SCIENCE AT THE EDGE

2018 SEMINAR SERIES

Quantitative Biology Graduate Program | Gene Expression in Development and Disease

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"Inter-constituent interaction in soft biological tissues: What do cells really feel?"

Every soft biological tissue is, in essence, a composite material. Within each tissue, multiple constituents can be found including cells, collagen fibers, elastin and glycosaminoglycans/proteoglycans (GAGs/PGs). While the content of each constituent with respect to one another and the cell type are specific to different tissue, the main structural constituents are, for the most part, common across different tissues. Several of these constituents play an important biochemical role in regulating the homeostatic condition, however they also contribute to the mechanical behavior of the tissue, which is often ignored. In this talk I will discuss how different constituents contribute to the overall mechanical behavior of soft biological tissues, specifically in arteries and in the left ventricle.

Many forces and deformations are at play in the cardiovascular system, where the arteries function essentially as high pressure vessels and the heart function fundamentally as a mechanical pump. Therefore, mechanical characteristics of the arterial and myocardial wall are critical factors in ensuring their proper function. Further, it is generally accepted that cells respond in a biochemical manner to forces and deformations applied to them (i.e., mechanotransduction), and that pathological conditions, e.g. increased pressure in hypertension, can result in changes in the mechanical structure of the tissues, such as stiffening of the arteries.

In addition to external forces such as blood pressure, there are also internal forces exchanged between the constituents (e.g., cells, GAGs/PGs, and collagen and elastin fibers) that coexist in the tissue. Essentially, since the structural constituents in the arterial and myocardial wall are in physical contact, it is reasonable to hypothesize that there are some mechanical interactions between them, where they can "push and pull" one another exchanging forces and deformations. Evidence of the existence of these interactions can be identified in the presence of "hidden" internal forces that can be released by applying cuts to the tissue. These "hidden" forces can contribute substantially to the load experienced by the cells, while at the same time cells may modify these interactions to alter their loading state. I will show how each tissue constituent contributes to the existence and distribution of these internal forces through combining experimental measurements and modeling. I will also demonstrate how the magnitude and distribution across the arterial and myocardial wall of these forces are affected by the interplay of multiple constituents.

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