DIRNANO

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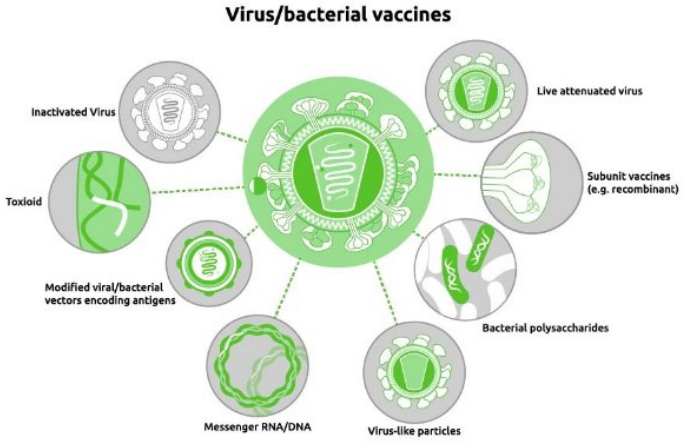
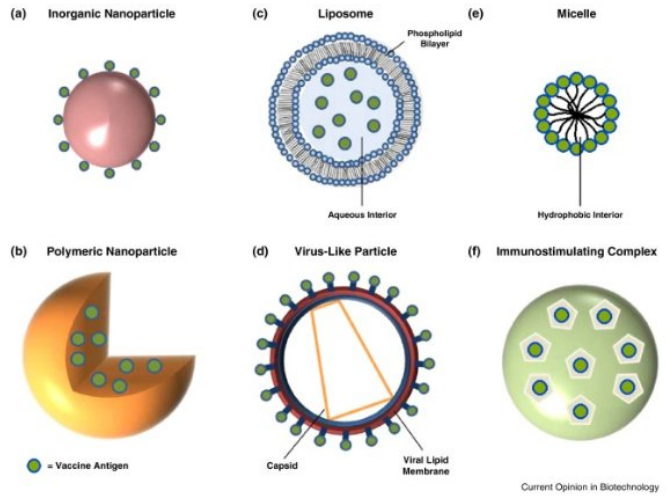
The use of nanoparticles in vaccine technology

Since its first discovery, vaccine technology has been advancing towards newer and safer vaccines. First vaccines consisted on the injection of microorganisms that generate the disease into the patient. Then, scientific advances in the field allowed the inoculation of attenuated microorganism, i.e. microorganisms that have lost the ability to cause serious illness but retain the ability to stimulate immunity (Riedel, 2005). This method, despite being effective, can seriously compromise the patient's health due to an exaggerated immune response after vaccination.

Later, newer methods to generate immunity were discovered, like the injection of fragments from pathogens, such as specific protein or chains of polysaccharides. It was observed that the injection of these elements was not capable of generating a sufficiently intense immune response, so they must be used together with an adequate adjuvant or delivery system. (Pasquale, Preiss, Silva and Garçon, 2015)



The use of **nanoparticles** results in a promising approach for vaccine technology. These nanoparticles can be composed of lipids, metal and non-metal inorganic materials or several polymers. The main characteristics of nanoparticles are to protect the antigens from early proteolytic degradation, control antigen release, and help antigen uptake and processing by antigen-presenting cells, while being safe for human administration.
In addition, the nanoparticles could be modified in their physicochemical properties to target specific cells and improve vaccine efficacy (Diaz-Arévalo and Zeng, 2020).



One of DIRNANO's objectives is to acquire the knowledge in nanoparticle engineering for vaccine applications. Some of our ESRs work on designing cancer therapeutic vaccines, from the synthesis of the nanoparticles and coating engineering to the rational design of the cancer-associated antigens.
In DIRNANO, we also investigate the efficacy of our vaccine candidates studying the interactions with immune cells in vitro and in vivo through immunization campaigns.

My project will primarily focus on the design of a therapeutic cancer vaccine based on gold NPs (AuNPs) coated with poly(ethylene glycol) (PEG) as carriers for tumor-associated self-antigens derived from MUC1, due to compelling preliminary results showing good immunogenicity of such vaccine candidates in vivo.

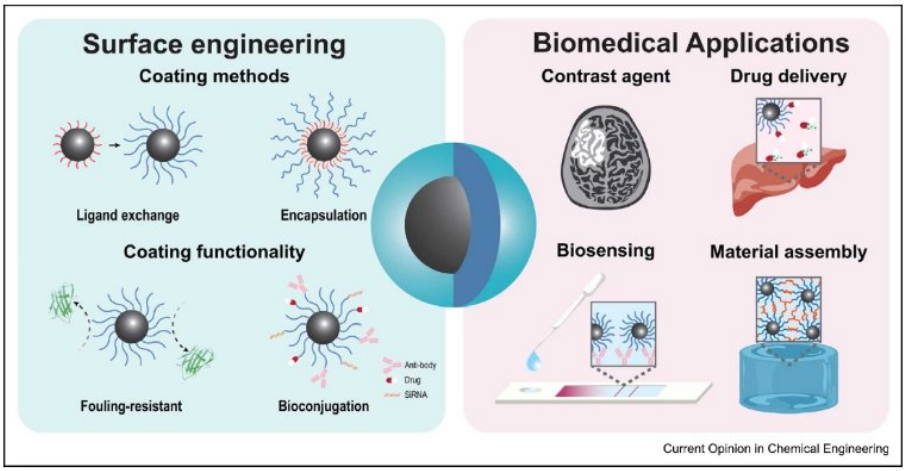
Current advances in the field:
A team of scientists from the Wyss Institute and Dana-Farber Cancer Institute led by Kai Wucherpfennig, M.D., Ph.D., has developed a novel cancer vaccine that targets this process by inducing the body to produce antibodies against the “kill me” proteins. When healthy cells experience DNA damage, they present on their surfaces proteins that serve as a “kill me” signals to both T cells and natural killer (NK) cells, members of the immune system that come and

destroy the labeled cells. Some cancer cells, however, have figured out how to clip those proteins off of their surfaces, allowing them to escape from the immune system's search-and-destroy team.

By generating antibodies against these proteins effectively locks them in place on cancer cells' surfaces, preventing the cells from destroying them. That, in turn, makes them available to trigger killing responses from both T and NK cells. For this purpose, they combine the use of mesoporous silica rods and antigen loaded ferritin as vaccine delivery method.
For further information, check it here.

DIRNANO NEWS:

- The ESR Tobias Komsthöft (SuSos AG) and Dr. Mark W. Tibbitt (ETH) have just published a review about polymer functionalization of inorganic nanoparticles for biomedical
  applications. Check it here!



- The ESR Hajira Banu Haroon (UNEW), Dr. Shadi Farhangrazi (SMDG), professor Alan Christy Hunter (UOL) and professor Moein Moghimi (UNEW) have just published a review about the history of long circulating nanoparticles. Check it here!

- Next Regular Meeting organized by University of Newcastle coming soon (21st-23rd September).

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