What happens to gold nanoparticles in cells?

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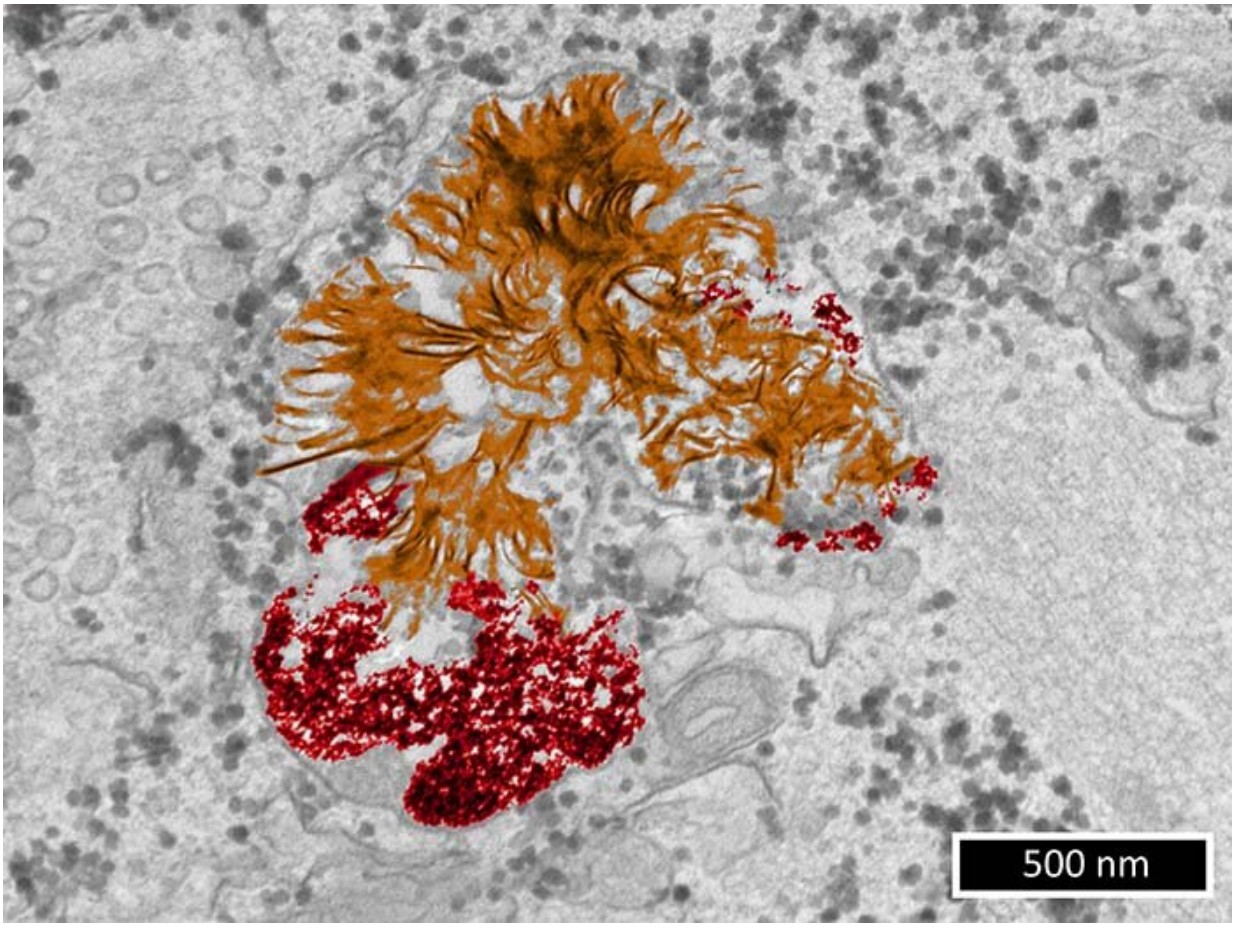

Image of a lysosome observed using transmission electron microscopy, a method that can reveal the form of nanoparticles inside of cells. The degradation products are made up of gold crystals measuring 2 nm in diameter self-organized in nanoleaves. Non-degraded nanoparticles are in red, and degradation products are in orange. Credit: Alice Balfourier, laboratoire MSC (CNRS/université de Paris) and Christine Péchoux-Longin (plateforme MIMA2, INRA)

Gold nanoparticles, which are supposed to be stable in biological environments, can be degraded inside cells. This research, conducted by teams from the CNRS, l'Université de Paris, Sorbonne Université, and l'Université de Strasbourg, will be published in *PNAS* on December 16, 2019, and reveals the ability of cells to metabolize gold, which is not essential for their functioning. This study opens the way for a better understanding of the life cycle of gold nanoparticles in organisms.

Gold nanoparticles possess unique optical properties that are used in nanomedicine for anti-cancer therapy and imaging. They are also included in cosmetic and food formulas. Yet their long-term fate in cells has been unclear, even though it was generally accepted that gold nanoparticles remained intact indefinitely in the lysosome, the cell's "waste recycling centre."

Contrary to the current paradigm, the scientists tracked the evolution of gold nanoparticles for six months in a cellular environment, and showed that they underwent significant transformations after a few weeks. By measuring the expression of over 18,000 genes over time, they revealed a biological process that includes mechanisms of detoxification and cell protection, which are also involved in the degradation of other nanomaterials. They also observed the presence of non-degraded nanoparticles and degradation products in the form of nanoleaves (see image).

Nanoleaves were first observed nearly 50 years ago in patients suffering from rheumatoid polyarthritis who had been treated with another form of gold (ionic gold or "gold salts") to relieve pain in their joints. Consequently, there is a shared metabolism of degradation between gold salts and gold nanoparticles.

This unexpected result, which generalizes the fate of gold nanoparticles in organisms, could help in the future to better evaluate the toxicity of

gold nanoparticles and their capacity to be eliminated from the organism. This interdisciplinary work also highlights that gold, whatever its initial form, can be metabolized by mammals despite not being essential to their survival.

More information: Alice Balfourier el al., Unexpected intracellular biodegradation and recrystallization of gold nanoparticles, *PNAS* (2019). www.pnas.org/cgi/doi/10.1073/pnas.1911734116

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