Zanele Munyikwa

Independent Study Proposal

**Modeling and Visualization of Renal Fluid Flow**

**Brief course description:**

I am proposing to do an independent study under the advisement of Anita Layton. This self-directed course will allow me to apply technical skills that I have attained during my course of study to an issue in mathematics, biology, and health. Specifically, I will be working with a model that investigates the rat’s renal hemodynamics in the nephron level.

**Introduction:**

In order for an animal’s kidney to function normally, autoregulatory mechanisms moderate its kidney glomerular filtration rate. This must be accomplished in spite of any change in arterial blood pressure. One such example of an autoregulatory mechanism is myogenic response, in which the afferent arteriole dilates or constricts in response to several signals. Mathematical modeling methods are vital to every branch of science and as a precursor to my proposed project, a mathematical model related to the renal system was created. The model represents an afferent arteriole that is myogenically active, meaning that elevation in pressure induces vasoconstriction, leading to resistance in blood flow. Based on the afferent arteriole’s fluid delivery output, the glomerular filtration rate is computed. Then, chloride concentration is computed along the renal tubule based on solute conservation. This model is highly relevant because it is the first model that combines a detailed representation of ionic transport, membrane potential, and contraction of the afferent arteriole smooth musle cells, representation of the tubular fluid flow and chloride transport in the kidney, and myogenic response induced by steady pressure steps and oscillatory pressure varations.

**Learning Goals:**

My priorities for this term are twofold. Firstly, I will establish a basic knowledge of the renal system, with a focus on autoregulatory mechanisms. I will learn how to model the autoregulatory mechanism using ordinary and partial differential equations. Secondly, I will study the MATLAB script for the existing model in order to establish an understanding of the way it functions in order to convert said model into C. Finally, I will utilize existing Javascript, HTML, and CSS knowledge to create a graphical user interface for the model, along with the help of a modeling and visualization package such as Cmgui. This will be both a learning experience and will also allow me to contribute to Professor Layton’s lab, because C code runs much faster than MATLAB and will allow for more efficient experiments. Furthermore, a visualization of the model will allow for clinicans who are not educated in physiology to have a solid understanding of what implications the model has for them as practioners.

**Meeting Schedule:**

The instructor and I have agreed to meet once a weekin order to discuss my progress and help me deal with any issues that may arise. My plan is bring a list of questions and concerns to these meetings for clarification.

**Expected outcome/ product:**

The independent study course will result in three deliverables that will be submitted at three different points in the semester. Firstly, the student will produce a zip file containing the source code written in C. Secondly, the student will produce a web application. Finally, the progressive work in the course will culminate in a paper, which will include a more extensive literature review, and an overview of pitfall sand difficulties that arose during the production of the converted MATLAB script and the web application.