Harnessing synthetic biology for the production of high-value chemicals

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Our ability to readily sequence complete genomes and to manipulate/re-design them on a large scale enables the design and construction of organisms with new functionalities of unprecedented scope ("synthetic biology"). We explore these possibilities in the context of high-value chemical production. Many microorganisms already have the machinery to produce diverse bioactive molecules that can be used in health, agriculture and food (Cimermancic et al., 2014). As a first step towards re-engineering these high-value chemical biosynthesis pathways for enhanced productivity and diversity, we aim to understand the interchangeability of biosynthetic parts (Diez et al., 2015) and to create orthogonal transcription mechanisms (based on signalling molecule circuits (Biarnes-Carrera et al., 2015). In addition, we are expanding our collection of computational tools for the detection and analysis of secondary metabolite biosynthesis gene clusters, to enrich our library of parts and building blocks for pathway engineering (Weber et al., 2015). We combine this analysis with high-resolution mass spectrometry analysis, which we also employ for the debugging of the engineered systems (Jankevics et al., 2012). Furthermore, we are using computational modelling (constraint-based descriptions of bacterial metabolism) to identify suitable overproduction hosts and pinpoint biosynthetic bottlenecks to target for further cellular engineering in a synthetic biology strategy (Breitling et al., 2013).

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