Form and Function in Multiscale Cardiac-Inspired Sensors for Experimental Biomechanics

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Abstract: Modern manufacturing requires that we work across multiple length scales. I study the biomechanics of microscale and nanoscale actuators from the heart, and I build microscale and nanoscale tools so that I can perform both classical and novel mechanics experiments *in vitro*. In muscle tissue, form and function go hand in hand. In the heart, there is exquisite organization at every scale and this multilevel structure imbues the heart with its tunable contractile properties. After a heart attack, regions of the heart can stiffen and become like scar tissue, thereby disrupting the function of the heart and often leading to heart failure. Stem cell based therapies offer opportunities for restoring function, and such approaches will require tools for assessing the functionality of these cells, which are notoriously difficult to manipulate and assay. I will present a micropost-based functional assay for primary and stem cell derived cardiomyocytes. Piezoresistive cantilevers were used to calibrate the micropost sensors for accurate and precise nanoNewton-level measurements. I will also present my work on another biosensor, a planar and conformal, stretchable electrode array with strain-invariant properties. Currently, I study pediatric-specific mutations in the human β-cardiac myosin using kinetic-, motility-, and optical trap-based assays. These mutations have been associated with early presentation of Hypertrophic Cardiomyopathy, and biomechanical studies of mutant proteins will help shed light on the mechanism of disease. In order to better control myosin placement and density, I have also worked to introduce DNA origami-based components into motility assays. The introduction of nanoengineered origami substrates allow us to study the emergent mechanics of the multiprotein, acto-myosin contractile system and scale up towards larger, more biomimetic reconstituted systems. This work on compliant substrates and contractile systems at the microscale and nanoscale will form the basis my future work.

Bio: *Rebecca Taylor* is a mechanical engineer who specializes in biomechanics and modern manufacturing. She received her Bachelor of Science in Mechanical Engineering from Princeton University in 2001. After working in product design for 5 years, she returned to complete her Masters (2010) and Ph.D. (2013) in Mechanical Engineering at Stanford, where she focused on microfabrication and biomechanics in the Pruitt Microsystems Group. Dr. Taylor's thesis work involved the fabrication and testing of microscale sensors for the functional assessment of primary and stem cell derived cardiomyocytes. Dr. Taylor is currently a Postdoctoral Fellow in the lab of Dr. James Spudich in the Biochemistry Department at the Stanford University School of Medicine. She applies her knowledge of micro- and nano-scale mechanics and manufacturing to measure the biomechanical properties of the primary contractile protein in the human heart, β-cardiac myosin.