Science at the Edge Seminar Series

Quantitative Biology Graduate Program/
Gene Expression in Development and Disease

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Designing Synthetic Multicellular Systems

Synthetic biology aims to engineer biological systems for practical purposes through the manipulation of gene regulation and enzymatic processes within the host. The vast majority of synthetic gene circuits have been built to operate within a single cell or isogenic colony of bacteria. However, it has been proposed that utilizing multiple strains or species of bacteria simultaneously could greatly expand the possibilities of synthetic biology. These systems, called synthetic microconsortia, more closely resemble the naturally heterogeneous environments of bacteria, such as gut microbiomes or biofilms. Here, I will describe our recent efforts to design, construct, and analyze multi-scale regulatory structures in synthetic microconsortia. This work includes 1) creating novel transcription factors and promoters that allow cells to sense and respond to complex environmental conditions; 2) engineering multiple intercellular signaling pathways to create population-level regulatory pathways; and 3) developing mathematical techniques that accurately model and predict the dynamics of gene regulation. By integrating each of these aspects, we were recently able to engineer novel, emergent behaviors in synthetic microconsortia. Specifically, we used two different bacterial quorum sensing systems to construct an "activator" strain and a "repressor" strain that respectively up- and down-regulate gene expression in both strains. When co-cultured in a microfluidic device, the two strains form coupled positive and negative feedback loops at the population-level, akin to the transcriptional feedback loops of the synthetic dual-feedback oscillator in single cells. The interacting strains exhibit robust, synchronized oscillations that are absent if either strain is cultured in isolation.

Friday, April 10, 2015 at 11:30a.m.
Room 1400 BPS

Refreshments at 11:15