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Magnetic nanoparticles in cell therapies: from combined approaches in cancer treatment to magnetic tissue engineering.

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To overcome some of the limitations of current cell therapies tools, new strategies have emerged since the advent of nanotechnology in medicine.

In cancer therapy, thermal treatments (magnetic hyperthermia or photothermal therapy mediated by magnetic or plasmonic nanoparticles) have provided noninvasive means of heating cells at therapeutic levels. However, while the ultimate target for nanoparticle-mediated photothermal therapy is the cancer cell, heating performance has not previously been evaluated inside the cells. In the attempt to bridge this gap, we provided the first thermal measurements mediated by magnetic¹ or plasmonic² nanoparticles inside cancer cells, *in vitro* or *in vivo* in the tumor environment. The ultimate goal of nanotherapies is anyway to improve the efficacy and combat the tumour from within. We proposed combined nanotherapeutic concepts^{3,4,5,6} based on magnetothermal, photothermal, and photodynamic therapies which led to complete cancer cell destruction *in vitro* and complete tumor ablation *in vivo*.

While magnetic nanoparticles are increasingly used as clinical agents for imaging and therapy, their use as a tool for tissue engineering opens up challenging perspectives that have rarely been explored. Our strategy has been to take advantage of magnetic nanoparticles internalization to create thick, organized, purely cellular 3D tissue structures^{7,8}, that can be stimulated on demand⁹.

The use of nanoparticles for cancer cell therapies or tissue engineering raise more general issues of nanoparticles biosafety, once internalized in cells. Yet the nanoparticles long-term tissular fate is poorly documented. We have developed original magnetic techniques to follow the fate of iron oxide nanoparticles and their assimilation within a living tissue, and evidenced that a massive biodegradation can occur at the endosome site.

¹ [Biomaterials](#) **24**, 6400–6411 (2014)

² [Advanced HealthCare Materials](#), 10.1002/adhm.201501035 (2016)

³ [ACS Nano](#), **10**, 2436-46 (2016)

⁴ [Nanoscale](#), **7**, 18872-18877 (2015)

⁵ [Nanomedicine](#). **10**, 2797 (2015)

⁶ [ACS Nano](#), **9**, 2904-2916 (2015)

⁷ [Advanced Materials](#). **25**, 2611-2616 (2013)

⁸ [Integrative Biology](#), **7**, 170-177 (2015)

⁹ [Phys Rev Lett](#), **114**, 098105 (2015).