Effects of morphological and functional heterogeneities on the intracellular Ca^{2+} signals in coupled pancreatic β-cells

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The Islets of Langerhans are mainly composed of insulin-secreting pancreatic β-cells, glucagon-secreting α-cells and somatostatin-secreting δ-cells[1]. At the cellular level, secretion of these hormones takes place through a common mechanism involving glucose metabolism, electrical activity and Ca^{2+}-handling[2]. In addition, pancreatic hormone secretion is regulated by intra-islet interactions including paracrine and autocrine signals, as well as electrical coupling mediated by gap junctions between β-cells[3].

Electrical coupling between β-cells has been previously studied both theoretically and experimentally. In these studies, it was shown that β-cell coupling is essential for the synchronized release of insulin[1]. In addition, it was demonstrated that the lack of functional gap junctions leads to impaired pulsatile insulin secretion due to uncoordinated Ca^{2+} oscillations[4].

In this work we used a computational model to assess the effect of morphological and functional heterogeneities in the islet β-cells (including differences in cell sizes, β-cell interconnectivity and electrophysiological and Ca^{2+} buffering properties) on the Ca^{2+} signal produced in the cytosol, ultimately related to the secretory response of the islet β-cells.

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