METABOLIC ENGINEERING STRATEGIES FOR PRODUCING OLEOCHEMICALS IN BACTERIA

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Finding a sustainable alternative for today's petrochemical industry is a major challenge facing chemical engineers and society at large. To be sustainable, routes for converting carbon dioxide and light into organic compounds for use as both fuels and chemical building blocks must be identified, understood, and engineered. Advances in metabolic engineering, synthetic biology, and other bioengineering disciplines have expanded the scope of what can be produced in a living organism. As in other engineering disciplines, synthetic biologists want to apply a general understanding of science (e.g. microbiology and biochemistry) to construct complex systems from well-characterized parts (e.g. DNA and protein). Once novel synthetic biological systems (e.g. enzymes for biofuel synthesis) are constructed, they must be engineered to function inside evolving cells without negatively impacting the host's physiology.

In this talk, I will describe pathways for producing high-value commodity chemicals derived from fatty-acids and how my group and others have combined synthetic biology and systems biology to improve oleochemical production in bacteria using sustainable feedstocks. The talk will describe the critical regulatory points in native fatty acid metabolism, strategies for deregulating the pathway, and alternatives that by-pass it altogether. I will highlight the use of heterologous plant and bacterial enzymes to alter the chain length distribution of products from common long-chain molecules to higher-value medium-chain analogs. I will also highlight strategies that we have used to produce medium-chain fatty alcohols, the highest value compounds in the class, through engineering of thioesterase and thiolase driven pathways. I will conclude with commentary on the remaining barriers to commercializing these technologies and areas where further research investment could prove fruitful.