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RESEARCH NEWS

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Researchers Identify Fly Genes Governing Taste, Smell

Scientists have identified a large family of fruitfly genes involved in taste and smell and taken a significant step forward in deciphering the molecular logic underlying odor and taste perception.

By characterizing a family of genes that code for the chemical receptors arrayed on the flies' proboscis, antennae, legs and larval chemosensory organs, the scientists have gained a better understanding of the animals' strategies for detecting chemicals.

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— Richard Axel

The study characterizing and extending the family of fly genes known as *GR* genes, for gustatory receptors, was reported in the March 9, 2001, issue of the journal *Cell* by a research team led by Howard Hughes Medical Institute (HHMI) investigator Richard Axel at Columbia University.

"The advantage of working in the fly is that the system is far simpler and the fly expresses fewer receptors," said Axel. "Since there are also far fewer neurons, we anticipate that higher-order processing will be equally simpler. Finally, the genetic facility of the fly and the relatively simple behavioral repertoire might make it possible to relate the recognition of chemosensory cues with specific behaviors."

In the latest work, Axel and Kristin Scott at Columbia in collaboration with HHMI investigator Charles Zuker at the University of California, San Diego, drew on earlier studies by Yale University researchers Peter Clyne and John Carlson, who identified a family of *GR* genes that coded for the possible gustatory receptors in *Drosophila* . In extending the studies by the Yale scientists, Axel and Scott used a technique called *in situ* hybridization, as well as genetic experiments, to determine where these receptor genes were expressed.

"Clyne had suggested that this new family of genes encoded gustatory receptors," said Axel. "When we examined the expression patterns of the individual gene family members, we indeed found that several members of the gene family are expressed in gustatory organs in the flyeither in the proboscis, which is the fly equivalent of the tongue, or in gustatory organs of unknown function.

Axel and his colleagues also identified additional members of the *GR* family, adding 23 new members and extending the gene family to 56 members. They also compared the proteins encoded by these genes in the *GR* family, and found that they shared little sequence similarity aside from a short sequence at one end that is conserved among the family members. This signature sequence resembles a similar sequence found in a *Drosophila* odorant receptor (*DOR*) gene family, indicating that the two families share a common evolutionary ancestor.

In studying how the *GR* genes were expressed in fly larvae, the scientists found that most genes are expressed in only one neuron. Studies of *GR* gene expression also revealed that the genes were expressed on such structures as antennae, for example, that suggested that the *GR* receptors also played an olfactory role.

According to Axel, the *Drosophila* studies contribute to a broader understanding of olfactory and taste perception. "There is a remarkable conservation of much of the logic of olfactory perception between insects and mammals, such that the basic principles of odor discrimination, we believe, have been conserved over 500 million years," he said. "The implication is that insects evolved an effective solution to an inordinately complex problemthe problem of odor recognition amidst an array of tens of thousands of different odorsand that this solution has been maintained over evolutionary time."

This solution involves the production of a multitude of odorant or taste receptors that are "tuned" to a single chemical, said Axel. However, each neuron expresses only one type of receptor, and each specialized neuron wires itself to a spatially fixed locus in the sensory way station, called the glomeruli, in the brain.

"The conceptual problem that emerges from such a model is the problem of how the map is read," said Axel. "How is it that a specific array of activated glomeruli encode a specific odor, such that the odor can elicit a specific behavior and moreover that odor can be learned and associated with other sensory stimuli?

Insights into *Drosophila* olfaction and taste could lead to methods that are more effective at protecting crop plants and humans from insects, said Axel. "Insects use smell and taste to find plant food sources, and in the case of insects like mosquitoes, human hosts," he said. "So, in the long term one might imagine chemicals that could divert insects from agricultural food sources without the use of pesticides; or improved insect repellants for humans. Or, one might develop an antagonist that would prevent feeding on crop plants."