Kristala Jones Prather is the Theodore T. Miller Associate Professor of Chemical Engineering at MIT and an investigator in the multi-institutional Synthetic Biology Engineering Research Center (SynBERC) funded by the National Science Foundation (USA). She received an S.B. degree from MIT in 1994 and Ph.D. from the University of California, Berkeley (1999), and worked 4 years in BioProcess Research and Development at the Merck Research Labs (Rahway, NJ). She is the recipient of a Camille and Henry Dreyfus Foundation New Faculty Award (2004), an Office of Naval Research Young Investigator Award (2005), a Technology Review “TR35” Young Innovator Award (2007), a National Science Foundation CAREER Award (2010), and the Biochemical Engineering Journal Young Investigator Award (2011). Prather has been recognized for excellence in teaching with the C. Michael Mohr Outstanding Faculty Award for Undergraduate Teaching in the Dept. of Chemical Engineering (2006) and the MIT School of Engineering Junior Bose Award for Excellence in Teaching (2010).

“Parts, Devices, and Chassis in Support of Metabolic Engineering”

The growing interest in a “biomass-based” economy has led to new efforts to construct and improve microorganisms capable of producing chemicals. The current focus is largely on liquid biofuels; however, a successful “biorefinery” is likely to be a mixed-product facility, with many compounds produced from one or more biomass-derived feeds. Identifying methods for the production of both novel biofuels and “value-added” compounds is both a challenge and an opportunity. The potential for biological conversion of feedstocks to bulk chemicals is enhanced by the availability of tools and techniques from the established discipline of Metabolic Engineering, which has enjoyed tremendous successes in the development of highly productive microorganisms for a variety of products of interest. We can also gain insights from Biocatalysis, where the choice of enzymes to mediate biotransformation of chemical substrates is based largely on consideration of the required functional group conversion without being limited by prior evidence of transformation of the full structure.

Our group is interested in applying principles from each of these intellectual arenas towards the design and construction of novel biosynthetic pathways for specified target compounds. This “retro-biosynthetic design” approach is aided by advancements in the development of new tools under the umbrella of Synthetic Biology that facilitate re-engineering of biological systems. Novel pathway designs for two “value-added” compounds will be presented. In the first case, we are exploring alternative biosynthetic routes towards a natural product (glucaric acid) found in fruits, vegetables, and mammals. In the second, we have developed a novel pathway towards a compound with no identified natural source, 3-hydroxy-α-butyrolactone. Considerations for the design and construction of these pathways as well as their influence on the synthesis of other value-added biochemicals will be presented.