Leveraging Bioelectronics and Synthetic Biology to Achieve Implantable, Biohybrid, and Regulated Cell Therapies

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Abstract
The union of bioelectronics with engineered mammalian cells is a transformative opportunity in regulated, personalized therapeutics. This approach involves combining the strengths of synthetic biology – namely biological specificity that leverages the natural machinery of cells – with bioelectronic systems, which offer precision timing, dose control, and communication with established sensing technologies and clinical feedback. To this end, we show how implanted biohybrid devices rely on bioelectronics to initiate the production of native peptides, control therapeutic dose, and support the health and productivity of these "cell factories". We demonstrate optogenetic induction of drug production, fluorescence feedback via photometry to probe cell factory viability, and on-site electrocatalytic oxygenation for maintenance of implanted cell health at high cell density. Current efforts focus on regulation of circadian rhythms; however, the biohybrid cell therapy concept can be broadly applied to chronic diseases including Type I diabetes, obesity, and cancer immunotherapies.

Short Biography
Jonathan Rivnay is a Professor of Biomedical Engineering and Materials Science & Engineering at Northwestern University. Jonathan earned his BSc in 2006 from Cornell University. He then moved to Stanford University, where he earned a MSc and PhD in Materials Science and Engineering, studying the structure and electronic transport properties of organic electronic materials. In 2012, he joined the Department of Bioelectronics at the Ecole des Mines de Saint-Etienne in France as a Marie Curie postdoctoral fellow, working on conducting polymer-based devices for bioelectronics. Jonathan spent 2015-2016 as a member of the research staff in the Printed Electronics group at the Palo Alto Research Center (PARC, a Xerox Co.) before joining the faculty at Northwestern in 2017. He is a recipient of a Faculty Early Career Development (CAREER) award from the National Science Foundation (2018), a research fellowship from the Alfred P. Sloan Foundation (2019) and was named a Materials Research Society Outstanding Early Career Investigator (2020).