Physics Colloquium, University of South Florida
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☞☞*Refreshment available* ☜☜

Exploring biomembrane lipid domain formation in artificial lipid vesicles and cells

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We proposed in 1994 that specialized domains in cell membranes form due to segregation of lipids into membrane domains with two different physical states: sphingolipid-cholesterol-rich liquid ordered (Lo) domains (now called “lipid rafts”) and unsaturated lipid rich liquid disordered (Ld) domains. These domains have been studied in artificial lipid vesicles and cells. However, artificial lipid vesicles are typically symmetric, composed of lipid bilayers with the same lipid composition in the inner leaflet (monolayer) and outer leaflet. In contrast, cell membranes are often asymmetric, with different lipids in the inner leaflet (monolayer) (leaflet) of the bilayer are often different from those in the outer leaflet of the bilayer. To investigate the effect of lipid asymmetry upon the formation of membrane domains required developing a method to prepare artificial membranes with different lipids in each layer. Our lab developed a method to achieve this via cyclodextrin-catalyzed lipid exchange. Using spectroscopy and microscopy our lab has now found that in some types of asymmetric vesicles Lo domains in the outer leaflet induce Lo domains to form in the inner leaflet, even when inner leaflet lipids would not spontaneously form such domains. With other lipid compositons, asymmetric vesicles can be prepared in which inner leaflet lipids that do not form Lo lipid domains prevent the formation of Lo domains in outer leaflets composed of lipids that by themselves would form Lo domains. This shows the physical state of the inner and outer leaflet lipids can be strongly coupled to one another, and that the consequences of this depend on lipid composition. This represents a new physical mechanism by which information can be transferred across a biomenbrane. Recently, the lab begun to extend studies to living cells, by extending the lipid exchange approach to efficiently replace the natural lipids in the outer leaflet of living mammalian cells with exogenous lipids. This has great potential for both investigations of membrane domain formation in natural membranes and studies of how lipid composition influences the function of membrane proteins.

Dr. Erwin London is a Distinguished Professor in the Department of Biochemistry and Cell Biology at Stony Brook University. He received his Ph.D. in Biochemistry at Cornell University in 1980. Dr. London has received many recognizable honors and awards, including 2014 Schroepfer Medal for advances in steroid or sterol field, American Oil Chemists Society; elected Fellow of the American Association for the Advancement of Science (AAAS) 2014; appointed SUNY Distinguished Professor 2014. Dr. London is a former and current recipient of multiple research grants from NIH and NSF. His research centers on biochemical and biophysical studies of membrane structure and function. A few examples are function of cholesterol in cells, characterization and regulation of membrane insertion by bacterial protein toxins, determination of rules for membrane protein folding, and development and application of fluorescence quenching approaches.