Excitable Systems

1684-Pos Board B576 Modeling K\textsubscript{ATP}-Dependent Excitability in Pancreatic Islets

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In pancreatic beta cells, K\textsubscript{ATP} channels respond to changes in blood glucose to regulate cell excitability and insulin release. Confirming this role, gain or loss of function mutations in K\textsubscript{ATP} are linked to neonatal diabetes or hyperinsulinism, respectively. Compared to neurons or cardiac myocytes, cellular models of beta-cell electrical activity have remained relatively rudimentary, but a recent detailed computational model of single cell pancreatic beta cell excitability (Cha et al., J Gen Physiol. 2011 138:21-37) accurately reproduces the beta cell response to varying glucose concentrations. Our aim was to test whether the model could also reproduce experimentally observed changes in excitability when K\textsubscript{ATP} conductance is altered by genetic manipulation. Since the experiments were conducted in islets, we extended the model from a single cell to a 3D model (10x10x10 cell) islet with 1000 cells. For each cell, the conductances of the major currents were allowed to vary as was the gap junction conductance between cells. Initial simulations showed that the model was unable to reproduce K\textsubscript{ATP} conductance-dependent changes in glucose-responses of excitability. By altering the ATP dependence of the L-type Ca\textsuperscript{2+} channel and the Na\textsuperscript{-}K\textsuperscript{+} pump to better match experimental data, appropriate K\textsubscript{ATP} dependence was quantitatively reproduced. In extending and refining the previous model, these simulations highlight the criticality of these parameters and suggest further experiments to improve characterization of beta cell excitability.

1685-Pos Board B577 Wavefronts and Mechanical Signaling in Early Drosophila Embryos

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Many developmental processes use signaling for synchronization. One possible and well-known method is for each component to measure the local concentration of some diffusing biochemical species, and if that concentration exceeds a certain threshold, to release more of the same biochemical, giving rise to wavefront propagation in the chemically excitable medium. There are however more ways in which a medium can be excited and wavefronts can be formed. We suggest a new kind of signaling based not on diffusion of a chemical species, but on the propagation of mechanical stress. We construct a theoretical approach to describe mechanical signaling in an overdamped system as a nonlinear wavefront propagation problem. We apply the theory to mitosis in the early syncytial Drosophila embryo, which is highly correlated in space and time, as manifested in mitotic wavefronts that propagate across the embryo. We compare our results to data taken on Drosophila embryos in which histones in the nuclear chromosomes are labeled with GFP. By analyzing confocal microscopy videos of the mitotic wavefront, we find that the wavefront can be resolved into two distinct wavefronts in each cycle, corresponding to the onset of metaphase and of anaphase, respectively. The two wavefronts have the same speed and are separated by a time interval that is independent of cycle, indicating that they are two different markers for the same process. We find that the dependence of wavefront speed on cell cycle number is most naturally explained by mechanical signaling via stress diffusion, and that the entire process suggests a scenario in which biochemical and mechanical signaling are coupled.