From mechanical resilience to active material properties in biopolymer networks

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The cells and tissues that make up our body juggle contradictory mechanical demands. It is crucial for their survival to be able to withstand large mechanical loads, but it is equally crucial for them to produce forces and actively reconfigure during biological processes such as tissue growth and repair. The mechanics of cell and tissues is determined by fibrous protein scaffolds known as the cytoskeleton and the extracellular matrix, respectively [1]. Fibrous networks have many advantageous mechanical properties: fibers can form space-filling elastic networks at low volume fractions and they reversibly stress-stiffen, which provides protection from damage. It is still poorly understood how biopolymer networks can combine these features with the ability to dynamically adapt their structure and mechanics. I will summarize recent insights in this question obtained via quantitative measurements on reconstituted biopolymer networks across molecular to network scales. I will focus on the cytoskeleton, which combines mechanical strength with the ability to generate forces by means of active filament (de)polymerization and the action of motor proteins, and on the extracellular matrix, which is adaptive due to mechanochemical activity of resident cells.

[1] F. Burla, Y. Mulla, B.E. Vos, A. Aufderhorst-Roberts, G.H. Koenderink, , Nature Physics Reviews 1, 249 (2019).