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The material world of the human body: from molecule to tissue to disease

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Our bodies are built up of cells and tissues with unique physical properties. Cells and tissues are living materials that combine high mechanical stability with active reshaping. This paradoxical mechanical behavior is governed by fibrous protein scaffolds known as the cytoskeleton and the extracellular matrix. 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. However, 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 the fundamental mechanisms from molecule-to-tissue obtained via quantitative measurements on cells and tissues and on simplified reconstituted model systems. In addition, I will discuss connections to applications in biomedicine, in particular for understanding the role of aberrant cell and tissue mechanics in cancer, fibrosis, and osteoarthritis.

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