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Project 1: Fluid-Induced Oscillatory Shear Stress (OSS) Mechanobiology of Valve Endothelial Cells (VECS)

The regulatory responses of VECs by OSS for regenerative therapeutics and for disease development are not well-understood. Our laboratory has shown direct links in the regulation of cell phenotype by OSS. This project will require static and dynamic (OSS) culture of VECs in both 2-D and 3-D settings. The end-goal of this is two-fold – (i) by exhaustive gene expression analyses (via RT-PCR), identify a specific range of OSS that leads to disease versus normal valve cell and tissue phenotypes and (ii) Leverage an identified magnitude of OSS to engineer *de novo* valvular tissues for enabling a regenerative approach to treating heart valve diseases and defects. Note that surgical training for *in vivo* procedures in a rat model will be a part of this research. Knowledge of cell and tissue culture, basic cell and tissue analyses (cell viability assessment, etc.) and RT-PCR will be advantageous for this project.

Project 2: Image-capture assembly to quantify dynamic leaflet curvature and strain as a function of elastin content

Aortic valve calcification (AVC) is projected to reach epidemic proportions in the next 30 years. Other than surgical valve replacement or repair, no other viable treatment is currently available. Early prediction of AVC onset via the identification of specific structural, biophysical, biochemical and biomechanical bio-markers would facilitate more effective management of patient health, potentially preventing or delaying AVC. This study builds on early evidence suggesting a link between aortic valve leaflet curvature and its loss of elastin, a precursor to AVC. Investigations will require the set-up of an image capture system that involves system validation and subsequently, utilization of the system to capture leaflet curvature and strain over multiple phases of a cardiac cycle. The procedure will serially be repeated for valves that have been enzymatically degraded for elastin content. Knowledge of MATLAB, Use of high-speed imaging cameras and basic knowledge of mechanical testing will be advantageous for this project.