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Mathematical modelling of adult GnRH neurons in the mouse brain

Gonadotropin-releasing hormone (GnRH) neurons are cells in the hypothalamus that produce GnRH, one of the major hormones that controls fertility and reproduction. However, despite their importance, little is known about the mechanisms by which GnRH is produced. GnRH neurons exhibit complicated membrane potential dynamics, in the form of electrical bursting, and this bursting is closely coupled to the dynamics of intracellular calcium (Ca^{2+}) in ways that are not yet well understood.

A mathematical model has been constructed to help understand the mechanisms underlying the observed behaviours of GnRH neurons, and how electrical bursting synchronizes with transients in the cytosolic Ca^{2+} concentration ($[Ca^{2+}]_i$). Simulations show that the model is consistent with all the crucial experimental data. Most importantly, the mathematical model predicted the existence of particular $[Ca^{2+}]_i$-activated potassium (K^+) channel ($sI_{AHP-UCL}$), which was then confirmed experimentally. In contrast to the apamin-sensitive $[Ca^{2+}]_i$-activated K^+ channels (sI_{AHP-SK}), which control both the structure of firing within bursts and the interburst intervals, $sI_{AHP-UCL}$ solely determines the interburst dynamics.

The work has been published in Lee et al., 2010 and Duan et al., 2011.

References

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