POC-17-warren-C1net-public-summary-application

PI Martin Warren, University of Kent

Towards improved bioprocess kinetics for C1 feedstock fermentation in acetogens

Many industrial processes, such as refining, steel milling, and chemical plants discharge significant amounts of waste gases containing mainly CO, CO2 and H2 into the atmosphere either directly or through combustion. Certain microbes can be exploited to convert these waste gases to chemicals and fuels as, for example, ethanol. This microbial process is known as C1 gas fermentation and is a recognized Green Technology, reflecting the application of environmental science to curb the negative impacts of industrialisation. However, C1 gas technology has known limitations including low growth rates and productivity. This application addresses this point by helping to develop methods to enhance metabolic processes within specific bacteria that are able to grow on C1 gases such as acetogens, bacteria that accumulate acetic acid as a product of their respiration.

To achieve this outcome we aim to engineer acetogens with an evolved novel metabolic pathway of specific suitability for C1 utilising microrganisms that is able to convert waste molecules such as acetic acid into more valuable commodity chemicals such butanediol. To do this we have to improve the activity of certain enzymes and then place the relevant enzymes close together within the cell to prevent the accumulation toxic metabolites. This can be accomplished by either the use of bacterial compartments or protein scaffolds. Such compartments are naturally found within many bacteria, including those associated with syngas fermentation. However, in this case we will use bacterial microcompartments that we know that we can manipulate. Similarly, we will use new technology that allows us to literally peg enzymes onto protein scaffolds. Our overall aim is to therefore to engineer enzymes that can convert derivatives of acetic acid into useful products through the use of metabolic micro-factories, without intoxicating the cells. In this way we may develop new ways to produce important commodities from very cheap substrate (syngas).

In order to achieve this ambitious goal we have assembled a highly interdisciplinary team of researchers covering such diverse areas as microbiology, biotechnology and engineering. Only via such an integrated approach will it be possible to design the desired functioning bacterial factories. Only through the exchange of concepts, ideas, and technologies between the industrialists and academics will we be able to advance our ideas at a rapid pace. Through this approach we are confident that we will be able to contribute to the development of new sustainable approaches to the generation of chemicals and fine chemical and for their rapid incorporation into manufacturing with leading companies.