CHEMICAL & BIOMOLECULAR ENGINEERING

SEMINAR SERIES

UNIVERSITY OF DELAWARE

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SEP 27
10:00 - 11:00 AM
COLBURN LAB
ROOM 102

RED BLOOD CELL MEMBRANE ARCHITECTURE, SHAPE AND BIOMECHANICS: FROM THE MICRO- TO NANOSCALE

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ABSTRACT

The biconcave disk shape and deformability of the mammalian red blood cell (RBC) is vital for its circulatory function and relies upon a specialized cytoskeletal structure called the membrane skeleton. This membrane skeleton consists of a two-dimensional, viscoelastic network of membrane-associated actin filaments (F-actin) interconnected with long, flexible spectrin molecules. Previous models have proposed that elastic network properties together with network linkages to transmembrane proteins are sufficient to explain RBC shapes. Recently, we discovered that RBC biconcave shape depends on the contractile activity of non-muscle myosin IIA (NMIIA) using super-resolution microscopy, biochemistry and biophysical assays. The NMIIA molecules assemble into bipolar filaments with actin filament (F-actin) binding motor domains at their ends that exert forces on the membrane skeleton F-actin to control RBC biconcave disk shape and deformability. Inhibition of NMIIA leads to reduced filament association with the membrane, enhanced local nanoscale membrane oscillations, micron-scale relaxation of the dimple and elongated shapes, and enhanced deformability. We are collaborating with computational biologists to examine the locations of contractile forces and their interplay with membrane tension in determining RBC biconcave shape. We propose that the mechanisms by which NMIIA contractility regulates membrane stiffness to control RBC shape and deformability may apply to control of micron-scale membrane curvature by spectrin-based membrane skeleton networks in other metazoan cell types.

BIOGRAPHY

Velia M. Fowler joined the University of Delaware as Professor and Chair of Department of Biological Sciences in January 2019. She received a B.A. from Oberlin College in 1974, a Ph.D. from Harvard University in 1980 and was a Jane Coffin Childs Postdoctoral Fellow at the NIH and Johns Hopkins University School of Medicine. She joined the Scripps Research Institute in 1987 and was promoted to Professor in 2000. Her research program broadly investigates how actin filament dynamics and myosin contractility provide stability and exert forces to shape membrane curvature and influence cell and tissue biomechanics and physiology across a wide range of cells and tissues, including red blood cells, striated muscle, and the eye lens. She has published 130 research papers, chapters and reviews, mentoring over 25 graduate students and postdoctoral fellows. Her research has been funded by investigator-initiated research grants from the NIH for over 30 years.