Abstract: Living cells can be programmed to dynamically respond to their environment and selectively bio-synthesize useful biomolecules by introducing DNA that genetically encodes these instructions. The ability to predictably and rapidly re-program cells has far-reaching applications, such as sustainable manufacturing, global agriculture, and human health. Designing and building these genetic programs require algorithms to guide how they are composed from DNA parts into functional programs and technologies to accurately construct the DNA. In this talk, I will present how genetic design algorithms can be developed and implemented using massively parallel, rational engineering of multi-gene systems, and I will describe how these approaches were used to program and probe bacteria with new genetically encoded functions. First, I will discuss how bacteria were engineered with synthetic regulatory networks to compute complex logic functions as a basis for implementing control logic in cells. New design architectures were developed to improve the performance of these genetic circuits and reduce their size. Second, I will describe how we engineered dynamic memory recording in cells for storage and recall of past events. Lastly, I will present how statistical design and modeling can be used to engineer and tune gene expression of a large pathway for biological nitrogen fixation in bacterial cells. Together, these genetic design strategies can be broadly applied to engineer cells with new functions and provide a foundation for optimization of genetic programs.

Biography: Lauren Woodruff received her B.S. in Chemical Engineering from Cornell University in 2006. She obtained her Ph.D. in Chemical Engineering from the University of Colorado at Boulder in 2012. At Colorado, she worked with Professor Ryan Gill to develop technologies for targeted genome engineering and engineered bacteria to produce biofuel. She is currently a postdoctoral researcher at the Broad Institute of MIT and Harvard and Massachusetts Institute of Technology working with Dr. Robert Nicol and Professor Christopher Voigt.