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Inorganic nanoparticles challenging lamellar and non-lamellar lipid membranes: the role of curvature in nano-bio interactions

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The interaction of engineered nanomaterials with living systems is mediated by biological barriers, determining their biological fate and cytotoxicity. Understanding the interaction of nanoparticles (NPs) with biological interfaces is the key to fill the gap between NPs development and end-use application. Lipid-based synthetic membranes can be used to mimic natural interfaces under simplified conditions, in order to identify key determinants in nano-bio interactions. While most of investigations so far focused on lamellar models, far less attention is given to curved-bilayer structures, ubiquitous in cells under certain conditions. Here, we address the interaction of inorganic NPs with biomimetic bilayers of lamellar and non-lamellar nature, i.e. flat membranes to cubic architectures encountered in diseased cells. With a library of gold NPs, we explore the effect of NPs shape and surface coating as a function of membrane curvature. Through an ensemble of structural techniques (SAXS, GISANS and Neutron Reflectivity), we found that highly curved membranes are associated with an enhanced structural stability towards NPs. Moreover, Confocal Laser Scanning Microscopy analysis highlights that cubic and lamellar phases interact with NPs according to two distinct mechanisms. These results are the first attempt to systematically study the role of membrane curvature in the interaction with NPs, disclosing new perspectives on the understanding and application of Nano-bio Interfaces.

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