Self-propelled, onion-like microvehicle can attract, trap, and destroy biological threats

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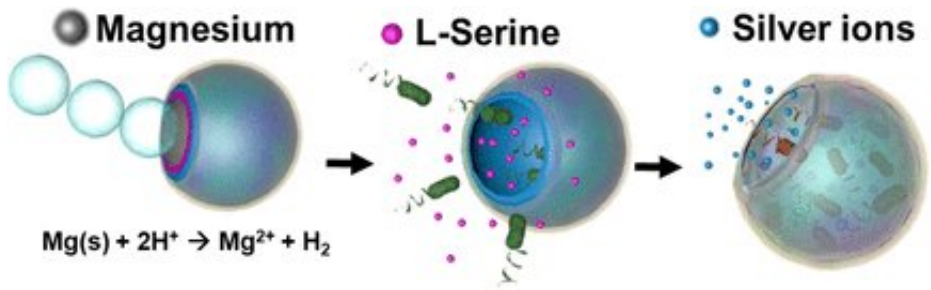

Credit: Angewandte Chemie International Edition

Antibiotics are more efficient when they can act on their target directly at the site of infestation, without dilution. In the journal *Angewandte Chemie*, American scientists describe a synthetic chemical trap that propels itself to its place of action in the body fluid and then lures the bacteria into its interior to poison them. One of the main functionalities of the microdevice is the communication with its target, says the study.

The scientists constructed the novel multifunctional weapon to address the common medical issue that most drugs dilute in body fluids before they can exert their function. It would be more efficient if the drug and its target were brought together so that less medicine is wasted. In association with Joseph Wang at the University of California San Diego, researchers have developed a self-propelling chemical trap to corner and destroy pathogens. It works by the sequential release of chemicals from a

container-like autonomous microdevice and could be especially useful against gastric pathogens, the authors report.

The scientists developed a microswimming device with an onion-like character. Its core was a bead of magnesium metal engine, which was partially covered with several polymer coatings—each having its own function. In an acidic environment, such as gastric acid, the magnesium bead reacted with the acid to produce hydrogen bubbles, which drove the microswimmer forward, similar to a submarine run by a jet of gas. The device's journey ended when it becomes stuck to a wall, such as the stomach lining. Once the magnesium engine was dissolved and exhausted, a hollow structure of about thirty times the size of a bacterium remained, like an empty, multiwalled spherical bag.

The bag worked as a trap. The hollow microdevice lured bacteria into it and then became a toxic cage. Its inner walls were made of an acid-soluble polymer incorporating the amino acid serine—a substance that signals food to the gut bacterium Escherichia coli. The dissolving polymer released the serine, which, through a phenomenon called chemotaxis, caused the bacteria to move towards the source. Under a microscope, the researchers observed accumulation of the bacteria inside the hollow sphere.

In the final step, a toxin was activated. A polymer layer dissolved and released silver ions, which killed the bacteria. This multistage pathway represents a novel approach to making antibiotics more efficient. The authors also see it as a "first step towards chemical communication between synthetic microswimmers and motile microorganisms." They believe that the concept could be expanded to a variety of decontamination applications; for example, in the food and healthcare industries, or for security and environmental remediation.

More information: Fernando Soto et al. Onion-like Multifunctional

Microtrap Vehicles for Attraction-Trapping-Destruction of Biological Threats, *Angewandte Chemie International Edition* (2019). DOI: 10.1002/anie.201913872