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Gene Expression Time Delays and Turing Pattern Formation

There are numerous examples of morphogen gradients controlling long range signalling in developmental and cellular systems. The prospect of two such interacting morphogens instigating long range self-organisation in biological systems via a Turing bifurcation has been explored, postulated or implicated in the context of numerous developmental processes. However, modelling investigations of cellular systems typically neglect the influence of gene expression on such dynamics, even though transcription and translation are observed to be important in morphogenetic systems.

The investigations of our study demonstrate that the behaviour of Turing models profoundly changes on the inclusion of gene expression dynamics and is sensitive to the sub-cellular details of gene expression. These results also indicate that the behaviour of Turing pattern formation systems on the inclusion of gene expression time delays may provide a means of distinguishing between possible forms of interaction kinetics, and also emphasises that sub-cellular and gene expression dynamics should not be simply neglected in models of long range biological pattern formation via morphogens. We present results mainly for Gierer-Meinhardt systems but our results are observed more universally in many Turing pattern formation systems. Exploring the dynamics of these systems suggests that the basic Turing mechanism should be reconsidered or would generally require a novel and extensive secondary mechanism to control reaction diffusion patterning.

***This work has already been extended in several papers. The works have been collaborated with E.A. Gaffney (University of Oxford), R.E. Baker (University of Oxford) and N.A.M. Monk (University of Nottingham).** Papers related with this work are given in the following References.

References

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