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Special Issue: Modelling Noise in Biochemical Reaction Networks

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Editorial

Modelling noise in biochemical reaction networks

It is now well appreciated that noise pervades the dynamics of intracellular reaction kinetics. Intrinsic noise is typical inside cells because of the inherent low copy number of several types of molecules. Equally important though much less studied are extrinsic sources of noise such as temporal variability in the ribosome number per cell and in the concentration of macromolecular crowding agents in the cytoplasm. Modelling is an important tool in Systems Biology to study how the interplay of these various noise sources impacts the dynamics on cellular and multi-cellular scales.

In this special issue we present five papers, which investigate the influence of intrinsic and extrinsic noise on processes occurring at the intracellular and cell population levels. The papers by Wallace et al and Scott probe the limitations of the linear-noise approximation (LNA), a popular approximation technique used to obtain intrinsic noise statistics of biochemical networks. The relationship of the LNA to the chemical master equation, which it approximates, is clarified and novel low copy number phenomena, which cannot be captured by the LNA, are elucidated. The chemical master equation description itself is based on the assumption of well-mixing within a compartment of interest. This assumption is scrutinized in the papers by Lago et al and Roussel and Tang which analyze the statistical properties of molecular movement in crowded intracellular compartments, where the crowding originates due to various inert macromolecules in the way of the mobile reactant molecules. It is shown how the lack of mobility can lead to large fluctuations in the export time distribution of mRNA from the nucleus to the cytoplasm. These fluctuations presumably lead to corresponding fluctuations in the concentrations of the translated protein, thus presenting another source of noise besides the well-studied intrinsic fluctuations. Finally the paper by Greese et al presents a detailed investigation of how cell-to-cell variability, stemming from both intrinsic and extrinsic sources of noise, influences pattern formation at the cell population level and thus of the importance of noise in developmental biology.

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