

THE KNOWLEDGE BASED BIOECONOMY (KBBE)

Bioenergy, industrial biotechnology, synthetic biology

The aim of this strategic theme is to encourage the submission of high quality research proposals requiring multidisciplinary approaches in scientific areas capable of driving forward the UK's Knowledge Based Bioeconomy (KBBE). The KBBE theme aligns with commitments in BBSRC's Strategic and Delivery Plans 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.

For proposals to the KBBE strategic theme, it is strongly recommended that there is formal involvement with one or more industrial companies, with interests in applying the research being proposed. This involvement does not necessarily need to involve co-funding of the proposal (although this would be an advantage) and could involve (for example) participation in the project management committee or the scientific advisory board.

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 strategic theme. This enhanced understanding of biological systems should pave the way for the development and application of synthetic biology approaches.

PHD TRAINING IN THE KBBE STRATEGIC THEME

Exceptionally, and in order to increase capacity and capability in the areas described in the KBBE strategic theme, BBSRC will make available a number of four-year BBSRC studentships based around successful sLoLa proposals, to start in October 2014. Applicants are asked to consider the type of doctoral training programme that would be appropriate to develop the next generation of researchers in the area of the proposed sLoLa, including opportunities for students to engage with any wider, non-academic, partners involved. The minimum number of studentships awarded to individual sLoLas will be three, in order to create a cohort of students, and up to 15 will be available for allocation.

The allocation of studentships will be made on the basis of a separate assessment of the quality of the training environment, and a successful sLoLa proposal is not guaranteed to receive an allocation of studentships. Applicants are recommended to refer to the skills statement in Annex 6 of the call for Doctoral Training Partnerships (see <http://www.bbsrc.ac.uk/web/files/guidelines/dtp-call.pdf>) as a guide to BBSRC's expectations regarding PhD training. **BBSRC's standard requirement of a minimum 70% four-year PhD submission rate in each of the three preceding years (for the departments involved in the proposal) will apply.**

Studentships will be funded through a Training Grant (TG) held by a lead institution which will be responsible for overseeing the allocation and management of studentships across the partners and the recruitment of excellent students. While the TG will be for a single cohort of students alongside the sLoLa for start in October 2014, requests to hold over studentships to start in October 2015 will be considered, if, for example, student demand or recruitment are problematic. The studentships will be funded with the higher £5k p.a. research training support grant (RTSG).

THEME 1: 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. Initial analysis of BBSRC's research and training portfolio suggests a need to build capacity and capability to undertake basic and strategic research in IB in the future

(<http://www.bbsrc.ac.uk/news/industrial-biotechnology/2011/110203-n-review-industrial-biotech-bioenergy.aspx>).

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 grant 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 residues, food and municipal waste, animal wastes and perennial biomass).

. Research grant 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.

THEME 2: 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 greenhouse 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 residues, food and municipal waste, animal wastes and perennial biomass.

Aims

BBSRC wishes to encourage research applications 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 outputs achieved to date from the BBSRC Sustainable Bioenergy Centre (BSBEC) <http://www.bsbec.bbsrc.ac.uk/index.html> and / or complements research to BSBEC 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's position on bioenergy research is available¹.

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

THEME 3: 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”

Synthetic biology is sometimes referred to as the ‘operational engineering’ of biology, an approach that, when fully developed, will standardise, systematise and accelerate bio-based industrial production. The EASAC 2010 report (see further reading) describes six sub-sectors that are commonly identified within the emerging definition of synthetic biology:

- *Minimal genomes: Understanding the minimal number of parts needed for life, to serve as a basis for engineering minimal cell factories for new functions.*
- *Orthogonal biosystems: Expanding information storage and adding coding capacity*
- *Regulatory circuits: e.g. Designing synthetic gene circuits that may be based on standard biological parts*
- *Metabolic engineering: Engineering modified biosynthetic pathways to yield useful products. Overcoming / removing elements that block production.*
- *Protocells: Bottom-up chemical design approaches to create cells de novo.*
- *Bionanoscience: e.g. Utilising and exploiting cellular molecular machines.*

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 (http://www.bbsrc.ac.uk/web/FILES/Publications/synthetic_biology.pdf), 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. Overall, UK synthetic biology research activity is emerging and there is an opportunity to build capacity and capability through the support of major research programmes in this area.

Research Grant Proposals

The aim of this priority is to support longer-term multidisciplinary synthetic biology research in areas that demonstrate potential pathways to impact in the UK white biotechnology industry. The priority has a particular focus on microbial cell factories (e.g. fungal, bacterial, microalgal) covering technology-led, experimental and computational approaches, as this builds on UK strengths; consultation indicates that microbial cell factories is the area that is most likely to deliver into the industry sector in the medium term.

The relevant areas identified as likely to benefit from the development and application of synthetic biology approaches include:

- Advanced biofuels
- Algal-based feedstocks
- Platform and industrial chemicals

- High- value chemicals and pharmaceutical intermediates
- Bio-based materials including Biosensors

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

BBSRC is keen to support interactions between the UK synthetic biology research community and relevant research groups overseas; and proposals may include international partnering activities such as workshops and visits as a part of the research project activities.

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 based on 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 / information sources

European Academies Science Advisory Council: Realising European Potential in Synthetic Biology – Scientific Opportunities and Good Governance.

See:

http://www.easac.eu/fileadmin/PDF_s/reports_statements/Synthetic%20Biology%20report.pdf

The Next Step for the Synthetic Genome. *Nature*, Vol473 pages 403-408. 19 May 2011

Synthetic biology international research community wiki See:

http://en.wikipedia.org/wiki/Synthetic_biology

Bromley et al. (2007) An outline of the synthetic biology space. *Chemical Biology Vol 3, p.38*

Five Hard Truths for Synthetic Biology *Nature (news feature) Vol. 463 21 January 2010*

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>