

## **THE KNOWLEDGE BASED BIOECONOMY (KBBE)**

### ***Bioenergy, industrial biotechnology, synthetic biology***

The aim of this priority is to encourage the submission of high quality proposals from the UK's **future research leaders** in scientific areas capable of driving forward the UK's Knowledge Based Bioeconomy.

The priority aligns with commitments in BBSRC's Strategic Plan and Delivery Plan to the high level strategic research priority 'Bioenergy and Industrial Biotechnology' and the enabling theme 'Exploiting New Ways of Working'. Three areas of importance to the development of the UK KBBE are specifically identified. These are:

- Industrial biotechnology
- Bioenergy
- Synthetic Biology for white biotechnology

Proposals that fit within the BBSRC remit that cover one or more of these areas are encouraged.

BBSRC's recent investments in the use of quantitative and predictive methodologies to study biological systems have underlined the importance of adopting this type of approach in research relevant to the KBBE priority area. This enhanced understanding of biological systems should pave the way for the development and application of synthetic biology approaches.

## **NEW STRATEGIC APPROACHES TO INDUSTRIAL BIOTECHNOLOGY**

### **Background**

Industrial Biotechnology (IB) is a set of cross-disciplinary technologies that use biological resources for producing and processing materials and chemicals for non-food applications. These resources can be derived from the tissues, enzymes and genes of plants, algae, marine life, fungi and micro-organisms. BBSRC has identified IB in its Strategic Plan as a high level strategic priority area for the next five years as a way of helping to reduce dependency on petrochemicals and helping the UK to become a low carbon economy, so contributing to the targets for reducing emission of green-house gases.

### **Aims**

BBSRC aims to support the development of new sustainable approaches to the generation of materials and chemicals and their incorporation into manufacturing, using renewable resources rather than fossil hydrocarbon sources and utilising biological processes. In order for this to be realised in the future, BBSRC will need to contribute to the following:

- Increasing the UK's capacity to undertake basic and strategic research in IB through increasing the critical mass of trained staff in UK universities and institutes.
- Increasing the opportunities for collaboration with industry, allowing the translation of basic discoveries ultimately into new products and processes.

### **Research proposals**

UK industry requires more basic and strategic research to underpin the development of innovative manufacturing routes to prepare high-value chemicals, industrial chemicals or platform chemicals from renewable feedstocks including algae, crop wastes, food and municipal waste, animal wastes and perennial biomass.

Research proposals should therefore address the following areas:

- new approaches to support the application of whole cell and enzymatic systems to the production of high-value chemicals (including recombinant DNA biologics and antimicrobial compounds), industrial chemicals and platform chemicals. Proposals should involve the application of systems and synthetic biology approaches to reach these goals. They may also include the incorporation of existing approaches drawn from other disciplines such as chemistry, engineering and mathematics.
- Innovative approaches to develop new biocatalytic entities and pathways, (for example in the production of specific chemicals from biomass through novel pathways and prevention of the inactivation of the biocatalyst/pathway by toxic products).
- New approaches to increase the production of high value chemicals from plants, and to improve their "processability", with a particular focus on the

translation of fundamental plant science (including knowledge from model plants such as *Arabidopsis* and *Brachypodium*) into more industrially-relevant non-food plants.

# BIOENERGY: GENERATING NEW REPLACEMENT FUELS FOR A GREENER, SUSTAINABLE, FUTURE

## Background

Bioenergy is a renewable form of energy generated from materials derived from biological sources. Bioenergy is increasingly being recognised as having an important role in helping the UK to maintain its energy security in the context of diminishing worldwide stocks of fossil fuels. Moreover, increasing the deployment of bioenergy within the UK will also play an important part in helping the UK to achieve its ambitious targets for reductions in green-house gas emissions, as set out in the Climate Change Act 2008. Replacement liquid transportation fuels will have a particularly important role to play in achieving these aims.

BBSRC's interests are focussed on supporting research projects that aim to develop liquid transportation fuels, biogases and biologically generated electricity derived from a wide range of different biological feedstocks including: algae, crop wastes, food and municipal waste, animal wastes and perennial biomass.

## Aims

BBSRC wishes to encourage proposals that:

- Increase the UK's capacity to undertake: basic, strategic and applied research into the development and scale-up of sustainable replacement fuels with emphasis on liquid transport fuels using both synthetic and systems biology approaches.
- Research should focus on growth and composition of the biological feedstock, through to metabolism and harvesting of fuel and its associated added value co-products.
- Encourage collaboration of academia with industry and the translation of research into biofuels and associated added-value co-products.
- Develop and / or improve enabling technologies relevant to the biorefinery concept. This approach, in which all components of the feedstock are used to make multiple products (chemicals, heat and fuel), improves the economic feasibility and resource efficiency/ sustainability of biofuel production.
- Build on successful research being undertaken by the BBSRC Sustainable Bioenergy Centre <http://www.bsbec.bbsrc.ac.uk/index.html>, e.g. by using alternative feedstocks, such as algae or municipal waste, or adopting synthetic biology approaches to produce alternative biofuels.

In all cases research applications must be targeted towards sustainable, advanced biofuels ("second-generation" and beyond). BBSRC does not wish to support research in the area of biomass combustion or combustion technologies.

Research projects that use multidisciplinary approaches to integrate biology with other disciplines including chemistry, engineering and mathematics are particularly encouraged.

## Further Reading

A document that sets out BBSRC position on bioenergy research is available<sup>1</sup>.

<sup>1</sup> <http://www.bsbec.bbsrc.ac.uk/assets/pdfs/bbsrc-bioenergy-position-statement.pdf>

# SYNTHETIC BIOLOGY FOR WHITE BIOTECHNOLOGY

## Background

Synthetic biology is an emerging, multidisciplinary research area at the intersection of engineering, bioscience, chemistry, and information technology. Commonly accepted definitions of synthetic biology have been evolving and currently there appears to be convergence and consensus around the following:

*Synthetic biology aims to design and engineer novel biologically based parts, devices and systems, as well as redesign existing natural biological systems for useful purposes. It incorporates the principles of engineering e.g. modularity, abstraction and orthogonality into classical biotechnology”*

BBSRC has identified synthetic biology as a strategically important ‘new way of working’ in the biosciences with potential application to a wide range of industry sectors. With other funders, BBSRC has established seven Networks in Synthetic Biology and the current portfolio of research projects is growing. Furthermore, the UK research community has strength and depth in several related research areas including genomics, systems biology, biomolecular sciences, metabolic engineering and protein engineering.

## Research Proposals

The aim of this priority is to support synthetic biology research in areas that demonstrate potential pathways to impact in the UK white biotechnology industry. The relevant sub-sectors include:

- Advanced biofuels
- Algal-based feedstocks
- Platform and industrial chemicals
- High- value chemicals and pharmaceutical intermediates

Project proposals should be formulated cognisant of one or more of the above challenges.

Synthetic biology raises ethical, legal and societal (ELS) issues as demonstrated by the 2010 media coverage of Craig Venter’s work that created a bacterial cell controlled by a chemically synthesised genome. Research projects should consider the ELS issues inherent in the work they are proposing and applicants should appraise themselves of the findings of recent public dialogue activities (see further reading).

## FURTHER READING

BBSRC Commissioned report: *Synthetic biology social and ethical challenges*

See: <http://www.bbsrc.ac.uk/organisation/policies/reviews/scientific-areas/0806-synthetic-biology.aspx>

BBSRC/EPSRC Synthetic Biology Dialogue

See: <http://www.bbsrc.ac.uk/web/FILES/Reviews/1006-synthetic-biology-dialogue.pdf>