LBNet IB Catalyst Seeding Proof of Concept (POC) funding

Projects funded 2017

LBNet is a BBSRC-funded Network in Industrial Biotechnology and Bioenergy

ISCF01: From lignocellulose to bioplastics: Improved enzyme based production of an aromatic bioplastic monomer

Lead applicant: Mark Caddick, University of Liverpool	**Other applicants:** Andrew Carnell, University of Liverpool & Paul Mines, Biome Technologies

Public Summary

This project addresses the current need for improved conversion of biomass into useful chemical precursors for bioplastics production. Presently, this involves traditional industrial chemistry, which represent an energy-demanding process, requiring harsh conditions. Enzymatic conversions require less energy and are carried out in more favourable and milder conditions, providing a highly selective production of target compounds that are purer. Previous research at Liverpool (Carnell Group) has shown that bioplastics building blocks, in the form of dicarboxylic acid compounds, can be derived from lignocellulose based intermediates using an alcohol oxidase enzyme catalysed reactions. While an existing alcohol oxidase is known, the reaction is inefficient.

Our group has used bioinformatic approaches to select enzymes from six families of alcohol oxidases. These will be synthesised and expressed in both a bacterial host and a cell-free system and screened for specific activity using an established assay.

Following this project, further funding will be sought to optimise the catalytic properties of the best candidates and scale-up the bio--conversion with our industrial partner, Biome Bioplastics.

The project outcome will include identification of new alcohol oxidases that can be used in the production of bioplastic precursors, establishment of a useful set of enzymes that can be screened against other substrates and the development of an efficient screening platform that can be applied to other enzyme families.

Public Project Outcome (to follow, March 2018)

ISCS02: Towards an alternative source of acrylic acid based on algal biosynthetic pathway

Lead applicant: Thierry Tonon, University of York	**Other applicants:** Simon McQueen-Mason, University of York

Public Summary

Acrylic acid (acrylate) is a platform chemical used to produce esters with applications in paper treatment, plastic additives, textiles, sealants, adhesives, and surface coatings. Its market value was $11b in 2013 and is expected to reach almost $19b by 2020. The conventional petrochemical production route of acrylate involves reacting propylene with oxygen at high temperature and pressure to produce acrolein, which is oxidized further to yield acrylate. Due to unstable oil prices, and environmental concerns, industry players have invested in R&D for bio-based acrylate production. Among the routes tested so far, fermentation processes of sugars to produce lactic acid or 3-hydroxypropionic acid which are then dehydrated to acrylic acid have been developed recently.

We propose an alternative pathway for bio-based acrylate production from dimethylsulfoniopropionate (DMSP) by fermentation. Some marine algae produce DMSP as an osmoprotectant in response to environmental stresses, and can cleave it into dimethyl sulphide (DMS) and acrylic acid. Because of their inert nature, osmoprotective molecules can accumulate to relatively large quantities without causing toxicity, and DMSP production may therefore offer advantages compared to 3-hydroxypropionate or lactic acid. Algal enzymes potentially involved in DMSP production have been identified, but none of them have been confirmed yet to be involved in this process. To fill this gap, our strategy relies on a medium throughput cloning and heterologous expression approach for the biochemical characterization of these enzymes. This will set the stage to engineer production of DMSP from biomass-derived sugars to provide sustainable bio-acrylic acid and DMS(O) for industry.

Public Project Outcome (to follow, March 2018)

ISCF03: A new ligninase for biorefining applications

Lead applicant: Neil Bruce, University of York	**Other applicants:** Simon McQueen-Mason, University of York & Phil Metcalfe, Efficiency Technologies

Public Summary

Lignocellulose is one of the most abundant forms of fixed carbon in the biosphere and its breakdown is a critical component of the global carbon cycle. There is currently much interest in the use of lignocellulose as an important renewable resource for biofuels but the composition and structure of lignin makes lignocellulose highly recalcitrant to biodegradation. The lignin component of plant cell walls does, however, also represent the largest global resource of natural aromatics that can potentially be liberated for the production of high-value chemicals if suitable enzymes could be indentified with utility for lignin-based industrial processes. There are currently no industrial biocatalytic processes for lignin.

This project builds on a considerable body of prior work in which we have been exploring the metaexoproteome from complex omposting microbial communitiesusing ‘omics’ technologies to identify new lignocellulose processing systems. We have identified a

new extracellular fungal β-etherase activity enzyme from Graphium sp., which was seen to dominate the latter stages of wheat straw decomposition in compost. The research proposed here is concerned with characterising this new enzyme and establishing its utility for biorefining applications.	
Public Project Outcome (to follow, March 2018)	
ISCF04: Merry-go-round: Draff pretreatments using fermentation-derived solvents	
Lead applicant: Nicholas Westwood, University of St Andrews	**Other applicants:** Julie Hawkins, Edinburgh Napier University & Eve Bird, Celtic renewables
Public Summary The worldwide success of the Whisky Industry provides a considerable supply of biomass-derived waste streams for future use. Sustainable valorisation of these streams will drive additional economic growth in this sector. This project focuses on one of the waste streams known as draff or spent grains. We will deliver an optimised process for pretreating draff. The selected pretreatment protocol will deliver sugar-dominated product streams that are suitable for fermentation, leading to the production of the solvents acetone, butanol and ethanol. A key benefit of the selected approach is that the solvents produced in the fermentation process will be used in the pretreatment process, completing a circular economy process that will have a number of economic and environmental benefits. For example, the need to transport solvents to a processing plant will no longer be required. The project will build on expertise and a preliminary study carried out by researchers at Celtic Renewables LTD (CRL), the Biofuel Research Centre, Edinburgh Napier University and the University of St Andrews.	
Public Project Outcome	
Public Project Outcome (to follow, March 2018)	