A Biophysical Model of the Neuroendocrine Circuit in the Pancreas: Towards Better Diabetes Care

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Diabetes is a disease that afflicts more than 30 million individuals in America alone and is projected to cost almost $70 billion in reduced productivity. Clearly, new quantitative and precise methods of modeling diabetes patients' physiology will be needed in order to improve diabetes care and management My project focuses on modeling pancreatic beta-cells and their adjunct neurons as a neuroendocrine circuit. Two biophysical models, the Hodgkin-Huxley model to describe neurons and the Fridyland-Jacobson-Philipson model to describe insulin secretion, were coupled through the common parameter of membrane potential in order to create one differential equation describing the system. This differential was then numerically evolved in MATLAB where I proceeded to analyze the relationship between the input stimulus from neurons and the output curve representing insulin secretion. Experiments were performed where the input stimulus was varied in frequency and amplitude allowing for the systematic discovery of stable and unstable regimes of insulin secretion. These results help elucidate the coupling between pancreatic b-cells and the nervous system in a quantitative and precise fashion. In the future, a thorough understanding of the dynamics of this neuroendocrine circuit could point to new strategies for diabetes care and management.