Custom suits for worms that can deliver functional cargo

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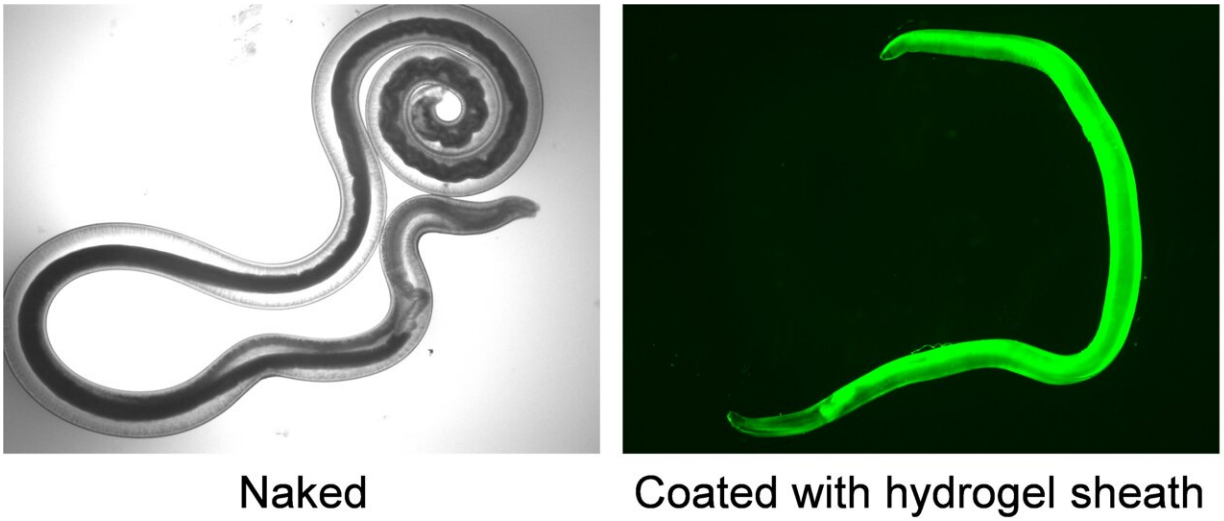

Naked A. simplex and A. simplex coated with hydrogel sheath containing fluorescence dye. Credit: Shinji Sakai

James Bond's legendary quartermaster Q provided the special agent with an endless array of tools and gadgets to help him accomplish his missions. Now, researchers from Japan have demonstrated equal prowess at equipping microscopic worms with a surprising arsenal of functional and protective factors.

Researchers from Osaka University have revealed that tiny free-range worms called nematodes can be coated in hydrogel-based "sheaths" that

can be further modified to carry functional cargo. Their study was published in *Materials Today Bio*.

Nematodes are free-living, microscopic worms that typically live in the soil or other environmental niches, and in some cases can invade the human body. Anisakis simplex, a nematode that usually lives in marine environments but can colonize humans when ingested, has demonstrated an unusual predilection for cancer cells.

"A. simplex has been reported to sense cancer, potentially by detecting a cancer 'odor,' and to attach to cancerous tissues," says Wildan Mubarok, first author on the study. "This led us to ask whether it could be used to deliver anti-cancer treatments directly to cancer cells within the human body."

To investigate this possibility, the researchers first developed a system for applying hydrogel sheaths to nematodes by dipping them in a series of solutions containing chemicals that bind together to create a gel-like layer all over their surface. This process essentially custom-fits a suit about 0.01 mm thick to the worm in about 20 minutes.

"The results were very clear," says Shinji Sakai, senior author of the study. "The sheaths did not in any way interfere with the worms' survival and were flexible enough to maintain the worms' motility and natural ability to seek out attractive smells and chemical signals."

Next, the researchers loaded the sheaths with functional molecules and found that this protected the worms from ultraviolet light or hydrogen peroxide. What's more, the sheaths could be loaded with anti-cancer agents that the nematodes, protected but unimpeded by their hydrogel armor, could transport and deliver to kill cancer cells in vitro.

"Our findings suggest that nematodes could potentially be used to deliver

functional cargo to a range of specific targets in the future," states Mubarok. Given the adaptability of the hydrogel sheaths, this worm-based delivery system holds promise not only for delivering anti-cancer drugs to tumor cells in patients, but it also has potential applications in other fields such as delivering beneficial bacteria to plant roots.

More information: Wildan Mubarok et al, Nematode surface functionalization with hydrogel sheaths tailored in situ, *Materials Today Bio* (2022). DOI: 10.1016/j.mtbio.2022.100328

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