

Siemens Competition

Math : Science : Technology

Regional Finalist

Names: Rishabh Kumar

High School: Carmel High School

Mentor: Professor Horia Petrache

Project Title: *Mathematical Analysis of Ion Channels* (Biophysics; Mathematics)

Ion channels, also known as pore-forming membrane proteins, are an integral component in the cells of our body. By opening and closing, they control the flow of ions through the cellular membrane. Currently, the physical dynamics behind channel systems are not completely understood. Hence, we develop a comprehensive model that mathematically characterizes an ideal channel system. Important parameters in ion channel recordings include channel <ON> and <OFF> times, channel-open probability (p), and multichannel parameters involving electrical signal overlap. In experimental channel recordings, single-channel parameters are hidden and unattainable due to signal overlap and the question of n (number of channels that open). Consequently, we derive a formula to predict n . Furthermore, we work to numerically relate multichannel parameters with single-channel parameters. A random number generator (computer program) and an electronic channel generator are used to vary single-channel parameters systematically and generate multichannel events as are present in actual channel recordings. Statistics are then obtained from simulations using PERL (a programming language). After compiling statistics, we discover novel relationships between observables (multichannel parameters) and single-channel parameters (<ON>, <OFF>, and p) graphically and compare results to mathematical models. Our work can serve as a reference/model for researchers studying channel systems.