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The chemistry-biology interplay emerging form molecule-coated nanoparticles

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Most of the nanoparticles studied for biomedical applications feature a complex structure, where different topological portions are designed to perform specific functions, as providing stability against aggregation, stealth properties, targeting, accumulate the payload or even perform direct theranostic activity.
The realization of systems of such complexity is greatly eased by the use of self-organization based synthetic protocols. The mechanism of most of these protocols can be considered as the controlled formation of surfactant stabilized aggregates, possibly completed by a core polymerization (Figure 1). In this lecture, we will examine in particular the cases of polymer-coated silica and poly(lipoic acid) nanoparticles.
The main advantage of these synthetic protocols is that, by taking advantage of the different solvophobic and solvophilc properties, the different nanoparticle precursor can be precisely placed in the site they are desired to be. As an example, water insoluble molecules (dyes, photosensitizers or drugs) locate themselves in the emulsion oil core, amphiphilic species locate at the interface forming a surface functionalization layer, hydrophilic reactive groups, as amines, take position in the outer part of the coating shell, resulting available for further conjugations.2
Such a precise structural organization is not only useful to control and program the functions of the nanoparticles, but it also allow to easily dissect their biological properties in comparative studies. Indeed, taking full advantage of such approach, we prepared nanoparticles densely coated with different hydrophilic polymers (PEG, PMOXA, PEtOXA). Functional studies in serum revealed that the different coatings elicit different, specific and somewhat unexpected interactions with the immune system, activating the complement systems and the innate recognition mechanisms. Molecular recognition processes occurring at the surface of the nanoparticles are hence fundamental in determining the biological role of nanoparticles.

References

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