UK Biotechnology impacting everyday lives
Industrial Biotechnology (IB): The application of technologies to turn biological resources into materials of industrial and societal value and utility.

The UK Industrial Biotechnology sector has a GVA of £7.5Bn and supports 14,000 jobs.
Foreword

We live in an exciting time for bioscience. The emergence of synthetic biology and gene editing has advanced Industrial Biotechnology giving us the potential to transform industries and contribute to a low-carbon circular economy through creation of cheaper, more sustainable processes and products.

Through 15 years of investment in collaborative research, we have built a vibrant and thriving community of academics and industrialists who are working together to tackle major societal and economic challenges.

BBSRC plays a vital role in developing fundamental knowledge and technologies and translating these into industry. This booklet compiles some of the most exciting examples of how BBSRC investments are impacting and have the potential to impact everyday lives, ranging from cheaper lifesaving pharmaceuticals to cleaner energy and water.

Dr Karen Lewis
Executive Director, Capability and Innovation, BBSRC
Primary coffee production generates large amounts of liquid waste, which can pollute local water supplies around coffee growing sites. A low-cost microbial fuel cell has been developed that breaks down contaminants in waste water from coffee production and generates cheap renewable energy. The fuel cell can be easily made from locally-available materials, and could reduce the environmental impact of coffee production whilst empowering producers to generate their own energy without expensive equipment.

Around 140 Litres of water are needed to produce just one cup of coffee*

Enzyme could hold the solution to plastic waste

PET plastics are currently “downcycled” into products like carpets or fibres, put into landfill or incinerated. A newly discovered enzyme, PETase, has been shown to break down PET into its original component chemicals. Studying the enzyme’s crystal structure has led to speeding up the process and could allow recycling of these plastics into equivalent products over and over again.

20,000 plastic bottles produced every second*

Further research could identify enzymes that can tackle mixed plastic wastes

*Source: Euromonitor

University of Portsmouth, US National Renewable Energy Laboratory
Based on research supported by BBSRC
Cloaking proteins for Zika virus vaccine

There are no approved vaccines for Zika and Dengue fever, due to the risk of inducing more severe disease by a similar viral type. Industrial biotechnology has developed a ‘cloaking’ technique to hide the part of the vaccine proteins responsible for this effect. This way they cannot be detected by the immune system, and are effectively masked via molecular modification.

390M people estimated to be affected by Zika and Dengue each year*

Stains and sustainability

Some oils from human skin (sebum) cannot be fully broken down by current washing detergents, leaving yellow-brown stains and odours on clothes after repeated washing. Enzymes have been identified that could break these persistent oils down, preventing the build-up of stains and odours.

New products under development could work at 20°C, using up to 70% less electricity*

*Source: S.A.F.E, 2014

New enzyme testing methods and models of sebum developed for industry use

Exeter University, Unilever
Based on research supported by BBSRC
Lignin is a side-product from the paper-pulp industry, with the potential to be made into bioplastics, but it needs extensive costly treatment. A species of *Rhodococcus* bacteria has been shown to break lignin down into component parts, which can be used as the raw material for bioplastics.

More sustainable bioplastics

Avoids treatment with high temperatures or acid

Based on research supported by BBSRC

University of Warwick, University of Leeds, Centre for Process Innovation, University of York, Biome Bioplastics
Waste wood biomass could be an abundant renewable carbon resource for making fuels and chemicals, but the sugars needed for this are surrounded by a lignin barrier. Marine wood borers (gribbles) have been found to digest wood using proteins (haemocyanins) that disrupt lignin’s structure and allow the release of sugars.

Faster, cheaper extraction of carbon for sustainable, cost-competitive chemicals and fuels

University of York, University of Portsmouth, University of Cambridge, University of Sao Paulo

Based on research supported by BBSRC
Speeding up drug discovery

Polyketides are an important class of pharmaceuticals, but discovering new ones is slow and expensive. A new technique called “Accelerated Evolution” has allowed the rapid production of new enzymes, which can be used to create “libraries” of polyketides. These libraries can be scanned to identify potential new drugs.

Discovery of novel compounds will improve our capability in overcoming anti-microbial resistance

Polyketides account for $20Bn of global sales each year*

*Source: Weissman KJ. Introduction to polyketide biosynthesis. In: Complex Enzymes in Microbial Natural Product Biosynthesis

John Innes Centre, University of Cambridge, Isomerase Therapeutics, Zuvasynthia

Based on research supported by BBSRC
A step change for the rapid production of complex biopharmaceutical products

Bacteria can be engineered to produce useful drugs, but many novel therapeutic molecules are too large to pass out of the bacterial cell and maintain their activity. A newly-discovered pathway used by bacteria to transport larger molecules out of the cell in their correctly folded form has been used to create a platform technology that allows more complex therapeutics to be made in bacteria.

Industrial partners are exploring the technology’s application for commercial biopharmaceutical production

Complex, novel therapeutics for human disease can now be made in the UK and developing countries

University of Warwick, University of Kent, UCL, University of Birmingham, University of Sheffield, UCB

Based on research supported by BBSRC
Sustainable natural flavourings

Nootkatone is a valuable natural flavouring found in grapefruit but needs 400,000kg of fruit to make 1kg and has a similar market price to caviar. A novel enzyme has been designed to convert an abundant ingredient found in oranges into nootkatone, in a process that allows the resulting product to be classed as a natural flavouring.

More environmentally sustainable and efficient manufacturing process

£5M private investment leveraged by spinout company Oxford Biotrans

University of Oxford, Oxford Biotrans

Based on research supported by BBSRC
Thousands of tonnes of industrial CO₂ emissions could be reduced each year if implemented at full scale. Increased investment in industrial partner NiTech Solutions, with additional staff hired.

A new continuous flow bioreactor has been invented that can efficiently convert industrial waste gases into “green methane” that can be used as a low carbon fuel source for the National Grid.
Bacteria can be used to produce \( n \)-butanol, an important chemical used in the production of plastics and polymers (e.g. paint), through fermentation, but the product tends to kill them, so it is currently cheaper to use chemical processes instead. By artificially evolving more butanol-tolerant strains of bacteria, research has made the bio-based method more efficient and competitive.

The global \( n \)-butanol market = 3 million tonnes per year*

*Source: UKBioChem10

£3M project brought together 5 universities and 4 industrial partners to broadly address the challenge of chemical toxicity across a number of bio-based processes.
BBSRC Mission:
To build capacity in UK IBBE by supporting open, flexible collaborations between different academic disciplines and the UK industrial community.

About BBSRC
The Biotechnology and Biological Sciences Research Council (BBSRC) is part of UK Research and Innovation, a non-departmental public body funded by a grant-in-aid from the UK government. 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 £498 million in world-class bioscience in 2017-18.

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.

BBSRC Investment Strategy for IBBE
We have invested £232M in collaboration with EPSRC and Innovate UK, and leveraged over £32M from industry...

Our support has helped to build a vibrant and thriving community of over 3000 academics and over 800 businesses, and led to the emergence of new supply chains across multiple UK industry sectors.
Investment Timeline

**2005**
- Sustainable Biorefining Research Centre (£19M)
- EPSRC-BBSRC Prosperity Partnership: Centre for Biocatalytic Manufacture of New Modalities (£2.5M)

**2006**
- EPSRC-BBSRC Future Biomanufacturing Research Hub (£5.6M)

**2007**
- IB Catalyst (£16M)
- IBTI: Integrated Biorefining Research and Technology Club (£660,000)

**2008**
- EPSRC-BBSRC Prosperity Partnership: Centre for Biocatalytic Manufacture of New Modalities (£2.5M)
- IBRI: Bioprocessing Research Industry Club (£6.3M)

**2009**
- IBRI: Bioprocessing Research Industry Club (£2M)
- IBTI: Integrated Biorefining Research and Technology Club (£660,000)

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**2020**
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**2021**
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**2022**
- IBRI: Bioprocessing Research Industry Club (£2M)

**2023**
- IBRI: Bioprocessing Research Industry Club (£2M)

**2024**
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BBSRC invests alongside UK and international partners to tackle global challenges

EU
ER2 Industrial Biotechnology 2014-2015 £1 M BBSRC invested in 21 international partners
ER2 CallTech 2017 present £3.2 M BBSRC investment in 9 projects with 18 international partners

INDIA
SubB: Sustainable Bioenergy and Biorefinery 2012-2016 £8M invested in 8 projects 5 university and institute partners, 2 international partners
Newcastle-India UK-India Industrial Biotechnology Joint Call 2017-2018 £2.5 M BBSRC investment in 9 projects with 13 international partners

SRI LANKA, INDIA, UGANDA
Global Challenges Research Fund Biotechnology and Bioenergy in the Developing World
Invested £1 M in 3 projects 11 university and institute partners, 4 international partners

EU
ERA Industrial Biotechnology 2012-2015 £9.1 M BBSRC investment with 21 international partners
ERACoBioTech 2017-present £2.3 M BBSRC investment in 9 projects with 13 international partners

BRASIL
BBSRC-FAPESP joint call in advanced biofuels £3.5M invested in 2 projects 4 academic partners, 1 international partner

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