Figure S1. SAXS profiles of MO/CA dispersions NT-02 (a), NT-04 (b), and NT-05 (c) at 25°C. The peaks are indexed using standard reflections of the primitive cubic phase (Im3m), double diamond cubic phase (Pn3m), and H_{II} phase respectively. The unidentified peak in NT-04 (b) could belong to a H_{II} phase. Indexing of the SAXS data of NT-02 (●), NT-04 (▲), and NT-05 (■) samples (d). The open symbol (○) show reflection which, although allowed by the space group, was not clearly observed. For the cubic phase, $q(hkl)$ was plotted against $(h^2+k^2+l^2)^{1/2}$ and for the hexagonal phase $q(hk)$ was plotted against $(h^2+k^2+2hk)^{1/2}$, where $h$, $k$, and $l$ are Millers indices.
Figure S2. 1D scattering profiles of the samples at 37°C collected by synchrotron SAXS.

Figure S3. Cryo-TEM images of cubic and hexagonal phase nanoparticles with Fast Fourier Transformation of the particles. Cubic phase particles are viewed from the [111] direction in samples NT-01 (A), NT-02 (B), and NT-04 (C). Typical patterns of the hexagonal phase nanoparticles in sample NT-05 is also visible (D).
Figure S4. Lattice parameters of self-assembled nanoparticles in cell media at 25°C. Particles with cubic phase $Q_{II}^p$ (♦) and hexagonal phase $H_{II}$ (△) were observed.
Table S1. Lattice parameters of lipid nanoparticles at 37°C

<table>
<thead>
<tr>
<th>Phase</th>
<th>NT-01</th>
<th>NT-02</th>
<th>NT-03</th>
<th>NT-04</th>
<th>NT-05</th>
<th>NT-06</th>
</tr>
</thead>
<tbody>
<tr>
<td>Space group</td>
<td>Im3m</td>
<td>Im3m</td>
<td>Im3m/Pn3m</td>
<td>Pn3m/Pn3m/H2</td>
<td>H2</td>
<td>EME</td>
</tr>
<tr>
<td>Lattice parameter* (Å)</td>
<td>141</td>
<td>130</td>
<td>123/91</td>
<td>81/80/59</td>
<td>53</td>
<td>365</td>
</tr>
</tbody>
</table>

* Two Pn3m phases were detected in sample NT-04. These two phases have very close lattice parameters.

$ This value is the characteristic distance of the non-ordered L2 phase.