Unraveling Supported Lipid Bilayer Formation Kinetics

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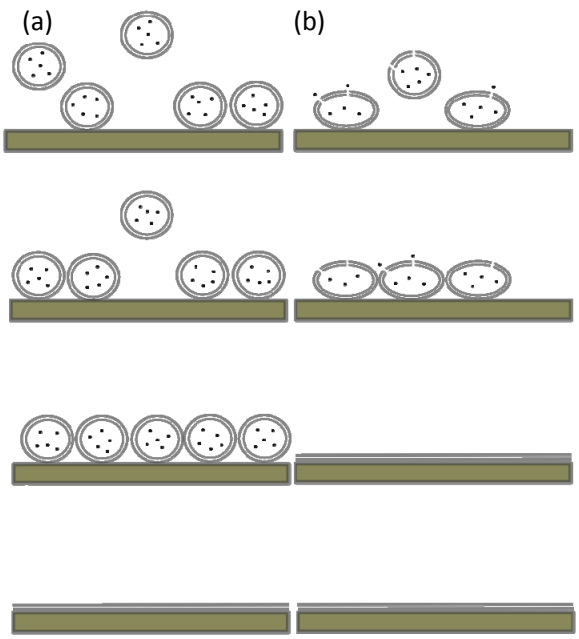
Supported lipid bilayers (SLBs) are widely used as cell membrane models and they are the basis of biomimetic and biosensor platforms. Although it is known that SLB formation results from the rupture of the adsorbed liposomes, the rupture pathway followed by the liposomes remains unclear. We examine the effect of solute permeability on the kinetics of this process by quartz crystal microbalance (QCM) and find that permeable solute glycerol speeds up SLB formation, while the impermeable solute sucrose has a limited effect on the SLB formation rate. To confirm that permeability is indeed the deciding factor, we used melittin to make pores in the lipid bilayer. SLB formation rate was enhanced by melittin but was once again diminished when liposomes contained dextrans too large to pass through the pores. To explain these observations, we propose that permeable liposomes are able to deform to a greater extent. This increases the probability of interaction between the neighboring liposomes and enhances the SLB formation rate.



Scheme: (a): Non-permeable liposomes, e.g., containing sucrose or dextran, and (b), permeable liposomes, either containing pores in the bilayer or a permeable solute, such as glycerol. Liposome deformation entails a volume change, which causes an osmotic pressure difference. This limits the deformation of non-permeable liposomes, but permeable liposomes can deform to a greater extent. Deformed liposomes occupy a larger area. This effect will in itself enhance the bilayer formation rate, but additional enhancement may arise from reduced stability of liposomes that are more deformed.