RATIONAL DESIGN OF INORGANIC NANOPARTICLE CONJUGATES FOR BIOMEDICAL APPLICATIONS

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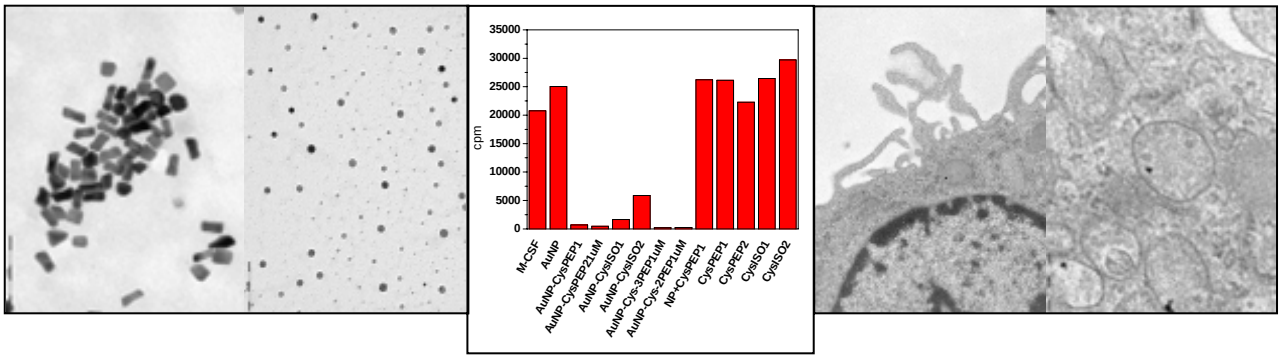
Recently, nanomaterials have received enormous attention for their potential applications in biology and medicine because is a revolutionary technology to address single molecules inside the cell.

Nanoparticles (NP) can be tailored with different properties such as fluorescence or magnetic moment [1,2]. These properties can be harnessed to use them as local nano-probes or nano-manipulators in biological and medical applications; e.g. fluorescence labelling of cellular compartments [1], use of fluorescent or magnetic particles as contrast agents, magnetic separation [3], targeted drug delivery [4].

Recently, NP conjugated with biological molecules have successfully been applied in materials science and biology. NP-macromolecules -like proteins or DNA- conjugates hold great promise both for biological diagnostics, where the NP could provide unique detection signatures, and for nanotechnology, where the information content of the biomolecule could be useful for spatial patterning of NPs. Many strategies, available for bioconjugation of NP, have been described: elastin [5], antisense [6], biotin-avidin [1], antigen-antibodies [7], peptides [8], proteins [9], among others. Furthermore, proteins have a particular interest in nanobiotechnology, because of their inherent programmability and biological activity [10].

Besides, in the same way that the organic molecule can modify the size, shape and therefore final properties of the growing NP [2,11], the inorganic nanoparticle has the ability to control the reactivity of the organic molecule attached to it (some preliminary evidence can be found in homogeneous catalysts [12] and antisenses [6] attached to AuNP). In this way, the NP has the ability to i) modify the local concentration of the molecule, ii) regulate the accessibility to the reactive sites, iii) control the molecule spatial orientation of different molecules attached to different crystal faces of the NP [13,2]) iv) allow the direct activation of the molecule by the remote excitation of the inorganic core to which it is attached [8]. In addition, the inorganic core has unique properties and signatures, facilitating conjugate detection, and consequently, surpassing complicated fluorescent or radioactive labelling.

In this scenario, preparation, isolation, control on the conjugation stability, and monitoring the conjugation, are conditions sine qua non to be able to properly interact with the biological machinery.



Synthesis of Gold Nanoparticles: rods and spheres (Left) DNA synthesis –proliferation assay- of cells in the presence of AuNP-peptide conjugates (center) AuNP-Peptide conjugates phagocited by macrophages (right)

References:

[1] Bruchez Science 281, 2013-2016 (1998)
[2] Puntes Science 291, (2115-2117) 2001.
[3] Puntes European Journal of Cells and Materials 3, (128-131), 2002
[4] Gallego Clinical and Translational Oncology 8(11):1-000 (2006)
[5] Nath J. Am.Chem.Soc.123(8197,(2001)
[6] Rosi *Science 312* 1027-1030 (2006)
[7] Farokhzad PNAS, 103, 6315–6320 (2006)
[8] Kogan Nanoletters 6, 110-115, 2006
[9] Chah Chemistry and Biology 12, 323-328 (2005)
[10] Pujals, Journal of the American Chemical Society, 128,(8479 -8483), 2006.
[11] Puntes Journal of the American Chemical Society, 124 (12874-12880), 2002 .
[12] Belser J. Am. Chem. Soc. 127 (8720-8731) 2005
[13] Jackson Nature Materials 3, 330 - 336 (2004)