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# Communicating with and controlling biology via biofabrication, synthetic biology, and microelectronics

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***Abstract***

There is great interest in understanding complex biological environments such as the GI tract. Few methodologies, however, provide information about interkingdom or even interspecies molecular communication, especially at the length and time scales of biological relevance. 'Omics technologies are static, expensive, and report on samples that are either invasively obtained or that are end-point in nature; not *in vivo*. While living cells can be engineered to perform these tasks, their design oftentimes necessitates deletion of extraneous functions. Thus, there is also great interest in advancing biomimetic materials, i.e., in materials whose structure and/or properties are inspired by nature as a means to both interrogate and control complex environments. We have created an array of "artificial cells", built from the bottom up, to survey and interrogate complex molecular communication networks. We are developing tools of "biofabrication" that enable facile assembly of these biological components within devices, including "artificial cells", that preserve their native biological function. In addition, we are developing biofabricated systems that respond to cues that are orthogonal to living cells, including electrical cues, that enable external input and even control. For example, by recognizing that biological redox active molecules are a biological equivalent of an electron-carrying wire, we have developed biological surrogates for electronic devices, including a biological redox capacitor that enables bi-directional "electron" flow. We will introduce the concepts of molecular communication that are enabled by integrating relatively simple concepts in synthetic biology with biofabrication for interrogating and potentially controlling complex biological environments.