Mathematical modelling of cooperative insulin secreting β-cells

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A thorough analysis of a stochastic model [1] for the electrophysiological behaviour of the insulin secreting β-cells in the pancreas has been carried out. In particular, we have studied the transition between the deterministic and the stochastic regimes, which represent intact islets of about 10000 cells and isolated cells respectively. It is known from experimental measurements that, when the cells are coupled in intact islets of Langerhans, they cooperate via gap junctions and their membrane potentials show bursting activity, optimizing the secretion of insulin. However, small clusters or isolated cells only show random spikes, which are known to be very ineffective when secreting this fundamental hormone [2]. The final goal of our work is to study the cooperation between β-cells, as a function of the size of the cluster. We have developed several numerical techniques to obtain information about the periodic or chaotic nature of the orbits, as well as the transition from bursting to spiking behaviour. Lyapunov exponents, return maps and histograms applied to interspike time intervals, as well as time series of the number of spikes in each burst have resulted to be of great use when analyzing noisy systems. We propose their applicability to experimental data obtained from patients.

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