Magnetic nanoparticles: A multifunctional vehicle for modern theranostics

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Abstract

Magnetic nanoparticles provide a unique multifunctional vehicle for modern theranostics since they can be remotely and non-invasively employed as imaging probes, carrier vectors and smart actuators. Additionally, special delivery schemes beyond the typical drug delivery such as heat or mechanical stress may be magnetically triggered to promote certain cellular pathways. To start with, we need magnetic nanoparticles with several well-defined and reproducible structural, physical, and chemical features, while bio-magnetic nanoparticle design imposes several additional constraints. Except for the intrinsic requirement for high quality of magnetic properties in order to obtain the maximum efficiency with the minimum dose, the surface manipulation of the nanoparticles is a key aspect not only for transferring them from the growth medium to the biological environment but also to bind functional molecules that will undertake specific targeting, drug delivery, cell-specific monitoring and designated treatment without sparing biocompatibility and sustainability in-vivo. The ability of magnetic nanoparticles to interact with matter at the nanoscale not only provides the possibility to ascertain the molecular constituents of a disease, but also the way in which the totality of a biological function may be affected as well. The capacity to incorporate an array of structural and chemical functionalities onto the same nanoscale architecture also enables more accurate, sensitive and precise screening together with cure of diseases with significant pathological heterogeneity such as cancer.

Keywords

Magnetic nanoparticles, theranostics, biomedical applications, nanomagnetism