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Mosquito taste receptor could lead to new insect repellents

Mosquitoes are the most dangerous animals in the world. The diseases they transmit have spread death and misery since time immemorial. *Aedes aegypti* is a particularly treacherous mosquito because it infects many tens of millions of people each year with the viruses that cause dengue, Zika, yellow fever and other diseases.

Repellents like DEET are one part of a multi-pronged defense, driving the insects away with unpleasant odors or tastes. However, DEET only lasts a few hours, damages many synthetic materials in clothing and gear, and can cause irritation or headaches. Better understanding the receptor proteins that mosquitoes use to taste chemicals could lead to improved repellents.

A research team at UC Santa Barbara led by Professor Craig Montell identified the first known taste receptor in the mosquito gustatory system. The receptor detects fatty acids — a naturally occurring component of human skin chemistry — which seem to taste bad to the insects. The receptor, called “Painless1,” presents a promising target for a new class of safer, more effective mosquito repellent. The study, focused on the species *Aedes aegypti*, appears in the Proceedings of the National Academy of Sciences.

“We discovered that the taste of fatty acids on skin causes a stop-feeding signal, which depends on a type of receptor specific to insects and other arthropods,” said Montell, the Duggan Professor and Distinguished Professor of Molecular, Cellular and Developmental Biology. “So chemicals that turn on this channel may prevent biting

without causing harm to people.”

Homing in on a host is a multisensory experience for a mosquito. It involves sight, smell, temperature, humidity and even infrared detection, as the Montell Lab previously discovered. Upon landing, a mosquito uses taste receptors on its legs and proboscis to decide whether to bite or fly away. Montell wanted to identify the taste receptors involved in this.

His team — Subash Dhakal, Angela Bontempo, Ramandeep Singh and Pratik Dhavan — focused on Painless1 (named for the nociceptive role that its analog plays in fruit flies). Painless1 is part of a class of receptors known as transient receptor potential channels, or TRP channels. These are proteins embedded in a cell membrane, and have many roles in sensory biology. They’re essentially gates that open when triggered, allowing positive ions to flood into a neuron and activate it. Montell first identified TRP channels in 1989 during his early work studying vision in fruit flies.

In addition to its involvement in processing noxious stimuli, Painless (the fruit fly version) is also present in the fly’s gustatory system. Montell’s team identified its counterpart, Painless1, in the *Aedes aegypti* taste organs on its legs and proboscis.

The authors used CRISPR-Cas9 to knock out the gene that codes for Painless1 in the mosquitoes, and performed assays to gauge the effect of eliminating Painless1. Their results demonstrated that this channel was a necessary part of the aversion the mosquitoes have toward fatty acids.

Ironically, fatty acids are one of the cues that attract mosquitoes to their hosts before landing. These compounds only become repellant once the insect actually touches down and switches from olfaction to taste. The fatty acids activate the Painless1 receptor on the mosquito’s legs and mouth, discouraging it from biting in the first place. “I was a little surprised that the same kinds of chemicals that are olfactory attractants also stop the mosquito from feeding,” Montell said.

But Painless1 is involved in the mosquito’s ability to taste fatty acids, which send it packing. So a chemical that activates this receptor could be a promising basis for stronger, safer mosquito repellent. “And because humans don’t have that particular TRP channel you don’t have to worry about such a chemical doing anything bad to us,” Montell said.

Developed in 1944, DEET is the most common active ingredient in insect repellents. Although an effective deterrent, it comes with a number of drawbacks. Montell and his lab members are very interested in developing a new class of safe, long-lasting repellents.

Tags
Health and Medicine

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