

SEMINAR NOTICE

Preston M. Green Department of Electrical and Systems Engineering

Electro-Mechanical Ionic Channel Modeling for Uterine Contractions and Oxytocin Effects During Pregnancy

PhD Preliminary Research Examination

Yiqi Lin

PhD Candidate

Preston M. Green Department of Electrical and Systems Engineering
Washington University in St. Louis

Abstract: Uterine contractions during normal pregnancy and preterm birth are an important physiological activity. Although the cause of preterm labor is usually unknown, preterm birth creates very serious health concerns in many cases. Therefore, understanding normal birth and predicting preterm birth can help both newborn babies and their families. In our previous work, we developed a multiscale dynamic electrophysiology model of uterine contractions. In this paper, we mainly focus on the cellular level and use electromyography (EMG) and cell force generation methods to construct a new ionic channel model and a corresponding mechanical force model. Specifically, the ionic channel model takes into consideration the knowledge of individual ionic channels, which include the electrochemical and bioelectrical characteristics of individual myocytes. We develop a new sodium channel, a new potassium channel based on the experimental data from the human myometrium, and the average correlations are 0.9946 and 0.9945, respectively. The model is able to generate the single spike, plateau type and bursting type of action potentials. Moreover, we incorporate the effect of oxytocin on changing the properties of the L-type and T-type calcium channels and further influencing the output action potentials. In addition, we develop a mechanical force model based on the new ionic channel model that describes the detailed ionic dynamics. Our model produces cellular mechanical force that propagates to the tissue level. We illustrate the relationship between the cellular mechanical force and the intracellular ionic dynamics and discuss the relationship between the application of oxytocin and the output mechanical force. We also propose a simplified version of the model to enable large-scale simulations using sensitivity analysis method. Our results show that the model is able to reproduce the bioelectrical and electromechanical characteristics of uterine contractions during pregnancy.

DATE: Tuesday, January 14, 2020

TIME: 1:00 p.m.

PLACE: Green Hall, Room 0120

Dissertation advisor:
Dr. Arye Nehorai

This seminar is in partial fulfillment
of the Doctor of Philosophy degree