

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 the solubility of the corresponding alkanes containing the same number of carbon atoms in water.
- The addition of a CH_2 group to the aliphatic chains influences the CMC of single chained amphiphiles (e.g. SDS) stronger than it influences double chained amphiphiles (e.g. phospholipids).
- The smaller the size of the counterion of an ionic surfactant, the larger is the change in CMC that is caused by the counterions.

2. CMC of phospholipids

You produced a liposome from phospholipid DPPC which has two C16 chains attached to a phosphatidylcholine head-group at 25°C . Assume the interfacial tension to be 30 mJ/m^2 and r of one C16 chain to be 0.2 nm .

- Estimate the CMC.
- Estimate the CMC if one of the C16 chains was removed.
- How would the residence time change if you remove one C16 chain?
- Assume $\alpha = 1$ for DPPC. What would be the equilibrium shape of aggregates formed from molecules that contain only one C16 chain and the same head group as DPPC? The CMC of DPPC is 7×10^{-14} .

3. Temperature dependence

Imagine the average temperature on earth would increase by 20°C .

- How would that affect the CMC?
- How would that affect the exchange rates of amphiphiles?
- How would that affect the stability of cell membranes?
- What would you change in the composition and/or structure of the phospholipids to obtain similar membrane properties to those you observe with the current phospholipids at room temperature but at 20°C higher temperatures?

4. 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 nm in diameter? What are the advantages and disadvantages of this technique?
- How would you characterize the size of these vesicles? What requirements must the sample fulfil for this technique to be accurate and reliable?

5. Rigid vesicles

You are asked to produce rigid vesicles.

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

6. pH-responsiveness

- Why is poly(acrylic acid) pH responsive?
- Around which pH does the degree of hydration change for poly(acrylic acid)?
- Is poly(acrylic acid) hydrated at very high pHs? If yes, why? If not, why not?

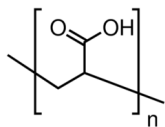


Figure 1: Chemical structure of poly(acrylic acid)

7. 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 (diameter between 50 nm and 100 nm).

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