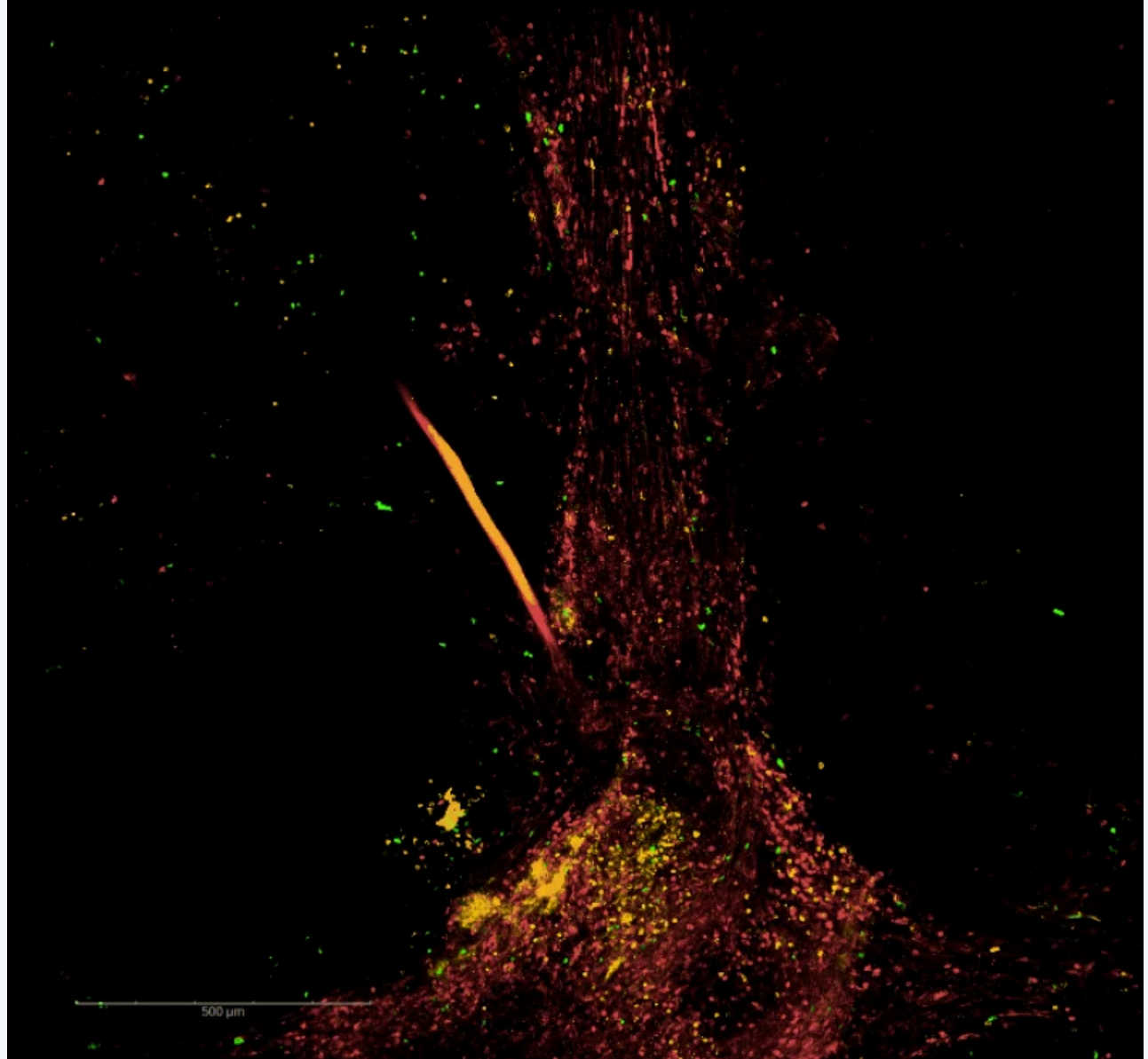




Okun
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Inside Our Research



A Lightsaber at the Brain's Border: Visualizing Immune Inflammation

This picture shows the meninges, the thin protective layers surrounding the brain, near the front part of the superior sagittal sinus, a large vein that runs along the top of the brain. These venous sinuses are increasingly understood as important 'meeting points' where immune cells can detect and respond to substances leaving the brain.

The bright fluorescent cells seen around the sinus indicate an accumulation of immune cells. This suggests increased inflammation in this area, which may be related to Alzheimer's disease.

One possible cause of this inflammation is activation of the cGAS-STING pathway, an immune alarm system inside cells. As cells age, damaged mitochondria and nuclei may release DNA into parts of the cell where it does not normally belong. The cGAS-STING pathway detects this misplaced DNA and triggers an immune response. Although this response can be protective in the short term, long-lasting activation may contribute to chronic, low-grade inflammation associated with aging, often called 'inflammaging'.

Experimental studies suggest that cGAS-STING activity increases in the aging brain and in mouse models of Alzheimer's disease, especially in microglia, the brain's main immune cells. In some mouse studies, blocking this pathway reduced inflammation, amyloid-related changes and memory problems.

The location of this response is also important. The meninges are no longer viewed simply as protective wrapping. They contain immune cells, blood vessels and lymphatic vessels that help monitor and remove waste from the brain. Researchers are therefore studying

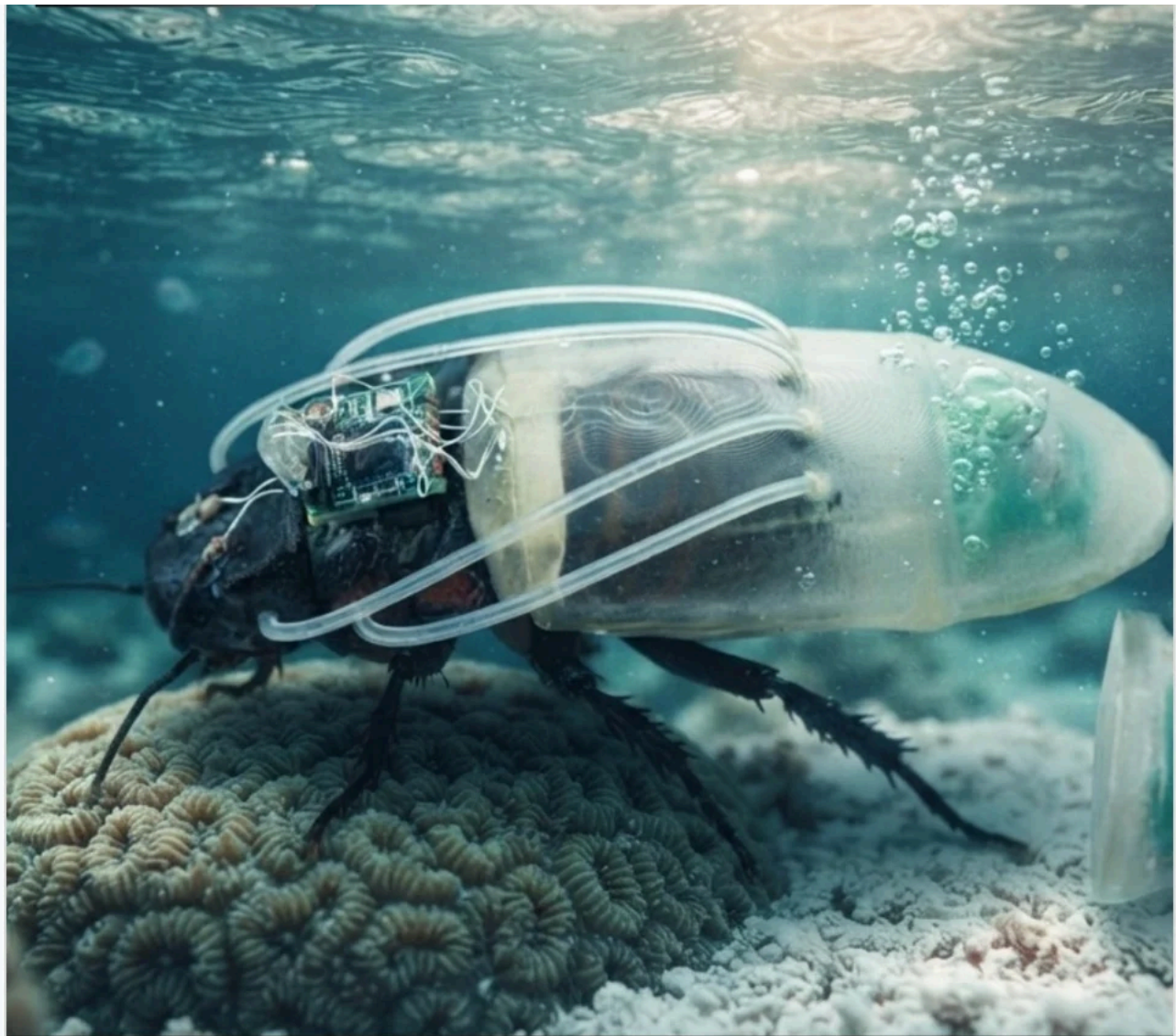
whether Alzheimer's disease involves not only changes inside the brain, but also problems with immune surveillance and waste clearance at the brain's borders.

The findings are not yet fully consistent. Some mouse studies suggest that improving lymphatic drainage from the meninges may reduce inflammation and cognitive decline, while others report little effect on the total amount of amyloid in the brain. More research is needed to determine how important these pathways are in people with Alzheimer's disease.

Back to the picture, and as homage to Star Wars, an ectopic accumulation of immune cells in the meninges, holds a saber sword.

Image credit: Tamir Hirsh. Fluorescent imaging of immune cell accumulation surrounding the superior sagittal sinus in the meninges of a mouse brain. The Paul Feder Okun Laboratory for Alzheimer's Disease Research.

Highlights From The Field



Cyborg Cockroaches: Tiny Robots Ready for Search and Rescue

Imagine a cockroach that can walk on land, dive underwater, and navigate spaces too small for conventional robots. Researchers have developed a lightweight "diving suit" for cyborg cockroaches that supplies oxygen while keeping water out, allowing them to survive and move underwater for up to three hours. Unlike traditional robots, these insect hybrids use the cockroach's own muscles for movement, making them remarkably energy-efficient while carrying only a small electronic controller.

The technology could one day help search for survivors after earthquakes, inspect flooded pipelines, or explore other dangerous environments that are inaccessible to people or larger machines. The researchers designed the miniature system to be lightweight, waterproof, and durable enough to withstand impacts while allowing the insects to move naturally across both land and water. Although still in the experimental stage, the work highlights how combining biology with engineering may inspire a new generation of highly adaptable rescue and exploration robots.

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