Scientists learn what's 'up' with a class of retinal cells in mice

March 27 2008

Harvard University researchers have discovered a new type of retinal cell that plays an exclusive and unusual role in mice: detecting upward motion. The cells reflect their function in the physical arrangement of their dendrites, branch-like structures on neuronal cells that form a communicative network with other dendrites and neurons in the brain.

The work, led by neuroscientists Joshua R. Sanes and Markus Meister, is described this week in the journal *Nature*.

"The structure of these cells resembles the photos you see in the aftermath of a hurricane, where all the trees have fallen down in the same direction," says Meister, the Jeff C. Tarr Professor of Molecular and Cellular Biology in Harvard's Faculty of Arts and Sciences. "When you look at these neurons in the microscope, they all point the same way. There’s no other cell type in the retina that has that degree of directionality."

The cells, like other retinal neurons, are composed of a round cell body surrounded by a tangle of dendrites. Most retinal neurons distribute their dendrites evenly around the cell body, but the upward motion-detecting cells arrange almost 90 percent of their dendrite tangle exclusively on one side of the cell body.

"This lopsided arrangement literally directs the cell's function, orienting the dendrites downward like roots of great trees," says Sanes, professor of molecular and cellular biology and Paul J. Finnegan Family Director

of Harvard's Center for Brain Science. "Because the eye's lens acts as a camera, reversing incoming light rays as they strike the retinal tissue, an object moving up will result in a downward-moving image at the back of the eye -- the exact orientation of the cells' dendrites."

The research builds on efforts by Meister to understand neural processing in the retina, as well as work in Sanes's laboratory to identify and mark neurons in the retina using molecular tags. Recently, they tracked down a family of molecules expressed exclusively by small subsets of retinal cells in mice. One in particular, called JAM-B, was present in cells that had a peculiar distribution and orientation.

According to Sanes, developmental neurologists have long tried to identify different types of neural cells based on their function and anatomy -- how they appeared on the outside.

"But it's a huge limitation because it's essentially a qualitative assessment," he says. "We really need some way to reliably identify and track these cells if we ever hope to study their development. So the emergence of cell-specific molecular markers is a very big deal, because it will do just that. Already we've seen that it helps us identify new kinds of cells we didn't know existed before. Once we have a promising molecule, we can track down the cells that it corresponds to."

"The other important result," continues Sanes, "is that we're actually mimicking how the brain itself identifies its cells. The brain has to be able to reliably recognize and tell apart different kinds of cells, and that's going to happen on a molecular basis. In fact, it’s possible that some of the molecules we've identified are, in fact, the same molecules the brain uses to distinguish cell types."

By identifying molecules that are solely expressed by specific types of neurons, scientists hope to gain insights into how nerve cells form

synapses, or connections, with other nerve cells -- in short, how the brain controls its development on a molecular basis.

For the moment, however, researchers are busy puzzling over the results of the JAM-B mouse retinal cells.

"Why in the world would mice need to develop cells to detect upward motion"" Sanes wonders. "It's a great mystery."

Source: Harvard University