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Combining magnetism and light to fight cancer

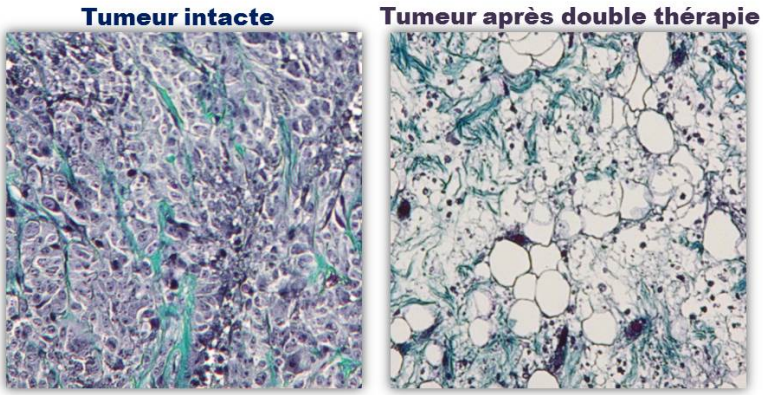
By combining, in a liposome[1], magnetic nanoparticles and photosensitizers that are simultaneously and remotely activated by external physical stimuli (a magnetic field and light), scientists at the Laboratoire Matière et Systèmes Complexes (CNRS/Université Paris Diderot) and the Laboratoire Physicochimie des Electrolytes et Nanosystèmes Interfaciaux (CNRS/UPMC),[2] obtained total tumor regression in mice. Non-toxic when they are not activated, such therapies can also achieve a reduction in adverse effects. These results, which demonstrate the importance of multiple treatments, were published in *ACS Nano* on 24 March 2015.

One of the strategies employed to limit the adverse effects of cancer therapies is the development of nanocarrier systems that can convey active ingredients to target tumor cells. These are referred to as "physical" therapies when the active substances, molecules or nanoparticles, can be remotely activated by external physical stimuli — in this case by light or a magnetic field. In this context, the study team developed a new type of carrier that combines photosensitivity and magnetism. To achieve this, they first encapsulated magnetic nanoparticles in the inner compartment of a liposome in sufficient quantities to render it ultra-magnetic, before incorporating photosensitizers into its lipid bilayer, while preserving an optimum size for circulation in the blood.

These liposomes, containing magnetic nanoparticles and photosensitizers, were injected directly into the tumor in the mouse model. The scientists thus combined two techniques to achieve complete destruction of cancer cells. The first one, magnetic hyperthermia, consists in exciting the nanoparticles with a magnetic field to raise the temperature of the tumor and destroy it. The second method, photodynamic therapy, is made possible by the photosensitizers, which, when activated, release reactive oxygen species[3] that are toxic to tumor cells. These two physical therapies act in synergy on the activity of the proteins involved in apoptosis, or programmed cell death. Their combination thus induces total regression of the tumor, while a single therapy is not able to stop its growth.

[1] A liposome is an artificial vesicle whose internal compartment is formed by lipid bilayers.
[2] In collaboration with scientists from the Paris-Centre de Recherche Cardiovasculaire (Inserm/Université Paris Descartes)
[3] Reactive oxygen species are oxygenated chemical species such as free radicals. In this case, activation of the photosensitizer causes the formation of a particular state of the oxygen molecule, which is chemically very reactive and hence highly toxic.

For the research team, the next stage consists in exploiting the "other" magnetic properties of liposomes in order to improve the treatment: nanoparticles are indeed visible under MRI and can be shifted using magnets. After an injection into the bloodstream, it would therefore become possible to use the magnets to target the liposomes towards the tumors, while mapping their final destination by MRI.



Masson's trichrome staining: the cell nuclei are blue-black, the cytoplasms (cell bodies) are mauve and the collagen fibers are green.
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Bibliography

Combining Magnetic Hyperthermia and Photodynamic Therapy for Tumor Ablation with Photoresponsive Magnetic Liposomes
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