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Engineering biology of yeast for the production of high-value aromatic compounds

Aromatics have a wide range of applications in food, pharmaceutical and chemical industries. Nowadays, the production of aromatics is mainly from petroleum-derived chemical process or extraction from plant resources. Microbial-derived aromatics provides an alternative renewable approach, which could be engineered, easily scalable and standardised (Peng et al. 2023 ACS Synth Biol 12(6): 1739-1749). However, the development of aromatics-producing microbial cell factories is limited by the time-consuming design-build-test-learn (DBTL) cycle, and the often complex and very long aromatics synthesis pathways. This project aims to develop advanced yeast microbial cell factories with improved production capabilities using cutting-edge synthetic biology tools and novel metabolic engineering strategies. These include advanced cloning methods such as Golden Gate and USER cloning, as well as genome editing tools like CRISPR-Cas9, genome-scale metabolic modeling (GEMs), and precision fermentation. This project will revolutionize the supply chain for aromatics by developing sustainable biosolutions that reduce dependency on non-renewable resources.

Lead Investigator: Dr Huadong Peng,

Metabolic dynamics of synthetic microbial communities

Microbial communities have attracted interest due to their wide applications in industrial processes (such as the production of biochemicals, biofuels, biomedicines and biomaterials) and their important role in human, animal and crop health. Despite the importance of microbial communities, we still know little about how communities are established and maintained, which restricts our ability to engineer them for either improving human health or industrial purposes. Our previous work has established a molecular toolkit that can build various types of synthetic yeast communities from scratch via the cross-feeding metabolic exchange (Peng et al. 2024 Nature Microbiology 9(3): 848-863.). However, the long-term stability of these communities is not known but essential for practical applications in the bioprocess of precision fermentation. This project aims to understand and control the stability of synthetic yeast communities in the long-term by combining the state of art synthetic biology tools and the open-source robotic bioreactor platform, Chi.Bio.

Lead Investigator: Dr Huadong Peng, Professor Esteban Marcellin Saldana

Engineering modular light-driven yeast biohybrid platform

Inorganic-biological hybrid systems hold the potential to become sustainable, efficient, and versatile platforms for chemical synthesis by combining the light-harvesting properties of semiconductors with the synthetic capabilities of biological cells (Science 362, 813-816, 2018). Meanwhile, yeast was reported to use light as an energy source by adding a special light-sensitive protein (Current Biology 34, 648–654, 2024). Porphyrin based metal organic frameworks are promising nanomaterials which can efficiently captures light and facilitates the transfer of photo-generated electrons into biological cells. Few studies have explored the feasibility of this biohybrid strategy for improved cell fitness and producing chemicals. This project aims to first utilize state-of-the-art synthetic biology tools to construct advanced yeast cell factories capable of utilizing light or producing high-value compounds, followed by the verification of the efficiency and modularity of a light-driven yeast-nanomaterials biohybrid system. This project is a collaboration between UQ Biosustainability hub and UQ Dow Centre.

Lead Investigator: Dr Huadong Peng, Dr Xiangkang Zeng

Contact the project advisor directly to discuss the project and arrange a meeting or AIBN Events (aibn.events@uq.edu.au) to arrange a visit to the AIBN lab.

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