in August 2007 a contribution of up to £400k (with additional funding from EPSRC, AHRC and ESRC) towards Networks in Synthetic Biology, aiming to develop and establish communication and networking between researchers in this emerging topic at the interface of the biological sciences with engineering, the physical sciences and the humanities.
- BBSRC announced in November 2007 its participation with other Councils in a third call for the New Dynamics of Ageing programme, a seven-year multidisciplinary research programme concerned with improving the quality of life of older people. BBSRC has contributed £2M.
- BBSRC has committed £1.5M to the first call of the Lifelong Health & Wellbeing cross-Council programme and has agreed up to £2M support for phases 2 (awarded in 2009) and 3 (to be announced in Spring 2010)
- BBSRC has awarded £2.6M for Partnering Awards with the US National Institute on Aging (NIA) to support collaborative research on the biology of ageing (with a similar contribution from NIA to support the US partners).
- Studentship awards made through the Quota Doctoral Training Grant mechanism provide funding for 450 students p.a. starting in October 2007 and 2008 on four-year awards. Students who start in 2008 may not complete their PhDs until 2012. This represents a commitment to future training of around £65M.
- In August 2009 BBSRC announced that it has awarded £10M to the European Molecular Biology Laboratory's European Bioinformatics Institute (EMBL-EBI), based at Hinxton near Cambridge, to permit a dramatic increase in the Institute's data storage and handling capacity. The funding is the first step in developing the existing data resources and IT infrastructure of EMBL-EBI towards its planned role as the central hub of the emerging European Life-Science Infrastructure for Biological Information (ELIXIR)
- BBSRC, working in partnership with Defra, the Wellcome Trust, NERC and the Scottish Government has established a joint funding scheme of up to £10M for research to help to identify the main threats to bees and other insect pollinators. BBSRC has committed £2.5M to this initiative.
- BBSRC has committed £3M to a £13M joint funding partnership with DfID and the Scottish Government in research into infectious diseases of the principal livestock species in Sub-Saharan Africa and South Asia. (Combating infectious diseases of livestock for international development - CIDLID)