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Magnetic nanomaterials as multifunctional vectors with promising potential for diagnosis and therapy.

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Abstract:

Magnetic nanoparticles are multifunctional agents that are receiving growing interest for the biomedical field. Indeed they can serve as tracers for Magnetic Resonance Imaging (MRI), as mediators to apply a force at a distance or to dissipate heat locally, and as mechanical probes for cellular materials. Besides, thanks to their nanometric size, they can interact with the very first components of any living cell, and be internalised. The multifunctionality of these magnetic agents can then be exported into the cells.

Labeling living cells with magnetic nanoparticles has received increasing interest for the last ten years, mainly because of the emerging method of MRI cell imaging. A few years ago, we proposed the use of anionic iron oxide nanoparticles as efficient agents for cell internalisation. Since this date, we achieved, with these nanoparticles, the magnetic labelling of a large variety of cells, demonstrating that this magnetic cell labelling procedure was ubiquitous and biologically innocuous.

At the cellular scale, conferring magnetic properties to cells allowed non invasive 3D detection of single cells using MRI. Beyond imaging, the concept of “magnetic cells” opens new possibilities for cell manipulation by non-contact constraints. A promising field of applications concerns the development of tissue engineering mediated by cellular magnetic force to mimic the most closely multicellular organisations found in the living.

Magnetic nanoparticles can also be used as heat sources for magnetic hyperthermia. Under the influence of an alternating high frequency magnetic field, they generate heat through relaxation processes. Cellular internalisation of magnetic nanoparticles localises the source of heat in the internal volume of the cell, with direct application for tumour cell therapies.

Finally, the combination of cell-derived biogenic vesicles with magnetic nanoparticles creates multifunctional bio-inspired nanovectors with promising potential for diagnosis and therapy.

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