UC Irvine Samueli
Department of Chemical and Biomolecular Engineering

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Physical Biology Strategies for Translational Bioelectrical Interfaces

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Abstract: The field of electronic and photonic biointerfaces is experiencing transformative advancements, propelled by physical biology approaches that integrate the core principles of materials science, biophysics, and physical chemistry. This interdisciplinary synergy has enabled the creation of multifunctional, and even living, bioelectronic systems, laying the groundwork for next-generation technologies in sensing, modulation, and regenerative medicine. Our research emphasizes non-genetic strategies for biological modulation and sensing, harnessing physical principles across molecular, cellular, and tissue scales. This presentation will highlight key milestones from our recent work, emphasizing translational applications enabled by physical biology. Among our advances, we have developed optoelectronic systems for photostimulation in clinical contexts, including nanoporous/non-porous heterojunctions that provide unparalleled precision and control in bioelectronic therapies. These designs are informed by rigorous understanding of charge transport, light-matter interactions, and the mechanics of biointerfaces. Another cornerstone of our efforts is the integration of living cells with wearable bioelectronic systems, achieved through insights into dynamic interface formation and bioelectrical signaling. This living bioelectronics paradigm seeks to create seamless, biocompatible interfaces that mimic and enhance natural biological processes, offering transformative potential in personalized healthcare and regenerative medicine. Looking ahead, I will outline our research agenda, which focuses on expanding the functional range of bioelectronic modulation and sensing through the lens of physical biology. By bridging the gap between synthetic materials and living systems, our vision is to translate these innovations into impactful clinical applications, advancing bioelectronic therapies to improve human health and well-being.

Bio: Dr. Bozhi Tian earned his Ph.D. in Physical Chemistry from Harvard University and completed postdoctoral research in regenerative medicine at the Massachusetts Institute of Technology. At the University of Chicago, his research focuses on developing new materials for bioelectronics, employing semiconductor- and electronics-based tools to investigate (sub-)cellular dynamics and soft-hard interface interactions, and the translational applications of diverse bioelectrical systems. Dr. Tian's work has been recognized with several honors, including the Raymond and Beverly Sackler International Prize in the Physical Sciences, the Presidential Early Career Award for Scientists and Engineers (PECASE), recognition as an MIT Technology Review Innovator Under 35 (TR35) in 2012, and the 2023 Faculty Award for Excellence in Graduate Teaching and Mentoring from the University of Chicago.

Hosted by: *Prof. Herdeline Ardoña*