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Geometry, Mechanics, and Microstructure: Relating Structure to Function in Articlar Cartilage

JESSE SILVERBERG, Wyss Institute for Biologically Inspired Engineering

Climbing cucumbers, popping pollen grains, wrinkled fingers, and curly hair. At heart, the modern revival of mechanics covers a diverse range of biological materials living at the intersection of function and form. It's at this point, where geometry, mechanics and microstructure meet, that we find buckling instabilities, mechanical phase transitions, exotic stress responses, and fracture. While these phenomena are widely observed in many inert materials, we also find them being actively employed in biological tissues, where they have evolved as essential tools for survival. In this talk, I'll specifically address articular cartilage, a biological material that enables smooth and painless joint motion. Using a combination of experimental techniques, an unusual structure-function relationship for this material is empirically determined, and a model based on percolating fiber networks is offered as a solution. In the end, a central theme will emerge placing this tissue in the wider context of "elastic network materials," and a wider need for advanced imaging methods will be called for.