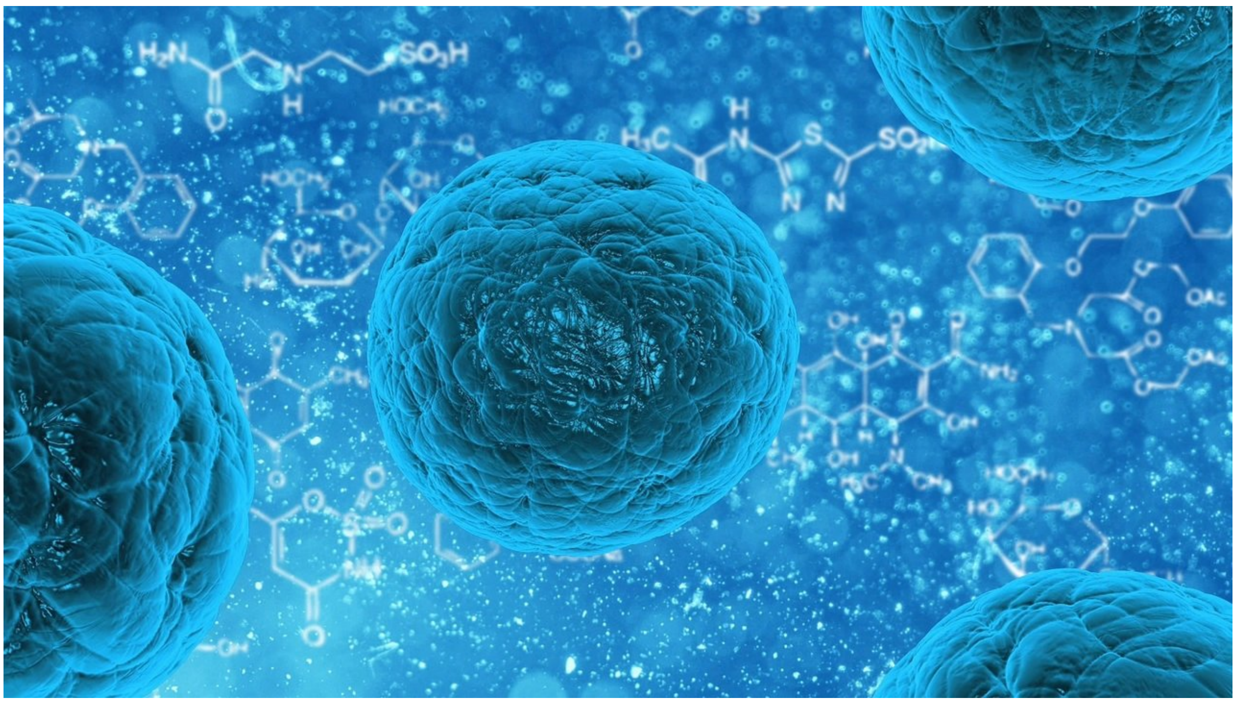
# During development, stress fibers help cells keep their shape—and may also regulate size

October 16 2020, by Morgan Sherburne



Credit: CC0 Public Domain

As organisms develop, mechanical forces exert pressure on their cells, and scientists have long wondered how cells keep their shape—and therefore remain healthy—through the process.

Now, a study led in part by a University of Michigan physicist has observed for the first time that cells use tiny fibers called apical stress fibers to help cells retain their shape during development. Additionally, the study shows that these stress fibers help the cell understand its own size and also help trigger when the cell should divide.

David Lubensky, a professor of physics and biophysics, and colleagues at U-M, the Curie Institute of the Paris Sciences and Letters University, and Sorbonne University in France looked at epithelial cells in the dorsal thorax, or lower back, of fruit fly pupae. Epithelial cells are the cells that compose surface areas in the body—they compose skin as well as blood vessels and inner organs.

The researchers found that as the fruit fly pupa develops, the fly's growing body pulls on cells in the region of the fly's lower back, and as these forces are exerted, the cells produce stress fibers to help them retain their shape in response. Their study is published in the journal *Science*.

"In development, you have an egg and you need to make it a fly. Along the way, you have to push and pull different tissues into place. The whole thing changes shape drastically, and changing shape and getting things into the right place requires actually exerting mechanical forces on them," said Lubensky, who studies the physical principles that govern the organization of living systems. "These fibers are vaguely like rebar in concrete, except the inside of a cell is more like Jell-O. But the idea is sort of the same: These linear fibers are good at resisting tension, and that strengthens the material to resist extension."

Each cell in a developing organism is surrounded by other cells; in epithelia, this dense packing shapes the cells into a polygonal or hexagonal structure. Where three cells meet each other is what's called a tricellular junction. Each junction generates these fibers, which travel toward the center of the cell in the direction of the forces exerted upon the cell. The fibers, composed primarily of a protein called actin, break apart toward the middle of the cell. Fibers are also generated in the junction opposite of the first junction and travel toward the center of the cell.

Their finding also sheds light on how the number of fibers produced varies with cell size and on how a cell knows how many of these fibers should be produced.

Cells in the epithelial tissues of the body form a tightly connected, continuous layer. The boundaries between the epithelial cells are nearly always relatively stiff because of a band of what's called cortical actomyosin that associates with the cell junctions, Lubensky says. This actomyosin associated with cell junctions is the same material that makes up the fibers. When epithelial cells are small, they need fewer fibers because these junctions keep the cell fairly rigid. But as the cell gets bigger, its softer middle becomes larger as well, requiring more fibers to keep the cell from becoming deformed.

"This is a clean example in biology of something adjusting its mechanical properties for its size," Lubensky said.

The work also revealed how these fibers may help the cell control its size. Bigger cells are more likely to divide in order to avoid becoming deformed. Lubensky examined the mechanical function of the fibers as well as how the cells know how many fibers to produce. He found that the cell uses the relationship between tricellular junctions and the cell area to scale the number of fibers within the cell area.

The researchers also found that these fibers regulate a pathway called the Hippo/YAP pathway, a pathway known to help control the growth of the cell. The team showed that components of this pathway cluster at the tips of the fiber, which affects the activity of the pathway.

"The Hippo/YAP pathway is very important in the biology world because it connects to so many processes, including cancer and tissue repair and regeneration," Lubensky said. "This finding shows we found a new way cells are regulating the Hippo/YAP pathway, and they're regulating it in a size-dependent way."

Next, the researchers hope to understand the system in more molecular detail, including determining why these fibers are born at certain junctions and break at other junctions. They hope these answers will help us understand how size is regulated in biology.

**More information:** Apical stress fibers enable a scaling between cell mechanical response and area in epithelial tissue. *Science* (2020). science.sciencemag.org/cgi/doi … 1126/science.abb2169

Provided by University of Michigan