Intracellular Calcium dynamics during T cell polarization and activation

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Processes as diverse as proliferation, fertilization and memory are controlled by Ca^{2+} signaling. However, how this versatility is regulated in terms of rate, magnitude and spatiotemporal patterning of Ca^{2+} signals is largely unknown. It has been observed that heterogeneity of Ca^{2+} concentration in the cell results in various global Ca^{2+} signals, which in succession control, for example, neuronal function and gene expression. However, much less is known about the relocation of channels, pumps and organelles which lead to the development of local Ca^{2+} micro-domains. Considering the context of T-cell polarization and activation, we are interested in combining the whole cell modeling framework for intracellular calcium dynamics involving Mitochondria and Endoplasmic Reticulum relocation with a stochastic model for calcium release activated channel (CRAC) assembly on the cell membrane via ORAI-STIM interaction. Technically we use the stochastically changing location and capacity of CRACs as point sources for a deterministic reaction-diffusion model for the intracellular calcium dynamics. This hybrid stochastic-deterministic approach will help to understand the complex mechanisms of physiological and pathophysiological characteristics of T-cells, which in turn seek to explain traits of disorders ranging from immunodeficiency to autoimmunity.