Conditioning the Cell

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Everyone knows that by working out you are able to make your body physically stronger. But what if you could do this on the microscopic level, where it really counts?

The cytoskeleton, present in all cells, is more or less a cellular skeleton contained within a cell's cytoplasm. It maintains cell shape, helps to protect the cell, and allows for cellular motion. Eukaryotic cells contain three main kinds of cytoskeletal filaments: microfilaments, intermediate filaments, and microtubules. Microfilaments, located just below the cell membrane, are responsible for resisting tension and maintaining cellular shape. Actin, a subgroup of microfilaments, contributes to cellular functions, including muscle contraction and motility.

Networks of cytoskeletal filaments like actin have viscoelastic properties that are very different from other biopolymers. Unlike most eukaryotic components that, when strain is applied, bend and weaken, actin filaments are stressed linearly, and then begin to stiffen. This causes a nonlinear correlation between the strain applied to the network and stress put on the individual filaments, until they finally break. In other words, it's as if the actin itself gets stronger. This phenomenon is known as strain stiffening.

Using microscopic imaging of cross-linked actin networks we are able to see how the individual filaments react to shearing. With further research, we can better understand the motility of these biopolymer networks, which could allow for further mechanisms by which cells can be made to respond to, and model, the mechanical characteristics of these networks. In essence, stronger cells make stronger beings.

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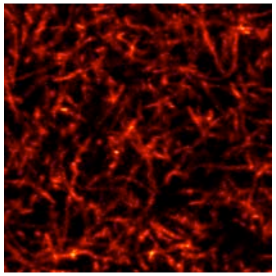
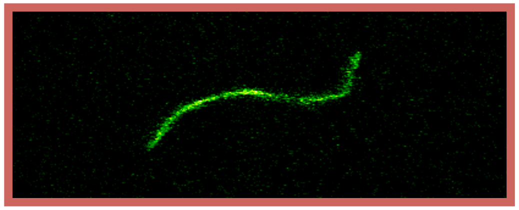
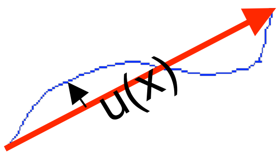


Actin Network



One of thousands of individual filaments in a dense actin network.



An actual filament.
The red line is the end-to end distance and u(x) represents the deviation of this. What we want to know is how the amplitude, u(x), changes when the strain put on the filament increases