Harrison Oen & Ryan Herrmann
BMED 430: Applying Numerical Methods Paper Proposal
02/23/2024

The topic that we are going to apply numerical methods to is the modeling of endothelial cell growth upon tissue engineered electrospun polymeric scaffolds used for blood vessel mimics. Electrospinning is a method that involves the use of electrically charged needle to extrude a polymer to an oppositely charged mandrel collector. This results in the formation of a micro/nanofiber mesh used to that mimics the extracellular matrix present in blood vessels.

These blood vessel mimics are seeded with endothelial cells and are used for preclinical testing of neurovascular devices used for stroke or aneurysm treatment. These models provide a bridge between traditional *in vitro* testing with cells on a well plate to *in vivo* animal models that can be costly and time consuming to perform. These scaffolds are placed under peristaltic flow which circulates cell media through the vessel.

Recent work in the Tissue Engineering Lab on campus has been performed altering parameters that affect pore size and fiber diameter of the polymers. The effect of the fiber diameter or pore size on endothelial cell coverage or growth has not been heavily investigated in the lab. Modeling the cell coverage and density with specific parameters obtained from the Tissue Engineering Lab will be useful for understanding the endothelialization behavior present within these scaffolds.

The paper that we chose, *"Model-based data analysis of tissue growth in thin 3D printed scaffolds"* uses methods of pore bridging experiments that used equations for cell growth in a 3 dimensions. Here they looked at using the Porous-Fisher equation to model the movement of the cells. They took the observations and specifically looked at cell density, coverage, edge density, and circularity, of which we would look at the cell density and the coverage as we feel those two are the most important aspects.

We will be using the same equation and the same derivations for the aspects of density, and coverage as the paper used to model the growth of the cells. Numerically, we are planning on using Euler's method or ODE to solve the differential equations.

Pseudo Code:

- Import Packages
- Declare Initial Conditions
    - Max density of cells
    - Doubling time of cells
    - Pore radius
    - Proliferation Rate
    - Diffusivity (D)
    - Initial density (u_0)
- Gov Equation (Porous-Fisher Eqn)
    - This may be reduced to a time – dependent boundary equation
- Declare Definitions
    - Cell density
    - Coverage
- Solve using Eulers or ODE

https://doi.org/10.1016/j.jtbi.2021.110852