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# Modelling and Simulation of Intracellular Signalling Pathways: Coupling Chemical Processes and Mechanical Properties

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## Abstract

Communication and interactions between cells happen mostly through intercellular signalling processes. These signalling pathways are important in all physiological activities of the cell, such as cell division, cell movement, immune response, and tissue development. In many of these signalling pathways, the chemical processes and mechanics of the cell work together. However, how exactly these two phenomena communicate is not well known. A common way to model the chemical processes of cell signalling pathways are reaction-diffusion equations. The mechanical properties of the cell are modelled assuming elastic constitutive relationships. Regarding the chemical process, our model includes the diffusion of signalling molecules and membrane receptors, and the reactions between the molecules and receptors. This is coupled to the mechanical properties such that the mechanics of the extracellular matrix influences the interaction between the signalling molecules and the results of the signalling pathways affect the deformation of the cell. To explore this coupling, we model the cell signalling processes involving the Rho signalling molecule, which is known to interact with the mechanical properties of the cell and the extracellular matrix. Simulation results, benchmarking and a comparison to experimental observations will also be presented.

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