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Biosensors and biocatalysis for biorefinery and bioremediation

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BIOSENSORS & BIOCATALYSIS FOR BIOREFINERY & BIOREMEDIATION

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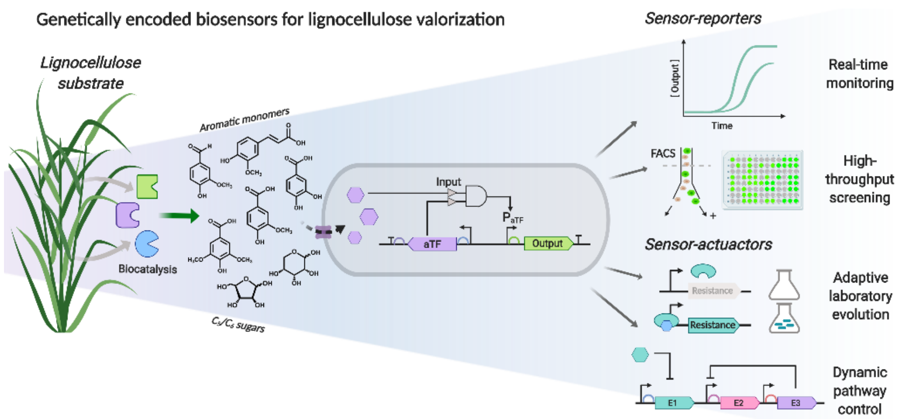
Sustainable production of fine chemicals and biofuels from renewable biomass offers a potential alternative to the continued use of finite geological oil reserves. However, in order to compete with current petrochemical refinery processes, alternative biorefinery processes must overcome significant costs and productivity barriers. Synthetic biology and metabolic engineering offer the potential to synergistically enable the development of cell factories with novel biosynthetic routes to valuable chemicals from these sustainable sources. Pathway design and optimization is however a major bottleneck due to the lack of high-throughput methods capable of screening large libraries of genetic variants and the metabolic burden associated with bioproduction. Genetically encoded biosensors can provide a solution by transducing the target metabolite concentration into detectable signals to provide high-throughput phenotypic read-outs and allow dynamic pathway regulation [1].



Here we report the development, and application whole cell biosensors, for the detection of biomass-derived aromatic chemical building blocks, supporting the use of sustainable feedstocks in the bulk and fine chemical industries [2-3]. The gene expression level of biosensor regulatory components required for optimal performance is non-intuitive and classical iterative approaches do not efficiently explore multidimensional experimental space. To overcome these challenges, we recently employed a Design of Experiments (DoE) methodology to efficiently map gene expression levels and provide biosensors with enhanced performance. This DoE methodology was applied to two biosensors that respond to catabolic breakdown products of lignin biomass, protocatechuic acid and ferulic acid [4]. Finally, we recently demonstrated the one-pot biocatalytic production of the versatile chemical building block, coniferol, for the first time, directly from lignocellulosic biomass. This system represents a consolidated biodegradation-biotransformation strategy for the production of high value fine chemicals from waste plant biomass, offering the potential to minimize environmental waste and add value to agro-industrial residues [5].

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