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Robust patterning of gene expression based on internal coordinate system of cells

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Cell-to-cell communication in multicellular organisms is established through the transmission of various kinds of chemical substances. It is known that gene expression triggered by a chemical substance in individuals has stable spatial patterns despite the individual differences in concentration patterns of the chemical substance. This fact reveals an important property of multicellular organisms called "robustness". Robustness has been conventionally accounted for by the stability of solutions of dynamical equations of chemical substances. However, any biological system is composed of autonomous elements, in which each element does not merely accept information on the chemical substance from the environment; instead, it accepts the information based on its own criteria for reaction. Therefore, this phenomenon needs to be considered from the viewpoint of cells. This study aims to explain theoretically the robust patterning of gene expression from the viewpoint of cells. For this purpose, we introduced a new operator for transforming a state variable of a chemical substance from an external coordinate system to an internal coordinate system of each cell. Then, this operator is applied to the simplest reaction diffusion model of the chemical substance. This extended model indicates that the robust patterning of gene expression against individual differences in concentration pattern of the chemical substance can be explained from the viewpoint of cells if there is a regulation field that compensates for the difference between cells seen in transformation. This result provides a new insight into the investigation of the mechanism of robust patterning in biological systems composed of individual elements.

Biography

Ken-ichro Ogawa has completed his PhD (Doctorate of Science) in 2011 from Tokyo Institute of Technology and was engaged in scientific pursuits as a Research Associate at Tokyo Institute of Technology from 2011 to 2012. He is currently an Assistant Professor in the Department of Computational Intelligence and Systems Science at Tokyo Institute of Technology. His research interests lie in the field of modeling embryogenesis of multicelluar organisms and embodied interaction in human communication.

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