Worms freeload on bacterial defence systems

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Caenorhabditis elegans. Credit: Wikipedia

Scientists have untangled a sensory circuit in worms that allows them to choose whether to spend energy on self-defence or rely on the help of nearby bacteria, a new study in *eLife* reveals.

The paper describes a novel sensory circuit that, if also conserved in humans, could be used to switch on defence mechanisms and improve health and longevity.

Bacteria, fungi, plants and animals all excrete hydrogen peroxide as a weapon. In defence, cells use enzymes called catalases to break down hydrogen peroxide into water and oxygen. But it is not known whether this mechanism is coordinated across different cells.

"We speculated that coordinating these hydrogen peroxide cell defences based on environmental cues would be beneficial because it would save the energetic cost of protection," explains lead author Jodie Schiffer, a graduate student at Northeastern University, Boston, US. "We used the worm Caenorhabditis elegans to study whether the brain plays a role in this coordination by collecting and integrating information from the environment."

Schiffer and her team found 10 different classes of sensory neurons in the worms that could positively or negatively control peroxide resistance. Among them was a pair of neurons that sense taste and temperature and caused the largest increase in peroxide resistance, which the team decided to study further.

To determine how the neurons transmit messages to tell the worm to change its peroxide defence mechanisms, the team set out to identify the hormones involved. They found that when the worms lacked a hormone called DAF-7, it doubled peroxide resistance. In a process of gene elimination, they established that the neurons release DAF-7, which in turn signals through a well-known communication pathway, via cells called interneurons, to coordinate with defence systems in the intestine. Together, these control the worm's peroxide resistance.

As worms can be exposed to peroxides through food, and those with faulty DAF-7 hormones have feeding defects, the team next explored whether feeding directly affects peroxide defenses. They placed worms that had never been exposed to peroxides on plates of Escherichia coli (E. coli) bacteria—their preferred snack—and then measured peroxide resistance. They found that worms grown on plates with the most E. coli were most resistant to peroxides. By contrast, worms grown without E. coli for only two days had a six-fold drop in peroxide resistance. Worms with a mutation that slows down their eating also had lower peroxide resistance. Taken together, these results suggest that the presence of E. coli was important for peroxide resistance.

To test this, they looked at whether the bacteria can protect worms from the lethal effects of peroxides. They exposed worms to high amounts of hydrogen peroxide that would normally kill them. In the presence of a mutant E. coli that cannot produce the hydrogen-peroxide-degrading catalase enzyme, the worms were killed, whereas in the presence of wild-type E. coli, they were protected.

"We have identified a sensory circuit in the worm's brain that helps them decide when it is appropriate to use their own defences and when it is best to freeload on the protection given by others in the environment," concludes senior author Javier Apfeld, Assistant Professor at Northeastern University. "Because sensory perception and catalases also determine health and longevity in other animals, it is possible that sensory modulation could be a promising approach for switching on defence systems that could improve health and increase lifespan."

More information: Jodie A Schiffer et al, Caenorhabditis elegans processes sensory information to choose between freeloading and self-defense strategies, *eLife* (2020). DOI: 10.7554/eLife.56186

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