Harnessing chemistry and biology for manufacturing: from rational engineering to intelligent design

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Food, energy, drugs are all derived from chemistry and biology. With increasing world population and growing resource demand, our overexploitation of nature has led to climate changes and rapid loss of ecological diversity. Metabolic engineering and synthetic biology are enabling technologies to produce the essential chemicals and drugs we use on the daily basis. Recent achievement in chemistry and biology allows us to repurpose the genetic and biocatalytic modules inside a living cell. To meet our sustainable goals, I will present our effort to reprogram biology for manufacturing applications. This effort allows us to optimize the cellular reaction networks to produce high value chemicals and pharmaceuticals from renewable feedstocks. This effort also led us to harness genetically encoded biosensors to detect environmental pollutants and probe cellular states. Guided by intelligent design principles, I will also present our recent effort to rewire transcriptional regulation to improve and stabilize long-term cellular performance. Engineering genetic, biocatalytic and feedback control modules in living cells will present us feasible solutions to address the most pressing challenges in health, energy and environment in the 21st century.