Vascularization is critical for tissue engineering as it provides blood flow to transfer oxygen, delivers nutrients, and removes waste. Engineering a functional vascular network enhances success of integration with host vasculature after implantation. Currently, in vitro models do not fully capture the dynamic and multicellular morphogenic process that occurs during angiogenesis, while current in vivo animal models suffer low throughput and are ethically controversial.

**Project Goal:** Engineer a unique organotypic model of angiogenic sprouting and neo-vascular formation by creating artificial vessels fully encapsulated within a 3D collagen hydrogel matrix. Mimicking vascularization provides knowledge of potential wound healing applications and cancer metastasis for personalized medicine.

**Materials and Methods**

Using a PDMS (polydimethylsiloxane) microfluidic chip, an in vitro fluidic system was able to be successfully modeled, which demonstrated channel flow and new blood vessel growth.

1. **Fabrication of Microfluidic Device:** Single-Channel AngioChip

   **Figure 5.** Schematic of hydrogel formation in a microfluidic device, cell seeding, and introduction of flow.

   **Two-Channel AngioChip Assembly and Collagen Hydrogel Integration**

   **Figure 6.** Collagen, an extracellular matrix protein, is placed in the center well to help support and stabilize cell morphology. The rheology, or elasticity, of collagen at a higher stiffness promotes more protein availability for attachment and smoother channel formation. Channels encapsulating endothelial cells are created by extracting gelatin-coated acupuncture needles. The microfluidic devices demonstrate flow through these channels, offering a sealed, in vitro system for studying angiogenic processes.

   **In Vitro Vessel Formation and Angiogenic Sprouting**

   **Figure 7.** In the presence of growth factors, HUVEC (endothelial) cells initiate angiogenic sprouting. By day 3, sprouts begin to form primitive vascular structures. Stalk cells provide support while tip cells exhibit migratory behavior. After 7 days, the sprouts mature into functional blood vessels, allowing for oxygen and nutrient transfer to local tissues.

**Background**

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