ACCOUNTS of chemical research

Editorial

Cite This: Acc. Chem. Res. 2018, 51, 987−987

pubs.acs.org/accounts

Creating Functional Interfaces with Biological Circuits

Guest Editorial for the Accounts of Chemical Research special issue on "The Interface of Biology with Nanoscience and Electronics".

Biological circuits governing the behavior of individual cells, organs, or entire organisms perceive and generate a diversity of chemical, electrical, mechanical, thermal, and optical stimuli. The ability to communicate across a multitude of modalities relies on the elaborate nanoscale machinery of biomolecules and their complexes. This issue of *Accounts of Chemical Research* discusses the recent advances in nanoscience and electronics enabling intimate interfaces with biological circuits at scales ranging from individual proteins to organs such as the brain.

To interact with the complexity of biological signaling cascades, materials and devices must operate at micro- and nano- spatial scales, comparable to those of cells, subcellular compartments, and individual proteins. While state-of-the-art nanofabrication readily delivers electronic components with dimensions comparable to biomolecules (in 2018, a transistor gate is <10 nm), this exquisite precision is confronted with structural variability, chemical diversity, and continuous reorganization characteristic of biological circuits. Unlike the traditional wafer-bound electronics, which are largely flat, rigid, and brittle, biological circuits are three-dimensional, soft, and viscoelastic, posing challenges to direct electrical sensing and actuation of cell function. The genetically encoded optical tools to manipulate and record cellular activity, such as microbial rhodopsins and fluorescent protein-based ion indicators, have to some extent enabled contactless interfaces with biological circuits. These optical techniques, however, rely largely on delivering and receiving photons in the visible part of the electromagnetic spectrum, where biological matter exhibits significant scattering and absorption. Hence optical probing of biological processes deep within the body demands implantable conduits, which, similarly to electronics, are subject to the mechanical and chemical compatibility constraints within the biological environment.

This issue presents a collection of recent advances from a diversity of fields ranging from nanofabrication and magnetism to photonics and colloidal synthesis jointly aimed at addressing electrical, mechanical, optical, and chemical challenges posed by biological matter to enable interrogation of biological signaling across scales. The approaches presented here range from leveraging signaling modalities that offer minimal coupling to biological matter, such as magnetic fields and near-infrared light, to remotely delivering stimuli deep into the tissue to developing soft and even transient electronic and optical devices that minimize impact on the surrounding cells. The progress in delivery and receipt of stimuli is in stride with the development of novel electrical, optical, and magnetic transducers to act as interpreters between the external signals and the targeted biological circuits. Finally, the engineering of biointerface tools is intimately coupled with advancing the basic study of cell signaling and the biophysical mechanisms that are inadvertently triggered by the interactions of tissues, cells, and molecules with the synthetic transducers and external fields. Fundamental understanding of these mechanisms may inform the design of interfaces that cause minimal disruption to the biological circuits they are intended to probe or control.

The seemingly disparate fields of electronics, nanoscience, and biology are brought together in this special issue by the underlying chemical principles that govern not only the synthesis of materials comprising sensors and actuators of protein, cell, and tissue function but also the formation of physical interfaces between the synthetic and the biological.

Polina Anikeeva
Massachusetts Institute of Technology
Charles M. Lieber
Harvard University
Jinwoo Cheon
Yonsei University

AUTHOR INFORMATION

ORCID

Polina Anikeeva: 0000-0001-6495-5197
Charles M. Lieber: 0000-0002-6660-2456
Jinwoo Cheon: 0000-0001-8948-5929

Notes

Views expressed in this editorial are those of the authors and not necessarily the views of the ACS.

Published: May 15, 2018

DOI: 10.1021/acs.accounts.8b00167
Acc. Chem. Res. 2018, 51, 987−987