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Programming Biology for Health and Sustainability

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Biology presents us with an array of design principles. From studies of both simple and more complex systems, we understand some of the fundamentals of how Nature works. We are interested in using the foundations of biology to engineer cells in a logical and predictable way to perform certain functions. By necessity, the predictable engineering of biology requires knowledge of quantitative behavior of individual cells and communities. By building and analyzing synthetic systems, we learn more about the fundamentals of biological design as well as engineer useful living devices with myriad applications. For example, we are interested in building cells that can perform specific tasks, such as remembering past events and thus acting as biological computers. Moreover, we design cells with predictable biological properties that serve as cell-based sensors, factories for generating useful commodities and improved centers for carbon fixation. We have recently engineered natural gut bacteria that can non-invasively report on the dynamics of the animal gut. In doing so, we have made new findings about how cells interact with and impact on their environment. These principles can be applied to problems of all natural environments.