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Cyanobacteria as photosynthetic biofuel factories: Synthetic biology methods in the development of next-generation production platforms

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Cyanobacteria are a diverse group of photosynthetic prokaryotes which have been extensively studied for their potential as advanced biotechnological hosts for the production of different chemical compounds, namely biofuels and their precursors. The ultimate advantage of cyanobacterial production platforms would be the capacity to generate desired end-products directly from atmospheric CO₂ using sunlight as the sole energy without the need for externally supplied sugar as a substrate. Despite the pre-eminent advantages, the use of such production systems is still limited by inefficiency and low production yields, which render the applications commercially non-competitive. To overcome these barriers, our current research is focused on the development and evaluation of a versatile molecular biology toolbox using synthetic biology approaches, in order to effectively harness the photosynthetic capacity to our advantage. Collectively, we aim at developing a palette of standardized validated tools for the assembly and optimization of complex multi-gene over-expression systems in cyanobacteria, which we currently are missing. This will allow us to find, characterize and compare the most suitable genetic elements and expression strategies for our needs and consequently, to exploit our extensive fundamental understanding on the photosynthetic machinery to re-route the metabolic flux towards the target metabolites more efficiently. In our view, systematic synthetic biology approaches combined with the biosynthetic potential of photosynthetic microorganisms may contribute to the development towards sustainable bioeconomy independent of petroleum-based fuels.

Biography

Pauli Kallio has completed his PhD at the Department of Biochemistry at University of Turku, Finland (2008), studying the secondary metabolic pathways and enzyme-level determinants behind the diversity of bioactive compounds in *Streptomyces* bacteria. Currently he leads a Synthetic Biology Group in the Plant Molecular Biology Unit at the University of Turku, funded by the Finnish Funding Agency for Innovation (Tekes), with a focus on biofuel research and synthetic biology applications in photosynthetic cyanobacteria. His primary fields of expertise include molecular biology, *in vitro* enzymology and bacterial metabolic engineering.

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