Examining the cell division machinery by using the cantilever system

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It has been demonstrated that the mechanical force produced inside and outside a cell plays an important role in cellular functions during the development and growth. Mitotic cells have to adapt to a variety of mechanical forces originating from cell-cell interactions or environmental fluctuations, in order to carry out the cell division properly. However, it is not known how the externally applied force affects the mechano-chemical processes in cell division. To directly address this issue, we have examined the effects of the external mechanical perturbations, which directly modulate the force balance in the mitotic cells, using a micro-fabricated cantilever system. Here we discuss the current progress in the biophysical research on the cell division machinery.

Mechanically-controlled tubular microenvironment for 3D cell culture

Hiroaki Onoe (Dept. Mech. Eng., Keio Univ.)

As well as intercellular chemical signals, mechanical stimuli are known to be an important factor for determining cell behaviors. I introduce a mechanically-controllable 3D microenvironment where cells can be cultured. The tubular microenvironment was composed of the shell of calcium alginate and the core of extracellular matrix, fabricated by using coaxial microfluidic device. Various types of cells can be cultured in the controlled microenvironment, indicating that this culture system could be an effective platform for analyzing single cellular behavior and tissue formation in 3D culture.

MEMS technology meets scaling laws for biology

Ko Okumura (Ochanomizu University)

Scaling laws have been appreciated in many fields, starting from biology to physics, recently in particular, in the understanding of wetting or hydrodynamic phenomena. Our group has worked especially on the dynamics of fluid drops and bubbles, establishing scaling laws; One of the topics is the imbibition of textured surfaces that are fabricated by MEMS technology. This phenomenon is useful for handling of small amounts of liquids, important in various fields from biology to pharmaceutical industries. In this talk, we review our recent studies in emphasizing capability of scaling laws for the development of various devices and industrial products, and talk on our recent work that demonstrates microdevices useful in biology on the basis of scaling laws.

Droplet-based microfluidics for nonequilibrium study in biophysics

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In biophysical systems, many nonequilibrium and dynamic phenomena are found, such as autonomous motion and pattern formation of microorganisms and cells, beating hearts, neural systems, circadian rhythms, etc. Recently, artificial cells and molecular robots have attracted much attention because of their potential of elucidation of the dynamic systems and application of them. Here, I will show recent studies of control of nonequilibrium phenomena using microdroplet-based microfluidics, including construction of anisotropic complex-shaped microstructures and their autonomous motion, nonlinear chemical reactions in nonequilibrium cell-sized vesicles. Finally, I would like to discuss the future of those technologies to understand "What is Life?"