INTEGRATING LIPID SCAFFOLDS AND INORGANIC NANOPARTICLES TO DEVELOP HYBRID FUNCTIONAL MATERIALS FOR NANOMEDICINE

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Combining inorganic nanoparticles with soft lipid scaffolds offers a promising approach to develop functional materials by merging the unique properties of inorganic nanoparticles with the biocompatibility and structural tunability of lipid self-assembly. Numerous examples of lipid-nanoparticle hybrids have emerged over the last decades, including magnetoliposomes and, more recently, lipid-coated nanoparticles. In this context, leveraging non-specific interactions at nano-bio interfaces offers a simple and effective strategy to achieve biocompatible, functional hybrid materials with controlled structural properties and responsivity, *via* spontaneous self-assembly.

This lecture explores different classes of hybrid systems where functional nanoparticles (magnetic, plasmonic, or magnetoplasmonic) spontaneously associate with lipid structures. By strategically leveraging lipid/nanoparticle interfacial interactions, such as ligand exchange or hydrophobic effects, it is possible to finely tune the structural, morphological, colloidal, and functional characteristics of the hybrids. This method enables building-up hybrid systems with a broad spectrum of biomedical applications, including: (i) non-lamellar lipid scaffolds incorporating hydrophobic superparamagnetic iron oxide nanoparticles (SPIONs) for controlled drug delivery; (ii) lipid vesicles covered by gold nanoparticles clusters with enhanced plasmonic properties, suited for biosensing and Raman imaging; (iii) ternary systems of magnetite and core-shell gold/magnetite nanoparticles integrated with lipid vesicles, offering combined magnetic and plasmonic properties for theranostics applications.

Key words: *Lipid membrane, vesicles, Cubosomes SPIONs, Gold Nanoparticles, Self-Assembly*

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