Microbial Engineering II Proceedings

4-5-2022

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ENGINEERING MICROBES AND BIOLOGY FOR COMMUNICATING WITH ELECTRONICS

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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 enable bi-directional “electron” flow. We have also turned to synthetic biology to provide a means to sample, interpret and report on biological information contained in molecular communications circuitry. We have based much of our work on the cell-cell molecular communication system known as bacterial quorum sensing, which mediates the phenotypic transition from single cells to a collective. That is, nearly from its discovery, we have participated in elucidating the molecular and genetic regulation of bacterial quorum sensing (QS) and have “rewired” its regulatory components so as to enable “eavesdropping” on bacterial crosstalk. We have also developed synthetic genetic circuits that enable electronic actuation of gene expression in QS and other systems. Using simple reconstructions, one can apply voltage on an electrode and directly actuate genetic responses and associated phenotypes. We have turned to information theory to help guide genetic multiplexing for maximum information transfer. We have exploited these circuits to develop systems that autonomously control subpopulations within bacterial co-cultures. This presentation will introduce the concepts of molecular communication that are enabled by integrating relatively simple concepts in synthetic biology with biofabrication. Our presentation will show how engineered cells represent a versatile means for mediating the molecular “signatures” commonly found in complex environments, or in other words, they are conveyors of molecular communication.