Laboratory of Single Molecule Biology

Graduate School of Frontier Biosciences

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Cells are complex systems composed of various biomolecules. The system is self-organized spontaneously with motility, information processing, and proliferation functions based on proteins, nucleic acids, lipids, and other biomolecules, and is able to flexibly adapt to a changing environment. Recent advances in advanced microscopy technology have made it possible to observe individual biomolecules working in living cells (single molecule imaging technology). Our laboratory applies such advanced imaging techniques, mathematical modeling to intracellular signaling systems, and also applies synthetic biology methods for in vitro reconstitution of intracellular signaling systems, aiming to elucidate how biological functions are expressed at the single-molecule granular resolution.

Development of Automated Intracellular Single Molecule Imaging Methods

Although intracellular single molecule imaging methods have been in development for more than 20 years, the acquisition and analysis of image data using single molecule microscopy still requires a large amount of manpower and time. In addition, it requires artisanal experimental techniques and highly specialized statistical analysis methods, which is a major barrier for newcomers to single-molecule research. Therefore, our group is developing a high-throughput automated analysis system for intracellular single molecule imaging. Through the development of these technologies, we hope to make intracellular single molecule imaging analysis a truly practical measurement technique for life sciences.

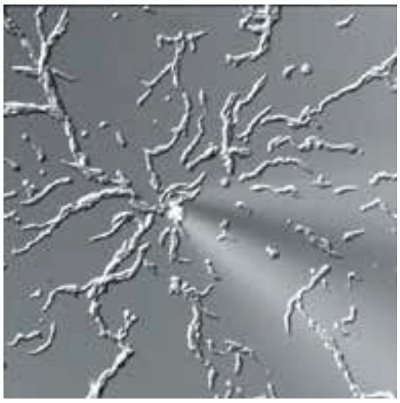
Single Molecule Biology of Chemotaxis Signaling Systems

Cells recognize a concentration gradient of a chemical substance in the environment, and perform directional movement toward (or away from) that substance. This property of cells is generally called chemotaxis. When they respond to light, temperature, or an electric field, they are called phototaxis, thermotaxis, and electrotaxis, respectively. Such chemotaxis is not only important for unicellular organisms to explore their environment, but is also known to play an important role in various physiological phenomena in multicellular organisms, such as neural circuit formation, morphogenesis, and immune responses. The cellular slime mold *Dictyostelium discoideum*, which we use in our experiments, is a well-known model organism used by researchers worldwide to investigate the molecular mechanisms of chemotaxis. We use intracellular single molecule imaging techniques to investigate chemotaxis signaling processes ranging from recognition of chemical concentration gradients to regulation of cell motility. Through these studies, we aim to elucidate the mechanisms how information processing functions are self-organized from intracellular biomolecules.

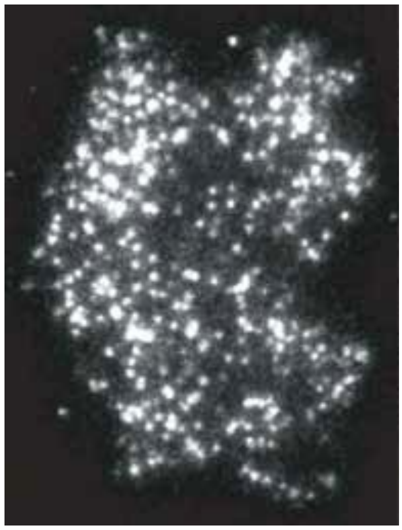
Synthesis of chemotaxis signaling systems Biology

We are trying to reconstitute the intracellular signaling function in vitro by purifying and mixing molecules that constitute the chemotaxis signaling system. Although this research has just begun, the methodology of "creating and understanding cells" is expected to pave the way for new life sciences in the future.

Let's study it together!



Amoeboid cells of the cellular slime mold Dicy ostelium showing chemotaxis to a concentration gradient of an attractant



Intracellular single molecule imaging of molecules that comprise the chemotaxis signaling system. Each white dot is a molecule of a molecule called PTEN.

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