BIO ⇔ ELECTRONIC INFORMATION PROCESSING: AN EMERGING TECHNOLOGY FOR BIOMANUFACTURING

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Microelectronics has transformed our lives. It has changed the way we collect, process, and transmit information. The intersection between microelectronics and biology has also been transformative – ionic currents that control cardiovascular and neural systems are detected and even corrected using electronics (e.g., EKG & defibrillators). Yet, the microelectronics world has barely "sampled" the vast repertoire of chemical information in our biological world. In biology, information is often contained in the *structure of its molecules* – molecules that move from place to place and based on their structure, convey information and provoke a response.

We envision new processes and deployable products that open the dialogue between biology and microelectronics – that eavesdrop on and manipulate biological systems within their own settings and in ways that speed corrective actions. An area of intense interest is in the manufacture of biological products, including monoclonal antibodies (mAbs). Here, cells dynamically respond to their microenvironments, secreting mAbs, that in turn are subject to stressors and modifiers that alter their structure and function. We are developing tools that interrogate the molecular dialogue within cells, among cells and proteins, and between these biological systems and microelectronics. We focus on redox processes, where electron exchange informs on the state of biological systems and can be probed with simple microdevices. We have developed a suite of methodologies that reveal, for example, the oxidation state of mAbs – are important methionine residues oxidized? Are disulfides reduced? Can we interrogate these states quickly and accurately, so as to take corrective action? In this talk, innovative materials, electronics, biomolecular and cellular engineering strategies are developed to mediate "molecular" communication - information transfer to microelectronic systems and back. New systems and devices are continually emerging that integrate abiotic and biological components at a hierarchy of length scales. We expect that a product's quality attributes as well as the manufacturing processes leading to these products will benefit by newly opened lines of communication between the biological systems and the devices in which they are operated and controlled.