Real-time observation of various morphological and topological transformations that induced into giant liposome

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Cells and cellular organelles are all compartmentalized by lipid bilayer membranes and show characteristic shapes depending on their specific functions. Their morphologies are quite changeable in response to physiological conditions. In particular, topological changes such as the fusion and the division of membranes play essential roles in cellular activities. Thus, the real-time observation of such morphological or topological transformations of membrane is important for understanding the regulatory mechanism of membrane dynamics.

In our studies, dynamic behaviors of unlabelled giant liposomes caused by interactions between liposomal membranes and proteins, peptides or surfactants were directly visualized by optical high-intensity dark-field microscopy [1]. Liposomes have been well studied as simplified models of biological membranes, and are used as such in a number of applications [2].

Surfactants or amphiphilic peptides, such as melittin, are thought to induce many events into lipid membranes, solubilization, pore formation or fusion; however, the actual process has not been clarified. We found that liposomes exposed to them exhibited novel behavior, namely continuous shrinkage accompanied by intermittent quakes, release of encapsulated liposomes, and inside-out topological inversion (Fig. 1), as well as fusion or opening membrane hole [1, 3, 4]. Which transformation induced into giant liposomes is depended on the lipid composition and solution condition, salt strength or pH. These results reveal that the lipid bilayer itself possesses the ability to undergo topological transformation, and their metamorphosis is made possible through interactions with biological amphiphilic components.

Cytoskeletal networks of microtubules (MTs) or actin filaments are also thought to be involved in determination of membrane morphology and traffics [1]. Therefore, we generated giant liposomes containing subunit proteins of those cytoskeletons and reconstructed cytoskeletal networks inside the liposomes to study their roles in the morphogenesis of the cells. The characteristic morphologies induced into the liposomes (Fig. 2) are indicating that the assembly and growth of encapsulated cytoskeletal filaments can generate sufficient force to deform liposome membranes [1, 5, 6].

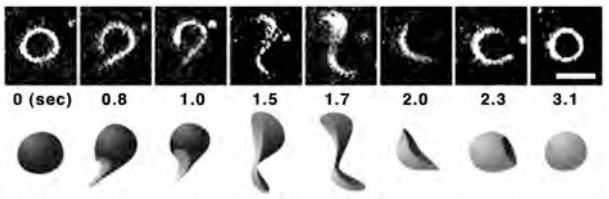

Fig. 1. The inside-out inversion, which was observed when liposome made from PC and a cationic lipid, DMTAP (1, 2-dimyristoyl 3-tetraamino propane) was added with a cationic surfactant, HTAB (hexadecyl tri-methyl ammonium bromide). A sequential dark-field image (upper) and its model (bottom) are shown.

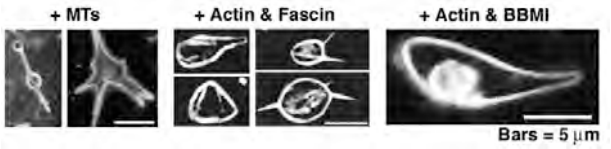

Fig. 2. The characteristic morphologies induced into giant liposomes by assembly and growth of MTs or actin bundles formed with fascin, an actin-crosslinking protein, or brush border myosin-I (BBMI).

References

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