

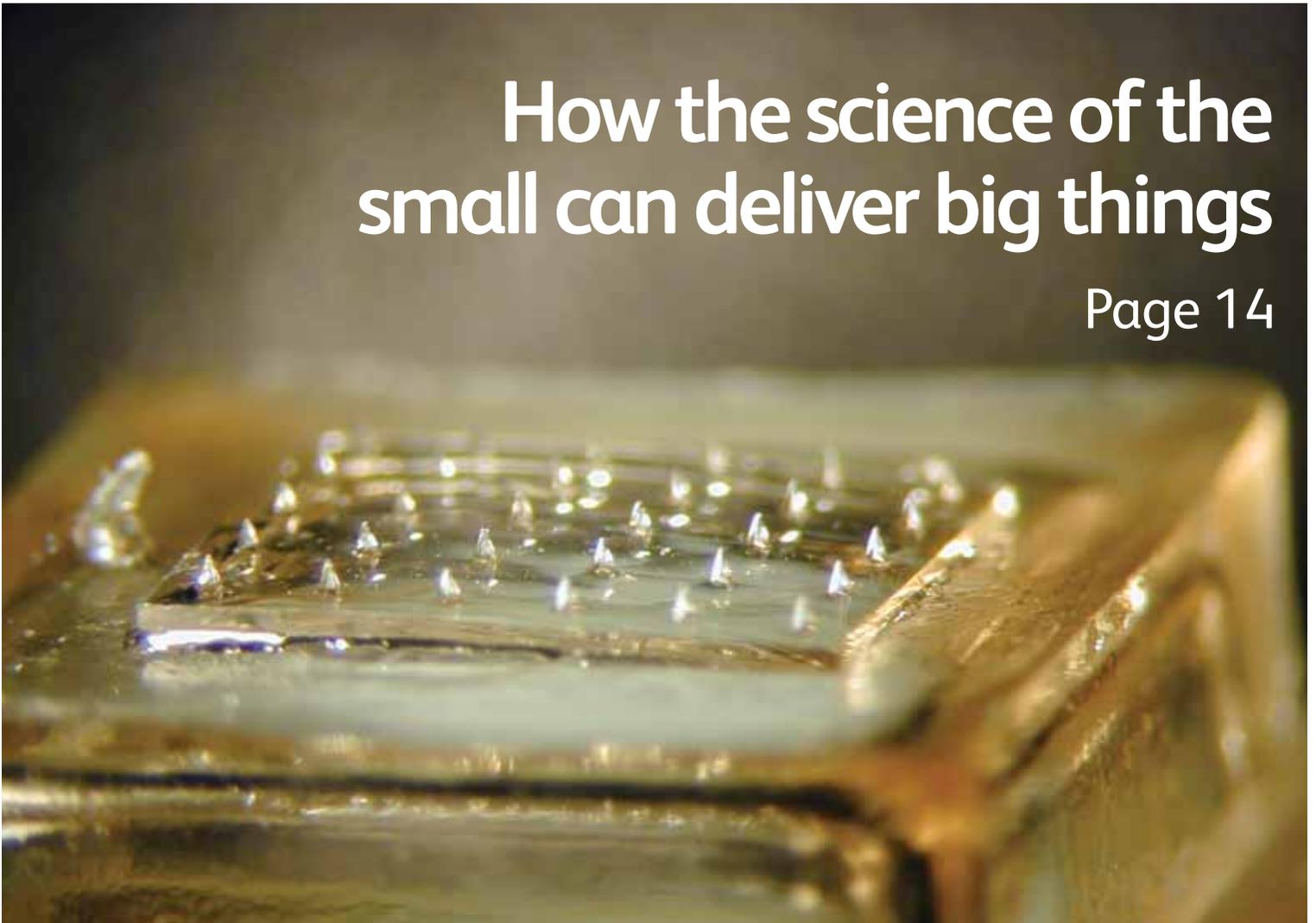
# BBSRC Business

Winter 2012

Connecting our science with industry, policymakers and society

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# About BBSRC

**BBSRC invests in world-class bioscience research and training on behalf of the UK public.**

Our aim is to further scientific knowledge to promote economic growth, wealth and job creation and to improve quality of life in the UK and beyond.

Funded by Government, and with an annual budget of around £445M, we support research and training in universities and strategically funded institutes. BBSRC research and the people

we fund are helping society to meet major challenges, including food security, green energy and healthier, longer lives. Our investments underpin important UK economic sectors, such as farming, food, industrial biotechnology and pharmaceuticals.

Further details about BBSRC, our science and our impact can be found at [www.bbsrc.ac.uk](http://www.bbsrc.ac.uk)



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[www.babraham.ac.uk](http://www.babraham.ac.uk)



Institute for Animal Health  
[www.iah.ac.uk](http://www.iah.ac.uk)



Institute for Biological, Environmental and Rural Studies (Aberystwyth University)  
[www.aber.ac.uk/ibers](http://www.aber.ac.uk/ibers)



Institute of Food Research  
[www.ifr.ac.uk](http://www.ifr.ac.uk)



John Innes Centre  
[www.jic.ac.uk](http://www.jic.ac.uk)



Roslin Institute (University of Edinburgh)  
[www.roslin.ac.uk](http://www.roslin.ac.uk)



Rothamsted Research  
[www.rothamsted.ac.uk](http://www.rothamsted.ac.uk)



The Genome Analysis Centre  
[www.tgac.bbsrc.ac.uk](http://www.tgac.bbsrc.ac.uk)



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## About BBSRC Business

**BBSRC Business is a controlled circulation magazine which is distributed free of charge to end users of research and to individuals with an interest in BBSRC.**

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More, regular news about BBSRC and the outcomes and impacts of BBSRC-funded research can be found at [www.bbsrc.ac.uk/news](http://www.bbsrc.ac.uk/news)

# In this issue

**Chief Executive Professor Douglas Kell looks back on an exceptional year of achievement and gives his thoughts on what lies in store for BBSRC in the year ahead.**

2011 was a challenging year for BBSRC and yet we have achieved a massive amount: a ring-fenced budget, many exciting scientific breakthroughs, the maintenance of the UK as the premier nation in biology, and a slew of announcements of large capital sums awarded for important biological projects.

## A year of investment

I am an ardent believer that investment in research and national research infrastructure is the best way to generate long-term economic growth. I was delighted to be part of a milestone event in October to celebrate the progress made in the construction of a new, £100M+ high containment facility at the Institute for Animal Health in Pirbright (see image this page and page 4).

The Chancellor of the Exchequer's announcement in December of an additional capital investment for the second phase of development at Pirbright will allow BBSRC and IAH to further our vision of founding an animal health science and innovation campus at Pirbright centred on world-leading research. It builds on the £70M investment announced in the March 2011 Budget to help develop innovation campuses at Babraham and Norwich, which I reported on in the last issue.

In the same week, we welcomed the Government's commitment of £75M for the ELIXIR research infrastructure (see page 5). The collaborative and centrally accessible approach represented by ELIXIR is the most effective and efficient way for life scientists to store, manage, share and interpret information. ELIXIR will help us maximize the outputs and impact of the UK's world-leading life science research base.

We've also welcomed the opening of new facilities at the University of Nottingham, home to one of the six BBSRC Sustainable Bioenergy Centre research programmes (see page 5) and a novel biorefinery plant at the Institute of Food Research (see page 18).



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## The year ahead

Over the coming twelve months we can anticipate greater increases in the use and uptake of next generation sequencing and issues around the 'big data' agenda. The 'super experiment' approach at the University of Dundee is an example of how BBSRC-funded research is helping to develop tools to meet the challenge (see page 12).

International research collaborations provide researchers with opportunities to move further and faster by working with other leading people in their field, thereby helping to increase impact activity. We will be extending some of our activities in this area, including those described with Brazil in this issue (see page 8).

Of course, these things go hand in hand with our continued commitment to our major research priority areas (global food security, industrial biotechnology and basic bioscience underpinning health) and in exploiting new ways of working.



## New £100M+ investment to protect food security and rural economy

**The UK farming and agricultural community joined BBSRC in welcoming the announcement in the Chancellor of the Exchequer's autumn statement (30 November) of £80M of capital investment for the further development of research facilities at the Institute for Animal Health (IAH) Pirbright campus.**

With additional support from BBSRC's own capital budget, this will allow the construction of the £100M+ second phase of development of the campus. This will include new high containment laboratories, experimental facilities and supporting infrastructure for studying avian and other animal diseases and to support the development of new vaccines and tests.

Together with the world-leading high containment laboratory currently under construction (see below), the investments form the foundation of ambitious plans by

BBSRC and IAH to develop an animal health science and innovation campus at Pirbright to drive economic growth and highly skilled job creation. The new facilities will allow the transfer of strategically important science from IAH's site at Compton in Berkshire, which is scheduled to close.

Prof. Douglas Kell said, "The Institute for Animal Health at Pirbright is not only involved in furthering scientific knowledge and promoting innovation but in protecting animal health, rural livelihoods and food security. The new facilities for studying avian and other diseases will help to protect huge sectors in the UK economy and protect hundreds of thousands of jobs that would be at risk during an animal disease outbreak."

Professor John Fazakerley said, "In support of the UK's valuable poultry industry, we can with this investment build on previous research and innovation successes such as vaccines against coccidiosis and Marek's disease and the elimination of avian leukosis virus from

poultry breeding stock. We will be able to expand our research into these and other important diseases of poultry and diseases that can spread from poultry to humans including influenza virus. In addition, we will extend our well-established role as a centre of excellence and partner of choice and offer opportunities for training and development to colleagues across the world."

National Farmers Union President Peter Kendall said, "We are delighted with the investment at Pirbright, which will allow IAH to build on its world-leading work on combating animal diseases like bird flu and foot-and-mouth, and help underpin the future of livestock farming."

Peter Bradnock, Chief Executive of the British Poultry Council, said, "The British Poultry Council welcomes this funding for developing the work of IAH at Pirbright. In particular, the science behind new vaccines against certain poultry infections will underpin sustainable growth in poultry production to the benefit of society, the environment, and of the birds themselves."



## Minister marks milestone in world-class laboratory build

**David Willetts, Minister for Universities and Science, led a 'topping out' ceremony on 24 October to mark a milestone in the construction of a brand new £100M+ high containment facility at the IAH in Pirbright, Surrey.**

Mr Willetts said, "The Government has made significant investment in this world-class facility, ensuring the UK remains at the forefront of research into animal diseases. This brings benefits for animal and human health, the agricultural industry and global food security. I am very impressed by the outstanding progress being made here at Pirbright."

The ceremonial signing of a steel beam by the Minister; BBSRC Chief Executive Professor Douglas Kell; IAH Director Professor John Fazakerley; and other invited VIPs was preceded by speeches celebrating the progress of the project and highlighting the role that the Institute and the new facility will play in protecting the UK from viral diseases of farmed animals.

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## New £25M home for BBSRC Sustainable Bioenergy Centre programme

**A multi million pound research facility for biofuels, brewing science and food and drink processing opened its doors in October. The new building at the University of Nottingham's Sutton Bonington Campus will be home to one of the six BBSRC Sustainable Bioenergy Centre (BSBEC) research programmes, set up to develop sustainable bioenergy fuels from industrial and agricultural waste.**

The Bioenergy and Brewing Science Building, which was part funded by the European Regional Development Fund (ERDF), has been created to advance innovative and sustainable solutions for the benefit of industry. It features a state-of-the-art micro-brewery – the biggest research facility of its kind in the country. It also has new food processing facility, equipped with everything from a bakery to the latest analytical equipment, to support the food industry in its quest to develop new products from conception to consumption.

Professor of Brewing Science Katherine Smart said, "The state-of-the-art facilities housed in the new Bioenergy and Brewing Science Building will provide an excellent foundation for the development of innovative technologies for the global and regional brewing, food and bioenergy sectors. This would not have been possible without significant investment from the ERDF, SABMiller, BBSRC and the University, for which I am very grateful."

Knowledge-based economy to benefit from multi-million pound investment

**The knowledge-based economy received a major boost in December following two UK Government announcements of investment in research infrastructure.**

BBSRC and the European Molecular Biology Laboratory's European Bioinformatics Institute (EMBL-EBI) warmly welcomed the announcement of a £75M commitment from the Department for Business, Innovation and Skills' Large Facilities Capital Fund (LFCF) for the ELIXIR research infrastructure.

ELIXIR – a pan-European effort to safeguard and foster data in life-science experiments – has the potential to enhance the development of Europe-based R&D business in fields ranging from pharmaceuticals to agriculture. The new funding will allow the construction of ELIXIR's central hub at EMBL-EBI on the Wellcome Trust Genome Campus in Hinxton, Cambridge.

"This commitment from the UK Government to ELIXIR emphasises the growing importance of biological information to every citizen," said Professor Janet Thornton, Director of EMBL-EBI and coordinator of the preparatory phase of ELIXIR. "This funding puts Europe in a uniquely strong position to solve some of society's most pressing problems, with the UK right in the middle of the action."

And as part of the Government's £158M investment in e-infrastructure, The Genome Analysis Centre in Norwich, which receives strategic funding from BBSRC, will benefit from investment in cutting edge computing hardware for data processing, vital for providing high quality, meaningful information to researchers in industry and academia in support of global challenges like food security.

Read more at [www.elixir-europe.org](http://www.elixir-europe.org)

## £8.5 million research to boost UK's regenerative medicine capabilities



Fourteen commercially-focused research and development projects that will lead to innovation in regenerative medicines are to benefit from nearly £8.5 million of funding from the Technology Strategy Board (TSB) and Research Councils' Regenerative Medicine Programme.

Ten of the collaborative projects will address generic challenges in the development of cell-based therapies, and will lead to demonstrators with commercial applicability. Four projects will engage in the development of regenerative medicine therapeutics. They include work that will develop novel stem cell manufacturing technologies; cell labelling and tracking technologies for quality control and monitoring in the body; stem cells treatments to repair corneal damage to the eye that can lead to blindness; and novel "Cell-Sheet" therapy for the treatment of heart failure.

[bit.ly/urTi9l](http://bit.ly/urTi9l)

## EMBO recognises excellence of BBSRC-funded researchers



Professor Andrew Millar, Chair of Systems Biology at the University of Edinburgh

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BBSRC-funded researchers were among 46 life scientists from 14 countries to be awarded life-long EMBO membership in October. The award is made in recognition of the commitment to research excellence and the exceptional achievements made by a life scientist. The three new EMBO Members join the ranks of 1,500 of the best researchers in Europe and around the world.

**Professor Cathie Martin** from the John Innes Centre has pioneered research to identify the genes that regulate cell shape in plants. In particular, her interests have been in how plants use flowers to attract pollinators, and the roles that specialised cells play in this. More recently, she has been co-ordinating research into how diet helps to maintain our health and reduce the risk of chronic disease, and looking at how crop plants can be fortified to help achieve this.

**Professor Andrew Millar**, Chair of Systems Biology at the University of Edinburgh leads research to understand the molecular mechanisms of circadian clocks and the role of circadian regulation in plant physiology. His work has uncovered aspects of the clock which, when modified, allow *Arabidopsis* to adapt to new environments. Similar modifications could also extend to a range of agriculturally important plants.

**Professor David Holden** FRS from Imperial College London invented signature-tagged mutagenesis (STM), in which molecular barcoding allows high-throughput screens by identifying mutants having reduced or increased adaptation to certain environments. Using STM, his group identified the *Salmonella* SPI-2 type III secretion system, which the bacterium uses to 'inject' proteins into host cells.

**Dr Marc Veldhoen**, an immunologist at the Babraham Institute which receives strategic funding from BBSRC, has been selected as one of 22 new scientists to join the prestigious EMBO Young Investigator Programme, which aims to support the career development of Europe's most promising young researchers.

Babraham's Director Professor Michael Wakelam said, "We are delighted that Marc has been selected for this prestigious scheme supporting the career development of some of Europe's most promising researchers. His recent research, revealing how dietary insufficiencies can adversely impact the immune system, is bringing new insight to understanding the basis of intestinal inflammatory disorders. A greater understanding of immunity and how the immune system is established is central to the goal of promoting a healthier lifespan."



David Holden from Imperial College London

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Cathie Martin from the John Innes Centre

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Marc Veldhoen from the Babraham Institute

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## Minister announces UK-India collaboration on bioenergy

On his visit to New Delhi in November, the Minister of State for Universities and Science David Willetts announced plans for a £10M joint call for sustainable bioenergy research between the UK and India.

The call will support collaborative science which aims to solve shared problems in the production and processing of plants and algae for bioenergy, research that could help both nations develop sustainable alternatives to fossil fuels.

The Minister said "International collaboration is vital to deal with shared challenges. Utilising the expertise we have in both of our respective nations will be fundamental to the success of developing bioenergy as a sustainable alternative to fossil fuels and I am delighted that we will have the opportunity to work together to tackle this global issue."

The call will be supported by funding from BBSRC and the Indian Government Department of Biotechnology (DBT). BBSRC will support the UK side of the collaborations while DBT will support the Indian side of the projects.

Read more at [bit.ly/sEd4K2](http://bit.ly/sEd4K2)

## New research will help make foods healthier, safer and more nutritious

Over fifty research projects and studies aimed at developing healthier, safer and more nutritious food are to share over £7M of Government investment.

The projects and studies, announced in October, will stimulate innovation in the UK's food and drink sector and lead to the development of new technologies and processes, with an emphasis on healthy and safe food. Funding for the research and development will be provided by the TSB, with support from BBSRC, the Engineering and Physical Sciences Research Council (EPSRC), Medical Research Council (MRC), Defra and Scottish Enterprise.

The projects to be funded include novel processing methods to retain the nutritional quality of raw fruit and vegetables in processed foods; formulation technologies to enable the reduction of fat and salt in food products; identification and development of functional foods that improve heart health, and strategies to

enable the control of *Campylobacter* in poultry.

In addition, 24 small and medium-sized businesses are to receive up to £25,000 each to carry out small-scale technical feasibility studies, which may be taken forward later into larger scale projects. These studies will be in areas such as extending the nutritional life of fruit and vegetables; development of novel products to increase satiety (feeling of fullness), and novel methods to identify ingredients which safeguard bone health.

The total value of the R&D exceeds £14.5M, which includes contributions from participating companies.

Read more at [bit.ly/uj3CvO](http://bit.ly/uj3CvO)

## UK scientists come together to help feed the seven billion

The Universities of Exeter and Bristol, in partnership with Rothamsted Research, which receives strategic funding from BBSRC, have officially joined forces to tackle global food security and to ensure resilient land management.

The launch of the Food Security and Land Research Alliance in October will establish the South West of England as a centre of global significance in the arena of food security and land research.

Professor Alistair Hetherington, Faculty of Science Research Director at the University of Bristol, said, "Our three institutions are strongly placed to address this challenge through world-class research.

"Together we hold a huge range of expertise, encompassing bioscientists engaged in tackling crop diseases, leading work on farm animal welfare, climate change science, soil and nutrients science, and the full breadth of economic, social science and humanities."

"Collaborations of this nature are essential as we look to meet the challenges of global food and energy security," commented Rothamsted Research Director Professor Maurice Moloney.

"The new [Rothamsted Research] Farm Platform, at North Wyke in Devon, gives us the facilities and technology to conduct collaborative research and we are looking for researchers to work with us on this Platform to explore alternative land use scenarios and their impacts."



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# On the road to Rio

Science relations between the UK and Brazil have shifted into a higher gear in recent years. And BBSRC-funded researchers are playing a key role in encouraging collaboration and investment in UK science and innovation, particularly in food security, industrial biotechnology and bioenergy.

Science and technology are a big priority for the Brazilian government. Public and commercial funding for research doubled between 2003 and 2008, an increase from 1.26% to 1.43% of Brazil's gross domestic product. And with further plans to increase science spend to 2% of GDP by 2020, combined with forecasts suggesting that Brazil will become the world's fourth largest economy by 2050, this Latin American giant is becoming an increasingly attractive partner for business research and innovation.

It's not a one-sided appeal either. The UK overtook France in 2008 to become Brazil's largest partner in science after the USA. Since the successful UK-Brazil Year of Science in 2007-08, and the extension of the programme under the UK-Brazil Partnership in Science and Innovation into 2008-09, the relationship has blossomed even further.

## Home from home

In 2009 EMBRAPA – the £400M agri-business and research arm of the Brazilian Government – signed a cooperation agreement with Plant Bioscience Limited (PBL), the UK technology management company, under which they will develop new technologies for Brazilian agricultural markets, and to promote and market new innovations emerging from EMBRAPA's large research network. The agreement gives EMBRAPA the right to access a group of patented technologies from PBL, which is jointly owned by BBSRC, the John Innes Centre and the Sainsbury Laboratory.

Agriculture is a major industry in Brazil, accounting for more than 30% of GDP. EMBRAPA provides innovative science and technology for all production regions and crop commodities in the vast and diverse Brazilian

territory, with more than 40 Centres distributed across the different ecological zones.

In 2010 EMBRAPA established its first UK base at Rothamsted Research, which receives strategic funding from BBSRC, building on links forged by the Rothamsted International team over the past decade.

The aim of the base is twofold: to carry out state-of-the-art research in the area of crop improvement, and to create new opportunities and links between UK and Brazilian scientists, not just within Rothamsted, but across other BBSRC Institutes and UK universities, and connecting with EMBRAPA's wider European 'Labex' network.

Based in Rothamsted's Department of Plant Pathology and Microbiology, EMBRAPA scientist Dr Alexandre Morais do Amaral is working with Professor John Lucas,



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Septoria leaf blotch in wheat, caused by the fungus *Mycosphaerella graminicola*

Professor Kim Hammond-Kosack and Dr Jason Rudd to devise new approaches to prevent Septoria leaf blotch, the most important foliar disease of wheat in Europe.

Brazil produces approximately five million tonnes of wheat annually (half of its national demand), and aims to become self-sufficient in the future. There is considerable potential for increased wheat production in Brazil, but the impact of pests and diseases are an important constraint.

In May 2011, leading UK wheat scientists travelled to Brazil as part of a joint EMBRAPA/BBSRC workshop to review the current range of research on wheat improvement in the two countries and to identify the most important topics for joint research and mechanisms for taking these forward. These include the control of plant pathogens (including wheat blast fungus), the use of crop residues for biofuel production, the improvement of resource (notably nitrogen) use efficiency and the improvement of grain quality for food processing and human health. More recently, Prof. John Lucas has flown to EMBRAPA's

base in Brasilia in a reciprocal arrangement, sponsored by BBSRC and Rothamsted, to explore further opportunities for collaboration between UK and Brazilian scientists working in areas relevant to sustainable agriculture.

## Exciting times

Lucas's visit is timely as negotiations are well advanced to put in place joint funding arrangements for UK-Brazil projects.

In June 2011 BBSRC and FAPESP (the São Paulo Research Foundation) announced a pump-prime partnering awards scheme, building on an existing agreement between RCUK and FAPESP to support grant proposals that involve international collaborative teams (see case study below).

In the same month BBSRC also announced new 'Brazil Partnering Awards' as part of an agreement between BBSRC and CNPq (the Brazilian National Council for Scientific and Technological Development) to facilitate long term collaboration between top BBSRC funded scientists and their counterparts in Brazil. Initially this will focus on priority areas identified by both parties, namely food security, bioenergy and industrial biotechnology.

"Networking on this scale is a daunting thought, but there are already well-established links between UK and Brazilian research groups, and now an increased momentum to build on this," says Lucas.

<sup>1</sup>Thomson Reuters (2009) Global research report – Brazil – research and collaboration in the new geography of science

## Further Reading

[www.bbsrc.ac.uk/news/archive/2009/090521-pr-EMBRAPA-pbl.aspx](http://www.bbsrc.ac.uk/news/archive/2009/090521-pr-EMBRAPA-pbl.aspx)

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[www.bbsrc.ac.uk/news/industrial-biotechnology/2010/100308-pr-seafarers-biofuel-future.aspx](http://www.bbsrc.ac.uk/news/industrial-biotechnology/2010/100308-pr-seafarers-biofuel-future.aspx)

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## Biofuel research: the quest for new sugar-releasing enzymes

The first BBSRC-Fapesp funded project brings together researchers from the University of York and University of Sao Paulo (USP) to identify new enzymes to disrupt lignin and release sugars from lignocellulose in cereal straw and sugar cane bagasse (the waste material from sugar production).

The project builds on the strengths of the two groups in enzyme discovery and development. At the University of York, Professors Neil Bruce and Simon McQueen Mason collaborate closely on lignocellulose deconstruction and are investigators on

the 'Marine Wood Borer Enzyme Discovery' programme funded as part of BBSRC's Sustainable Bioenergy Programme (BSBEC).

Working closely with Brazilian scientists in the area of biomass degradation provides the benefit of working in the context of a mature biofuels industry and its associated research infrastructure. Both teams will benefit from access to complementary skills, facilities and expertise, especially in the area of examining the impact of enzymes on lignocellulose deconstruction.



The digestive tract of the gribble, scourge of seafarers for centuries, is home to many enzymes that attack wood.

# Green vegetables are good for you – and getting better!



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Transgenic brassica plants flowering in a glasshouse.

“Our research has given new insights into the role of broccoli and other similar vegetables in promoting health, and has shown how this understanding can lead to the development of potentially more nutritious varieties of our familiar vegetables”

Professor Richard Mithen, IFR

**When it comes to eating your greens, it appears that mother really does know best. A recent BBSRC-funded study has shown that green vegetables can directly influence immune defences and help maintain intestinal health. Meanwhile, the launch of ‘super broccoli’ on UK supermarket shelves in November has demonstrated how more than two decades of work on both the biology of plants and the link between human nutrition and health can provide benefits to consumers. And BBSRC-funded researchers are continuing to develop the tools and knowledge that breeders will need to improve brassica crops in the future.**

Leafy greens have been shown to influence our intestinal health by delivering a protective factor to certain cells of the immune system, according to BBSRC-funded research published in October. The findings, reported in the journal *Cell*, have implications for better understanding the basis of intestinal inflammatory disorders such as inflammatory bowel disease (IBD) and may offer new opportunities for treatment.

The collaboration between researchers at the Babraham Institute, which receives strategic funding from the BBSRC, and the Medical Research Council’s National Institute for Medical Research provides new insight into how cruciferous vegetables like broccoli govern the survival of a special type of white blood cell – part of the body’s front line

defence against infections and important in wound repair.

The research shows for the first time that mice fed a diet low in vegetables rapidly lose specialised immune cells, known as intra-epithelial lymphocytes (IELs), lining the intestinal tract.

“This was surprising,” said Dr Marc Veldhoen who conducted a large part of these studies<sup>1</sup> in Dr Brigitta Stockinger’s department at the MRC National Institute for Medical Research (NIMR) prior to joining the Babraham Institute. “I would have expected that cells at the surface would play some role in the interaction with the outside world, but such a clear cut interaction with the diet was unexpected.”

The team discovered that a particular receptor molecule present at high levels on IELs – the aryl hydrocarbon receptor (AhR) – is central to understanding the connection between diet, numbers of IELs and a healthy gut. Animals lacking AhR activity for either genetic or dietary reasons showed lower levels of antimicrobial proteins, heightened immune activation and greater susceptibility to injury.

## Mice and men

Dr Brigitta Stockinger, Head of the Division of Molecular Immunology at NIMR added,

“This study in mice is an important step towards increasing our understanding of how environmental signals shape immune responses at barrier sites such as the intestine.

Marc Veldhoen’s continuing studies at the Babraham Institute will no doubt take this onto the next step.”

The implications to human intestinal immunity are currently not known. However, as an immunologist, Veldhoen hopes the findings will generate interest in the medical community, since some of the characteristics observed in the mice, on either a low vegetable diet or lacking AhR, are consistent with some clinical observations seen in patients with inflammatory bowel disease.

The discovery will also enable scientists to ask fundamental questions about the frequent interactions of cells of the immune system with external environmental factors. This was highlighted with the additional finding that IELs present in mouse skin also crucially depend on the activation of AhR. While the nature of the interactions preserving skin IELs is currently unknown, it may provide a rationale for the reported association between some intestinal and skin disorders, the most frequent of which is psoriasis, as well as diet choices.

## It’s not just broccoli...

When Beneforté ‘super broccoli’ was launched onto selected UK supermarket shelves in October 2011, it represented a special achievement for UK bioscience – a consumer-focused, nutritionally-enhanced product developed over more than two decades through collaboration between two BBSRC-supported research world-class institutes and a specialist technology transfer company, part-owned by BBSRC.

The team from the Institute of Food Research (IFR) and the John Innes Centre (JIC) used conventional breeding techniques to develop the new broccoli, which is two to three times higher in the compound glucoraphanin than standard broccoli.

Following digestion, glucoraphanin is converted to sulforaphane, which studies in animal model systems have shown can lead to lower



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rates of heart disease, act against some forms of cancer, and boost the body’s levels of antioxidant enzymes which can protect DNA from damage and is thought to be a useful component of healthy ageing.

“Now there will also be something brand new for consumers to eat as a result of the discoveries we have made,” said IFR’s Professor Richard Mithen.

## Breeding brassicas for the future

The study of wild relatives of cultivated crop species is invaluable for probing gene function and identifying genetic markers that breeders can use to develop new and improved varieties. Genetic modification, or transformation, is used routinely in the model plant *Arabidopsis*, where the ability to modify genes or to switch them on and off has led to a wealth of potentially exciting traits being identified.

To translate and validate the claims made in the model species into economically important crop species, such as brassicas, robust transformation resources for *Brassica napus* (oil seed rape) and *B. oleracea* (horticultural Brassica) have already been developed through a Defra-funded programme<sup>1</sup>.

The similarity in fruit morphology between *Arabidopsis* and *Brassica* species provides an ideal system to unravel, for example, fundamental aspects of organ formation and to develop tools for crop improvement. Recent work at JIC by Professor Lars Østergaard has demonstrated how knowledge of pod shatter control in *Arabidopsis* can be used to understand the process in brassicas. This knowledge has significant implications for UK agriculture where unsynchronised pod shatter in oilseed rape accounts for over 10% seed loss, estimated at £60 million per year.

Recently funded by BBSRC, Prof. Østergaard and Dr Penny Sparrow are looking to develop a cost effective and efficient transformation system for *Brassica rapa* – a wild relative of oilseed rape – which has a simpler, diploid genome than the crop plant and is more desirable for forward and reverse genetic studies. Together with the recent publication of the *B. rapa* genome sequence and ‘TILLING’ reverse genetics resource at JIC, these resources are greatly enhancing knowledge and the speed at which researchers are able to elucidate gene function and, ultimately, to translate fundamental research into crop species.

## Further Reading

<sup>1</sup>www.bract.org

Exogenous stimuli maintain intraepithelial lymphocytes via aryl hydrocarbon receptor activation. *Cell* DOI:10.1016/j.cell.2011.09.025

Glutathione S-transferase M1 polymorphism and metabolism of sulforaphane from standard and high-glucosinolate broccoli. *American Journal of Clinical Nutrition* (2005) Vol. 82, No. 6, 1283-1291

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## Discovery pipeline



Blue skies

Strategic research

Proof of concept

Demonstration

\*Market

\*super broccoli work

<sup>1</sup>The research was funded initially by MRC and later by BBSRC at the Babraham Institute

# From loyalty cards to proteomics and the birth of the super experiment

Like tracking customer buying preferences with a loyalty card, BBSRC-funded researchers at the University of Dundee are using business intelligence software to discover patterns and trends in proteomics data which were not visible previously.

It's a novel solution to a common problem, and one that has allowed the team to overcome a major bottleneck to proteomics research: how to compare and integrate data from many independent experiments. Now with a suite of customised software under their belt, the team is developing a super experiment for functional proteomics analysis, which in the long term could help to deliver on the promises of the human genome project – tailor-made medicines.

A few years ago it was usually only possible to study one or two proteins at a time. Today researchers can generate data for thousands of proteins and their associated genes in a single experiment. While this is great in principle, the reality is that colossal amounts of untapped data are generated which are kept in isolation, with little or no chance of being used at a future date.

Professor Angus Lamond, Director of the Wellcome Trust Centre for Gene Regulation and Expression at the University of Dundee, recognised early on that the collection and analysis of proteomics data was limiting progress. "We needed a more sophisticated approach," he said.

"Working with colleagues in Dundee at the School of Computing we quickly realised that business intelligence techniques could be the key to creating what I've termed 'super experiments'."

By creating a multi-dimensional database to manage all the consistently annotated data from the many hundreds of experiments in Lamond's lab, he realised that it would also be possible to integrate data from multiple experiments and extract information that simply isn't available when individual experiments are considered in isolation.

But instead of using business intelligence software to track consumer spending

patterns in order to maximise profits, for example in the use of own brand versus high value products, by high volume, or by season or location, Lamond and his team would track multiple variables such as cell type, whether proteins are switched on or off, the location of proteins with a cell and post-translational modifications.

"It's the same concept, just the names are different," he says.



According to Lamond, such an approach could open the door to large scale, functional proteomics experiments to find out exactly what multiple proteins are doing in cells, and the relationships between them. Because most medicines affect proteins rather than DNA, there is the potential to build on the findings of the human genome project and use the integrated information from proteomics experiments for the development of safer, more tailor-made drugs.

## Software solution

The first step was to create a customised suite of software – called PepTracker. Development was supported in part through the Radical Solutions for Researching the Proteome (RASOR) programme, funded by BBSRC, the Engineering and Physical Sciences Research Council and the Scottish Funding Council, as well as by a BBSRC-funded PhD studentship and additional support from the Wellcome Trust.

BBSRC-funded PhD student Yasmeen Ahmad, a computer science graduate who built PepTracker explains how the system works, "Users start by designing and performing a proteomics experiment in the laboratory. As well as the data output from the mass spectrometer, we also collect a great deal of metadata about each experiment. Among other things, this includes information about the specific mass spectrometer that was used, the cell line, genotype, extract analysed etc. as well as the time, date and the researcher. The measured data and associated metadata are entered into PepTracker and then stored on a dedicated database server – the data warehouse."

PepTracker provides researchers with a set of very powerful, bespoke tools for analysis of proteomics data, based in part on Microsoft® business intelligence software (see further reading panel for case study).

"We couldn't use off-the-shelf software, and that meant assembling a team of people who understand both worlds – the experimental design, the instrumentation, and the informatics challenge," says Lamond. "When Yasmeen started work my lab, she didn't know what a protein was. But I think she was fascinated by the opportunity and has learned quickly the background biology."

"It was a steep learning curve, I was, and still am, constantly learning" says Ahmad. "I was excited and intrigued to see where it could go."

"The team comprises a very diverse group of people, from lots of different countries and scientific backgrounds, which makes things

interesting, richer. We all have different experiences, some have a life science PhD, other PhDs in protein chemistry, mass spectrometry or computing science, so our skills set is very diverse and I know I can call on anyone if I have questions."

## Growing legs

Although PepTracker was initially conceived as a focussed software solution for experiments in Lamond's laboratory, the team reached a turning point when they realised that they could do so much more outside of one project.

"These tools will provide insightful analysis through interactions with individual datasets, as well as allow for comparisons of data produced by different researchers, using both similar and different experimental methods," explains Lamond. "They will thereby help to promote new collaborations and to cross-fertilise projects."

The software is already used by other researchers in Dundee. And, having proved the principle behind his super experiment, Lamond is now leading a major expansion of the proteomics facility to provide the scale of resources needed to move the project forward.

In addition, the team are continuing to develop novel solutions, working with both academic and commercial collaborators to enhance the use of very fast, parallel computing solutions and business intelligence. Their aim is to continue to innovate, making software tailored to the specific needs of the new types of experiments and building better, faster tools to analyse proteomics data.

"This project has grown lots of arms and legs," says Ahmad. "There are so many exciting branches for this work over the next few years, and I'm so pleased to be a part of it."

**"We quickly realised that business intelligence techniques could be the key to running what I've termed 'super experiments'."**

Professor Angus Lamond, University of Dundee

## Further Reading

Systematic analysis of protein pools, isoforms and modifications affecting turnover and subcellular localisation. *Molecular and cellular proteomics* DOI: 10.1074/mcp.M111.013680 mcp.M111.013680

Microsoft® case study [bit.ly/tBGUoK](http://bit.ly/tBGUoK)

## Next steps

- Develop the PepTracker software to improve the tools and resources provided
- Open use of PepTracker to the wider research community and build the super experiment approach

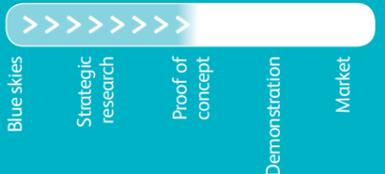
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## Discovery pipeline



# How the science of the small can deliver big things

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Hydrogel microneedle array (microneedle height 300µm, spacing approx 900µm)

**A fascination in the basic bioscience underpinning pharmacy – from the physical and chemical properties of a drug substance, how the body deals with it, and how to overcome biological barriers – has led Ryan Donnelly at Queen’s University Belfast to develop novel microneedles for vaccine delivery.**

The biotechnology boom has produced a range of important peptide and protein-based drugs. Currently, the only way they can be given is by injection, since this avoids acid destruction by the stomach and overcomes poor gastrointestinal absorption of these large, complex, molecules. And given the risk of infection and problems with disposal of needles, especially in the developing world, vaccine delivery is obviously a big area for development.

“If we can find a way to take administration of these exciting new medicines out of the hands of skilled practitioners in a hospital environment and into the hands of ordinary people in their own homes, we would create a profound advantage and greatly improve patient care,” says Donnelly.

The transdermal delivery market, mainly based on drug-containing patches and ointments, is

currently worth around USD\$20bn even with only about 20 drugs. Most medicines have a degree of water solubility since they have been developed for oral delivery, which means they won’t move across the skin very well because the skin is an oily barrier.

“If we could open this market up by successfully delivering water soluble molecules across the skin it would have much greater value,” Donnelly explains.

He and his team in the School of Pharmacy at Queen’s University Belfast have been developing microneedles capable of delivering water soluble drugs such as insulin, factor VIII for haemophiliacs and various hormones. With their system, it doesn’t matter how large the molecule is, as long as it is water soluble, which opens the door to a much wider range of drugs that could be delivered across the skin.

And, according to Donnelly, there are numerous benefits for patients, “Say you have a medicine that has to be administered three times a day, every day of the week, if you have an elderly patient who is forgetful, treatment may not be optimum. If instead you have a microneedle patch that is only applied twice a week then you would clearly improve treatment – vastly.

**“A microneedle patch that is only applied twice a week... would clearly improve treatment – vastly”**

Ryan Donnelly, Queen’s University Belfast

He continued, “If you have a medication that is rapidly metabolised by the liver, you are losing up to 60-70% of the medicine, and getting formation of a range of metabolites that could have side effects. If you deliver such a drug across the skin you are straight into the systemic circulation and you could deliver a lower dose and reduce side effects.”

## Advancing technologies

Historically, metal and silicon were used to develop microneedles because the manufacturing technology originated from the electronics industry. But silicon is not a biomaterial approved by any main regulators and, with metal microneedles coated with a drug or vaccine, there’s nothing to stop someone from sticking the microneedles into someone else after removing them from their own skin.

Instead, the group at Queen’s have developed novel polymers that dissolve in the skin to deliver a ‘bolus’ dose [a large dose in one go, like an injection] and a cross-linked hydrogel polymer system that swells in skin to facilitate controlled drug administration.

“With our polymer systems the microneedles are self-disabling,” explains Donnelly. “They dissolve in the skin or become soft in the skin so you could never stick them in another person, either on purpose or, more likely, by accident.”

Interestingly, with the hydrogel system, the drug is not in the microneedles prior to administration as the cross-linked polymer matrix is in a hard, dry state. When the microneedles enter the skin, they absorb skin interstitial fluid and swell, which allows controlled administration of the drug from an attached transdermal patch. This facilitates administration of greater doses of drug over a longer period of time. Importantly, these hydrogel microneedles are removed from skin completely intact, but are then too soft for re-insertion.

What’s more, they can also be combined with an electrical current for pulsatile delivery to mimic normal secretion of hormones by the body, for example, or for the rapid delivery of a vaccine or local anaesthetic.

## Delivering to patients

With funding from BBSRC, Donnelly and his team have demonstrated the capabilities of the hydrogel system to swell in the skin and deliver a wide range of therapeutically-useful drug substances. As well as investigating peptide and protein delivery using their polymer systems, they used BBSRC follow-on funding to perform

*in vitro* and *in vivo* safety evaluations with a view to taking the technology forward to commercialisation.

Donnelly expands, “Success with the BBSRC funding has allowed us to protect our work through an international patent application and gave us the track record to get a grant from the Wellcome Trust to pay for imaging equipment, and then a small Royal Society grant to look at delivering gene therapy.

“We have a three-year grant from EPSRC, in which the idea is to use microneedles in the reverse sense. If we can deliver drugs through microneedles, whatever is in the skin interstitial fluid can come out the other way. This fluid is in balance with blood, so it’s a way of indirect blood sampling. This further development of the hydrogel technology would be very useful in minimally-invasive monitoring of premature neonates, and also opens up the possibility to devise unique roadside tests for illegal drugs and prescription drugs that could affect driving performance.

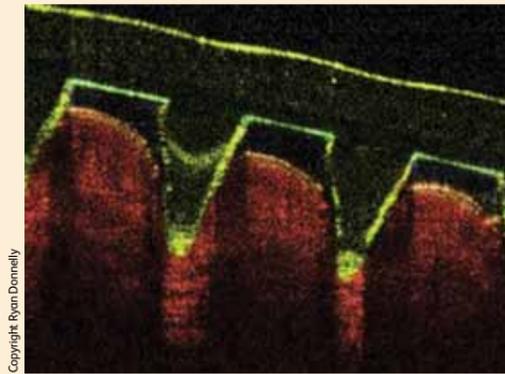
“We also have two industrial development contracts running to develop the microneedles as a commercial product. The first is more blue skies thinking to show microneedles can deliver a range of active cosmetic ingredients into the skin, to demonstrate the utility of the technology. The other one is pushing towards clinical trials with low molecular weight compounds.

“All of this was made possible by the work we did during the tenure of the BBSRC grants.”

Although there are no microneedle drug delivery products on the market yet, all of the materials Donnelly uses to make his microneedles are in widespread use in other approved pharmaceutical and healthcare products. He is confident that, once safety investigations are complete, what he is doing will be successful.

“In the School of Pharmacy at Queen’s, our skill is in formulation science, rather than engineering of metals or silicon. This gives us a unique insight into novel applications of polymeric systems and their utility in microneedles research. As pharmacists, we understand how to take laboratory developments through to the end-user, the patient.”

“With any sophisticated drug delivery system, if the average person in the street can’t use it, or doesn’t like using it, or uses it in an unsafe way that harms themselves or others, then that’s going to kill your technology. You need something that’s safe and easy to use for every member of the public.”



Copyright Ryan Donnelly

2D optical coherence tomography (OCT) image showing novel polymeric microneedles inserted into human skin

## Further reading

Microneedle arrays as medical devices for enhanced transdermal drug delivery. *Expert reviews of medical devices*. DOI: 10.1586/ERD.11.20

Laser-engineered dissolving microneedle arrays for transdermal macromolecular drug delivery. *Pharmaceutical Research* DOI: 10.1007/s11095-011-0419-4

Design, optimisation and characterisation of polymeric microneedle arrays prepared by a novel laser-based micromoulding technique. *Pharmaceutical Research* DOI: 10.1007/s11095-010-0169-8

## Next steps

- Develop a closed loop delivery system. For example, one set of microneedles to monitor blood glucose and then send a signal to another to deliver insulin

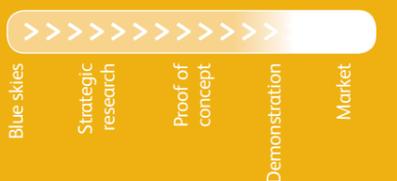
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## Discovery pipeline



# 'First step' to perfect drug combinations

**BBSRC-funded scientists at the University of Manchester have discovered a way of speeding up the creation of perfect drug combinations, which could help patients recovering from critical health problems such as stroke, heart attacks and cancer.**

The research team has found a way of identifying ideal drug combinations from billions of others which would prevent inflammation from occurring. Most non-infectious disease, such as cancer, stroke and Alzheimer's are worsened by inflammation – the body's natural defence mechanism.

Inflammation has evolved to help fight infection but can also be very damaging in long term disease, prolonging suffering and ultimately risking premature death.

After a stroke, for example, the body reacts to the injury as if it were an infection, causing further damage. By blocking inflammation, the chances of survival or higher quality of life are thus greatly enhanced.

Existing 'clot-busting' stroke drugs are only effective if administered within three hours after the stroke – often very difficult to achieve – and even then do not completely solve the problem, often leaving sufferers with serious disabilities. However, the researchers suggest they can block inflammation and greatly reduce damage by using ideal drug combinations.

The multi-disciplinary team of researchers, led by Professor Douglas Kell, Professor of Bioanalytical Science at the University of Manchester, developed an evolutionary computer programme which rapidly sifted

through nine billion different combinations of potential drugs.

## Darwinian approach

Using robotics to sort and test 50 drug combinations at a time, the scientists were able to find effective combinations and then refine them as many times as necessary to find ideal combinations. Ultimately, they hope this will lead to the development of tailored therapies for treating inflammation. Another advantage of choosing ideal drug combinations is that it allows patients to take smaller doses, which reduces potential toxicology concerns.

Prof. Kell and his team worked with computer scientists at the University to create the programme. Professor Pedro Mendes explained, "The [programme] suggests new drug combinations from previous ones by re-mixing their components – much like the DNA of a child is a mix of that of their parents."

"The new drug combinations are then tested and the best are selected to continue generating new ones. In each experiment we tested 50 drug combinations, then the software would tell us which new ones to test in the next experiment."

Dr David Brough, a Wellcome Trust Research Fellow, said, "This strategy may also allow us to revisit drugs that had shown promise

in preclinical work but had failed in clinical trials due to toxicity. At lower concentrations, in combination with additional drugs that potentiate their activity, these drugs may ultimately find use".

Prof. Kell, who is also BBSRC Chief Executive, said, "Most diseases have complex causes. This makes their analysis a problem of systems biology, and to find novel therapies multiple targets need to be attacked at once.

"We have devised a strategy, based on Darwinian evolution, to make this considerably easier. Although our immediate interest is inflammation and conditions such as stroke, our approach is universal and is thus applicable to all complex diseases."

## Further Reading

Efficient discovery of anti-inflammatory small-molecule combinations using evolutionary computing. *Nature Chemical Biology* DOI:10.1038/nchembio.689

## Next steps

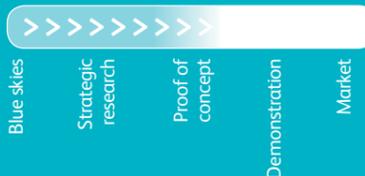
- High-throughput *in vivo* screen using model organisms such as fly or worm
- Use of an unbiased, and larger, library to discover novel anti-inflammatory drugs

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## Discovery pipeline



# Protein sheds insight into spread of vCJD to the brain

**A protein linked to the immune system could play a key role in helping scientists understand how variant Creutzfeldt-Jakob disease (vCJD) spreads throughout the body.**

The disease occurs when corrupted proteins – known as prions – accumulate in the spleen, lymph nodes and tonsils before spreading to the brain where the disease destroys nerve cells.

Researchers found that they could thwart the spread of prions to the brain by preventing production of a protein in just one type of immune cell, follicular dendritic cells. Stopping these cells from expressing this protein did not affect the regular function of the immune system.

The study by a team of scientists from The Roslin Institute at the University of Edinburgh (which receives strategic funding from BBSRC), University of Bristol and Harvard Medical School could lead to treatments to stop vCJD spreading to the brain and causing disease. However, any treatments would be viable only

if scientists are able to find a way to diagnose the condition in its early stages.

## Changing expression

Dr Neil Mabbott of The Roslin Institute at the University of Edinburgh, who led the study, said, "If we can find a way of stopping this protein from being expressed by follicular dendritic cells then we could potentially block the spread of the disease to the brain. We also want to understand how these cells are infected with vCJD in the first place, so that we can look at ways of stopping this from happening and find ways to diagnose the disease at its early stages."

The study, funded by BBSRC, looked at production of a protein – called PrP<sup>C</sup> – in follicular dendritic cells. These cells act like

spider's webs, attracting foreign particles, which can then be disposed of by the body's immune system.

The researchers found that when these cells expressed PrP<sup>C</sup>, corrupted prion proteins, were able to replicate on the surface of these cells and spread throughout the body. However, when these cells were specifically prevented from producing PrP<sup>C</sup>, the prions were not able to multiply and were destroyed by other cells.

## Further Reading

Follicular Dendritic Cell-Specific Prion Protein (PrP<sup>C</sup>) Expression Alone Is Sufficient to Sustain Prion Infection in the Spleen. *PLoS Pathogens* 7(12): e1002402. DOI:10.1371/journal.ppat.1002402

## Next steps

- Understand how and why prions initially infect follicular dendritic cells
- By understanding this process it may be possible to design treatments to block prions from spreading to the brain where they ultimately destroy nerve cells

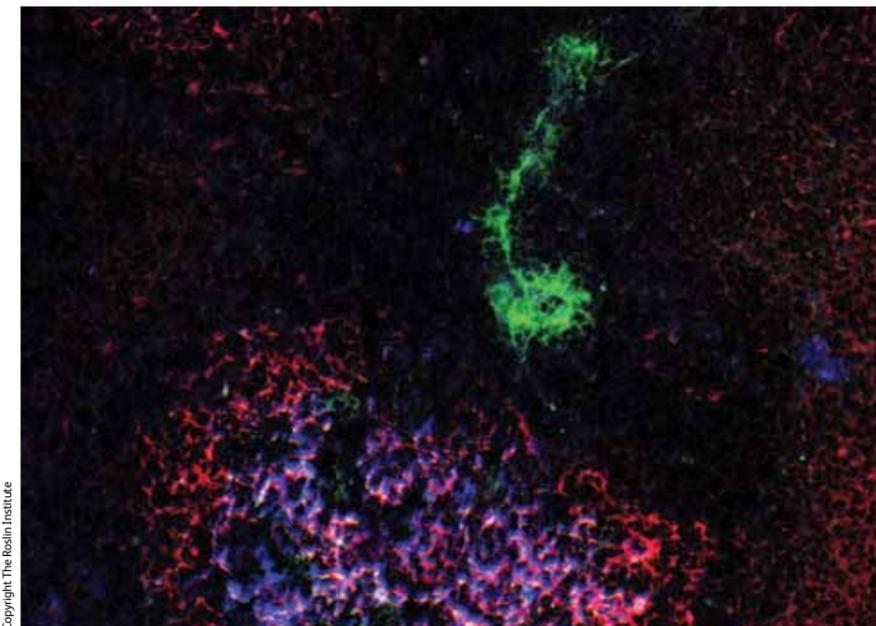
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## Discovery pipeline



When the follicular dendritic cells (red in image) expressed PrP<sup>C</sup> (blue), prions were able to replicate on the surface of these cells in the spleen and spread throughout the body. Neurons are shown in green.

**"The [programme] suggests new drug combinations from previous ones by re-mixing their components – much like the DNA of a child is a mix of that of their parents."**

Professor Pedro Mendes, University of Manchester



# From food waste to fuel in six days

A new biorefinery centre, funded in part by BBSRC, will allow researchers to explore ways to make use of residual plant material from food processing and agriculture in applications such as biofuels, high value chemicals, and in the production of natural and composite fibres.

The state-of-the-art centre, which opened at the Institute of Food Research (IFR) in Norwich in October, is led by Professor Keith Waldron, whose research to develop novel peat replacement from food chain wastes led to his award in 2011 as BBSRC's most promising innovator of the year.

With millions of tonnes of residual plant material generated during food processing and by agriculture, Professor Waldron saw an opportunity to find new uses for it that would not compete with food production.

"Once the food part of a crop has been exploited, there is a mass of plant material left behind that is often discarded as waste," Prof. Waldron explained. "With the launch of the pilot plant and through collaborations on the Norwich Research Park we have all the expertise necessary to help industry explore ways to make use of it."

According to Richard Parker from Renewables East, one of the project's funders, the ability to break down the structure of waste portions of wheat and other crops is the holy grail of biomass exploitation. "The advanced technologies from the Biorefinery Centre could provide valuable IP that could be used not just in the UK but globally, giving a return to UK plc," he said.

## Improving fuel performance

The Centre employs a steam explosion pilot plant, which is being used to break down the structure of plant cell walls in, for example, wheat straw. Once processed in this way, the plant material provides useful natural products, including those that can be fermented to produce bioethanol for use as a transport fuel.

The team at IFR are working with Lotus Engineering and other partners to address the challenge of producing fuel with a lower carbon footprint as well as combining a performance advantage.

The biofuel generated will be tested by Lotus in their bi-fuel and tri-fuel engines and their engineers will experiment with optimising combustion and efficiency.

"Just about any type of alcohol can be used to fuel a car and, if it is optimised, can even give a performance advantage," said Dr Richard Pearson, senior technical specialist at Lotus Engineering. "For example, we see significant improvements in torque at low and high speed."

An added benefit of using bioethanol is that existing engines can be easily adapted to run on it and existing distribution methods can be used. "Bio-alcohol is still a liquid fuel

and it does not require a quantum change in vehicle technology or in fuel distribution infrastructure," said Dr Pearson.

Work with a variety of industry partners will also enable testing of the commercial viability of materials produced for different sectors.

## Sustainable stocks

As well as wheat straw, there are a number of other possible sustainable sources of feedstocks. For example, East Anglian brewer Adnams, another partner in the research, generates about 2,400 tonnes of spent grain a year. Other waste will include unused oilseed rape straw, hemp and waste cereal grain from milling.

At the same time as this work on processing straw and other waste products, scientists at the John Innes Centre are researching ways to breed crop varieties that combine optimum traits in a plant stem for biomass exploitation as well as optimum traits for food.

Speaking at the opening of the Centre, George Freeman MP, chair of the All-Party Parliamentary Group on Science and Technology in Agriculture said, "I am thrilled and excited by the developments at the Institute of Food Research and congratulate them on their new addition of a Biorefinery Centre.

"I have long been a supporter of our scientific potential in the East and this is another example of Norfolk's world class potential."

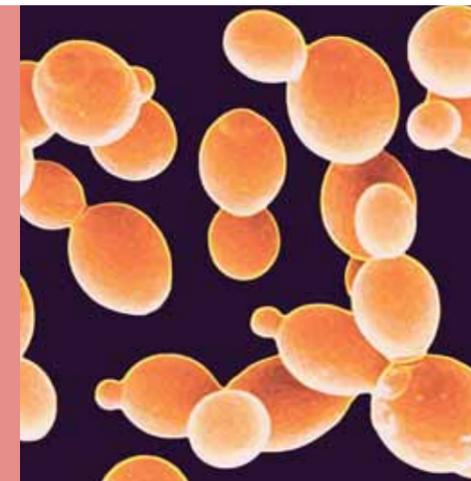
"Just about any type of alcohol can be used to fuel a car and, if it is optimised, can even give a performance advantage."

Dr Richard Pearson, Lotus Engineering

## Microbe power

A key component in the fermentation process is yeast – a micro-organism that breaks down the sugars released by the steam explosion process and converts them into alcohol. The new centre will also house a yeast screening facility and a yeast propagator to generate sufficient yeast for bulk processing.

Specialist yeast strains from IFR's National Collection of Yeast Cultures will be used in the fermentation process to create the bioethanol.



"I have long been a supporter of our scientific potential in the East and this is another example of Norfolk's world class potential."

George Freeman, MP

IFR Director Prof. David Boxer and George Freeman MP (pictured centre) hear about the Steam Explosion Unit from Prof. Keith Waldron



## Further Reading

[www.ifr-extra.com/Biorefinery.aspx](http://www.ifr-extra.com/Biorefinery.aspx)

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## Discovery pipeline

>>>>

Blue skies

Strategic research

Proof of concept

Demonstration

Market

Construction of the Biorefinery Centre was supported by funding from BBSRC and EEDA.

Recent and on-going research is being funded by BBSRC, Defra, the Technology Strategy Board (TSB), AHDB-HGCA, the Horticultural Development Company (HDC) and Renewables East.

Collaborating Industrial partners include Lotus, Vireol, Adnams, and Biocatalysts Ltd. Collaborating academic partners include the University of East Anglia, the John Innes Centre and Brunel University.



Copyright Elvis Mbiwa

Novel fisheye camera system to monitor plant growth

# Defeating nematode worms with GM bananas

**Researchers in the UK and Africa are using genetic modification (GM) technologies to make banana and plantain crops resistant to attack from nematode worms. The work uses the GM approach because bananas and plantain crops are sterile, and most breeding techniques cannot be applied for rapid crop improvement.**

Bananas and plantains (*Musa* species) are together the fourth most widely produced food crop in Africa by quantity (1). As a calorie-rich staple, they support the highest density of people per unit area of crop – about 2x rice, 5x maize and 8x sorghum (2). They are cheaper to produce than other staples such as rice and maize and as such are a vital food for 100 million Africans, including very many low-income families in the poorest areas on the continent where child undernutrition is particularly prevalent.

*Musa* crops are attacked by a variety of pests and pathogens, including nematode

worms that cause estimated yield losses of up to 50-70% in sub-Saharan Africa (3), and damage levels have increased in recent decades in the Great Lakes region of East Africa. Nematode control in Uganda would provide an estimated benefit of more than US\$250M over 30 years with equal benefits to poor producers and consumers (4).

Commercial plantations use pesticides to control nematodes but these can be environmentally damaging and cause health problems for agricultural workers. Moreover, these chemicals are too expensive for small-scale subsistence farmers in Africa

where losses are felt most acutely. There is clearly a pressing need to control nematodes but bananas are very difficult to improve by conventional plant breeding techniques because they are sterile.

## No sex please, we're bananas

Professor Howard Atkinson from the University of Leeds' Africa College says most important plantain and banana types are propagated vegetatively to make new plantlets because they do not produce pollen and so can't fertilise other plantain/banana types. "Consequently," he says, "they are sexually isolated from other

## "Such projects require the combination of Leeds' GM anti-nematode expertise and IITA's expertise in African crops."

Howard Atkinson, Africa College, University of Leeds

banana varieties. So even if natural resistance genes are found in other banana types they cannot be improved readily by crossing."

Atkinson says that biotechnological (GM) methods offer the most rapid way to provide nematode resistance into susceptible banana types because the approach is not dependent on the plant being fertile. Furthermore, the sterility and the lack of pollen of any new GM varieties means there is no risk of transferring new genes to other plants.

## Development programme

Funded through the joint BBSRC/DFID Sustainable Agricultural Research for International Development (SARID) programme, the project has demonstrated that two safe technologies developed in the UK for potatoes (using funding from BBSRC) can control nematodes and eliminate the yield losses they impose in plantain.

The initial technology was developed at the University of Leeds and the novel genes transferred into plantain by colleagues led by Dr Leena Tripathi at the International Institute of Tropical Agriculture (IITA). "Leeds and IITA together have shown that the technology is effective and a GM field trial is now planned for 2012," says Atkinson, who adds that, if trials are successful, uptake could be rapid as the majority of banana consumers in Africa live in countries that favour deployment of [GM] plant biotechnology.

Part of the work involved developing a digital camera-based system to measure the impact of nematode population size on plantain and banana canopy growth. The method used a fisheye lens at ground level to record the leaf area index (the extent that leaves cover the camera image, see picture). Previous methods have required the time-consuming destruction of banana roots to extract nematode populations at several points throughout a trial

or measurement of banana plants or roots by hand. "Quite laborious, particularly for 9ft cooking banana varieties," says Atkinson. "In contrast, the camera system allows the rapid measurement of the entire banana canopy."

The project is also driving local development. All areas of work have involved training of Africa-based scientists who have worked alongside researchers in Leeds. Most training has been in laboratory techniques required for the development of GM technology. African scientists have been trained in techniques to show the new gene is present and expressing in plantains; methods required to measure nematode multiplication on the crop; and in the use of the canopy growth camera system.

Dr Tripathi says the project was an effective way to transfer technology to Africa and national partners. "Many young African scientists were trained at University of Leeds as well as IITA," she says. "About 10 Africans were trained on this project – six at Leeds and four at IITA."

The relationship between the University of Leeds' and IITA may extend into additional projects. "We are looking to trial the banana plants in countries across Africa and also to move our GM technology into other neglected African crops that suffer severe nematode damage," says Atkinson. "IITA are particularly concerned about nematode damage to yams, another important food security crop in Africa. Such projects require the combination of Leeds' GM anti-nematode expertise and IITA's expertise in African crops."



Copyright Hugh Roadrick

Young GM banana plantlets tended by African scientists.

## Further Reading

- 1: [faostat.fao.org](http://faostat.fao.org)
- 2: Farming systems and poverty [www.fao.org/DOCREP/003/Y1860E/y1860e00.htm](http://www.fao.org/DOCREP/003/Y1860E/y1860e00.htm)
- 3: Strategies for resistance to nematodes in *Musa* spp [www.musalit.org/pdf/IN090748\\_en.pdf](http://www.musalit.org/pdf/IN090748_en.pdf)
- 4: An Economic Assessment of Banana Genetic Improvement and Innovation in the Lake Victoria Region of Uganda and Tanzania. *IFPRI research report*; 155 DOI: 10.2499/9780896291645RR155

## Next steps

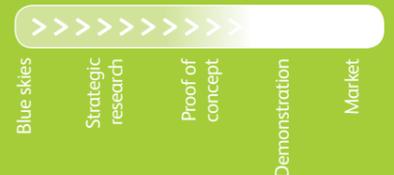
- The 2012 trial involves a selection of plantain lines developed in the SARID grant, as well as East African Highland banana lines generated by Ugandan scientists using constructs from the University of Leeds
- The trial will be run by Ugandan scientists using skills acquired through the SARID grant
- The demonstrated efficacy of the two defences in crops as diverse as potato in the UK and plantain in Africa provides a platform for developing both public goods and commercial uptake of the technology. The work is being extended to other crops with demonstrations in rice and Brinjal (eggplant) in India

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## Discovery pipeline



# Early-career researchers excel in entrepreneurship

A team of four budding entrepreneurs from the University of Oxford have been crowned winners of this year's Biotechnology Young Entrepreneurs Scheme (YES).



Dr Malcolm Skingle, Director of Academic Liaison at GlaxoSmithKline with the winning team, Metachem Solutions (l-r) Philip Wulff, Hannah Richards, Bonnie Murphy and Ben Owens

Copyright: Meryn Paynor

During an intense final in London on 5 December, the winning team (Ben Owens, Hannah Richards, Bonnie Murphy and Phillip Wulff) pitched their plan for a hypothetical business called Metachem Solutions to a panel of investors. The panel were impressed by their idea of using yeast to produce high value fragrance components.

This year's winners emerged from 390 competitors across five regional heats. Their Managing Director Ben Owens said, "We're delighted to have won. We formed our team especially for the competition – we didn't all know each other before – and it has been an incredible journey."

"It has been great to develop a diverse range of skills outside of the lab and I know these are going to be invaluable for the rest of my career. The competition has made me think completely differently about how academic research can be translated to a commercial environment and has given me the confidence to think that researchers can do it themselves – take your own research forward to create a viable business. It's really unique to have this kind of opportunity and I really encourage all early-career researchers to get involved."

## Skills for knowledge-based bioeconomy

This year, for the first time, one of the regional heats was hosted by an industrial sponsor, the agri-business Syngenta, at their Jealott's Hill site. This gave participants the opportunity to learn about the commercialisation of science

from the perspective of a large agri-business company, expanding the career horizons beyond academia.

Minister for Universities and Science David Willetts said, "I would like to congratulate the winners of the Biotechnology and Environment YES\* competitions on their success. Scientists who are able to combine their expertise with an understanding of business are a very precious resource. By learning how to translate research into wider successes, they can help ensure their work delivers the maximum benefits to society and the economy."

"I am impressed that the participants are taking the opportunity to develop their skills and knowledge at this early stage of their

careers – it suggests a bright future for the commercialisation of UK research."

Glyn Edwards, Interim Chief Executive of the BioIndustry Association, said, "Recent announcements by the government have underlined how important the commercialisation of our world-class life sciences research will be to rebalancing our economy and driving growth. The early-career researchers I saw at Biotechnology YES demonstrated an impressive understanding of what it takes to bring scientific research to market and tremendous enthusiasm for taking their science out of the lab. Encouraging and developing business skills in scientists is a great investment for the UK economy."

Biotechnology YES is an annual business plan competition, delivered by a partnership between the University of Nottingham, Institute of Enterprise and Innovation (UNIEI) and BBSRC, which is designed to raise awareness of commercialisation amongst bioscience postgraduate and postdoctoral researchers.

Other winners this year were:

- Best healthcare business plan sponsored by GlaxoSmithKline – Instant Diagnostics (University College London)
- Best consideration of financial planning strategy sponsored by James Cowper LLP – Instant Diagnostics
- Best consideration of IP strategy sponsored by Potter Clarkson – Synthetica (University of Liverpool)
- Best plant and microbial science business plan sponsored by Syngenta – Horti-Sense (John Innes Centre)
- Best presenter sponsored by University of Nottingham Institute for Enterprise and Innovation – Mehmet Fidanboylu (King's College London) from Biomimix and Qasim Rafiq from Scigen (Loughborough University)

Read more at [www.biotechnologyyes.co.uk](http://www.biotechnologyyes.co.uk)

\* A spin-off competition run by the Natural Environment Research Council, now in its sixth year

## Coming soon

### February

8 February

Deadline for outline applications to the Bioprocessing Research Industry Club

[www.bbsrc.ac.uk/bric](http://www.bbsrc.ac.uk/bric)

17 February

BBSRC session on enhancing photosynthesis for increased food and fuel production at the AAAS Annual Meeting, Vancouver

[www.aaas.org/meetings](http://www.aaas.org/meetings)

21-22 February

NFU annual conference, International Convention Centre, Birmingham

[www.nfuonline.com](http://www.nfuonline.com)

### March – April

30 March – 15 April

Edinburgh International Science Festival

[www.sciencefestival.co.uk](http://www.sciencefestival.co.uk)

24 – 25 April

Healthy food from healthy animals. Annual conference of the British Society of Animal Science

[www.bsas.org.uk/Meetings\\_&\\_Workshops](http://www.bsas.org.uk/Meetings_&_Workshops)

### May

16 May

Deadline for applications to BBSRC's pilot super follow-on fund

[www.bbsrc.ac.uk/followon](http://www.bbsrc.ac.uk/followon)

18 May

Fascination of plants day

[www.plantday12.eu](http://www.plantday12.eu)

### June

13 – 14 June

Cereals: the arable event, Boothby Graffoe, Lincolnshire

[www.cerealsevent.co.uk](http://www.cerealsevent.co.uk)

## New science strategy for Rothamsted Research

**Where Knowledge Grows, the new science strategy launched by Rothamsted Research in November, aims to deliver the knowledge and new practices to increase crop productivity and quality and to develop environmentally sustainable solutions for food and energy production.**

Rothamsted Director Maurice Moloney said, "Rothamsted's strength lies in its ability to move with the times and embrace the evolving scientific challenges through creativity and ingenuity". He added, "This Strategy will deliver the new scientific

knowledge that can be translated into robust technologies to improve crop yields, enhance nutrition, contribute to energy security, reduce the carbon-footprint of farming and protect and nurture the agricultural environment".

"We believe that it is possible to provide secure and increasing amounts of healthy food and make a contribution to the supply of renewable energy without reducing other ecosystem services. We will aim to show how such systems can be delivered through research into better ways of managing pest control, biodiversity, grazed grassland and soils with the overall goal of designing and quantifying sustainable systems."



View our video channel at [www.youtube.com/bbsrcmedia](http://www.youtube.com/bbsrcmedia)



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# Got any bright ideas?



**BBSRC's follow-on fund programme helps bridge the gap between basic science and commercialisation.**

Up to £2M grants are available to help BBSRC-funded researchers demonstrate that all important 'proof of concept'.

With a proven track record in the generation of high-tech spin-out companies, follow-on funding can act as a springboard to attract serious investors.

**Closing date for applications 16 May 2012**

[www.bbsrc.ac.uk/followon](http://www.bbsrc.ac.uk/followon)

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