A Model-based Analysis of Glycolytic Oscillations and Electrical Activity in Pancreatic α-cells

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It is well known that glucagon secretion is essential in blood glucose homeostasis and its defective regulation in diabetes disease has also been established [1]. Therefore, it is of key physiological interest to elucidate the underlying mechanisms of stimulus-secretion coupling in α-cells. Glucagon secretion in this cell type is associated with cytosolic Ca^{2+} increase evoked by firing action potentials at low glucose concentration. However, given the complexity of the network of regulations involved in this process, modelling approaches are required [2]. Due to evidence of metabolic oscillations in this cell type [3], we analysed the possible contribution of glycolytic oscillations to the characteristic electrical activity in α-cells. To do it, we modified the model proposed by Bertram, et al. (2004) which is capable to reproduce not only glycolytic and electrical oscillations but also compound oscillations in β-cells. Since glycolytic behaviour is expected to be similar in α- and β -cells, we focused on the differences in electrical activity, specifically in cell capacitance and KATP channels. We found that because of cell capacitance and difference in maximal conductance of KATP channels, α-cells are electrically active at low glucose, in contrast to the situation in β-cells. Besides, the model suggested that the electrical activity of α-cells is insensitive to glycolytic oscillations.

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