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Hylonome

The primary cilium: What once did nothing, now does everything

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Primary cilia are microtubule-based organelles that exist in almost every mammalian cell type and function as sensors of extracellular signals. In cycling cells, they grow from the mother centriole of the centrosome during early G12 and are lost before mitosis. However, the mechanisms that govern primary cilium formation are largely unknown.

Primary cilia play important roles in developmental processes such as kidney tubule patterning and the establishment of left-right axis asymmetry and have been implicated in sensing signalling molecules including Shh and PDGF. The primary cilium grows from the centrosome, which is the microtubule organizing centre in most mammalian cell types and contains two centrioles, a mother centriole and a daughter centriole, surrounded by pericentriolar material. These centrioles each nucleate the growth of a new daughter centriole during S phase such that during G2, each cell has two centrosomes, one containing the original mother centriole and one containing a new mother centriole. Between S phase and mitosis, the new mother centriole undergoes a maturation process during which it gains a set of mother centriole-specific proteins and appendages. Because centrosomes are segregated at the spindle poles during mitosis, every cell division is asymmetric with respect to mother centriole age: one sister cell receives the centrosome with the older mother centriole, while the other receives the centrosome with the new mother centriole.

Asymmetry in the fate of sister cells after division is essential for tissue differentiation during development and is important for the maintenance of stem cell identity. Asymmetric protein localization is a hallmark of asymmetric cell division, but there is evidence that organelles and DNA also segregate non-randomly in some cell divisions. Interestingly, during asymmetric stem cell division in the *Drosophila* male germ line, the older centrosome remains in the stem cell, while the younger centrosome is segregated to the differentiating cell. However, it is unknown whether the segregation of differently aged centrosomes determines phenotypic differences between sister cells.

We report that in sister cell pairs, one cell grows a primary cilium before the other, and that this asymmetry is independent of cytoplasmic differences between sister cells. We also show that the older mother centriole usually generates a primary cilium first, and that the timing of centriole maturation relative to cell cycle progression is an important factor in this asymmetry. Finally, we show that two ciliary proteins required for development, inversin and PDGFRα, localize asymmetrically to primary cilia in sister cell pairs. These results suggest that the segregation of differently aged mother centrioles, an asymmetry inherent to every cell division, might influence how sister cells respond to environmental signals after mitosis, leading to altered behavior or fate for one or both sister cells.

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