Stable Disk-fused Vesicle in DMPC/DHPC Lipid Mixture System

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For phospholipid mixture system consisting of long- and short-chain lipids, it was reported that small uni-lamellar vesicles (ULVs) were spontaneously formed \cite{1}. Recently, Nieh \textit{et al.} have carried out small-angle neutron scattering (SANS) experiments on aqueous solutions of dimyristoyl-phosphatidylcholine (DMPC) and dihexanoylphosphatidylcholine (DHPC) mixture \cite{2}. The experimental results showed that disk micelles at low temperature fuse into ULVs above the chain melting temperature, $T_c$, of DMPC molecules (about 24°C) in an adequate condition. Although disk-fused ULVs usually fissure into small disk micelles below $T_c$, it was shown that the ULVs were stable even below $T_c$ at very low lipid concentration \cite{3}. However, the mechanism of the stable ULV formation has not been clarified yet.

In this study, we investigated the structural change on a disk-fusion and vesicle-fission by SANS to understand the mechanism of the stable vesicle formation at low lipid concentration. The SANS experiment was performed with changing lipid concentration, $c_L$, the molar ratio of DMPC to DHPC, $q'$, and temperature. The sample temperature was increased from 20°C to 50°C on a disk-fussion process, and decreased to 20°C again on a vesicle-fission process. Figure 1 shows the $c_L$-dependence of SANS profiles with changing temperature in case of $q' = 3.2$. From the SANS profiles, it was shown that the disk size increased with decreasing $c_L$ at 20°C before heating, and the vesicle size increased with increasing $c_L$ at 50°C. On the other hand, the SANS profiles at 20°C after heating were irreversible in case of low $c_L$, and large disk micelles were observed. Moreover, stable ULV were observed in case of $q' = 4.6$ as shown by Nieh \textit{et al.}

For the quantitative discussion, the relation between the disk radius at 20°C and the vesicle radius at 50°C for were shown in Fig. 2. In the disk-fusion process, the relation between the

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Figure 1: Dependence of SANS profiles on lipid concentration, $c_L$, with changing temperature, when the ratio of DMPC to DHPC, $q'$, is 3.2.

Figure 2: (a) The relation between the disk radius at 20°C and the vesicle radius at 50°C. (b) Schematic illustration of disk-fusion and vesicle-fission process suggested by the experimental results.

disk- and vesicle-size is roughly on a master curve for all $c_L$ and $q'$. Whereas, the relation in the disk-fission process was different from that in the heating process: small disks and large disks were observed with decreasing $c_L$. Remarkably, the relation between large disk- and vesicle-size was on another master curve, and the stable ULVs were observed in the crossover region of the two master curves at low $c_L$. From these results, it can be said that the relation between disk- and vesicle-size is essential to understand the stability of disk-fused ULVs. The detailed discussion will be shown in the conference.

References