Experimental Cell Mechanobiology: The Need for Theoretical Modeling

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Mechanical forces influence many aspects of human health and disease. Gravity, tension, compression, fluid shear stress, and hydrostatic pressure are just a few examples of the forces that constantly act on cells within tissues and organs and cause their physiological and pathological changes. Cell mechanobiology is concerned with the effects of mechanical forces on cells and the mechanotransduction mechanisms by which forces are transduced into a cascade of cellular and molecular events. In this presentation, I will first describe general effects (e.g., increased muscle mass) of mechanical forces on the human body to highlight the concept that cells are the central player in realizing these physiological and pathological effects. Second, I will discuss our research on cell contraction, as well as its relationship with the formation of cell proliferation and differentiation patterns. Research questions will be posed to emphasize the need for modeling work in order to deepen understanding of cell behavior in a mechanical environment. Finally, our recent work on tendon stem cell mechanobiology will be presented, and I will discuss the need for mathematical models to better define the relationship between mechanical force and division of stem cells and to better characterize the cells' phenotypical changes in response to mechanical force.