Advanced amphiphilic nanobiomaterials for drug delivery: From design to preclinical evaluation

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Polymeric micelles (PMs) are nanostructures formed upon the spontaneous self-assembly of amphiphilic copolymers blocks above the critical micellar concentration and they emerged as one of the most versatile nanotechnology platforms for drug encapsulation, delivery and targeting owing to the high diversity of hydrophilic and hydrophobic blocks and the chemical flexibility to tailor the amphiphilic architecture [1]. The low physical stability of PMs upon dilution in the biological environment is the most striking drawback. Moreover, PMs were mainly utilized for the intravenous administration of antitumorals drugs and not for mucosal routes because of two main limiting drawbacks: weak interaction with mucus and inability to sustain the release of the encapsulated payload over time. Finally, despite their high chemical functionality, PMs are not often designed to actively target specific cells populations (e.g., cancer cells). My research group dedicates dauntless efforts to design novel amphiphilic nanomaterials with advanced features and thus, to extend the application of PMs pharmaceutical research and development [2]. Aiming to expand the application of PMs in drug delivery, we have developed a new type of non-covalently crosslinked nanogels based on the aggregation of amphiphilic graft copolymers that display a multifunctional hydrophilic backbone and hydrophobic side blocks. The complementary characterization of the nanostructure by means of DLS and electron microscopies indicated the formation of multimicellar aggregates with size in the 200-350 nm range. One of the striking advantages of these novel nanobiomaterials is its modular nature that enables the optimization of the nanoparticle properties (e.g., size, size distribution, surface charge, hydrophilic-lipophilic balance) and the exploitation of different chemical pathways for the crosslinking [3,4]. Seeking for more versatile nanomaterials, more recently, we developed novel hybrid organic-inorganic amphiphilic nanobiomaterials with improved physical stability and more controlled release kinetics than standard PMs. In this presentation, I will overview the progresses made in our laboratory and discuss their potential in advanced drug delivery.

References

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