Shape Deformation of Ternary Vesicles with Various Shapes

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均一なベシクルは、非圧縮条件下で弾性エネルギーを最小化するように様々な形態を取る。その形態を決定する上で支配的なパラメーターは、余剰面積と、2分子膜の内膜と外膜の面積差に由来する非対称性である。実際に膜外に塩を加えると、浸透圧差によってベシクルの余剰面積が徐々に増加し、ベシクルは分岐を繰り返しながら形態変化する。一方、飽和リン脂質・不飽和リン脂質・コレステロールからなる3成分ベシクルは、転移点以下で相分離しドメインを形成する。膜に出来たドメインは、界面エネルギーを減らすために粗大化し、さらには発芽と呼ばれる膜変形を示す。我々は今回、3成分ベシクルを用いて、浸透圧差による形態変化と異なる曲げ弾性率を持つ相が共存する相分離の競合による変形ダイナミクスについて報告する。

Homogeneous vesicles deform their shapes so as to minimize the elastic energy under the total area and total volume conservation constraints. The most important parameters to determine the shape of the vesicle are excess area defined by the total area to total volume ratio, and the area difference between the upper and lower leaflets of the bilayer. If we add salts outside of the vesicle, the excess area increases with elapse of time due to the osmotic pressure difference and the vesicles show a parade of deformation with repeating bifurcations as shown in Fig.1. On the other hand, the ternary vesicles composed of saturated phospholipid, unsaturated phospholipid and cholesterol show a phase separation and form domain structures in the vesicle. The heterogeneity coupled with the membrane elasticity brings a shape deformation, *i.e.* the budding. In this time, we discuss the shape deformation of the ternary vesicle generated by the competition between the phase separation and the osmotic pressure difference. When the temperature is dropped below the immiscible transition temperature, numerous small domains appear on the vesicle and grow in a diffusion-and-coalescence manner. During the domain growth process, the vesicle deforms its shape to minimize the total free energy consisting of the elastic energy and boundary energy. The deformation pathways depend on the excess area. When the excess area is small, the vesicle keeps a spherical shape due to the geometrical constraints, whereas if the vesicle has a polygon shape (oblate, prolate, starfish) with large excess area, the vesicle deforms to a circular biconcave shape with two large domains on the two sides of the vesicle. Furthermore, the excess area strongly affects to the budding behavior of domains. We will show the shape deformation pathways systematically.

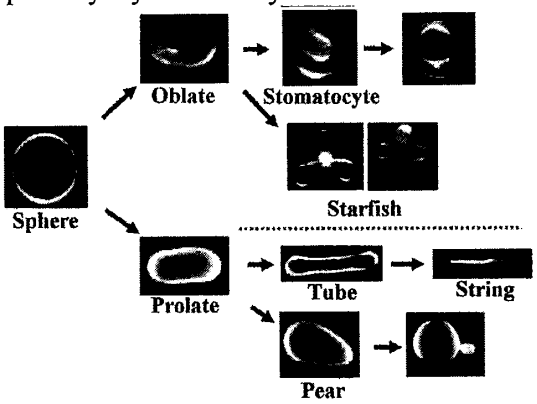

Figure 1: Shape deformation pathway of the homogeneous vesicle

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