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Shaping fluid lipid membranes with proteins and biological filaments

Cell membranes are highly deformable surfaces and have to be strongly curved to a few tens of nanometers, for instance during exchanges when small buds or tubules form and eventually detach from cell membranes, or during cell migration upon the formation of actin-sustained cellular protrusions (filopodia). These membrane-shaping processes always require the interaction with proteins (for instance, proteins with an intrinsically-curved shape) and in some cases with biological polymers (actin cytoskeleton). In vitro membrane nanotube pulling assays where membranes with controlled curvature are formed, combined to theoretical models have been instrumental for understanding how proteins and cytoskeleton shape cellular membranes, and conversely how membrane curvature is a cue for the local enrichment of peripheral or trans-membrane proteins with non-symmetric shape. Similarly, they help understanding how non-curvature sensing proteins are recruited on curved membranes. In this lecture, I will discuss examples of proteins with intrinsically-curved shapes that are enriched in curved membranes, how they assist the recruitment of non-curvature sensing proteins, or induce filopodia generation, due to their intrinsic coupling to membrane curvature.