Enzyme helps control extension of cellular tendrils by regulating delivery of supplies needed for growth

May 20 2011

An electron microscope image of a sensory bristle from the body of the fruit fly Drosophila melanogaster. Credit: Tetsuhisa Otani

The body of the adult fruit fly is covered with hair-like bristles (Fig. 1) that act as sensory organs for detecting tactile stimuli. Each one consists of a single cell that has gradually elongated over the course of pupal development, reinforced by bundles of actin protein filaments.

The signaling protein IKKε helps to regulate this process by controlling the organization of these actin bundles, but a recent study from Shigeo Hayashi and colleagues at the RIKEN Center for Development Biology in Kobe has revealed that IKKε also promotes bristle growth by managing the trafficking of cellular cargoes.

Initial experiments by Hayashi and team showed that activated IKKε is primarily found at the tips of developing bristles, where growth-associated cargoes are most likely to be unloaded. “Membranes and associated proteins are water-insoluble and thus do not easily diffuse to distant sites, and one model is that distal trafficking actively delivers such insoluble materials as packages,” explains Hayashi.

Membrane-enclosed bubbles known as endosomes are a core component in this process, using so-called motor proteins to travel along routes defined by a microscopic ‘railway’ of fibers known as microtubules. The researchers found that this trafficking is severely disrupted in the absence of IKKε, with endosomes remaining trapped at the ends of the bristle rather than being distributed throughout the cell.

Hayashi and colleagues determined that IKKε interacts with a protein called Nuf, which links the motor protein Dynein with a key endosome-associated protein and thus contributes to directional transport of cargoes toward the tip of the growing bristle. Upon arrival at the tip, IKKε-mediated inactivation of Nuf sends the newly emptied endosomes on a return trip, thereby completing a ‘recycling’ process. “Such endosomal movement occurs in other cell types, but the shape of bristles makes this shuttling very prominent,” says Hayashi. “I think this is a very good example of how a highly specialized cell and its shape can reveal a mechanism of general significance.”

Many other cells grow in a similar fashion, ranging from the tiny branches that help connect neurons to the hairs on plant roots that assist in water absorption, and Hayashi speculates that similar regulatory mechanisms may also operate in these contexts. Moving forward, he and his colleagues will further explore the apparently central coordinating role of IKKε. “We are currently studying actin as a target,” says Hayashi, “and we are also studying upstream regulators of IKKε, hoping to uncover a comprehensive view of this signaling pathway.”

More information: Otani, T., et al. IKKε regulates cell elongation through recycling endosome shuttling. Developmental Cell 20, 219–232 (2011).

Provided by RIKEN