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Gold Nanoparticles Used as a Carrier Enhance Production of Anti-Hapten IgG in Rabbit: A Study with Azobenzene-Dye as a Hapten Presented on the Entire Surface of Gold Nanoparticles

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Akiyama, Yasushi Tamada, Kaoru Tamada

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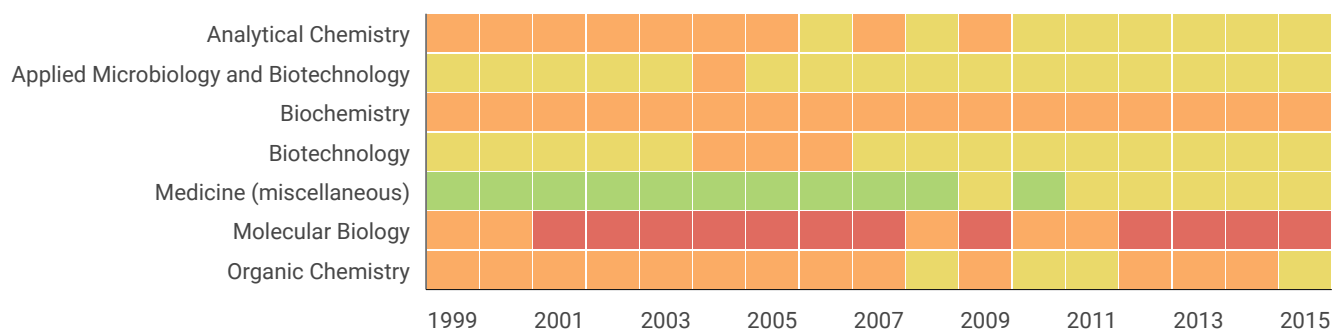
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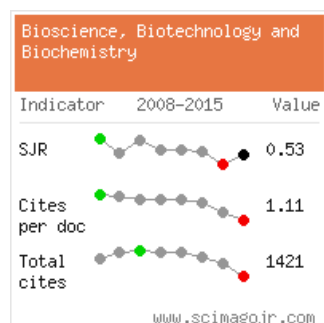
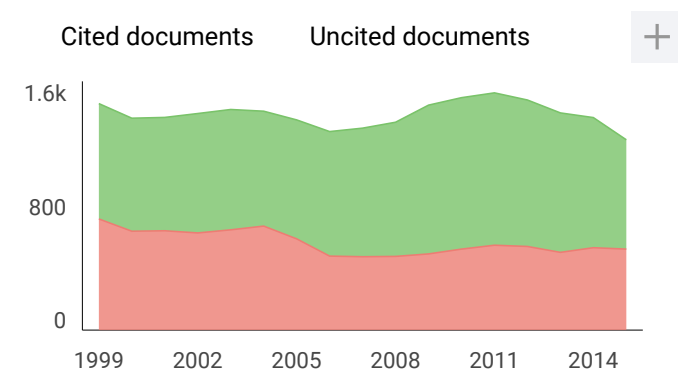
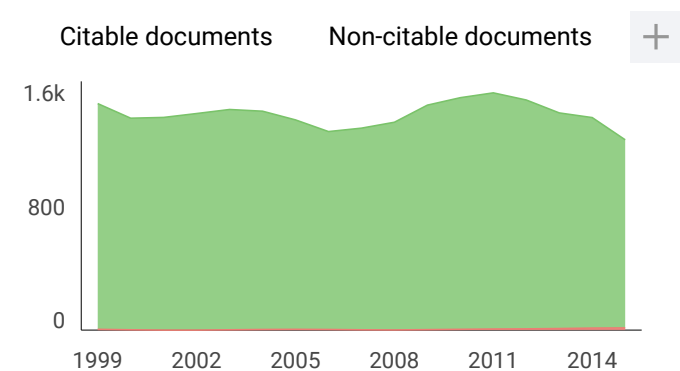
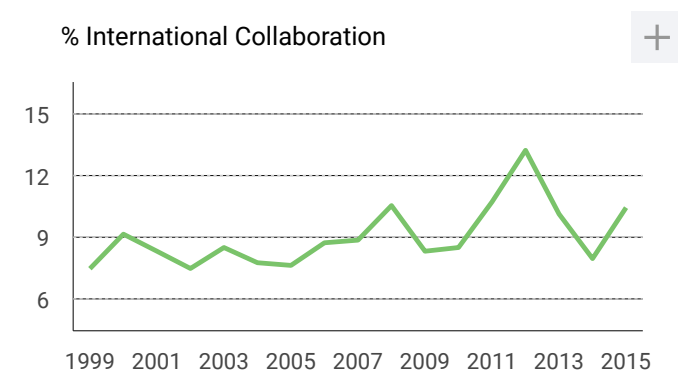
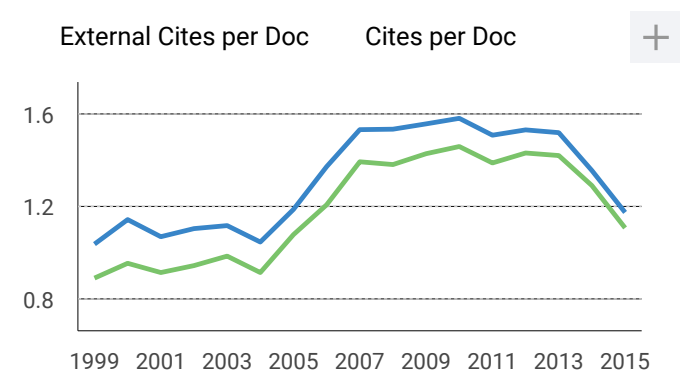
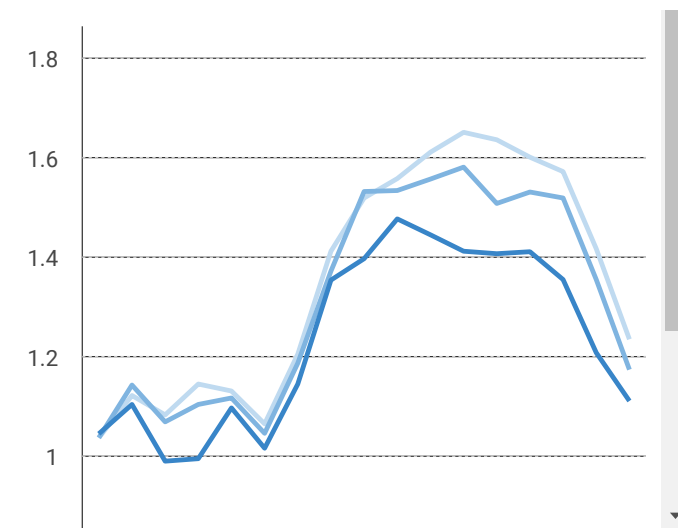
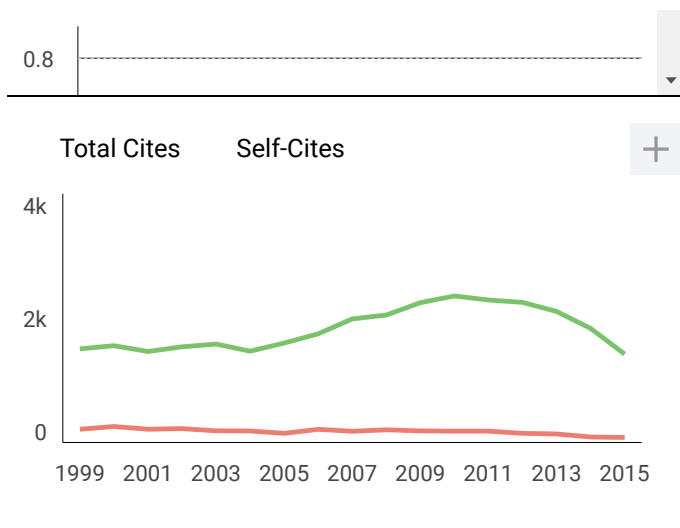


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Horatio (Satire 1,1,106)

Gold Nanoparticles Used as a Carrier Enhance Production of Anti-Hapten IgG in Rabbit: A Study with Azobenzene-Dye as a Hapten Presented on the Entire Surface of Gold Nanoparticles

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The azobenzene moiety, well-known not only for its reversible *cis-to-trans* photoisomerization but also as a hapten, does not induce antibodies on its own, but it reacts with antibodies raised against conjugates with protein carriers. Hence we selected azobenzene dye as an indicator to assess the possibility of having gold nano-particles act as an immunological carrier instead of protein carriers. In rabbits, we confirmed an *in vivo* response against azobenzene dye presented on the entire surface of gold nanoparticles (azo-nanoparticles), where the gold nanoparticles appeared to play a role as a carrier for the hapten. A high yield of immunoglobulin G (IgG) against the azobenzene derivative took place in rabbits injected with azo-nanoparticles, whereas no increase in IgG was recognized in other rabbits treated solely with chemically equivalent azobenzene dye instead of azo-nanoparticles. Electron microscopy and surface plasmon resonance spectroscopy indicated that the IgG obtained specifically recognized the difference between the isomer conformations of the azobenzene moiety.

Key words: hapten; carrier; nanoparticles; electron microscopy; surface plasmon resonance

Size-quantized noble metal and semiconductor nanoparticles have attracted keen interest in various fields such as biotechnology, cell biochemistry, electronics, energy, and industrial products, where scientists and engineers can exploit the tools of nanotechnology to design materials at the molecular level.^{1,2)} Their unique physical and chemical properties offer nanoscaled material engineering considerable potential applications in optical, electronic, and magnetic devices, in catalysis, as lubricants, and for many other uses.^{3–7)} In the immunological field, reports are accumulating on development and applications using polymer-based nanoparticles and nanoparticles mainly consisting of biodegradable materials such as gelatin and chitosan.^{8–10)} Indeed, many available vaccines, including protein antigens and DNA vaccines, are very unstable and need to be protected from degradation in the biological environment. In addition, their efficacy is limited by

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Abbreviations: azo-nanoparticle, a gold nanoparticle capped by unsymmetrical azobenzene disulfides; IgG, immunoglobulin G; BSA, bovine serum albumin; C6AzSSC12, unsymmetrical azobenzene disulfide [4-hexyl-4'-(12-(dodecylthio)dodecyloxy)azobenzene]; PBS, phosphate buffered saline; ELISA, enzyme-linked immunosorbent assay; SPR, surface plasmon resonance; SAM, self-assembled monolayer; SDS-PAGE, polyacrylamide gel electrophoresis in the presence of 0.1% sodium dodecylsulfate; TEM, transmission electron microscopy