T.J. KOBAYASHI LAB.

[Mathematics and Informatics for Life Science]

Laboratory for Quantitative Biology

Systems biology, Quantitative biology, Theoretical Biology

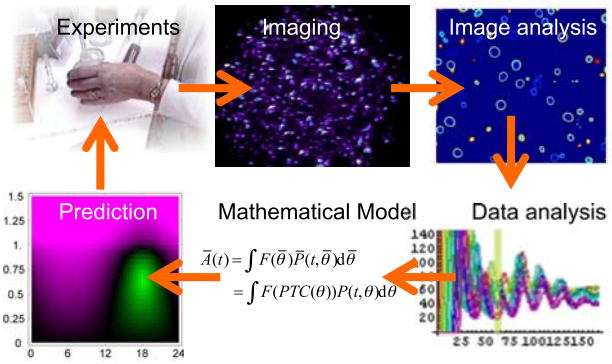
Department of Electrical Engineering and Information Systems (EEIS)

Department of Mathematical informatics

http://research.crmind.net

Frontier of Biology as an Interdisciplinary Science

Cellular phenomena such as development, immunity, and cancer are intrinsically dynamics. Recent development of bio-imaging technology enables us to directly and quantitatively observe these dynamics. This innovation in turn drives the frontier of biology to become an interdisciplinary field by incorporating the knowledge and technologies of other fields such as engineering, informatics, and mathematics where quantitative data and analysis are commonly used.



Information Technology for Biology

Information technology such as image and data analysis is indispensable to exploit the potential information that bio-imaging data have. We have developed methods for 4D tracking of mouse embryogenesis (Fig.1-2) from 4D bioimaging data, and prediction of peptide folding and its determinants (Fig. 3). By using these methods, we have revealed that desynchronization of circadian cells underlies singularity phenomena in which stop of circadian oscillation is induced by unusual mid-night light.

Ukai , Kobayashi, et al., (2007), Nat. Cell Biol.

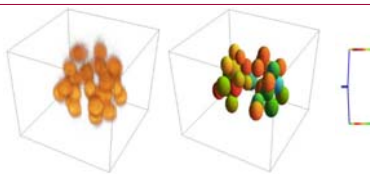


Fig.1 Image analysis of embryogenesis

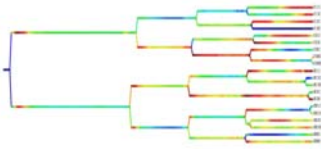


Fig. 2 Image analysis of epidermal cells

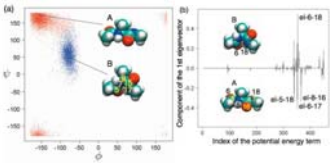


Fig. 3 Potential energy PCA analysis of peptide folding

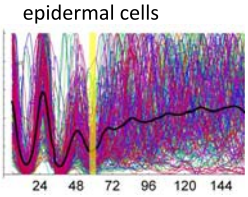


Fig. 4 Desynchronization of cells induced by mid-night light

Theory for robust operation of a cell with noisy components

Mathematical modeling is also crucial to understand design principles of dynamic biological systems. For example, bio-imaging revealed that cellular systems can operate robustly even with substantial noise in their components. However, its mechanism still remains unknown. By combining statistical theory with that for stochastic chemical reaction, we have theoretically clarified that a very simple intracellular reaction can conduct surprising information-processing to extract relevant information from very noisy signal. This theory may also be employed to design noise-immune engineering systems.

Kobayashi,, Phys. Rev. Lett., 2010, 2011