ERA CoBioTech

BioTech Research & Innovation Hack

2021

ERA CoBioTech Funded Projects at A Glance: MemBRane

MemBRane Modulation for BiopRocess enhANcEment

PART OF EUROPEAN BIOTECH WEEK

INNOVATION IS IN OUR GENES

MemBRane

Optimising microbial bioproduction by modifying the cell membrane

Researchers within MeMBrane are using a combination of computational and laboratory approaches to understand the effect of stress on the cell membrane. This allows them to modify bacterial and yeast strains to better produce chemicals during fermentation.

Understanding the cell membrane in order to rationally improve bioprocesses

The reliance on fossil fuels to produce chemicals is a key driver of climate change. As such, bioprocesses that use microbes to produce such compounds by fermentation are increasingly attractive. However, such processes are often hindered by toxicity towards the producing organism, with much of this focussed at the cell membrane.
The membrane is a complex environment containing lipids and proteins, providing a barrier for entry to, and exit from, the cell. In order to better understand the stress responses in fermentations, and to provide rational targets for strain engineering, a more complete understanding of the cell's response to stress is required. Once this is understood, we can design strains that will be more effective in bioproduction, thereby reducing the cost of such fermentations and making bioproducts more economically viable. Ultimately, we want to replace fossil fuels with more environmentally friendly alternatives.

An interdisciplinary, intersectoral project

MeMBrane involves academic and industrial partners from across Europe, forming a multidisciplinary team who operate on a range of research scales, from molecules to industrial fermentations. The methods used include computational simulations (looking at the way individual molecules behave), biophysical approaches (understanding the effects of molecules on the way cells behave), microbiology (the growth and characterisation of yeast and bacteria), -omics technologies (analysing how whole suites of molecules e.g. proteins within a cell change in different conditions), fermentation (larger-scale production of chemicals using microbes) and life cycle analysis (understanding if a process is more efficient and "greener").

Main results

We have worked on two substantial projects - the production of ethanol using yeast and propionic acid using propionibacteria.
For the yeast project, we have characterised the protective changes that occur in the cell membrane in response to ethanol stress - these have been determined in model systems and correlating changes seen in yeast cells themselves. We have also generated a number of "hybrid" strains that perform better than traditional strains and are currently being tested by our industrial partner at scale. If confirmed, these yeast will have roles in restarting "stuck" fermentations and secondary fermentations.
For the propionic acid project, we have successfully optimised the fermentation conditions to help overcome stress and maximise product yield. This protocol is currently being scaled by our industrial partner.

Future prospect

Throughout the project, the team have worked together to ensure that the approaches taken are of industrial relevance. Although we may have made scientific advances and now have firm ideas about how to take strain development forwards, it is really important to the team to apply our research in the "real world". As such, our industrial partners are currently testing strain in scale up to ensure suitable performance. Furthermore, we are undertaking life cycle assessment and economic viability studies to ensure that our processes are both "greener" and profitable.

Project coordinator:

Alan Goddard
Aston University, United Kingdom

Consortium:

University of York, (United Kingdom)

Consejo Superior de Investigaciones Científicas (CSIC), (Spain)

Forschungszentrum Jülich (FZJ), (Germany)

The University of Groningen, (The Netherlands)

Pakmaya, (Turkey)

Lallemand, (Turkey)

Project duration:

1 April 2018 - 31 October 2021

Total budget: 2.4 €M

This project has received funding from the European Union´s Horizon 2020 research and innovation programme under grant agreement No [722361]

We have published a number of papers detailing both the experimental approaches we take and also our findings relating to the modulation of yeast cell membranes under ethanol stress.

Lairón-Peris, M., Castiglioni, G.L., Routledge, S.J., Alonso-del-Real, J., Linney, J.A., Pitt, A.R., Melcr, J., Goddard, A.D., Barrio, E. and Querol, A., 2021. Adaptive response to wine selective pressures shapes the genome of a Saccharomyces interspecies hybrid. Microbial genomics, 7(8), p.000628.

Lairón-Peris, M., Routledge, S.J., Linney, J.A., Alonso-Del-Real, J., Spickett, C.M., Pitt, A.R., Guillamon, J.M., Barrio, E., Goddard, A.D. and Querol, A., 2021. Lipid Composition Analysis Reveals Mechanisms of Ethanol Tolerance in the Model Yeast Saccharomyces cerevisiae. Applied and Environmental Microbiology, 87(12), pp.e00440-21.

Routledge, S.J., Linney, J.A. and Goddard, A.D., 2019. Liposomes as models for membrane integrity. Biochemical Society Transactions, 47(3), pp.919-932.

Figure 1: MeMBrane Consortium - York, January 2019

Website: https://www.membrane.org.uk/
Twitter: @CoBioMeMBrane
YouTube: Megson "Using Biology" - YouTube

This project has received funding from the European Union´s Horizon 2020 research and innovation programme under grant agreement No [722361]