Ciclo di incontri – Tavolo di discussione

INTERACTIONS BETWEEN SYNTHETIC NANOPARTICLES AND MODEL BIOLOGICAL MEMBRANES

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Synthetic nanoparticles (NP) play important roles in pharmaceutical and medical technology as diagnostic or therapeutic devices. Metal NPs, in particular, can nowadays be engineered in a multitude of shapes, sizes, compositions, and surface functionalizations. Despite such technological advances, there is still a poor understanding of the molecular processes that drive the interactions of metal NPs with cells. Cell membranes are the first barrier encountered by NPs entering living organisms. The comprehension and control of the interaction of nanoparticles with biological membranes are therefore of paramount importance to understanding the molecular basis of the NP biological effects.

In this talk, I will focus on Au nanoparticles functionalized by a shell of amphiphilic ligands [1]. These nanoparticles have a stable interaction with lipid bilayers: they affect membrane curvature [2], cause liposome-liposome aggregation, alter the membrane lateral phase separation [3], and spontaneously form large, ordered NP assemblies [4]. We show that the unexpected aggregation of same-charge NPs is both ion-mediated and membrane-mediated. The understanding of NP self-assembly in the membrane environment is especially relevant, as the aggregation of cell membrane inclusions drives fundamental cell functions, such as signaling and transport. In this perspective, it is interesting to wonder if NPs can be considered as protein toy models, and what we can learn by comparing their self-assembly behavior in the membrane environment.

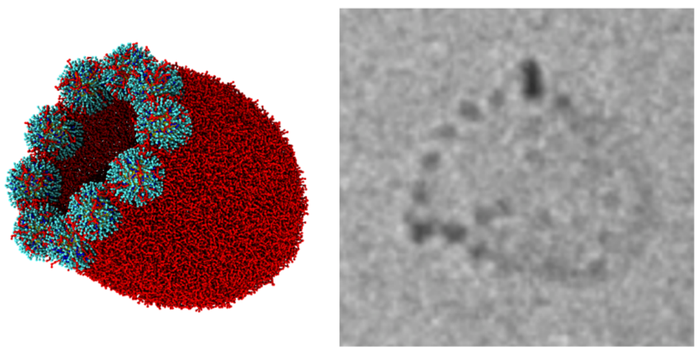

Fig. 1: Amphiphilic AuNPs favorably adsorb at regions of large positive curvature of the lipid bilayer. Here, they seal the edge of a jellyfish liposome [2], in simulations and in a cryo-EM sample.

References:
[1] Pengo, P., et al. “Gold nanoparticles with patterned surface monolayers for nanomedicine: current perspectives.” Eur Biophys J 46, 749–771 (2017).
[2] Lavagna, E., et al. "Amphiphilic nanoparticles generate curvature in lipid membranes and shape liposome–liposome interfaces." Nanoscale 13.40 (2021): 16879-16884.
[3] Canepa, Ester, et al. "Amphiphilic gold nanoparticles perturb phase separation in multidomain lipid membranes." Nanoscale 12.38 (2020): 19746-19759.
[4] Lavagna, Enrico, et al. "Ions and lipids drive aggregation of surface-functionalized gold nanoparticles on lipid membranes." bioRxiv (2021).

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