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Meeting Report

3rd congress on applied synthetic biology in Europe (Costa da Caparica, Portugal, February 2016)

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ABSTRACT

The third meeting organised by the European Federation of Biotechnology (EFB) on advances in Applied Synthetic Biotechnology in Europe (ASBE) was held in Costa da Caparica, Portugal, in February 2016. Abundant novel applications in synthetic biology were described in the six sessions of the meeting, which was divided into technology and tools for synthetic biology (I, II and III), bionanoscience, biosynthetic pathways and enzyme synthetic biology, and metabolic engineering and chemical manufacturing. The meeting presented numerous methods for the development of novel synthetic strains, synthetic biological tools and synthetic biology applications. With the aid of synthetic biology, production costs of chemicals, metabolites and food products are expected to decrease, by generating sustainable biochemical production of such resources. Also, such synthetic biological advances could be applied for medical purposes, as in pharmaceuticals and for biosensors. Recurrent, linked themes throughout the meeting were the shortage of resources, the world's transition into a bioeconomy, and how synthetic biology is helping tackle these issues through cutting-edge technologies. While there are still limitations in synthetic biology research, innovation is propelling the development of technology, the standardisation of synthetic biological tools and the use of suitable host organisms. These developments are laying a foundation to providing a future where cutting-edge research could generate potential solutions to society's pressing issues, thus incentivising a transition into a bioeconomy.

Introduction

The 3rd Applied Synthetic Biology in Europe (ASBE) Symposium was organised by the Microbial Physiology section and the Bioengineering & Bioprocessing Section (EBBS) section of the European Federation of Biotechnology (EFB). The symposium was held from the 22nd to 25th February in Costa da Caparica, Lisbon, Portugal. Following two highly successful meetings in Barcelona in 2012 and Malaga in 2013, it was clear that the European scientific community is very interested in the advances in fundamental research in synthetic biology and its applications for European biotechnology industries. This follow up meeting was truly multi-disciplinary, attracting delegates representing academia, research institutes and industry. It provided a platform to showcase the scope of applied synthetic biology in Europe and an ideal networking environment to form new collaborations across the continent.

The meeting explored a wealth of applied synthetic biology research in six sessions. These were: technology and tools for synthetic biology (I, II and III), bionanoscience, biosynthetic pathways and enzyme synthetic biology, and metabolic engineering and chemical manufacturing. All the lecturers' innovation presented at this meeting, demonstrated how synthetic biological advances from different corners of Europe could enable biotechnology to ameliorate many of society's problems. The meeting comprised 33 oral presentations and a poster flash session (5 min presentations of each of the 13 posters displayed during the meeting), including plenary lectures by Anne Osbourn (John Innes Centre, Norwich, UK), and Jussi Jäntti (VTT Technical Research Centre of Finland) and an invited lecture by Birgit Wiltschi (Austrian Centre of Industrial Biotechnology, ACIB).

Technology and tools – bioparts, cell factories and foundries

The meeting opened with the plenary lecture by Anne Osbourn. Osbourn described harnessing plant metabolic diversity, specifically focused on mining the 'Terpenome' and how the vast

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metabolic diversity found in plants is yet untapped, despite its huge potential and value for humankind. Osbourn briefly introduced the history behind the use of plant natural products and their applications as medicines, flavourings, fragrances, pigments and insecticides. Osbourn described the recent discoveries of how genes that specifically synthesise different types of natural products are organised in clusters in plant genomes, and how this discovery is opening new opportunities for systemic mining of new pathways and chemistries. Throughout her presentation, Osbourn emphasised the importance of the systematic design cycle for an iterative approach to understand, harness and optimise plant-derived small molecules for different applications through the genetic research, design, build and transform, test and learn cycle (Fig. 1).

Among the many synthetic biology technologies and tools is the use of biological devices and systems in the form of well-defined parts or 'BioParts'. With the ongoing standardisation and characterisation of these BioParts, foundries and cell factories can be designed and engineered to produce given metabolites of industrial and medical importance. Richard Kitney (CSynBI, SynBiCITE, UK) reiterated the importance of moving from an oil-based feedstock economy to a bio-based one (a bioeconomy), and how biotechnology and synthetic biology are growing and will have an expected $90 billion global market value by 2020. With the help of the different technological platforms and applications available, such as biomining, biosensors, crops and soils biotechnology, fine chemicals, synthetic biology and bioremediation, the biotechnology industry is predicted to grow rapidly. Kitney also described specific protocols to develop BioParts from data acquisition. This included going from experimental data to its analysis and finally to developing a standardised BioPart and how BioParts should be reviewed by a compliance checker such as SynBIS, a synthetic biology web-based information system with an integrated BioCAD and modelling suite for DNA assembly and characterisation for BioParts. SynBIS incorporates the new DICOM-SB standard, designed to capture all the data, metadata and protocol information associated with BioPart characterisation experiments. DICON-SB also includes services towards the automated exchange of data and information between modalities and repositories and follows the systematic design approach of design, build, test and learn cycle [1].

Staying with the topic of the tools and applications in synthetic biology used in the engineering of cell factories, Pablo Nickel (CNB-CSIC, Spain) described the platform strain *Pseudomonas putida* KT24400, and how it can be tailored for the biocatalysis of haloalkanes. The transition from planktonic and biofilm lifestyles of *P. putida* KT24400 can be controlled by external and endogenous cues yielding different triggering signals of cyclic di-GMP (c-di-GMP). By using a synthetic genetic device involved in the synthesis or degradation of c-di-GMP, the bacterium produces biofilms at the user's will. Under a tight transcriptional control, *yedQ* (encoding a diguanylate cyclase) or *yhjH* (encoding a c-di-GMP phospodiesterase) from *E. coli* endow the resulting recombinant strain with a synthetic dehalogenation operon.

Another project related to the engineering of cell factories is Cell2Fab (from cells to fabrication), a project focused on an orthologous light-inducible protein expression platform in *Saccharomyces cerevisiae*. Leading this venture is Katrin Messerschmidt (University of Potsdam, Germany). She explained how protein expression systems based on xYACs (circular yeast artificial chromosomes) could facilitate and highly regulate protein and peptide syntheses. The system consists of first assembling the expression cassettes, artificial operons and regulatory systems with AssemblX. The second part is a regulatory system composed of artificial transcription factors (TF) and their promoters, and a regulation system in the form of light-inducible protein expression, where the light-activated photoreceptor activates the TF and the target protein is expressed.

The use of synthetic microbial consortia as next-generation cell factories was the topic presented by Suvi Santala (Tampere University of Technology, Finland). A new trend in synthetic biology is an engineered microbial consortium that can provide

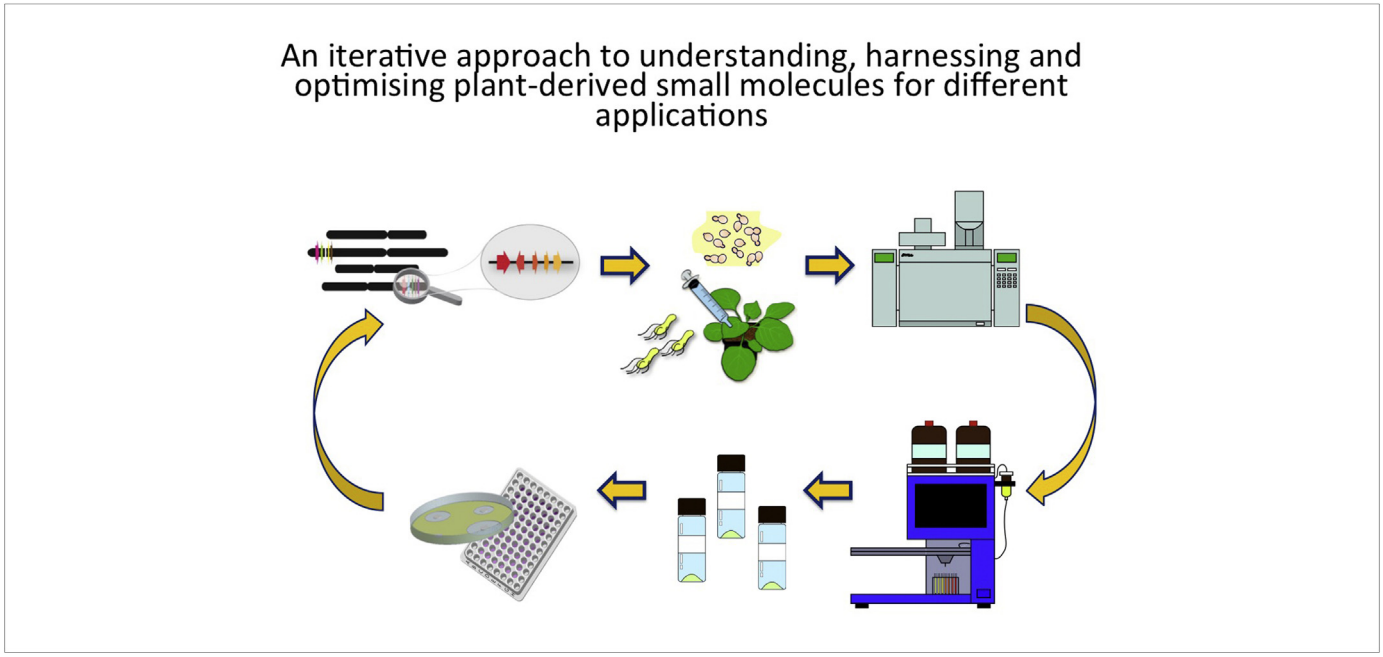

Fig. 1. Iterative approach to harness and optimise plant-derived small molecules for different applications.
Image provided by Dr Anne Osbourn.