BBSRC Business

Winter 2016

Connecting our science with industry, policymakers and society

Biology winter wonderland

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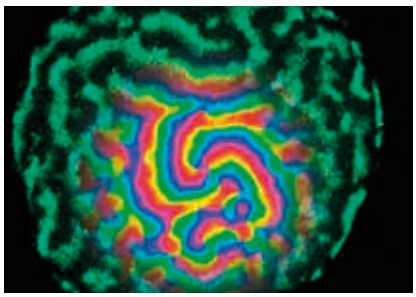

BBSRC
bioscience for the future

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, BBSRC invested over £509M in world-class bioscience in 2014-2015. 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**

RESEARCH COUNCILS UK

BBSRC is part of the Research Councils UK partnership

Strategically funded institutes

Babraham Institute
www.babraham.ac.uk

The Pirbright Institute
www.pirbright.ac.uk

Institute for Biological, Environmental and Rural Studies (Aberystwyth University)
www.aber.ac.uk/en/ibers

Institute of Food Research
www.ifr.ac.uk

John Innes Centre
www.jic.ac.uk

Roslin Institute (University of Edinburgh)
www.roslin.ac.uk

Rothamsted Research
www.rothamsted.ac.uk

The Genome Analysis Centre
www.tgac.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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For regular news about BBSRC and the outcomes and impacts of BBSRC-funded research visit **www.bbsrc.ac.uk/news**

In this issue

BBSRC Chief Executive Professor Jackie Hunter highlights some of the opportunities for UK bioscience and the research community in 2016 and beyond.

Max Alexander

2015 drew to a close with some fairly momentous announcements on science funding, the future of the Research Councils, as well as from me personally.

The announcement of the Comprehensive Spending Review at the end of November presented a very positive outlook for UK research, in light of the current, challenging environment surrounding public finances. The annual research budget of £4.7Bn has been protected, together with the addition of a cumulative amount, over the spending review period, of £1.5Bn for a Global Challenges Research Fund. There was also a reconfirmation of the £6.9Bn for science capital as well as other announcements of relevance to bioscience, such as the announcement of three new Agri-Tech centres, the £1Bn Ross Fund for infectious diseases, capital for Defra capital estates, and doubling of the Newton Fund by 2020.

Brussels and beyond

Much of what we do as a Research Council is focussed on supporting research and researchers in the UK. But the importance of engaging with scientific communities around the globe has never been greater.

At a recent meeting between BBSRC and key Directorates of the European Commission, facilitated by our colleagues in the UK Research Office (UKRO), we discussed forward strategies of mutual interest and it became very clear that the Commission sees the bioeconomy agenda as critically important for economic growth. Indeed, when I attended the Berlin Bioeconomy Summit in November, I was struck by the momentum building behind the bioeconomy across Europe and the globe. In the UK we know it directly contributes £36M to our economy and employs 600,000 people (and it's growing) – much of this success rests on the UK's excellent bioscience research base. BBSRC will work with both the UK Government and the Commission in the coming months to make the most of the opportunities presented by the bioeconomy.

The meeting with the Commission also highlighted a lot of support for more dialogue on new crop breeding technologies at a scientific level and we were urged to continue with our plans for a meeting in Brussels this year.

Operations, strategy and delivery

The Nurse Review of the Research Councils, published a week ahead of the Spending Review, echoes a number of steps that the Research Councils have already begun the move towards, including strengthening collective working and bringing together our operational activities. It also offers opportunities for increasing cross-disciplinary engagement and ways of working. We are working with Government, our staff and communities to understand and shape the changes that will arise from the Nurse recommendation and which the Chancellor indicated in the Spending Review will now be adopted.

As I write this, we are awaiting the publication of the cross-Government Animal and Plant Health Strategy, and we are making great progress in scoping out the detail of two of the pilots we and our partners want to undertake as part of the strategy. All this work will feed into the agri-food aspects of the next BBSRC delivery plan. The coming weeks will be spent on formulating our delivery plans across our portfolio in preparation for our final allocations, which can be expected in early 2016 across the Research Councils.

Moving to pastures new

On a personal front, I announced that I will be leaving BBSRC at the end of February, after we have secured BBSRC's spending review allocations. This is something that I do with mixed emotions as I have really enjoyed my time at BBSRC and working with the fabulous team here at the Swindon office. I will also miss the interactions with the institutes and the researchers we fund at universities. I have learnt a lot about the many different aspects of BBSRC science from wheat to gribbles and, as you have just read, with just under two months left, there's a lot to do!

Headlines

Network to foster best animal welfare research

BBSRC has pledged over £100,000 to establish a network that will foster collaboration within the UK animal welfare research community. The network will be headed by one of the UK's leading experts on animal behaviour, Professor Mike Mendl from the University of Bristol.

Ensuring high standards of welfare for managed animals such as livestock and domestic animals is high on the agenda for both the public and a wide range of stakeholders. Decisions about the needs of animals by government and stakeholders therefore must be based on objective scientific research.

The UK Animal Welfare Research Network, led by Mike Mendl, Professor of Animal Behaviour and Welfare, will bring together UK animal welfare researchers and those in related disciplines with professionals from across the sphere, including industry bodies, charities and government. The Network will share best practice and knowledge through workshops and associated events, identifying research gaps and areas where increased focus could strengthen and support UK animal welfare research. To foster skills and collaboration, the network will also facilitate mentoring and training opportunities for early-career researchers.

Improving the reproducibility of biomedical research

A new report from the Academy of Medical Sciences lays out how the reproducibility and reliability of biomedical research can be improved.

The report, *Reproducibility and reliability of biomedical research: improving research practice*, proposes potential solutions to keep science in top shape. The report is the result of a symposium co-organised by the Academy with BBSRC, the Medical Research Council and the Wellcome Trust.

Read more at www.acmedsci.ac.uk/researchreproducibility

Putting a value on excellence

Independent analysts have attempted to quantify the impact of the BBSRC strategically-funded institute Rothamsted Research over its 172 year existence.

In the report, Sean Rickard Ltd has attempted to quantify the cumulative impact Rothamsted Research has had through key impact pathways that are most directly linked to its research. The assessment suggests that the contribution of the institute's research output to feeding the nation is in excess of £3Bn a year.

Rothamsted Research Director and Chief Executive, Professor Achim Dobermann, said: "It has been demonstrated numerous times that rates of return on investment in agricultural R&D are high in both developed and developing countries, that spill over of innovations among countries is substantial, and that investments in R&D often have large, long-lasting cross-sectoral growth benefits."

Read the report at bit.ly/1TadJ1r

'Life' isn't a barrier to a successful research career

A recent survey of former Fellows has highlighted the overwhelming success and impact that Daphne Jackson Fellowships have on researchers who are returning to the workplace following a prolonged career break.

The survey which had a 79% response rate, shows that over 90% of former Daphne Jackson Fellows continue working in STEM for the majority of their career, with over 70% remaining in research-based roles for two years post-Fellowship and 57% for up to five years post-Fellowship.

90% of former Fellows who responded to the survey, said the Fellowship had helped them secure subsequent jobs, and 72% said they are now in their first choice career. Over 90% said the Fellowship had a beneficial effect on their confidence, and 88% said it helped their professional/job satisfaction.

The Daphne Jackson Trust is is the UK's leading organisation dedicated to realising the potential of scientists and engineers returning to research, following a career break taken for family, caring or health reasons, and is supported by BBSRC.

Read the report at bit.ly/Nps0p6

North Wyke Farm Platform launched as LEAF Innovation Centre

This BBSRC-supported National Capability, part of Rothamsted Research, in Devon becomes LEAF's eighth Innovation Centre – a network of research organisations whose work supports the research, evidence, development and promotion of Integrated Farm Management (IFM).

Rothamstead Research

It will showcase sustainable farming methods, particularly in the area of grassland systems, and support the development and promotion of sustainable farming through IFM.

Professor Michael Lee, Head of the North Wyke site, said: "The Farm Platform National Capability, supported by BBSRC at North Wyke, is at the cutting edge of research into sustainable grazing livestock systems. However, impact will only be achieved through the dissemination of this research to the farming community. The enrolment of the North Wyke site of Rothamsted Research as a LEAF Innovation Centre is part of our growing activities to aid knowledge transfer to our stakeholders to put research into action."

LEAF (Linking Environment And Farming) is the leading organisation promoting sustainable farming.

BBSRC and USDA join forces to support research to prevent animal disease

BBSRC and the US Department of Agriculture's (USDA) National Institute of Food and Agriculture (NIFA) are awarding five jointly funded research projects.

With awards of more than £2.3M from BBSRC and $2.3M from NIFA, the US-UK Collaborative Animal Health and Disease and Veterinary Immune Reagents Programme seeks to address high impact diseases and animal health issues relevant to both countries.

"As a leading livestock producing nation, the health of the people in the United States and around the world depends on the safety, security, and quality of the livestock we produce," said Sonny Ramaswamy, NIFA Director. "These grants enable an international research partnership that looks to control the spread of pathogens, ensuring we can effectively reduce the health risks and environmental impacts of food production worldwide."

Research funded through this Programme will look at biological and physiological mechanisms in relation to disease prevention in ruminants (cattle, goat, sheep), swine, poultry, equine, and aquaculture species. Specifically, the projects will address the development of immune reagents, breeding for genetic resistance to disease, studying the ecology of diseases spread by vector insects, and developing improved vaccines. The discoveries made through these projects will improve animal health and well-being, enhance production efficiency, and support the safety of animal products by addressing challenges facing animal agriculture.

Lobsters, scallops and whisky among £17.8M Agri-Tech projects

Pioneering projects to improve agriculture and food production at home and overseas, have been funded in the latest multi-million pound round of the Government's Agri-Tech Catalyst.

Projects include one assessing the potential to commercialise lobster farming, a proposal to cultivate scallops on ropes, and a way of continuing to make whisky with UK wheat, by using a novel variety.

BBSRC Chief Executive Professor Jackie Hunter said: "Investing in advances in agriculture is vital, not only for our future food supply but also to help build the UK bioeconomy. These new research projects highlight how UK bioscience is at the forefront of innovative approaches for modern farming."

Ministers launch world's first Big Data Centre for Agricultural Innovation

Agrimetrics brings together expertise from the BBSRC strategically-funded institute Rothamsted Research, the University of Reading, the National Institute of Agricultural Botany (NIAB) and Scotland's Rural College (SRUC), in the first Big Data Centre of Excellence for the whole food system, created by the UK government through Innovate UK under the UK Strategy for Agricultural Technologies.

(l-r) George Freeman MP, Parliamentary Under Secretary of State for Life Sciences and George Eustice MP, Minister of State for Farming, Food and the Marine Environment.

The Centre will support a revolution in the use of big data science in the agri-food industry and contribute to a highly intelligent, productive, efficient, resilient and sustainable system. Professor John Crawford, interim Chief Executive Officer of Agrimetrics, commented: "We are delighted to have been awarded £11.8M from UK Government, through Innovate UK and the Agri-tech Strategy, for the establishment of the Centre, which has been designed in consultation with more than 50 organisations from industry and academia and now has in excess of 190 companies engaged."

The Centre, which will work with all business and universities, will engage with partners throughout the food system to enable detailed and collective understanding of the needs of farmers, food manufacturers, food retailers, consumers and the environment through the use of big data and analytical tools. This high-value collective information, will allow the identification of opportunities for innovation projects among the partners.

New roadmap for non-animal technologies

BBSRC has been working together with other funders (Innovate UK, NC3Rs, Dstl, EPSRC and MRC) to develop a strategy and vision for non-animal technologies (NATs), with the aim of improving the methods and tools available for the safety and efficacy testing of pharmaceuticals, veterinary products, chemicals, agrichemicals and consumer products.

The roadmap sets out a vision for the UK as a market leader in NATs and is intended to guide the efforts of all those working in the area.

Read more at bit.ly/1LvSOzx

UK and China team up on superbug research

BBSRC, the Medical Research Council and the Economic and Social Research Council are joining forces with the National Natural Science Foundation of China to establish a joint fund of £9M to support research on antimicrobial resistance. The funding was announced by Minister of Life Sciences George Freeman as part of the UK-China Business Forum.

The UK contribution (£4.5M) will be channelled through the Newton Fund, an initiative launched in April 2014 intended to strengthen research and innovation partnerships between the UK and emerging knowledge economies. The Chinese government will provide matched funding to support internationally competitive and innovative collaborative projects between researchers from China and the UK.

Life Sciences Minister George Freeman said: "Antimicrobial Resistance is a major threat to millions of lives around the world. This £9M joint investment will help leading scientists in the UK and China share expertise and innovations to develop new treatments that could help eradicate this threat to global public health."

Saving British wildlife

Farmers can maintain high yields and boost nature by signing up to a wildlife-friendly scheme, new research has found.

A team of researchers, led by the Centre for Agri-Environmental Research (CAER) at the University of Reading, has found that farms signed up to the 'Fair to Nature' farming scheme supported 20% more species of butterflies, while still producing the same amount of crops as conventional farms. Growers using organic methods had higher levels of biodiversity than conventional farms but wheat yields were significantly lower. The scheme offers a way for consumers to shop for more nature-friendly products, without having to buy fully organic goods.

Imperial College London invests in Babraham Research Campus

Imperial College London is funding a new facility at the Cambridge-based campus to support spin-out and scale-up companies, helping to maximise the impact of research.

The move expands Imperial's capacity to support fast-growing science- and technology-based companies alongside its existing London facilities, including the College's new research and innovation district, Imperial West in White City. BBSRC, Babraham Bioscience Technologies Ltd and Imperial announced the signing of a long-term lease on BBSRC-owned land at the Babraham Research Campus.

Professor David Gann CBE, Vice President (Development & Innovation) at Imperial College London, said:
"Our move to invest in facilities at Babraham underlines Imperial's commitment to create value from ideas, wherever we and our partners are best placed to thrive.

"We are determined to help technology spin-outs with specialist support, and the space to grow and scale up. This collaboration strengthens our ability to create conditions for science-based ventures to flourish, opening up new opportunities and revenue streams to support the college's academic mission."

Biology winter wonderland

While the world outside may look cold and bleak, bioscience continues to make an impact in the winter months. Here is a selection of BBSRC science suited to a colder climate.

Protecting Brussels sprouts

Brussels sprouts are a winter staple but they are under threat from disease. Turnip mosaic virus (TuMV) can infect all kinds of plants, including peas and brassicas (cabbages, cauliflower, broccoli, Brussels sprouts, turnips, radish and oilseed rape), causing significant damage and losses to crops.

In 2014, scientists described a mechanism conferring resistance in brassica plants to TuMV, a discovery which it is hoped will lead to durable resistance being introduced into many food crops.

The resistance, which arises from a particular form of a gene called *eIF4E*, has been shown to be effective against different strains of TuMV from across the world.

The University of Warwick, Chinese Academy of Agricultural Sciences and Syngenta Seeds team reported their finding in *The Plant Journal*.

GM potatoes to reduce waste

Christmas dinner wouldn't be the same without roast potatoes but producers and processors face huge challenges getting potatoes to our plates.

Late potato blight costs UK potato farmers an average of £55 million per year in losses and costs of controls. Potato cyst nematodes are increasingly hard to control and can cause up to £26 million a year in losses. Researchers are developing a new potato which could be better for the environment, healthier for consumers and cheaper to produce.

The project, which takes a GM approach, aims to combine the benefits of ground-breaking research from The Sainsbury Laboratory, the University of Leeds and Simplot, to develop a Maris Piper potato that will be resistant to late potato blight and potato cyst nematodes. It will also contain much lower than normal levels of reducing sugars and asparagine – naturally occurring chemicals in many starchy foods that form toxic acrylamide when cooked at high temperatures. In addition, by silencing a polyphenol oxidase gene, the new variety will be less prone to bruise damage, which will reduce food waste caused by discarding bruised tubers.

Reindeer vision

BBSRC-funded researchers from University College London discovered that the eyes of Arctic reindeer change colour through the seasons from gold to blue, adapting to extreme changes of light levels in their environment and helping detect predators.

They also found that the reindeer may avoid high voltage power cables because of flashing UV light that is undetectable to the human eye. In dark Arctic winters power lines may appear to reindeer as lines of flashing lights stretching across the terrain.

By choosing to avoid power lines, animals such as reindeer face disruption of migration and substantial loss of grazing land. This can affect the growth, viability and genetic variability of populations as well as influence the well-being of herds and of herders who rely on the animals for their livelihoods, cultural identity and food.

Turkey welfare

BBSRC srupports a range of research involving animals and is committed to ensuring high standards of welfare for all managed animals (including farmed, laboratory, and companion).

This research informs strategies for improving conditions for farmed and laboratory animals, particularly within the UK. One project is looking at turkey welfare in the poultry industry to help improve their housing.

Foot Pad Dermatitis (FPD) will be one of the main parameters to measure welfare in turkey production in the near future. FPD is associated with lesions of the skin on the foot pad and the underlying tissue. In severe cases these lesions may result in ulcerations of the foot pad tissue and this adversely affects animal health and welfare. FPD is very common in flocks of growing turkeys and is a potential health and welfare problem in intensive production systems.

A new research project aims to determine the relationship between different foot pad lesions and pain. In addition it will more clearly define the minimum litter moisture content that will avoid the risk.

Snowproof helicopter blades

BBSRC, working with the Defence Science and Technology Laboratory and the Engineering and Physical Sciences Research Council, has made up to £2.5M of funding available to explore how synthetic biology could be used to develop protective materials.

There are many potential applications. One area of interest is creating wear-resistant and self-repairing coatings suitable for helicopter rotor blades that operate in sand, dust, rain or snow.

The coating would need to be very thin, low mass, relatively easy to apply and repairable in the field.

Other areas of interest include novel camouflage solutions, adhesives for submarine surfaces and lightweight armour.

Digital Vision Thinkstock

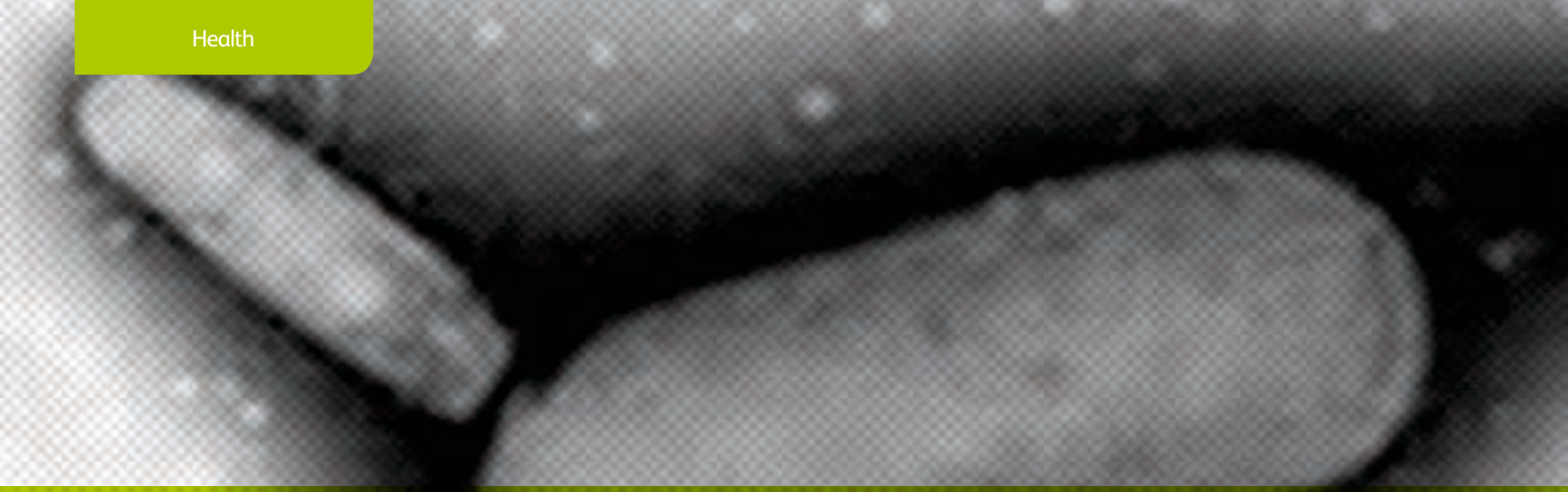
Roman Babakin

Protecting pine

Trees face a variety of challenges to their health from many different threats, often at the same time. To find a sustainable long-term strategy for keeping our trees healthy, the range of real and potential threats to tree health need to be considered, along with the trees' potential to adapt. This not only includes recognising important pests and pathogens, but also understanding how trees are adapted to their environment, how populations evolve and the impact of other pressures such as climate change and habitat fragmentation.

Using the example of Scots pine, an important native tree species, a project that is part funded by BBSRC will assess variation in three key threat species: Dothistroma needle blight, the pine-tree lappet moth and pine pitch canker. It will test variation in Scots pine's resistance to these threats and, using new and existing field trials, measure the extent to which Scots pine populations may be able to adapt. At the same time, by working with the public and with those who manage and use trees, the researchers hope to find ways to use the biological information to make change happen on the ground.

Martin Sarikov Thinkstock



New insights into evolution of predatory bacterium

Dr Andrew Lovering

A joint study from the labs of Dr Andrew Lovering and Professor Liz Sockett, at the Universities of Birmingham and Nottingham, has shown how predatory bacteria protect themselves from their own weapons that are able to kill other species so successfully.

The research, published in *Nature Communications*, offers insights into early steps in the evolution of bacterial predators and will help to inform new ways of combatting antimicrobial resistance.

A useful predatory bacterium called ***Bdellovibrio bacteriovorus*** eats other bacteria (including important pathogens of humans, animals and crops). It attacks them from the inside out using enzymes (called DD-endopeptidases) that first loosen the cell walls of prey bacteria and then cause them to round up like a pufferfish, providing space as a temporary home for the predator. But ***Bdellovibrio*** have similar cell walls so why don't they fall victim of their own attack?

The study has found that the bacterium uses an ankyrin-type protein called Bd3460 that binds to the tip of its enzyme weapons, nullifying their action until they are safely secreted out of their own cells and into the prey bacteria.

Uncovering the mechanism

Dr Andrew Lovering and Ian Cadby at the University of Birmingham determined the structure of the ankyrin protein using X-ray crystallography and found that it attaches to two DD-endopeptidase weapons to temporarily deactivate them.

Carey Lambert, Rob Till and Professor Liz Sockett at the University of Nottingham confirmed the antidote protein's use when the gene responsible for its production was deleted.

Professor Sockett said: "The ***Bdellovibrio*** bacteria lacking the *Bd3460* gene tried to invade the bacteria but suddenly rounded up like pufferfish and couldn't complete the invasion – the fatter predator cell could not enter the prey cell."

This is the first paper to discover a 'self-protection' protein in predatory bacteria.

Professor Sockett added, "Most bacteria are not predatory and so understanding these mechanisms gives us a glimpse of how predation evolved. In this case it seems that the *Bd3460* gene was transferred into ancestors of *Bdellovibrio*, probably when they were beginning to develop as predators."

Dr Andrew Lovering added: "If we are to use Bdellovibrio as a therapeutic in the future, we need to understand the mechanisms underpinning prey killing and be sure that any self-protective genes couldn't be acquired by pathogens, causing resistance. Brilliantly, Liz and Carey have demonstrated this did not happen with the Bd3460 antidote protein, and Ian and I showed how the mechanism works on predator enzymes only. This is a great inter-university collaboration."

Further reading

Ankyrin-mediated self-protection during cell invasion by the bacterial predator *Bdellovibrio bacteriovorus*. *Nature Communications*
DOI: 10.1038/NCOMMS9884

Specialized peptidoglycan hydrolases sculpt the intra-bacterial niche of predatory *Bdellovibrio* and increase population fitness.

PLoS Pathogens
DOI:10.1371/journal.ppat.1002524

Next steps

- Investigate other mechanisms of self-protection
- Characterize further prey cell wall modifications

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Discovery pipeline

Blue skies | Strategic research | Proof of concept | Demonstration | Market

Scientists produce beneficial compounds in tomatoes

Scientists at the John Innes Centre have found a way to produce industrial quantities of useful natural compounds efficiently, by growing them in tomatoes.

The compounds are phenylpropanoids like Resveratrol, the compound found in wine that has been reported to extend lifespan in animal studies, and Genistein, the compound found in soybeans, which has been suggested to play a role in prevention of steroid hormone-related cancers, particularly breast cancer.

As a result of the research, led by Dr Yang Zhang and Dr Eugenio Butelli working in Professor Cathie Martin's lab at the John Innes Centre, one tomato can produce the same quantity of Resveratrol as exists in 50 bottles of red wine. Another tomato has also produced the amount of Genistein found in 2.5kg of tofu.

Drs Zhang and Butelli have been studying the effect of a protein called *AtMYB12* which is found in *Arabidopsis thaliana*, a plant used as a model in scientific investigation.

The protein activates a broad set of genes involved in metabolic pathways responsible for producing natural compounds of use to the plant. The protein acts a bit like a tap to increase or reduce the production of natural compounds depending on how much of the protein is present.

In response to the influence of the *AtMYB12* protein, tomato plants began to create more phenylpropanoids and flavanoids and to devote more of energy to doing this in fruit.

Introducing both *AtMYB12* and genes from plants encoding enzymes specific for making Resveratrol in grape and Genistein in legumes, resulted in tomatoes that could produce as much as 80mg of novel compound per gram of dry weight – demonstrating that industrial scale up is possible.

Scaling up

Tomatoes are a high yielding crop – producing up to 500 tonnes per hectare in countries delivering the highest yields (FAOSTAT 2013). They require relatively few inputs so producing valuable compounds like Resveratrol or Genistein in tomatoes could be more economical than relying on artificial synthesis in a lab or extracting them in tiny quantities from traditional plant sources (eg grapes, soybeans etc).

Dr Yang Zhang said: "Our research provides a fantastic platform to quickly produce these valuable medicinal compounds in tomatoes. Target compounds could be purified directly from tomato juice. We believe our design idea could also be applied to other compounds such as terpenoids and alkaloids, which are the major groups of medicinal compounds from plants."

Further reading

Multi-level engineering facilitates the production of phenylpropanoid compounds in tomato.

Nature Communications
DOI: 10.1038/ncomms9635

Next steps

- Identify master regulators for other metabolic pathways
- Use tomato as a bio-incubator to produce secondary metabolites for multiple purposes

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Discovery pipeline

7activestudio Thinkstock

Intellectual disabilities may share disease mechanisms

Brain disorders that cause intellectual disabilities and autism spectrum disorders may share common defects despite having different genetic causes.

A BBSRC-funded study of two models of intellectual disability in mice has found that they share similar disease mechanisms. Researchers found that treatment with a statin drug called *Lovastatin* – commonly used to treat high cholesterol – can correct high levels of protein production in the brain linked to the conditions.

The findings suggest that different types of intellectual disabilities may benefit from common therapeutic approaches, the researchers say.

Mouse models

Researchers at the University of Edinburgh studied mice with a genetic mutation that means they produce lower levels of a protein called SynGAP. The mice show learning and behavioural difficulties and act as a model system to understand why people with mutations in the human version of the gene suffer from intellectual disability.

The team from the University's Patrick Wild Centre and Centre for Integrative Physiology found that treatment with *Lovastatin* normalised levels of protein production in the brains of these mice. Their results suggest that *Lovastatin* acts by reducing levels of the active form of a protein called ERK1/2.

They compared their findings with mice that lack a protein called FMRP, which also causes cellular and behavioural changes that can be rescued with *Lovastatin*. Loss of FMRP in people leads to Fragile X Syndrome, the most common inherited form of intellectual disability and autism.

Professor David Wyllie, Director of the University of Edinburgh's Centre for Integrative Physiology, said: "This study shows that the core deficits associated with two very different causes of intellectual disability are shared. This is important because it means that people with diverse types of intellectual disability or autism may benefit from the same treatment."

Professor Peter Kind, Director of the University of Edinburgh's Patrick Wild Centre for Research into Autism, Fragile X Syndrome and Intellectual Disabilities, said: "Statins, such as lovastatin, are already used widely for treating people, including children, for high cholesterol with minimal side effects. Further studies are needed to determine whether these existing medications could also help people with intellectual disabilities."

> "This study shows that the core deficits associated with two very different causes of intellectual disability are shared."
>
> Professor David Wyllie, University of Edinburgh

Further reading

Convergence of hippocampal pathophysiology in Syngap$^{+/-}$ and Fmr1$^{-/y}$ mice.

J. Neuroscience
DOI: 10.1523/jneurosci.1087-15.2015

Next steps

- Assess whether targeting protein synthesis may be appropriate for treating genetically divergent forms of ID/ASD

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Discovery pipeline

Stress in pregnancy can impact future generations

EmilioU Thinkstock

Children whose grandmothers were stressed during pregnancy have an increased chance of mental health problems, a study suggests.

The effects of maternal stress during pregnancy can be transmitted to the first and second generations of offspring, research carried out in rats has shown. A Scottish team has found that increased anxiety is linked to changes in genes expressed in the part of the brain that regulates emotions such as fear and anxiety.

Previous research has suggested that stress during pregnancy is harmful to developing babies' brains and is linked to a greater risk of mental health disorders. However, until now it was not known that the harmful effects of prenatal stress could present themselves in future generations, the team says.

Long term effects

Researchers at The Roslin Institute, part of the University of Edinburgh, which receives strategic funding from BBSRC, has found that the second generation of offspring from rats who had experienced social stress during pregnancy – caused by short periods of exposure to unfamiliar female rats – were more anxious than those whose grandmothers had not experienced stress.

These offspring showed a pattern of gene expression in a region of the brain known as the amygdala, which is linked with an increased risk of anxiety disorders.

The findings provide researchers with greater insight into the origins of mood disorders. Understanding the mechanisms that allow the effects of stress to be transmitted to future generations could help researchers find new ways of treating some mental health conditions, the team says.

Dr Paula Brunton, of The Roslin Institute, who led the study, said: "It appears from this work that stress during pregnancy has long term health implications not only for the unborn child but also for future generations."

> "It appears from this work that stress during pregnancy has long term health implications not only for the unborn child but also for future generations."
>
> Dr Paula Brunton, University of Edinburgh

Further reading

Prenatal stress programs neuroendocrine stress responses and affective behaviors in second generation rats in a sex-dependent manner.
Psychoneuroendocrinology
DOI: 10.1016/j.psyneuen.2015.08.010

Next steps

- Establish the mechanism via which prenatal stress effects are transmitted from one generation to the next

Contact

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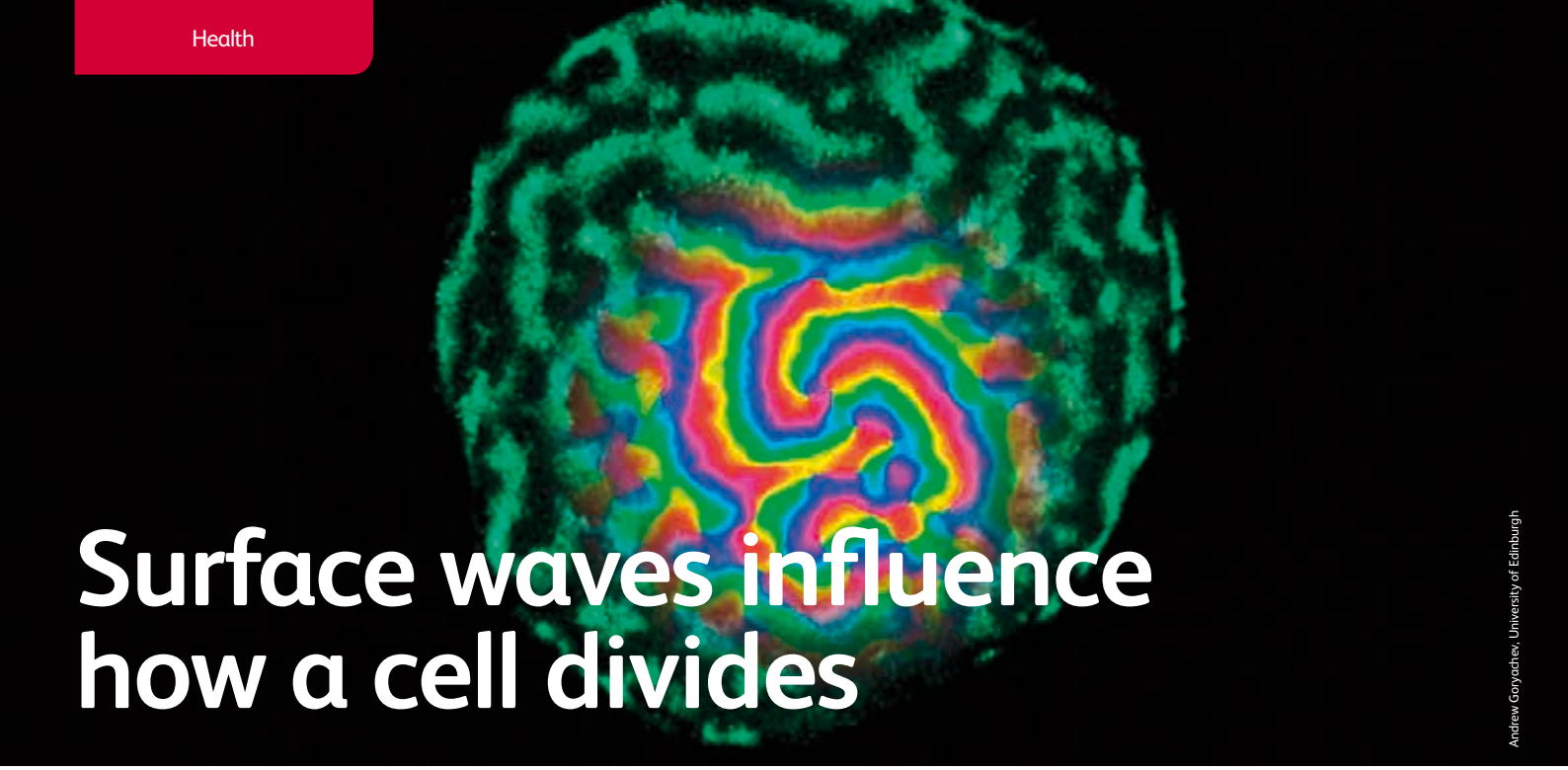
Discovery pipeline



Andrew Goryachev, University of Edinburgh

Surface waves influence how a cell divides

A group of researchers from the University of Edinburgh working in close collaboration with colleagues in the USA have discovered a novel phenomenon that could give a new insight into the final stages of cell division and explain puzzling experimental observations made several decades ago.

A consortium of computational biologists from the University of Edinburgh and the two leading experimental cell and developmental biology groups in the USA have discovered that, in preparation for the final separation stage of the cell cycle known as cytokinesis, the cellular surface becomes an excitable system.

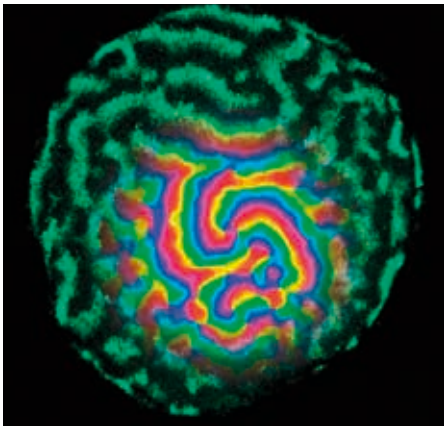
'Excitabilitiy', the ability to respond with a large spike of activity to a small stimulus, has long been known to explain the propagation of neural pulses and muscular contractions.

New role for waves

One of the fundamental properties of excitable behaviour, crucial for the activity of nerve and muscle cells, is the ability to propagate as waves, such as the waves of contraction recorded in human hearts.

Now the researchers report in *Nature Cell Biology* that, unexpectedly, excitability plays a crucial role in the cell's decision of where to place the final cut between the nascent daughter cells. Errors in this process are known to cause mis-segregation of genetic material and, thus, cancer.

Using cutting edge microscopy tools and novel reagents, based on the technology of fluorescent proteins, the trans-Atlantic team has, for the first time, observed dramatic waves sweeping the surface of frog and starfish embryonic cells preparing for division.



Andrew Goryachev

Researchers for the first time observed dramatic waves sweeping the surface of frog and starfish embryonic cells preparing for division.

Dr Andrew Goryachev, Reader in Computational Cell Biology at the University of Edinburgh, said: "Excitability is a ubiquitous property of many biological systems. Surprisingly, most experimental biologists still think of it solely as an attribute of nerve cells. One of our roles as computational modellers is to raise the awareness of our experimental colleagues of the fundamental nature of physico-chemical principles that underlie what they observe under their microscopes."

Further reading

Activator–inhibitor coupling between Rho signalling and actin assembly makes the cell cortex an excitable medium.

Nature Cell Biology
DOI: 10.1038/ncb3251

Next steps

- Identify the detailed molecular mechanism of cortical excitability

Contact

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Discovery pipeline

Gene Gostincar Thinkstock

Yeast treasure trove goes live

A new partnership between two BBSRC strategically-funded institutes is sequencing the genomes of a collection of yeast strains, to uncover the great biodiversity within them. The aim: to produce biofuels and other chemicals more sustainably.

The UK National Collection of Yeast Cultures (NCYC) is a world-leading biological resource at the Institute of Food Research (IFR), maintaining and supplying an extraordinarily diverse array of yeast strains for academia and industry in the UK and overseas.

In partnership with The Genome Analysis Centre (TGAC), the NCYC has begun an exciting new project to sequence the genomes of all of its approximately 4,000 strains, thereby revealing their genetic blueprints.

Dr Ian Roberts, NCYC Curator, said: "We have publicly released genome sequences for the first 48 yeast strains to be analysed within our ambitious new project. As more data become available, genome sequences of additional NCYC strains will be released from our website, adding greatly to this rich treasure trove of information."

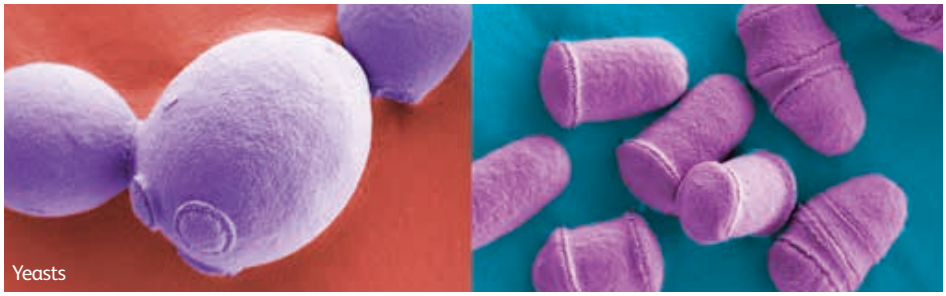
Genome mining

The special capabilities of each yeast strain, whether in baking, brewing, biorefining or surviving in extreme conditions, can now – for the first time – be compared to its genome, thereby enabling the genetic basis of its talents to be uncovered. This rich new data cache will enable academic and industrial researchers to maximise the potential of currently available yeast strains and develop hyper-efficient strains with even better properties.

Dr Jo Dicks, yeast genomes project leader, said: "This is the beginning of an exciting journey to realise the full potential of yeast. We look forward to working with NCYC's partners and customers to mine the entire diversity in the collection and gain maximum economic benefit from this unique resource".

Dr David Swarbreck, Regulatory Genomics group leader at TGAC, who led TGACs efforts to generate the genome assemblies for the 48 yeast strains, said: "The release of the first genome sequences from this ambitious project showcases the advances that have been made in next generation sequencing technology that now enable us to cost-effectively sequence large microbial collections, which will facilitate further comparative analysis into the genetic differences between strains."

The yeasts have been collected from pole to pole and have great potential in producing renewable fuel and chemicals from non-food biomass. The NCYC supports businesses from established multinationals to local microbrewery start-ups. Rapid robotic screening methods are under development enabling further added value for NCYC and its user community. The NCYC endeavours to meet all obligations under the terms of the Convention on Biological Diversity and the Nagoya Protocol.



Yeasts

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> "As more data become available, genome sequences of additional NCYC strains will be released from our website, adding greatly to this rich treasure trove of information."
>
> Dr Ian Roberts, Institute of Food Research

Further reading

The National Collection of Yeast Cultures: *www.ncyc.co.uk*

Next steps

- Sequence the genomes of the entire NCYC collection
- Characterise the collection's extraordinary genetic diversity

Contact

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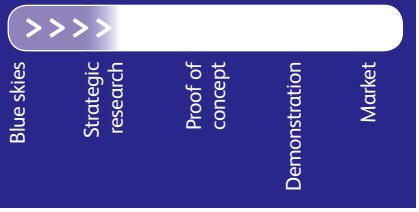
Discovery pipeline



University of Reading

New technique offers a window into light-activated therapies

Researchers have observed how a light-activated compound alters the structure of DNA – a finding that could be the first step in creating new, targeted cancer treatments.

Photo-dynamic therapy, a form of treatment for a number of conditions including several cancers and psoriasis, is an area of intense research activity. This strategy uses light to activate a drug in a specific area of the body, which can reduce the side effects observed with conventional anti-cancer treatments.

Now a group of scientists working in Reading and Dublin have developed a new technique to find out how such compounds work at a fundamental level. This information can then be used to improve anti-cancer drug development.

Crystal clear

It is really difficult to observe such fast processes in living cells, but the much simpler environment of a DNA crystal has enabled the team to watch the initial crucial step in great detail.

The crystals contain a ruthenium compound which is bound to a short piece of DNA. This class of compound is used in DNA sensing and is of interest to the pharmaceutical industry for cancer treatment.

The researchers found that, by using infrared radiation, they could get a snapshot of the extremely fast process – which occurs in half a billionth of a second – that takes place when light is shone on the crystals. This activates the compound, making it cause damage to DNA.

This research was carried out using two UK central research facilities: the laser facilities in the Central Laser laboratory of the Science and Technology Facilities Council and Diamond Light Source, the UK national synchrotron facility.

Dr Susan Quinn, from the School of Chemistry at University College Dublin is the lead author of the study. She said: "These results are very exciting as they demonstrate the ability to follow the flow of electrons from DNA to a molecule whose exact position is known and this is an enormous advantage in the study of the early events that lead to DNA damage."

Professor Christine Cardin, from the University of Reading, is a nucleic acid crystallographer who led the UK team, including co-author Dr James Hall, and who has received major funding from BBSRC in support of this work. She said: "This work is an exciting step in helping us to understand DNA damage. Among other things, the insights from this study will feed into the development of new drugs that target cancerous tissue, without damaging healthy tissue around it.

"This paper is one result of a longstanding collaboration with Professor John Kelly in Trinity College Dublin, and an excellent example of multidisciplinary international collaboration.

> "This is an enormous advantage in the study of early events that lead to DNA damage."
>
> Dr Susan Quinn University College Dublin

Further reading

One-electron photo-oxidation of guanine in DNA crystals.

Nature Chemistry
DOI: 10.1038/nchem.2369

Watch more at
youtu.be/uFHI7CowwGo
youtu.be/2rMgWx0iwHA

Next steps

- Work with variable temperatures, other crystals and extend to cell-based systems

Contact

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Discovery pipeline

Plant discovery could help develop stress-resistant crops

A gene that helps plants to remain healthy during times of stress has been identified by BBSRC-funded researchers at the University of Oxford. Its presence helps plants to tolerate environmental pressures like drought, and it could help create crops that can better withstand adverse conditions.

Plants rely on structures called chloroplasts within their cells to carry out photosynthesis. But, during times of stress such as drought, the same reaction can also generate substances known as reactive oxygen species, which are toxic to plants and cause them to become damaged or even die.

Chloroplast development is controlled by the presence of the *SP1* gene, which governs the passage of the proteins involved in photosynthesis through the chloroplast's outer membrane. Professor Paul Jarvis, from the University of Oxford's Department of Plant Sciences, suspected that the gene might use this ability to help plants survive hostile conditions.

"With the human population growing rapidly, increasing pressure on natural resources and the threat of climate change, it's more essential than ever to develop crops that can survive sub-optimal growing conditions," explains Professor Jarvis. "We wanted to find out if *SP1* helped plants to remain healthy by limiting the production of the toxic compounds made during photosynthesis in harsh conditions."

A team of researchers led by Professor Jarvis has investigated the idea. The group worked with three versions of *Arabidopsis thaliana* plants: the naturally occurring wild type, a mutant lacking *SP1*, and an engineered plant that over-expressed *SP1*.

In separate experiments, the three types of plant were exposed to different stressful conditions: high salt concentrations, drought, and the herbicide paraquat, which stimulates production of the toxic reactive oxygen compounds. In each case, the mutant plants that lacked *SP1* failed to develop. Meanwhile, the *SP1* overexpressors were more tolerant of the conditions than the normal plants. These results indicated that *SP1* was responsible for the resilience.

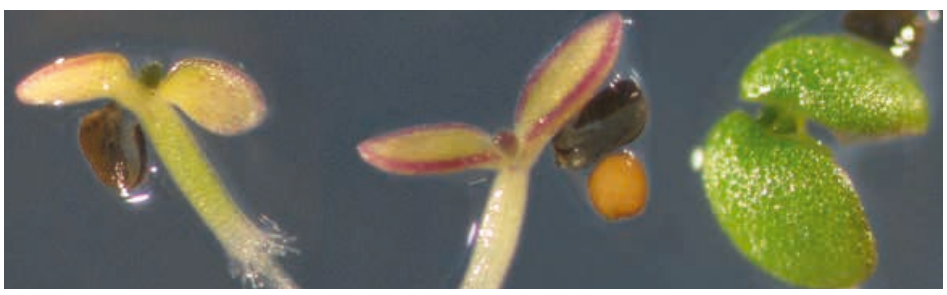
The researchers then tested the plants for the build-up of hydrogen peroxide – a common reactive oxygen species produced during in stressful conditions. The team found high levels of hydrogen peroxide in the mutant plants but low levels in the normal plants and even less in the *SP1* overexpressors.

"In fact, the overexpressors were indistinguishable from healthy, unstressed control plants," explains Professor Jarvis. "The production of the toxic compounds was reduced to a background level – it was as if the plants were not experiencing stress at all, instead of struggling to survive like the others."

Understanding at the molecular level

The team found that the movement of proteins used in photosynthesis into the chloroplast was significantly reduced in the overexpressors. That demonstrated that *SP1* reduces the production of toxic compounds by limiting photosynthesis in times of stress, making plants less likely to suffer serious or fatal damage.

The discovery that *SP1* helps plants cope with adverse conditions like drought and high salt concentrations suggests that it should be possible to create crops that can grow more easily in harsh environments. "All plants have the *SP1* gene," explains Professor Jarvis. "Now it's just a question of getting plants to over-express it so that they can survive in adverse conditions."



Paul Jarvis, University of Oxford

SP1 overexpressor plants (right) were healthy compared to wild type (left) and mutant plants (centre) when grown in high-saline conditions.

Further reading

Regulation of chloroplast protein import by the ubiquitin E3 ligase *SP1* is important for stress tolerance in plants.

Current Biology
DOI: 10.1016/j.cub.2015.08.015

Next steps

- Establish whether these findings can be used in a wider variety of plants such as wheat, rice, tomatoes and brassicas

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Discovery pipeline

Smoother tasting ice-cream in the pipeline

Fuse Thinkstock

Childhood memories of sticky hands from melting ice-cream cones could soon become obsolete, thanks to a new food ingredient.

Scientists have discovered a naturally occurring protein that can be used to create ice cream that is more resistant to melting than conventional products.

Enabling ice creams to stay frozen for longer is good news for consumers and manufacturers. But the new ingredient has added attractions. It could also prevent ice crystals from forming, ensuring a fine, smooth texture like those of luxury ice creams, and the development could even allow products to be manufactured with lower levels of saturated fat – and fewer calories – than at present.

Researchers at the Universities of Edinburgh and Dundee designed a method for producing the new protein in friendly bacteria. The protein, known as BslA, works by adhering to fat droplets and air bubbles, making them more stable in a mixture. Using the ingredient could offer significant advantages for ice cream makers. It can be processed without loss of performance, and can be produced from sustainable raw materials.

Design for life

The research was developed with support from the Engineering and Physical Sciences Research Council and BBSRC. By investigating the properties of BsIA and how this protein helps bacteria to develop waterproof coatings – biofilms, and then combining this experimental work with theoretical work and computer simulation, has helped to establish design principles that would allow a range of new 'soft' materials to be developed. The researchers estimate that ice-cream made with the ingredient could be available within three to five years.

Professor Cait MacPhee, of the University of Edinburgh's School of Physics and Astronomy, who led the project, said: "We're excited by the potential this new ingredient has for improving ice cream, both for consumers and for manufacturers."

Dr Nicola Stanley-Wall, of the University of Dundee, said: "It has been fun working on the applied use of a protein that was initially identified due to its practical purpose in bacteria."

> "We're excited by the potential this new ingredient has for improving ice cream, both for consumers and for manufacturers."
>
> Professor Cait MacPhee, The University of Edinburgh

Further reading

Interfacial self-assembly of a bacterial hydrophobin.

PNAS

DOI: 10.1073/pnas.1419016112

Watch more at youtu.be/hO3HjtJ1TsE

Next steps

- Look at functional performance of BslA in other food and non-food formulations

Contact

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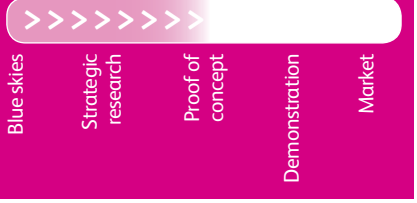
Discovery pipeline



Rothamsted Research

Rapid propagation of disease free willow

Scientists develop a fast, simplified method for multiplying a wide range of willow genotypes.

Conventional plant breeding in willow, involves crossing male and female plants which show desired traits such as high biomass yields, erect shoots, and pest and disease resistance. The initial cross is followed by four rounds of selection where promising material is progressed through successive field trials. But there is a bottleneck in this process as only limited amounts of material are available in early selection rounds.

Now a new rapid multiplication technique has been developed which removes this bottle neck and has the potential to reduce the time it takes from making a cross to releasing a willow variety by four to five years. The research, which was strategically-funded by the BBSRC, is published in the *Canadian Journal of Forest Research.*

Commenting on the success of the work Dr Elena Palomo-Rios, research scientist at the Department of Plant Biology & Crop Science, Rothamsted Research, said: "By careful optimisation of plant cuttings and media components we found we could produce almost 5,000 disease-free willow clones from a single plant in only 24 weeks and showed this method could be used for a wide range of different willow types."

The micro-propagation method used by the scientists allowed for rapid lab-based multiplication and establishment of individual willow genotypes. The plantlets were cultured from sterilised plant bud tissue taken from promising short rotation coppice (SRC) willow genotypes that had been bred at Rothamsted Research. A simple single growth medium, supplemented with a plant hormone, was used to successfully culture the cuttings.

Removing import barriers

Canada, like many other countries has strict controls that currently prevents the import of un-rooted woody cuttings. By incorporating molecular-based screening for a major pathogen, the team demonstrated the disease-free status of the plantlets, which were exported to Canada where they were successfully transferred to soil in the glasshouse and then to the field.

Emphasising the importance and value of the micro-propagation method, Professor Huw Jones, Head of the Plant Transformation & Tissue Culture Laboratory at Rothamsted Research, said: "This method significantly reduces the time required to generate the number of plants needed to carry out multisite yield tests, and for the first time allows the export of disease free material to markets that are currently inaccessible due to phytosanitary restrictions."

Recognising the potential application of the research findings, Professor Angela Karp, who leads Rothamsted Research's strategic research programme 'Cropping Carbon', said: "Driven by the challenge to reduce dependency on fossil fuels and help build the bioeconomy, there has been an increasing interest in growing improved willow varieties for renewable energy and diverse bioproducts.

"The micro-propagation method enables fast propagation and distribution of disease-free willows from our breeding programme in the UK for multiplication, trialling and use in a wide range of countries."

Further reading

Efficient method for rapid multiplication of clean and healthy willow clones via in vitro propagation with broad genotype applicability.

Canadian Journal of Forest Research
DOI: 10.1139/cjfr-2015-0055

Next steps

- Include this *in vitro* propagation system as part of the Rothamsted Research willow breeding scheme

Contact

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Discovery pipeline

Plant Power

Amazing science from everyday plants

Photography Company

Healthy plants, including crops and trees, are vital for our future. They are fundamental to our food, environment, economy and social wellbeing.

Plant scientists are finding innovative ways to try to solve some of our biggest challenges, such as protecting our forests, finding new fuel sources, cleaning up contamination and ensuring that we have enough food for a growing population. Last year, BBSRC invested nearly £87M in the best UK plant science to help address these challenges and many others.

Our plant science funding covers a range of important topics, including: crop breeding; the study of crop diseases and insect pests; pollinators; soil-plant interactions, using plants for the pharmaceutical industry; non-food crops (such as willow); improving our understanding of plants or plant cells, and other (non-plant) photosynthetic organisms (such as seaweeds, mosses and ferns).

Plants vs explosives:

Professor Neil Bruce
University of York

Professor Neil Bruce and his team use genetic modification to combine characteristics of bacteria that can degrade or detoxify different types of explosives, with the greater mass and processing ability of plants. This results in plants capable of removing TNT and RDX – two of the most widely used, and highly toxic, explosives in munitions – from soil and water.

Developed with funding from BBSRC and the Ministry of Defence, this research earned Professor Bruce runner-up position in BBSRC's Innovator of the Year 2014 competition.

John Houlihan

Plants vs fish:

Professor Johnathan Napier
Rothamstead Research

Rothamsted Research is conducting a field-based experiment of Camelina plants that have been genetically modified to produce omega-3 fatty acids (EPA and DHA) that may provide health, environmental and societal benefits.

Around 80% of all fish oil taken from the sea is consumed by the aquaculture sector which, as a whole provides 206,000 tonnes of EPA and DHA, but at the same time consumes a total of 210,000 tonnes; ie in practice providing the same amount as it consumes. This rapidly expanding, modern and progressive industry is therefore seeking new Omega-3 fatty acid sources to ensure its production practices remain sustainable.

Emma Foster

Plants vs obesity:

Professor Jeffrey Pearson and Dr Matthew Wilcox,
Newcastle University

While seaweed isn't technically a plant, it does have some serious plant power. Researchers at Newcastle University have found that a seaweed extract added to bread not only boosts the dietary fibre content but could even aid weight loss.

In an acceptability study using bread supplied by Greggs the baker, they demonstrated that alginates had no adverse effects on people, such as those associated with some weight management products currently on the market.

"We've found that not only do people not mind the taste of the alginate bread compared to ordinary bread they prefer it. This is very encouraging as we look to further develop alginate food products, building on the links that we have forged with industry," says Professor Pearson.

Tim Gander

Plants vs cars:

Professor Richard Cogdell
University of Glasgow

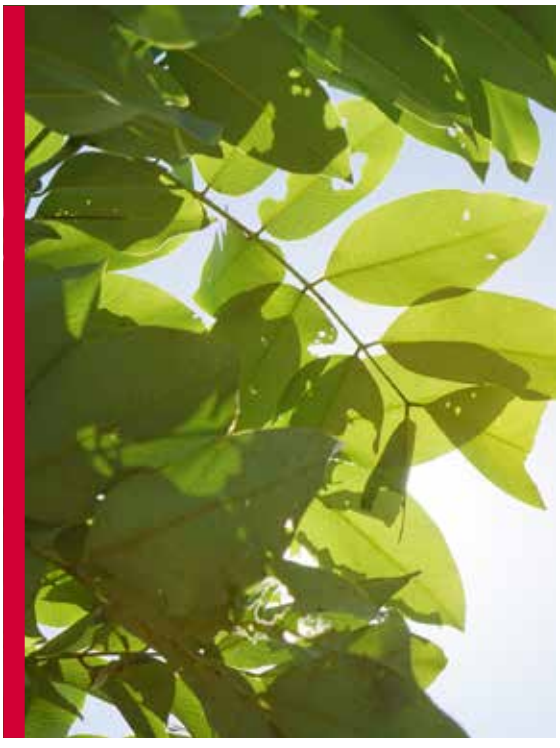
A synthetic biology approach is being used to create an 'artificial leaf' capable of converting the sun's energy to liquid fuel.

Professor Cogdell explains: "The sun gives its energy away for free but making use of it is tricky. We can use solar panels to make electricity but it's intermittent and difficult to store. What we are trying to do is take the energy from the sun and trap it so that it can be used when it is needed most."

The researchers hope to use a chemical reaction similar to photosynthesis but in an artificial system. Plants take solar energy, concentrate it and use it to split apart water into hydrogen and oxygen. The oxygen is released and the hydrogen is locked into a fuel. The latest research aims to use synthetic biology to replicate the process.

Professor Cogdell added: "We are working to devise an analogous robust chemical system that could replicate photosynthesis artificially on a grand scale. This artificial leaf would create solar collectors that produce a fuel, as opposed to electricity."

The artificial system could also improve on natural photosynthesis to make better use of the sun's energy. By stripping back photosynthesis to a level of basic reactions, much higher levels of energy conversion could be possible.



Thinkstock

PlantPower

Amazing science from everyday plants

bbsrc.ac.uk/plantpower

350,699 plant species exist

2,000 new species of vascular plants named each year

2nd The UK ranks 2nd in the world for plant science

Every second 16,000 tonnes of plant matter is created on earth in the form of trees, grass, seaweed, dandelions, giant redwoods, apples...

5 crops provide 60% of human food-energy needs

rice
wheat
maize
millet
sorghum

7,000 species have been cultivated or collected for food

22% of the UK's fruit and veg is grown in the UK

FOOD

Crop protection currently saves UK consumers an estimated £70 Billion in annual food costs

Up to 40% of global crop yields are lost to plant pests and diseases each year

Coming soon

January

5 – 7 January

BBSRC is exhibiting at The Oxford Farming Conference.

www.ofc.org.uk/conference/2016/2016-conference

12 – 15 January

Steps to Sustainable Livestock conference.

Supported by two BBSRC International Partnering Awards.

www.globalfarmplatform.org/conference-intro

28 January

BioIndustry Association Gala Dinner.

BBSRC will be hosting a table at the dinner.

wwww.biagaladinner.org

February

3 February

FLexible Interchange Programme (FLIP) awards application deadline

www.bbsrc.ac.uk/flip

3 February

Strategic Training Awards for Research Skills (STARS)

www.bbsrc.ac.uk/stars

11 – 15 February

The Research Councils will be at the The AAAS Annual Meeting.

http://meetings.aaas.org/

23 – 24 February

BBSRC will be exhibiting at the National Farmers' Union (NFU) Conference

www.bbsrc.ac.uk/news/events

May

18 May

Fostering Innovation 2016

www.bbsrc.ac.uk/fosteringinnovation

Science to support a productive, prosperous and sustainable UK

Each year, BBSRC invests around £510M in bioscience research and training on behalf of UK tax payers. This funding underpins the British bioeconomy to deliver:

Transformative new business opportunities

Innovation from new discovery

A resilient secure future

The UK as a global partner of choice

A talented and productive workforce

For more information visit **www.bbsrc.ac.uk** or email: **press.office@bbsrc.ac.uk**

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