Biomimetic bilayers designed for nanoparticles-membrane interactions and proteins transport studies

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Biological membranes carry out the essential function of a natural barrier that separates the cell from the outside environment. To study, in controlled conditions, the biological events occurring at the cell membrane interface, we recently develop biomimetic devices based on supported biomembranes.
A solid supported biomimetic membrane was developed to study *in vitro* the translocation process of a bacterial toxin, the adenylate cyclase (CyaA) from *Bordetella pertussis*. The membrane was assembled over a calmodulin (CaM) layer and exhibits the fundamental characteristics of a biological membrane separating two *cis* and *trans* compartments. The activation of the catalytic activity of CyaA by the tethered CaM was used as a probe of its translocation across the bilayer. This work constitutes the first *in vitro* demonstration of protein translocation across a tethered lipid bilayer.
Biomimetic assemblies are also important tools for the study of the interaction of mesoporous silica nanoparticles (MSN) with membranes. We have developed synthetic routes to achieve the production of gold loaded radial mesoporous silica nanoparticles (Au-MsNP) and MSN@Fe_3O_4 materials incorporating magnetic and fluorescent properties as multifunctional platforms. The size of particles was checked by dynamic light scattering while zeta potential measurements reflect their surface charge. The particles morphology was characterized by transmission and scanning electron microscopies. Their textural properties, specific surface area and pore size, were determined from N2 adsorption.
The gold metallic nanoparticles embedded in the pore channels of Au-MsNP are responsible for a plasmonic activity. The coating with phospholipid bilayers of Au-MsNP particles provided a biofunctional device with plasmonic properties relevant for biosensing. For this purpose different model systems have been investigated, direct adsorption of bovine serum albumin or molecular recognition events between a biotin receptor, integrated in the supported lipid bilayer, and avidin molecules. The obtained results demonstrate the plasmonic sensitivity of the bare Au-MsNP particles or coated lipid bilayer Au-MsNP devices.
We investigate MSN@Fe_3O_4 cell membrane interactions depending on nanoparticle surface coverage, to study MSN@Fe_3O_4 behavior in biological fluids. The dispersibility of MSN@Fe_3O_4 materials (pristine, lipid or polyethylene glycol coated) was largely dependent on medium composition and nanoparticle coating. A biomimetic membrane model was used to investigate MSN@Fe_3O_4 – cell membrane interactions. The presence of a -80mV transmembrane potential applied in *trans* side seems to increase MSN@Fe_3O_4 interaction with the membrane. Dispersion media, MSN@Fe_3O_4 coating and transmembrane potential appeared as major factors influencing MSN cell membrane interactions.

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