Coating mitochondria without damaging them: research opens a possible avenue for addressing their dysfunction

A study by IRCCS Fondazione Istituto Neurologico Carlo Besta and Politecnico di Milano, published in the Journal of the American Chemical Society, demonstrates that it is possible to coat mitochondria with innovative materials (MOF) without compromising their ability to produce energy, opening up new prospects for diseases linked to their dysfunction

Coating mitochondria with innovative materials without compromising their function: this is the result of a study by **IRCCS Fondazione Istituto Neurologico Carlo Besta (FINCB) and Politecnico di Milano**, conducted as part of the BraiNs joint laboratory, inaugurated in 2023. The study, which brings together the **mitochondrial biology** expertise of the group led by **Dr Valeria Tiranti** (FINCB) – of the Medical Genetics and Neurogenetics Complex Unit (SC) and head of the **Fondazione Mariani Centre for Paediatric Mitochondrial Diseases** – with the chemical and materials engineering expertise of the group led by **Professor Pierangelo Metrangolo (Politecnico di Milano)**, was **published in the prestigious *Journal of the American Chemical Society (JACS)***.

Mitochondria are the structures in cells that produce the energy needed for cells to function. When they do not work properly, they can be involved in **several, often rare diseases**, first and foremost **mitochondrial diseases**, which affect tissues with high energy demands, such as the **brain and muscle**, and for which treatment options are still limited.

At the heart of the study are **Metal-Organic Frameworks (MOF), innovative materials that can be modified and adapted according to their use, which were recognised in 2025 with the Nobel Prize in Chemistry awarded to Susumu Kitagawa, Richard Robson and Omar Yaghi**. Applying them to mitochondria is complex, however, because mitochondria are very delicate structures. Researchers have developed a process that makes it possible to **coat the surface of mitochondria directly with these materials**, using them in very small quantities. The most important finding is that, even after coating, mitochondria **retain their ability to produce energy**.

"The possibility of **modifying the coating now opens up new research prospects**: in the future, it will be possible to **develop MOF with different characteristics depending on the objective**, creating coatings capable of performing specific functions," observes Prof. Metrangolo. One possible application, still at an experimental stage, is **mitochondrial transplantation**, a strategy that aims to transfer healthy mitochondria into cells where the existing ones do not function properly. "A specifically designed coating could, in the future, **facilitate this transfer and the interaction between mitochondria and cells**," emphasises Dr Tiranti.

This prospect, however, has yet to be verified: further studies will be needed to determine whether the coating could offer a tangible advantage in transplantation compared with uncoated mitochondria.

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LINK TO THE PUBLICATION

LINK TO THE PHOTOGALLERY

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