Biological Design Doctoral Defense

Phage-Enabled Nanotechnology and Novel Sensing Architectures in Ribodevices

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Abstract

Two distinct aspects of synthetic biology were investigated: the development of viral structures for new methods of studying self-assembly and nanomanufacturing, and the designs of genetic controls systems based on controlling the secondary structure of nucleic acids. Viral structures have been demonstrated as building blocks for molecular self-assembly of diverse structures, but the ease with which viral genomes can be modified to create specific structures depends on the mechanisms by which the viral coat proteins self-assemble. The experiments conducted demonstrate how the mechanisms that guide bacteriophage lambda's self-assembly make it a useful and flexible platform for further research into biologically enabled self-assembly. While the viral platform investigations focus on the creation of new structures, the genetic control systems research focuses on new methods for signal interpretation in biological systems. Regulators of genetic activity that operate based on the secondary structure formation of ribonucleic acid (RNA), also known as riboswitches, are genetically compact devices for controlling protein translation. The toehold switch ribodevice can be modified to enable multiplexed logical operations with RNA inputs, requiring no additional protein transcription factors to regulate activity, but they cannot receive chemical inputs. RNA sequences generated to bind to specific chemicals, known as aptamers, can be used in riboswitches to confer genetic activity upon binding their target chemical. But attempts to use aptamers for logical operations and genetic circuits are difficult to generalize due to differences in sequence and binding strength. The experiments conducted demonstrate a ribodevice structure in which aptamers can be used semi-interchangeably to translate chemical inputs into the toehold switch paradigm, marrying the programmability and orthogonality of toehold switches with the broad sensing potential of aptamer-based ribodevices.

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Zoom Link: https://asu.zoom.us/j/86971801113