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Toxic Effects of Biofuel Molecules on Membrane Domains as an Unrecognized Mode of Cell Stress

Solvent toxicity represents an upper limit on fermentation titer and yield. This co-solvent induced stress occurs as amphiphilic co-solvent molecules partition into membrane, leading to membrane thinning, destabilization, and ultimately cell death. However, such stress does not fully account for the effect on the lateral membrane organization. In this study, we utilized small angle neutron scattering and molecular dynamics simulations to investigate the effect of n-butanol on transverse and lateral membrane structure. N-butanol is an important biofuel and biobased chemical precursor which can be produced through fermentation. Our studies demonstrated the extent of n-butanol partitioning, solvent induced membrane thinning, and solvent induced changes to the size of membrane domains. Parallel simulations proved a clear mechanism connecting membrane transverse structure, solvent partitioning and changes to line tension at the membrane domain boundaries. As the line tension increases, membrane domains appear to coalesce into fewer, larger domains to minimize the interfacial length –if one assumes constant domain area. We also observe significant structural disorder at the domain interface. Both observations represent unrecognized modes of membrane / solvent associated cell stress which may represent new directions to improve microbial solvent tolerance.

Topical Area

Biology and life sciences

Authors: TAN, Luoxi; NICKELS, Jonathan (University of Cincinnati)

Co-authors: Prof. SMITH, Micholas Dean; PINGALI, Sai Venkatesh; O'NEILL, Hugh (Oak Ridge National Laboratory); KATSARAS, John; Prof. SMITH, Jeremy C.; Dr DAVISON, Brian H.

Presenter: TAN, Luoxi