Project: Biorefineries: production of pharmaceutical and nutraceutical bio-products
Areas: Biotechnology/Biocatalysis
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This proposal aims at 1) engineer bacterial ligninolytic enzymes to improved thermal stability and enhanced conversion of a variety of lignin-related phenolic compounds, 2) design whole-cells multi-enzymatic systems targeted at the degradation of lignin preparations and production of valuable aromatic products with pharmaceutical and/or nutraceutical applications, 3) assessment of the biological activity of the bio-products, in particular the antimicrobial and antioxidant activities.

The **lignocelluloses biorefinery** is a promising alternative source of renewable chemicals, materials, energy and fuels for future sustainable development. In order to be economically feasible, *i.e.* capable to separate cellulose, lignin, and hemicelluloses constituents in the same way petrol refineries separate oil fractions to provide diverse fuels and chemicals, future biorefineries need to overcome the **lignocellulose recalcitrance** to degradation. (1)

This is mostly related with **lignin** molecular architecture, which relies on different non-phenolic phenylpropanoid units linked by a variety of ether and carbon-carbon bonds that form a complex, irregular and insoluble three dimensional networks. Lignin is the most abundant aromatic polymer in Earth and the second most abundant raw material next to cellulose, and a potential important source of bulk and fine-chemicals, plastics, polymers, surfactants and adhesives, among others. Furthermore, **lignin** is considered as **bio-waste** by current lignocellulose industries, being burned for energy supply. Current global market value for lignin-derived products is at ~2.8 billion €, with energy capturing about 89% of the market (2). Other markets include vanillin production (160 million €) and cement additives (150 million €). Potential market value of new lignin- based products is estimated to be about 12 billion € by 2020-2025, with lignin-based phenols and carbon fibres poised to capture the largest market potential. The development of biocatalytic processes that selectively break or rebuild lignin blocks is of the foremost importance to support the economic health of the bio-refinery vision of the XXI century.

Biocatalysis is considered a key component for the development of a sustainable bio-economy. Enzymes are sustainable, selective and efficient, and offer a variety of benefits such as cleaner reactions with lower energy requirements.(3,4) Enzymatic depolymerization of lignin into phenolic platform chemicals is envisaged as one of the potential environmentally friendly breakthrough applications for the successful **valorisation of lignin bio-wastes**.

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