Scientists develop phagocytic protocells capable of the targeted delivery of enzymes

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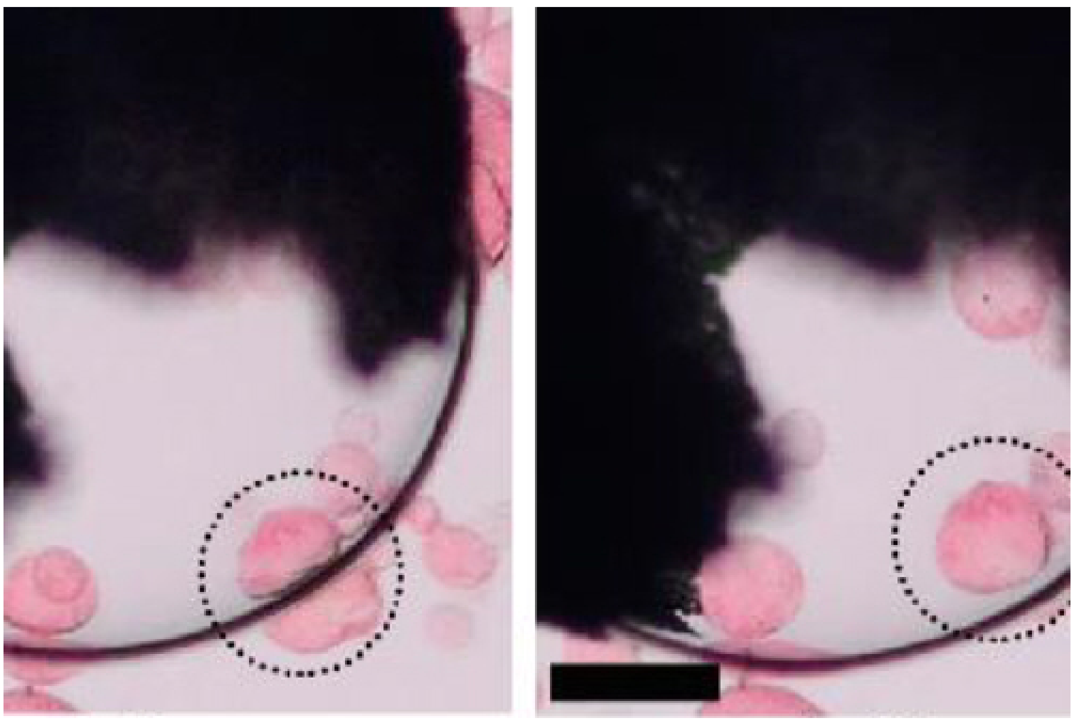

Time sequence of optical microscopy images showing spontaneous transfer of a dye-loaded cross-linked silica colloidosome (red object, dotted line) into a magnetic emulsion droplet through a fatty acid stabilized aperture. Scale bar = 100 µm. Credit: University of Bristol

Researchers at the University of Bristol have designed a community of artificial cell-like droplets that collectively displays a simple form of phagocytosis behavior. The work provides a new approach to designing complex life-like properties in non-living materials.

The chemists have made a major advance in the construction of synthetic communities of artificial cells capable of mimicking phagocytosis—a complex biological process seen in living cells that enables the ingestion of foreign material by certain cell types. The work, published in *Nature Materials*, has potential applications ranging from microfluidics to delivering enzymes for spatially controlled reactions or for the removal of hazardous pollutants.

In the new work, the researchers led by Professor Stephen Mann together with colleagues Dr Mei Li, Dr Laura Rodriquez-Arco at Bristol's School of Chemistry and Bristol Centre for Protolife Research, designed a protocell community consisting of a mixture of two different types of nanoparticle-coated aqueous micro-droplets that collectively exhibit a simple form of artificial phagocytosis. The droplets are either small and surrounded by a semi-permeable crosslinked silica membrane (colloidosomes), or large and enclosed by a porous non-crosslinked iron oxide shell (magnetic emulsion droplets). When the two types of protocells are mixed together in oil, they undergo collisions but do not interact. However, if a fatty acid is added to the oil then the magnetic emulsion droplets develop an aperture in their iron oxide shell through which the smaller colloidosomes are ingested when the protocells come into contact. As a result, the colloidosomes are captured and remain trapped within the water-filled interior of the larger protocells.

Using this spontaneous engulfment process, enzymes trapped within the colloidosomes can be transferred into the magnetic emulsion droplets to trigger specific chemical reactions even though the enzymes remain located within the ingested colloidosomes. Alternatively, by using non-crosslinked colloidosomes, enzymes and other payloads such as polymer beads can be released into the larger emulsion droplets after phagocytosis by spontaneous disassembly of the silica nanoparticle membrane.

Professor Stephen Mann said: "Our long-term aim is to build on this latest work by developing a portfolio of protocell behaviours that mimic complex life-like properties ranging from artificial phagocytosis, predation and chemical communication with applications that can be used to clean up pollutants, store and release drugs, monitor chemical reactions, and serve as models for the origin of life."

More information: Laura Rodriguez-Arco et al. Phagocytosis-inspired behaviour in synthetic protocell communities of compartmentalized colloidal objects, *Nature Materials* (2017). DOI: 10.1038/nmat4916

Provided by University of Bristol