DIRNANO

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Coating of nanoparticles with lipid bilayers

Nanoparticles, thanks to their small sizes and high surface area can modulate and improve the performance of several drugs in comparison with conventional formulations, which has highly benefic the medical field [1]. However, there is a lack of knowledge of how the nanoparticles interact with the human body, specially with the immune system. The immune system is the main cause of the unspecific and unsuccessful delivery of the nanoparticles to the site of action. When the nanoparticles enter in contact with the blood, there is adhesion of different proteins to its surface, creating the protein corona, this protein corona triggers the immune system which clears the nanoparticles [2].

To overcome the unspecific adhesion of proteins nanoparticles have been coated with different polymers: naturals such as chitosan or dextran and artificial, such as polyelectrolytes, PNIPAM or polyethylene glycol (PEG) [3]. This polymer will create cover the nanoparticles creating a biocompatible surface to interact with the body. One of the most widely used is PEG that is not only used as coating but also within the nanoparticles like the recent COVID-19 vaccines [4]. But, recent studies have shown that PEG can also cause immunogenicity.

At DIRNANO different ERS are working on new coatings for increasing the biocompatibility of the nanoparticles. My main focus is to study the lipid bilayers and which is their interaction with the immune system.

Why lipid bilayers?

Lipid bilayers are a part of our cells that separates its component from the environment. They main component are phospholipids which are arranged in a two layer leaflet due to their aliphatic characteristics. Phospholipids are highly biocompatible since we have them already present in the membrane of cells [5]. Also, zwitterionic phospholipids (with a neuter overall charge) have an ant

anti-fouling property, therefore the protein absorption in the surface is reduced, and as a result the immune system activation decreases [6].

The lipid bilayer can arrange themselves in liposomes, small vesicles, which have been widely used in nanomedicine. There are several examples of approved systems such as Doxil (for cancer treatment) [7]. They can be load with hydrophilic or hydrophobic moieties which makes them very versatile systems for drug delivery. Moreover due to their aliphatic properties we can load nanoparticles inside the liposome turning it to a coating.

There are several lipid bilayers used as the external surface of nanoparticles, especially on inorganic ones to improve their biocompatibility and stability. Also, the lipids can be easily modified which make the functionalization of the particle more easier [8]. The most common coated inorganic particles are gold and silica due to their physical properties that enables theragnostic approaches, diagnosis and therapy simultaneously and imaging, specially in the cancer field [9].

Even though phospholipids have been used as coating for different nanoparticles it is still unknown which paper they have in the interaction of the nanoparticles and the immune system. Which kind of lipids are more prone to activate the immune system? Do zwitterionic lipid bilayers shield the immune system indecently of the nanoparticle core? Can we tune the lipid formulation to make use of their immunogenicity to create new immunotherapy or vaccines? My project at LipoCoat focuses on studying the behavior of lipid bilayers in different nanoparticles to bring more knowledge in all this questions.

NEWS IN THE FIELD

- In the recent study of L. Liu et al. they have develop silica nanoparticles coated with a mixture of cancer cells cellular membrane and lipid bilayers to improve the targeting of cancer cells [10]

- In this other recent study by Q. Liu et al. they show how mimicking the surface of the nanoparticle with phospholipids of the pulmonary surfactants improve the uptake of pulmonary cells [11]

- The NanoBio-Tech Conference in Montreux has taken place this November, this conference englobes the newts research in micro and nanoscale technologies for bioscience.

NEWS IN THE CONSORTIUM

- Mireia Vilar (ESR 15) is currently in Padova in the group of Dr. Emanuele

Papini studying the interaction and activation of the immune cells with the nanoparticles

- Carlos Pavon (ESR 5) will star in December his short stay in Switzerland to further characterize the polymers he works with.

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