An Integrative Multi-Scale Model of Extracellular Matrix Mechanics in Vascular Remodeling

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In this project, we seek to develop a multi-scale predictive mechanobiology model of vascular extracellular matrix (ECM) mechanics from a fundamental mechanics perspective coupled with critical biophysical input, and to provide a clinical relevant relationship between biomechanical integrity, biochemical composition stability, and microstructure of the ECM. The research goal will be accomplished through two specific aims that couple modeling and experimental work for a complete model development and validation. We will create a multi-scale model to describe the macroscopic tissue-level mechanical behavior of ECM based on its structure and biochemical composition. A statistical mechanics based constitutive model will be established to achieve the link between scales and across hierarchies within ECM.

Models that can incorporate fundamental physics with patient-specific data are essential for the development of vigorous multidisciplinary research program focusing on cardiovascular mechanics and imaging. The multi-scale mechanobiology model integrating ECM structure and molecular basis that mediate ECM mechanics is critical for future therapeutic intervention in a variety of diseases. Results from this research will establish a foundation to investigate the role of microstructural components in vascular remodeling.