Three Projects in the Computational Cardiac Electrophysiology Lab (Advisor: Dr. Trayanova)

IMPORTANT Requirements: Candidates must have taken or are taking BMEN 361 Bioelectricity. Candidates are required to take BMEN 611 Cardiac Electrophysiology in the spring. Preference will be given to candidates who intend to continue in the 5th Year BS/MS Program (or somehow intend to continue their research in cardiac electrophysiology). Some knowledge of Unix and computational skills are desired, but not necessary. The candidates must be committed to work in the lab during the summer months and be aware of expectations of quality of work such that ensures publishable results by the end of the senior project.

While there are three projects described below, it is likely that Dr. Trayanova will be able to take on only 2 students (most likely the first two projects).

Project 1: Electroporation of cardiac cells following strong shocks to the heart. The aim of this project is to determine the damage inflicted on the membrane of cardiac cells during defibrillation of the heart. Defibrillation is the only currently available method to terminate lethal disturbances in cardiac rhythm. While clinically effective, it is associated with rupture of the membranes of cells when the potential across the membrane exceeds a certain threshold value. The intend of this project is to determine the depth of penetration of electroporation in the heart and what is its spatial pattern of distribution. This project uses a realistic model of the heart developed in Dr. Trayanova's lab. No further model development is required for this project; the student is expected to run simulations, visualize the results, and analyze the data.

Project 2: Anti-arrhythmia drugs and their interaction with defibrillation shocks in the heart. Patients who receive implantable defibrillators are often on anti-arrhythmia drugs. The mechanisms by which these drugs interact with the applied electrical shocks to the heart remain unknown, i.e. it is not well understood whether they facilitate or impede the rhythm-restoring effect of the defibrillation procedure. This project aims to determine how these drugs affect the behavior of ionic channels in the cardiac membrane, and how this altered membrane kinetics responds to the delivery of strong electric shocks. Again, no model development is required for this project; the student is expected to run simulations, visualize the results, and analyze the data.

Project 3: Mechano-electric feeback in the heart. This project examines the role of a variety of stretch-activated channels in the initiation and maintenance of cardiac arrhythmia following tissue stretch or mechanical impact to the heart. These arrhythmias can be lethal (the effect is termed commotio cordis) and is responsible for the sudden death of young individuals participating in sporting activities following an impact to the precordial region. This project uses a realistic model of the heart to examine how arrhythmias (electrical

turbulence) are formed. No model development is required for this project; the student is expected to run simulations, visualize the results, and analyze the data.

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