Electronic Supplementary Material (ESI) for Lab on a Chip.

Supplementary File: "Design and Construction of Three-Dimensional Physiologically-Based Vascular Branching Networks for Respiratory Assist Devices," by J. Santos *et al.*

This supplementary file presents images representing the horizontal blood distribution manifolds in the microfluidic oxygenators reported in the main file. **Figures S1-S4** below are of a RAD2 device with 200 µm tall channels, and **Figures S5-S8** are of a RAD1 device with 65 µm tall channels. **Figure S1 and S5** show the branching pattern with curved transition regions from the trunk line into the gas transfer channels of a device layer. In **Figure S2 and S6**, a side view shows the smoothly varying depth changes ranging from the tubing inlet at the left to the gas transfer channels at the right. **Figure S3 and S7** represents a COMSOL simulation of the blood velocity distribution through the horizontal layer trunk line, bringing blood into the 176 parallel channels in a RAD2 device layer and 120 channels in a RAD1 device layer, respectively. The scale shows the range of blood flow velocities seen in this trunk line; in the Rad 2 device the highest flow is present at the D-shaped connector where the blood enters each layer as the inlet hole remained scaled to the connector tubing. **Figure S4 and S8** shows a line plot of velocity distribution across the end of the manifold going into each channel. The velocity profile is uniform across all channels, within computational error.

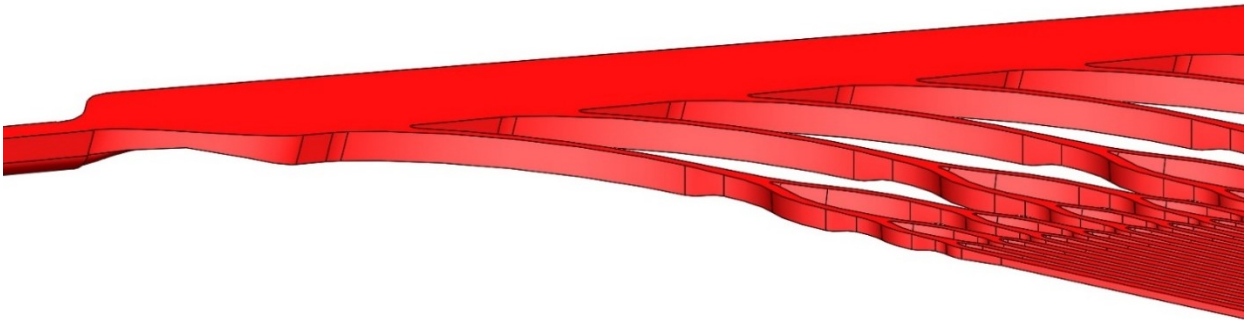

Figure S1. Image of branching channels with smoothly varying depths coming off of the horizontal manifold trunk line in RAD2 device.

Figure S2. Side view of variable depth along the trajectory from the tubing inlet (U-shaped feature) to the gas transfer channels at the right in RAD2 device.

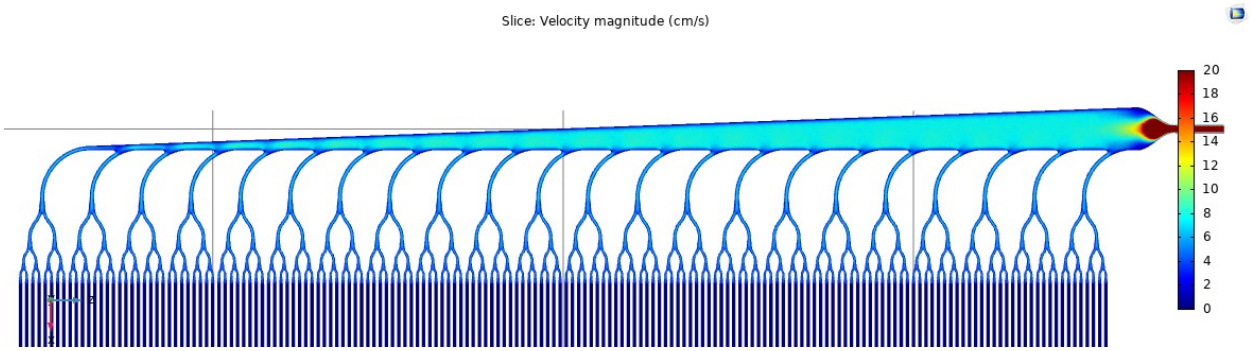

Figure S3. COMSOL simulation of blood velocity distribution in the distribution manifold region and leading into the gas transfer channels of a single-layer RAD2 device.

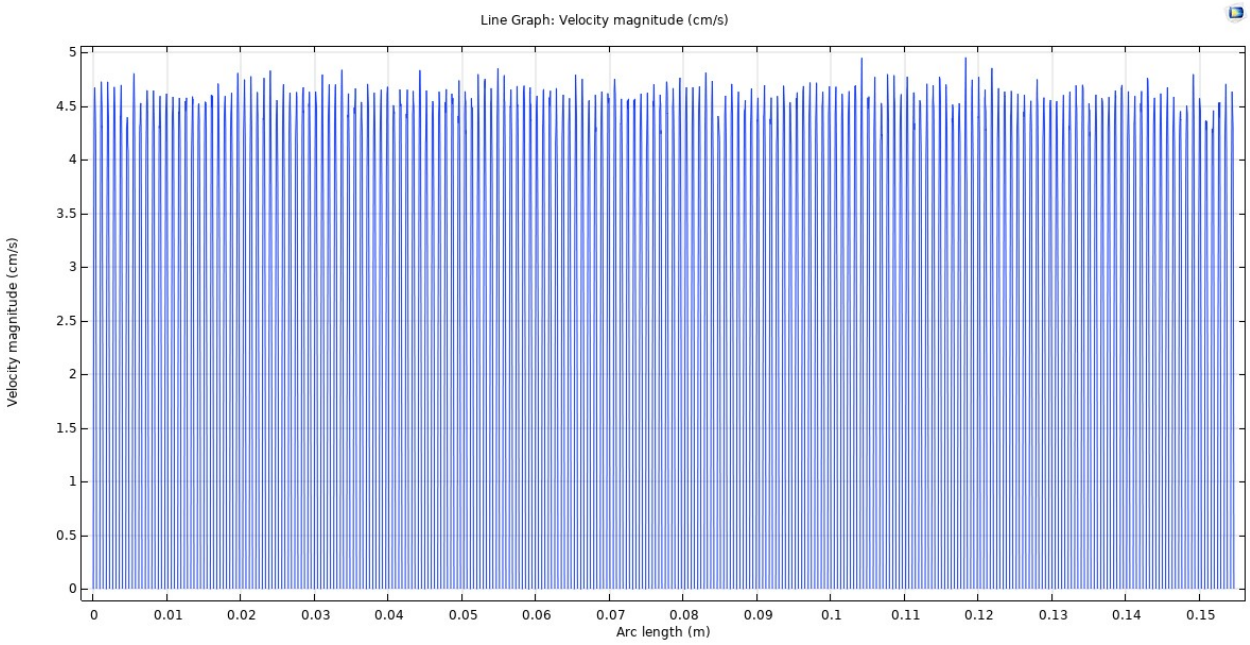

Figure S4. Line plot of velocity across channel inlets from COMSOL simulation results of RAD2 layer, showing uniform maximum velocity (within computational error) across all channels.

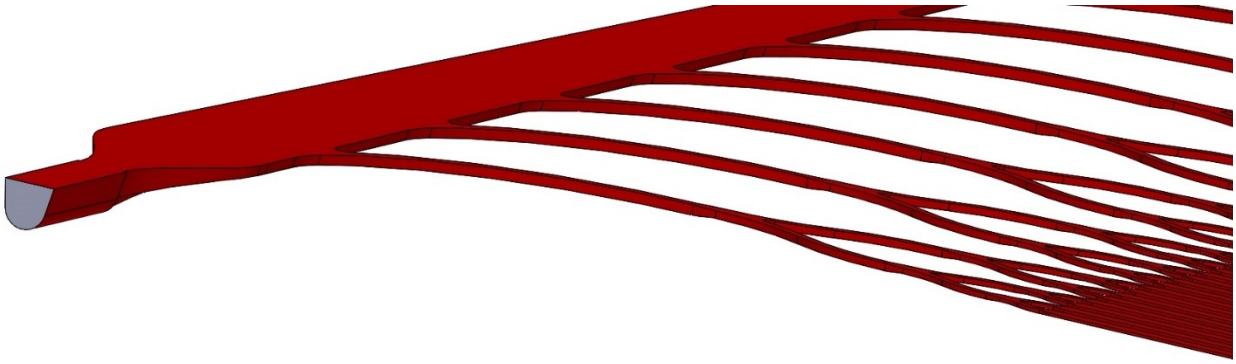

Figure S5. Image of RAD1 branching channels with smoothly varying depths coming off of the horizontal manifold trunk line.

Figure S6. Side view of variable depth along the trajectory from the tubing inlet (U-shaped feature) to the gas transfer channels at the right in a RAD1 device with 65 µm channel depth.

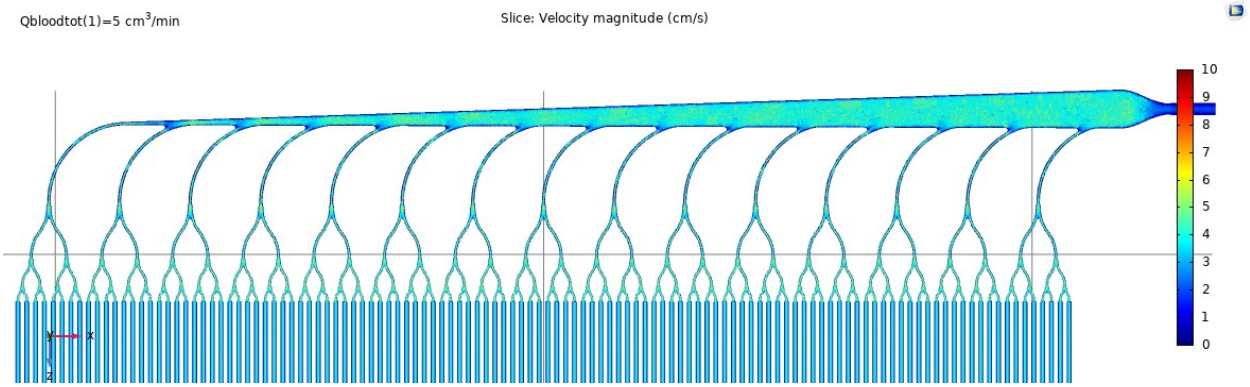

Figure S7. COMSOL simulation of blood velocity distribution in the distribution manifold region and leading into the gas transfer channels of a single-layer RAD1 device.

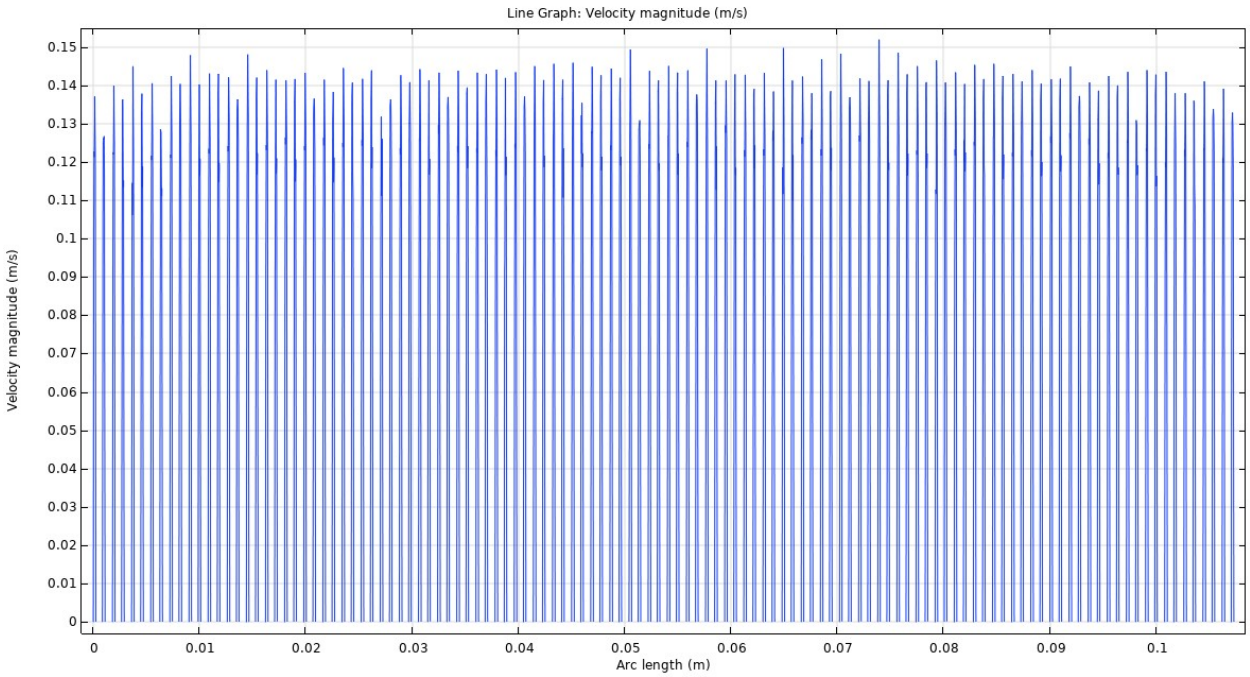

Figure S8. Line plot of velocity across channel inlets from COMSOL simulation results of RAD1 layer, showing uniform maximum velocity (within computational error) across all channels.