Reshaping of membranes by septins

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Septins are cytoskeletal proteins that assemble into a variety of supramolecular organizations from paired filaments to bundles, ring like structures or gauzes of orthogonal filaments [1,2]. Septins are bound to the inner plasma membrane through specific interactions with phosphoinositides [3]. Septins are essential for cytokinesis, participate in the formation of diffusion barrier and might be involved in membrane deformation and rigidity.

We have used complementary in vitro tools to analyze in details the septin-membrane interactions from cryo-electron microscopy to Atomic Force Microscopy or a variety of quantitative biophysical assays.

Septins are able to deform GUVs strongly by inducing spikes and tubules a few µm apart. Those giant vesicles are more rigid than naked liposomes. Besides the curvature sensitivity of Septin filaments using patterned PDMS substrates at a given periodic wavelength is assessed. By SEM we have been able to show that the organization of septins is strongly dependent on the curvature. Septin filaments tend to avoid strong positive curvatures while they polymerize along negative 2 μm^{-1} curvatures. Hence the visualized deformations of liposomes are closely related to the curvature preference of the Septin filaments.

Using LUVs (100-300 nm in diameter), we have visualized, in three dimensions by cryo-tomography, the possible deformations that septins induce to small vesicles. We observe a flattening of the vesicles from round shaped to a “pancake” shape and the formation of protusions. With the resolution of cryo-EM we visualize both the septin filaments and the deformed vesicles. Besides, on supported lipid bilayers, septins induce a dramatic reorganization and deformation of the bilayers as visualized by Atomic Force Microscopy.

References

[1] - A. Bertin, , M. McMurray, L. Thai , G. Garcia, V. Votin, P. Grob, T. Allyn, J. Thorner, E. Nogales (2010), Phosphatydinositol 4,5 biphosphate promotes budding yeast septin filament assembly and organization, J. Mol. Biol., 404(4), 711-31.
[2] - G. Garcia, A. Bertin, Z. Yi, Y. Song, M. McMurray, S. Gradia, A. Hartland, J, Thorner, E. Nogales (2011), The regulatory budding yeast septin Shs1 promotes ring and gauze formation in a phosphorylation dependent manner., J. Cell. Biol., 195(6), 993-1004.
[3] - A. Bertin, P. Grob, M. McMurray, G. Garcia, S. Park, H. Ng, T. Alber, J. Thorner, E. Nogales (2008), Saccharomyces Cerevisiae septins: supramolecular organization of heterooligomers and the mechanism of filament assembly, Proc.Natl. Acac. Sci USA, 105, 8274-8279.