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"Engineering self-assembling vascular constructs for a membrane free-microphysiological system"

Microvasculature mediates the pathophysiology of nearly every disease, and there is an urgent need to better understand how it impacts the initiation, progression, and conclusion of disease. To this end, it is essential to have a reliable method for constructing vascular networks in vitro which phenotypically resemble the human body. Here we optimize the morphology of self-assembling microvascular networks in collagen-fibrin hydrogels for use in a perfusable, membrane-free organ chip (MFOC). Human umbilical vein endothelial cells (HUVEC) and human lung fibroblasts (HLF) were co-cultured in collagen-fibrin hydrogels and vasculogenesis was observed to begin within 24 hours and continue for 8 days. After 8 days of culture, the resulting vascular networks were stained, imaged, segmented, and analyzed. Network analysis included quantification of vessel length, vessel diameter, branchpoint count, tortuosity, and diffusion distance. Collagen concentration, fibrin concentration, cell seeding density, O2 tension, and HLF/HUVEC seed ratio were shown to have significant impacts on network morphology. This characterization of in-vitro vasculogenesis will have significant utility for engineering vascular networks that morphologically resemble the microenvironment of a targeted pathology.