

## Soft Matter Exercise - Chapter 4: Vesicles

### 1. CMC of Surfactants

Give some possible explanations for the following observations:

- The CMC of the surfactants is higher than that of the solubility of the corresponding alkanes containing the same number of carbon atoms in water.
- The addition of a single  $\text{CH}_2$  group to the aliphatic chains influences the CMC of single chained amphiphiles (e.g. SDS) more strongly than it influences double chained amphiphiles (e.g. phospholipids).
- The smaller the size of the counterions of an ionic surfactant, the larger the change in CMC caused by those counterions.

### 2. CMC of Phospholipids

You produced a liposome from phospholipid DPPC, which has two  $\text{C}_{16}$  chains attached to a phosphatidylcholine head-group. Assume the interfacial tension to be  $30 \text{ mJ/m}^2$  and  $r$  of one  $\text{C}_{16}$  chain to be  $0.2 \text{ nm}$  at  $25^\circ\text{C}$ .

- Estimate the CMC.
- Estimate the CMC if one of the  $\text{C}_{16}$  chains was removed.
- How would the residence time change if you removed one  $\text{C}_{16}$  chain?
- Assume  $\alpha = 1$  for DPPC. What would be the equilibrium shape of aggregates formed from molecules that contain only one  $\text{C}_{16}$  chain and the same head group as DPPC? The CMC of DPPC is  $7 \times 10^{-14}$ .

### 3. Vesicles

You are asked to fabricate vesicles.

- How would you fabricate them if they should be approximately  $10 \mu\text{m}$  in diameter? What are the advantages and disadvantages of this technique?
- How would you fabricate them if they should be approximately  $100 \text{ nm}$  in diameter? What are the advantages and disadvantages of this technique?
- How would you characterize the size of your produced vesicles? What requirements must the sample fulfill for this technique to be accurate and reliable?

### 4. Rigid Vesicles

You are asked to produce rigid vesicles.

- What parameter would you tune to control the rigidity of vesicles?
- How would you manipulate this parameter?
- What could be a disadvantage of making vesicles rigid?

## 5. Characterization of Delivery Vehicles

You are working for a company that develops new delivery vehicles. You developed a new type of molecule that you think is more efficient in delivering reagents. These molecules assemble into vesicles with diameters between 50 nm and 100 nm.

- a. How would you characterize the size of these vesicles?
- b. Describe the working principle of this technique.