CUA engineer offers microfluidic platform to tackle notorious obstacle in biology and pharmaceutics

The cell is the basic unit of all living organism that can replicate independently. Natural cell membranes that separate the interior of all cells from the outside environment are composed of (1) a thin lipid bilayer (LB) that forms a continuous barrier around the cell, and (2) abundant membrane proteins that are the main targets of fundamental research and pharmaceutical drugs. As such, model LBs have been the crucial platform to study transport and signaling processes of membrane proteins and to screen and discover novel drugs. However, current model LBs suffer from notorious limitations including (1) short LB lifetime, (2) fluidic and/or electrical inaccessibility to both sides of the membranes, and (3) lack of the rich constituents of natural cell membrane. Addressing these limitations of model LB systems should significantly expedite both fundamental biological studies and pharmaceutical drug screenings.

Assistant professor Dr. Xiaolong Luo in the School of Engineering at CUA proposes a novel engineering solution to tackle this notorious obstacle in biological study and pharmaceutical development. The novel platform has recently been recognized by a prestigious NSF CAREER award (titled "CAREER: Highly stable lipid bilayers on freestanding cytoskeleton-like membrane", with the total amount of $504, 671 for the period June 1, 2016 through May 31, 2021) to develop a highly stable lipid bilayers (HSLB) system in microfluidic networks. Dr. Luo proposes to fabricate LB on a freestanding, semi-permeable and mechanically robust biopolymer membrane, the first time such a configuration being pursued. The work will assess the hypothesis that the supporting membrane can serve as a model cytoskeleton layer for the lipid bilayer with high stability that presents in natural cell membranes. The fabricated HSLB will be characterized and compared with current model LBs, applied to study ion channel activities and the virus-cell membrane fusion process, and scaled up for other research and industrial users. Compared to current suspended and supported LBs, the developed HSLB system will provide long-term stability, better replication of cell membranes and ease of scaling-up, as well as enabling simultaneous fluidic, electrical and optical measurements and manipulations.

When fully established, the HSLB platform can be a game-changer for studying fundamental membrane biology and identifying membrane-associated novel drug targets, which are limited by current model LB systems. For CUA community, the research will provide training opportunities for graduate, undergraduate and high school student to learn and perform research in an interdisciplinary setting. For broader impact, this research will be of interest to bioengineers developing microfluidic and Lab-on-a-Chip devices, scientists studying biopolymer materials and membrane protein activities, industrial researchers investigating drug targets and high throughput screening, and educators at large in teaching biomaterials and biomicrosystems.