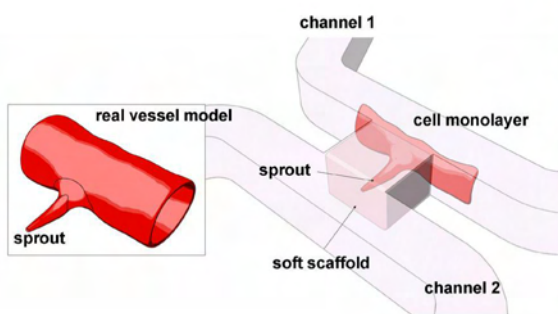


# Microfluidic Systems for the Study of Vascular Networks

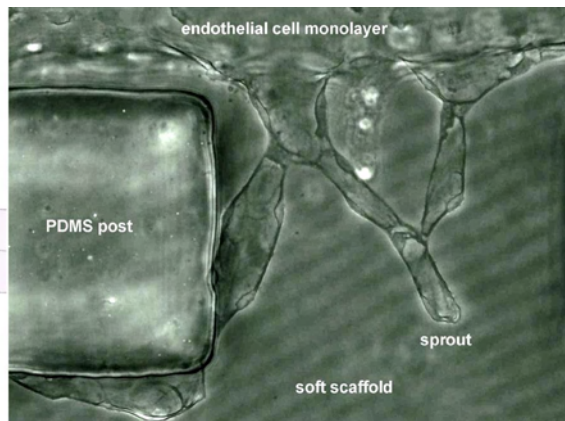
S. Chung, V. Vickerman Kelly, R. Sudo, R.D. Kamm  
Sponsorship: Draper Labs, NIH NIBIB

Mechanical forces are important regulators of cell biology in health and disease. Cells in the vascular system are subjected to fluid shear stress, cyclic stretch, and differential pressure [13],[3], and at the same time they receive multiple biochemical cues. All these factor into the integrated response of the tissue. A microfluidic bioreactor has been constructed to facilitate studies into the roles of both biophysical and biochemical factors on capillary morphogenesis. The device is fabricated from PDMS, cured on an SU8 patterned wafer. Then a scaffold material, collagen, is introduced into a specific region in the device that was designed to provide gel stability and ready access to the two sides of the collagen gel, and to facilitate microscopic imaging. Cells are seeded via one flow channel on the surface of the scaffold and then subjected to controlled mechanical factors such as surface shear stress and transendothelial pressure, or biochemical angiogenic factors, inducing the formation of vascular sprouts that extend across the scaffold to a second flow channel. With the bioreactor, cells on the scaffold form a confluent monolayer and generate sprouts. They exhibit different responses and interactions with the scaffold, depending on the angiogenic factors, fluidic factors, surface characteristics and scaffold properties.

Experiments are now underway to find the relations between cell responses and controlled factors. The developed system is the first that can simultaneously control biochemical and mechanical factors together, and it can be used for comparing the effects of angiogenic factors in a regulated environment with high resolution imaging. It can also be applied to study the process of angiogenesis that entails the growth of vascular sprouts emanating from one endothelial surface and connecting with the other.



\*\*\*\*\*  
▲ Figure 1: Concept drawing of the developed device. Seeded monolayer on the scaffolding mimics the wall of a real artery or vein.



\*\*\*\*\*  
▲ Figure 2: An MVC sprout formed in collagen gel emanating from the cell monolayer.

## REFERENCES

- [1] L. You and C.R. Jacobs, "Cellular mechanotransduction," in *Nanoscale Technology in Biological Systems*, Boca Raton, Florida: CRC
- [2] P. Carmeliet, "Angiogenesis in life, disease and medicine," *Nature*, vol. 438, pp. 932-936, Dec. 2005.
- [3] L. Coultas, K. Chawengsaksophak, and J. Rossant, "Endothelial cells and VEGF in vascular development," *Nature*, vol. 438, pp. 937-945, Dec. 2005.