Role of bio-nanoparticles' surface properties on transport processes within confined materials	
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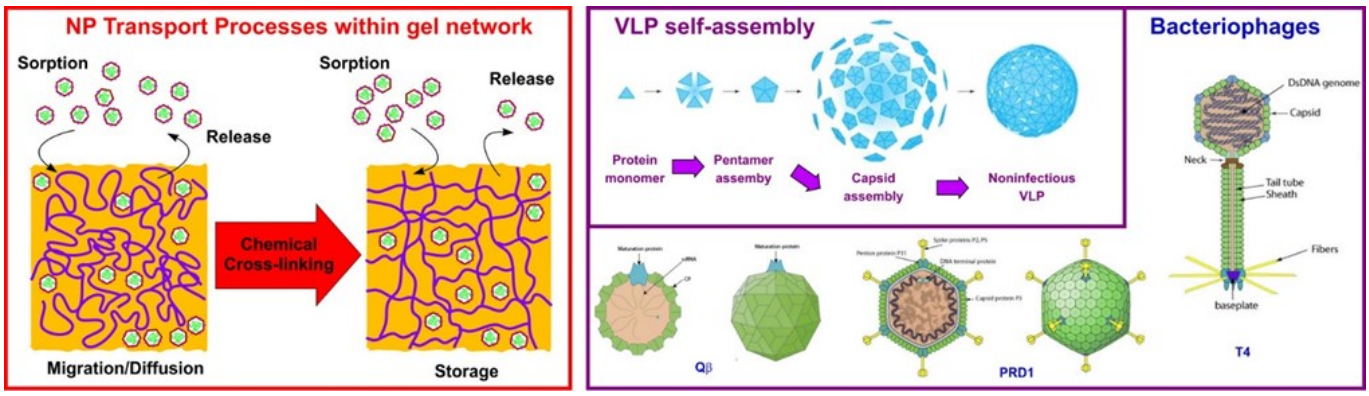
Transdermal patches are materials commonly used for the local treatment of particular bacterial infections. New patches should allow the delivery and subsequent diffusion of not only soluble drugs but also nanotransporters (NT) carrying active agents in a controlled manner. One limit of this strategy is related to the physical/chemical properties of the patch's reservoir whose components may partially or completely impede the desired diffusion of the active agents. The further use of NT to convey active agents without any interactions with the reservoir components has become of major importance for the production of successful delivery systems. NTs such as nanocapsule, nanoliposome or virus-like-particles (VLPs), possess surface properties that play a critical role in sorption and transport mechanisms. In particular, VLPs and bacteriophages are biological nanoparticles consisting of a capsid protein assembly. VLPs constitute promising nanosystems for a successfully delivery of genes or other therapeutics because their surface properties can be used to effectively target specific cells (tumor, bacteria, etc). Among the materials used to properly store and efficiently deliver active agents, materials based on polyelectrolytes are suitable candidates since they are known to potentially concentrate an active drug at a concentration that is up to 1000 times larger than that in the inoculum. Although many studies realized on these materials, the physical/chemical interactions governing the related mechanisms of active delivery agents within 3D and confined materials such as multilayered films/gels remain poorly understood. In addition, other constraints arising from the size and the geometry of the NTs remain widely unexplored.



In this project, we propose to evaluate on a mechanistic level the role(s) of the surface and morphological features of drug delivery VLP agents with regard to their sorption and diffusion within poly(allylamine hydrochloride)/hyaluronic acid gels (PAH-HA). The objective of this work is ultimately to develop a new type of device functionalized with bionanoparticles (VLP and bacteriophages) for wound care. As part of this project, we shall investigate the impacts of surface properties (naked capsid and integrated membrane capsid) size and geometry (icosahedral and head-tail shape) on the mobility of these nanoparticles within the polyelectrolyte gels. These analyses will be carried out by coupling physicochemical techniques such as fluorescence (flow cytometry, confocal microscopy), atomic force microscopy (AFM), electrokinetics (streaming current and surface conductivity), confocal Raman spectroscopy and theoretical modeling. The expected results should provide a better understanding of the intricate relationships between surface/morphological properties and reactive transport processes (diffusion, migration and sorption) through a PAH-HA network defined by a tunable cross-linked structure. These studies will be focused first on VLP of MS2 bacteriophage and then extended to 3 other types of bacteriophages (Qβ, PRD1, T4). Attention will be further paid to the impact of the rheological properties of the gels on VLPs diffusion across the network/outer medium interface and ii) kinetics of VLPs accumulation.

Profile of the candidate :
Master's degree/engineering degree or equivalent qualification.
Strong skills in physical chemistry, polymer chemistry is required.

Application submission deadline:
May 05, 2018