Multifunctional Ferritin Nanoparticles for Multimodal MRI-OI-SPECT Imaging

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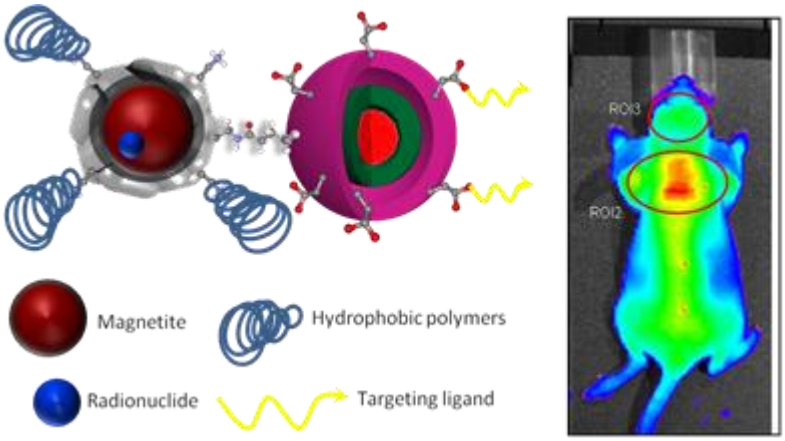
Medical Imaging has made great progress due to advances in imaging devices and chemical probes. Several modalities such as Magnetic Resonances Imaging (MRI), Optical Imaging (OI), radionuclide imaging using Single Photon and Positrons (SPECT and PET) are currently being used. Each imaging modality has its merits and limitations but strong points of some of them can be combined by the use of a single nanoprobe. In this sense, one of the most exciting challenges in this field is to create more and more powerful nanoprobes capable of getting parallel detection by several modalities for an early diagnosis, if possible at molecular level.

We have developed a flexible method for the preparation of magnetic-fluorescent nanostructures by covalent coupling two nanobuilding blocks: a magnetic ferritin and a quantum dot (QD), through the reaction between lysines and carboxylic groups at the external shells of ferritin and QD, respectively [1]. The resulting nanostructure can serve as a platform for the addition of other functional chemical species, including hydrophobic polymers and targeting ligands. In addition, the inorganic material inside the ferritin cavity can be doped with some "non inocent" anions, such as phosphate or $^{99m}TcO_4^-$.
We can create therefore, a library of nanostructures simultaneously containing: i) a doped magnetite nanoblock (for MRI), ii) a quantum dot or eventually a dye (for OI), iii) a radionuclide such as ^{99m}Tc (for SPECT), iv) some hydrophobic polymers (for improving plasma half life) and v) a targeting ligand ("à la carte") [2].



The in vivo OI study on nude mice shows that whereas free QD is mainly located at the liver, our multifunctional nanostructure is preferentially accumulated at the lungs. This different biodistribution points out that whereas the QD is detected and removed from the bloodstream by the reticulo-endothelial system, the full ferritin-QD nanostructure has a longer blood circulation time, thus improving the probability of attaining the desired target.

References:

[1] B. Fernández, N. Gálvez, R. Cuesta, A. B. Hungría, J. J. Calvino and José M. Domínguez-Vera. ***Adv. Funct. Mater***. **2008**, 18, 3931-35.
[2] José M. Domínguez-Vera, N. Gálvez, B. Fernández, E. Valero, B. Federico, L. Calderan, P. Marzola, J. J. Calvino, A. B. Hungría, R. Cuesta. Patent ES1634.24B. José M. Domínguez-Vera, N. Gálvez, E. Valero, P. Sánchez. Patent ES1634.24C.