Light-activated polymerization methods unlock new possibilities for intracellular applications

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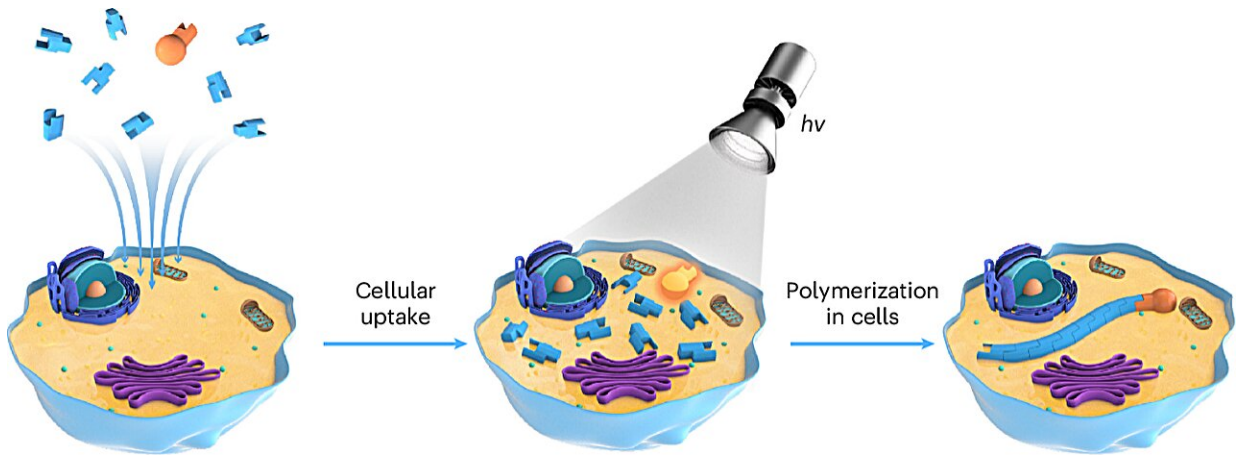

Light-mediated intracellular polymerization. Credit: Geng Jin

Synthetic polymers play a crucial role in cell biology, serving as delivery vehicles for DNA and drugs, acting as fluorescent probes for cellular sensing, functioning as bioinks for tissue engineering, and mimicking biological functionality (e.g., artificial antigen-presenting cells). However, synthesizing polymers within an intracellular environment remains challenging due to the complex intracellular conditions that can hinder or suppress such reactions.

Earlier this year, Prof. Geng Jin's team at the Shenzhen Institute of

Advanced Technology (SIAT) of the Chinese Academy of Sciences detailed two innovative methods for intracellular polymerization using light stimuli for biomedical applications. The findings are published in *Nature Protocols*.

In this study, the researchers demonstrated the initiation of polymerization reactions, such as reversible addition–fragmentation chain transfer or free radical polymerization, by introducing highly biocompatible monomers into living cells and using photoactivation.

They found that light initiation allows precise spatial and temporal control over the polymerization process, with fast reaction kinetics and good biocompatibility. The synthesis of macromolecular polymers with various structures can be achieved within a few minutes (typically 5–10 minutes, depending on the wavelength), minimizing cellular stress and avoiding the denaturation of cellular contents.

Compared to alternative methods, the proposed approach has the potential to modulate various cellular functions, including motility, differentiation, proliferation, and cell–cell interactions, making it a promising avenue for therapeutic interventions.

The protocol paper summarizes the technical details of two methods for achieving intracellular polymerization: conventional photo-polymerization via free radicals and photoinduced electron/energy transfer-reversible addition–fragmentation chain transfer polymerization. It also provides guidelines for the synthesis and isolation of His-tagged intracellular polymers.

"The ability to produce customized functional polymers within cells brings us closer to advanced therapeutic strategies and innovative bioimaging methods," said Prof. Geng. "Our study could represent a captivating frontier in the realm of biomedicine, holding great promise

for future developments."

More information: Mohamed Abdelrahim et al, Light-mediated intracellular polymerization, *Nature Protocols* (2024). DOI: 10.1038/s41596-024-00970-8

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