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Cilia drop anchor

Neurons use cilium's transition zone to get a grip on surfaces.

Cilia hoist dust out of the lungs, propel sperm toward the egg, and enable us to catch the scent of fresh coffee. The structures also help some cells attach to their surroundings, Schouteden et al. reveal (1).

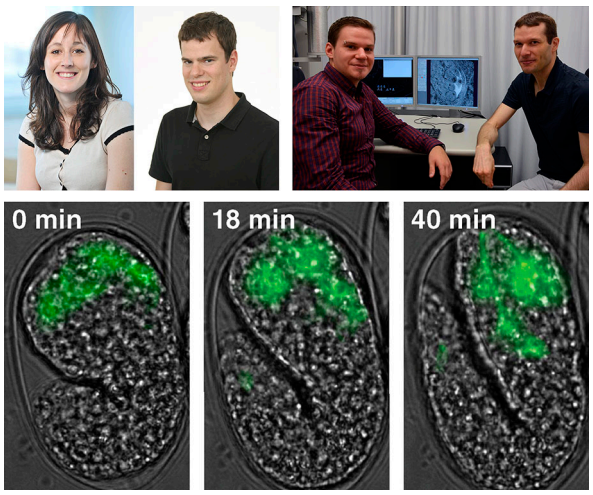
A cilium is built around the axoneme, an internal shaft of microtubules that sprouts from a structure known as the basal body. Between the axoneme and the basal body lies the transition zone, whose distinctive architecture includes a central cylinder and so-called Y-links that fasten the axoneme to the membrane of the cilium. Researchers are still trying to determine the transition zone's functions. It may serve as a gate to control which molecules move into the cilium (2). Some evidence also supports the notion that the transition zone promotes cilium assembly (3).

By studying ciliopathies, genetic diseases in which cilia are faulty, researchers have discovered three protein complexes that reside in the transition zone: MKS, NPHP, and CEP290. The roles of the individual complexes are unclear. However, research in *C. elegans* linked proteins in the MKS and NPHP complexes to the formation of the Y-links in the transition zone (4).

Schouteden et al. probed the function of the protein that gives the CEP290 complex its name. The cilia of nematodes contain a version of this protein known as CCEP-290. Only a few sensory neurons in nematodes sport cilia, and the worms appear to get along fine without these cells, so researchers can manipulate the cilia without undermining the animals' survival or reproduction.

The team found that CCEP-290 is located in the middle of the transition zone, whereas proteins from the MKS and NPHP complexes are found at its edge. In mutant worms lacking CCEP-290, the Y-links were present but the central cylinder was fragmented, suggesting that the CEP290 complex helps assemble this latter structure.

Focal Point



(Top row, left to right) Clementine Schouteden, Mate Palfy, Daniel Serwas, and Alexander Dammermann investigated the role of the protein CCEP-290 in the transition zone of cilia. They found that the transition zone isn't necessary for forming the axoneme of a cilium, but it does help certain neurons attach to surfaces. (Bottom row) In this time series of a developing worm, the cell bodies of neurons (green) migrate away from their dendrites, which are anchored by cilia.

PHOTOS COURTESY OF DAMMERMANN LAB (SCHOUTEDEN); FRANZISKA FRIEDRICH, MPICBG (PALFY); AND HARALD KOTISCH (SERWAS AND DAMMERMANN)

The researchers next asked what would happen if they disrupted all three transition zone complexes. They found that, in mutant worms, the transition zone structures largely collapsed. But the axoneme didn't. "The axoneme above the transition zone was pretty much structurally normal," says senior author Alexander Dammermann. Contrary to what researchers suspected, the transition zone isn't essential for assembly of the axoneme.

> "The axoneme above the transition zone was pretty much structurally normal."

So what does the transition zone accomplish? One answer came from neurons whose dendrites carry cilia and extend through an unusual mechanism. Rather than stretching out, each dendrite anchors to the surface and lets the body of the cell crawl away from it. Schouteden et al. determined that cells lacking CCEP-290 or other transition zone proteins moved the same distance as normal cells, but their dendrites didn't adhere.

Those findings imply that cilia anchor dendrites to their substrate. The axoneme isn't likely to make the connection, however. During worm development, dendrites extend before axoneme assembly is complete. Dendrites also latch on even if they lack a key protein from the basal body, suggesting that this structure isn't directly involved in attachment either. Instead, the researchers' results indicate that the transition zone gets a grip on the surface, linking to two proteins in the extracellular matrix: DEX-1 and DYF-7.

"We say that in addition to their well-described roles in signaling and motility, there's also a role for cilia in cell morphology by functioning in this adhesion process," says Dammermann. Cilia might anchor cells in other situations, he and his colleagues suggest. For example, during development of the cerebral cortex in vertebrates, cilia might provide traction for certain neural precursors as they push away from an epithelial zone known as the apical adherens belt. The research opens up several questions about cilia assembly and function, including what the role of cilium-mediated anchoring is in ciliopathies and how the axoneme forms without the aid of the transition zone.

1. Schouteden, C., et al. 2015. *J. Cell Biol.* http://dx.doi.org/10.1083/jcb.201501013
2. Rosenbaum, J.L., and G.B. Witman. 2002. *Nat. Rev. Mol. Cell Biol.* 3:813–825.
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4. Williams, C.L., et al. 2011. *J. Cell Biol.* 192:1023–1041.