Ion Channel Circuits-on-a-Chip: A Bioelectronic Platform to Measure Transmembrane Protein Activity

Professor Susan Daniel, Chemical and Biomolecular Engineering, Cornell University, USA

Despite advancements in transmembrane protein (TMP) structural biology and a growing interest in their applications, this class of proteins remains challenging to study. Progress has been hindered by the complex nature of TMPs and innovative methods are required to circumvent significant technical hurdles such as expression, purification, and reconstitution. We offer two new approaches that facilitate the study of the activity of ion channel proteins based on a bioelectronic biomembrane platform we developed. First, we harvest materials from plasma cell membranes that contain the ion channel of interest and coat our electrodes with these "cellular biopsies." Second, we use cell-free protein synthesis using reconstituted components of the cellular transcription and translation machinery *in vitro* for integrating TMPs directly into a membrane coating the electrode. In this talk, I will highlight both approaches for functionalizing electrodes with biological materials and measuring their activity. The bioelectronic biomembrane platform used in these studies is made possible by using a biocompatible conducting polymer film that supports a lipid bilayer. Specifically, PEDOT:PSS films on electrodes, which are both transparent and electrically conductive, allow the assessment of protein activity by optical and electrical means. Here, fluorescence microscopy and electrochemical impedance spectroscopy (EIS) are used to characterize the ion channels in these devices. Examples of activity measurements from the human, plant, and bacteria world will be given with implications in health, agriculture, and sensing.