Neurons in zebrafish may reveal clues to the wiring of the human ear

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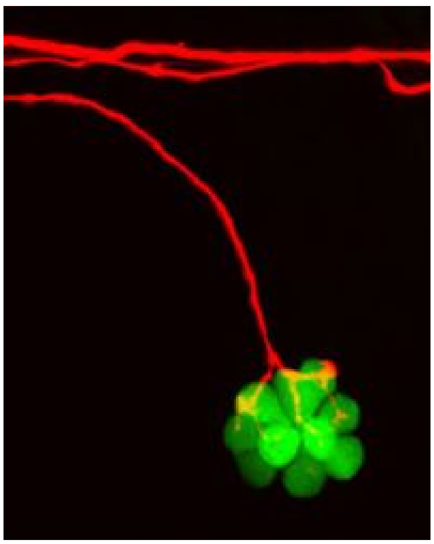

The right match. A zebrafish nerve fiber (red) descends toward a cluster of motion-detecting hair cells (green), synapsing only with those that detect water disturbances coming from the same direction.

(PhysOrg.com) -- Developing neurons tend to play the field, making more connections than they will ever need. Then, the weakest are cut. But Rockefeller University scientists now show that neurons in young zebrafish — vertebrates, like humans — behave differently: They immediately find a cluster of specialized cells and make the right match. The findings may help reveal the mechanism by which analogous cells are wired in the human ear, and eventually help those who are deaf or hard of hearing.

“These neurons seem to come out of nowhere and know exactly where to go,” says first author Aaron Nagiel, a biomedical fellow who works with James Hudspeth, head of the Laboratory of Sensory Neuroscience and an investigator at Howard Hughes Medical Institute. “The nerve fiber heads straight for its target, suggesting the brain takes a hardwired approach to assessing its surroundings.”

That target: hair cells, sensory cells with discrete bundles of hair-like projections called stereocilia, which increase in length from one edge of the hair bundle to the other. When deflected, the stereocilia can detect vanishingly small sounds or motions — and the direction in which the stereocilia are deflected determines the response of the hair cell. Nagiel and Hudspeth found that nerve fibers coming from the head only form connections with hair cells that detect stimuli coming from the same direction.

“The sister cells are mirror images of each other, and somehow they are able to advertise their different polarities,” says Nagiel. “The hair cells could be using a chemical cue to tell the neuron, ‘We are the right match.’”

Specifically, Nagiel and Hudspeth studied the zebrafish’s posterior lateral line system of cells whose hair-like projections are directly exposed to the water and sense its movement. The posterior lateral line, which runs horizontally from the zebrafish’s neck to its tail, is dotted with several clusters of hair cells called neuromasts, which are distributed in precise locations and contain up to 20 cells each. By using live imaging techniques with a confocal microscope and special dyes, the researchers found that nerve fibers form connections with many hair cells of the same polarity within one neuromast or several of them.

But that’s not all. Up to now, Nagiel and Hudspeth had showed that neurons and hair cells make contact. вЂњBut we wanted to rigorously show that these contacts were synapses," says Nagiel. To do so, Nagiel and his colleagues constructed a molecule that enabled the team to look at the two cells' point of contact underneath an electron microscope, a powerful camera that can image objects smaller than one-millionth of an inch.

"Once hair cells gather information from the environment, these synapses allow this information to be relayed to the brain," says Nagiel. "That way, the zebrafish can respond accordingly."

As for human medical therapies, several promising advances have emerged that can stimulate the growth of new hair cells in those who are deaf or hard of hearing. "Our work might eventually give us an idea of possible ways to make sure these hair cells get wired appropriately to the brain," says Nagiel.

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