Abstract

Neha Venkatesh & Sophie Liu

April 2024

The Morris-Lecar model was an ODE system that allowed for complex voltage behavior for a barnacle muscle fiber to be modeled by a simple system of two non-inactivating conductances. Depending on the biological parameters used, the study found that limit cycle oscillations, damped oscillations, and plateau potentials could be modeled with the ODE system similar to those experimentally found in barnacle muscle fibers. Because the Morris-Lecar model made a few simplifications regarding intracellular Ca^{++} dynamics, this study investigated what would happen if the sources of cytosolic Ca^{++} were separated, changing the model by incorporating another ODE for sarcoplasmic reticular Ca^{++}. Additionally, the Morris-Lecar study found that for varying amounts of applied current, limit cycle oscillations, damped oscillations, and plateau potentials could be seen in a joint K^+ and Ca^{++} system. Therefore, in this study, the ODE systems from Morris-Lecar were used and the steady-state behavior of voltage for K^+ only systems and joint K^+ and Ca^{++} systems were found and modeled using bifurcation diagrams and the relationship between steady-states and the amount of current applied was determined. Furthermore, the specific applied currents for which different voltage behaviors emerge were determined and voltages for which steady states cannot exist were also determined to better understand the role of applied current in muscle contractions.