Synthetic Membrane Biology in Microbial Cell Factories

Dr. Itay Budin, Assistant Professor
Department of Chemistry & Biochemistry
University of California San Diego
La Jolla, California 92093

Yeasts and bacteria can be engineered to function as cell factories for the production of next-generation biofuels and biochemicals. Like all organisms, microbial cell factories are compartmentalized by cell membranes composed of lipids and proteins. These structures are only a few nanometers thick yet play critical functions during bioproduction. Membranes serve as the molecular microenvironment for the Electron Transport Chain (ETC), which is composed of a number of protein complexes and other molecules that carry out cellular respiration to provide energy to the cell. Therefore, membranes play a key role in controlling the rate of energy-producing reactions in central metabolism. They also act as the primary chemical interfaces with the extracellular environment, regulating the transport and efflux of internally produced molecules. The overall goal of this project is to engineer the structure and properties of cell membranes to improve the performance of industrially relevant microbes. The project's first objective is to enhance the rate and efficiency of the respiratory metabolism by engineering the organization of the ETC. Engineering efforts will define the limits of respiratory metabolism and seek to increase the production of energy-intensive next generation biofuels. The second objective is to apply the emerging biochemistry of intracellular lipid trafficking pathways to develop new transporters for the capture of valuable biochemicals produced by the engineered yeasts. Soluble transporters will be developed for terpene-based substrates and be applied to develop new efflux pathways for this class of bioproducts. The planned research activities will thus harness fundamental membrane biology to develop novel biotechnologies to advance towards the development of renewable energy production systems.

This research was selected for funding by the Office of Biological and Environmental Research.
