Objective

The objective for this project is the fabrication of a 3D scaffold for the co-culture of fibroblasts and endothelial cells within a microfluidic device to be used as a BBB model. This device provides similarity to the brain microenvironment by allowing for cell proliferation as well as simulation of in-vivo shear stress flow conditions. Thus, it will facilitate the discovery of possible links between vascular conditions and disease progression.

Results

<table>
<thead>
<tr>
<th></th>
<th>Human Umbilical Vein Endothelial Cells (HUVEC)</th>
<th></th>
<th>Normal Human Lung Fibroblasts (NHLF)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Initial HUVEC Seeding</td>
<td>1 Day later</td>
<td>Fluorescence Images</td>
</tr>
<tr>
<td>Front</td>
<td><img src="image1.png" alt="Image" /></td>
<td><img src="image2.png" alt="Image" /></td>
<td><img src="image3.png" alt="Image" /></td>
</tr>
<tr>
<td>Down Channel</td>
<td><img src="image7.png" alt="Image" /></td>
<td><img src="image8.png" alt="Image" /></td>
<td><img src="image9.png" alt="Image" /></td>
</tr>
</tbody>
</table>

Methods

- PDMS baked onto SU8 silicon water molds. Vertical holes punched at the beginning of both inlets and the end of the outlet channel. PDMS bonded to glass sides and sterilized.
- Tubes are attached and clamped. Photocurable hydrogel scaffold + NHLF cells is flowed through one Y inlet and PBS through the other.
- Device attached to pump. Flow is initiated until laminar is reached. Flow is stopped and device exposed to UV to polymerize while retaining laminar profile. Media flowed in other Y inlet.

References


Acknowledgements

I would like to thank Dr. Ashlyn Young the inventor of this Y-channel BBB model concept. Her mentorship has been invaluable. I would also like to thank Dr. Michael Daniele for the opportunities to grow as a researcher in his lab on this and other projects. Finally I would like to thank the NCSU Department of Chemical Engineering for the training to analyze problems like these!

Challenges

Co-culture is achieved in this model by taking advantage of laminar flow within the channel of the microfluidic device

- Optimizing flow rate (via pressure-driven flow controller) to achieve optimal laminar line after stop flow during polymerization
- Achieving consistent barrier in single channel
- Limitations due to cellular proliferation rates
- COVID19 lab restrictions!

Future Work

- Calculation of pump pressure and flow conditions to match and/or induce symptoms of physiological disease states!
  - Utilization of Navier-Stokes and Fick’s law
  - Is there a marker in endothelial cells?
- Standardization of device production and commercialization for industry environment