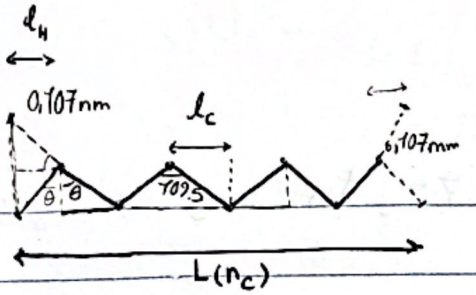
7.1)



$$L(n_c) = 2l_{H-C} + (n_c - 1)l_{C-C}$$

for each two carbon atom $\rightarrow l_{c-c} = 0{,}154 \times 10^{-9} \times \sin\left(\frac{109.5}{2}\right) = 0{,}126$ nm

for C–H bonds $\rightarrow l_{c-H} = 0{,}107 \times 10^{-9} \times \sin\left(\frac{109.5}{2}\right) = 0{,}087$ nm

$$L(n_c) = 0{,}174 + (n_c - 1) \times 0{,}126 \text{ nm}$$

b) for $n_c = 14 \rightarrow L = 1.812$ nm

for $n_c = 20 \rightarrow L = 2.568$ nm

7.2) entropy per molecule for a gass (ideal) is:

$$S_{gas} = K_B \left\{ \frac{5}{2} - \ln\left(\rho \cdot [h/(2\pi m K_B T)^{1/2}]^3\right) \right\}$$

where for an ideal hydrogen gass: $PV = \frac{N}{N_A} RT \rightarrow PN_A = \rho RT \rightarrow \rho = \frac{PN_A}{RT}$

So $\rightarrow S_{gas} = K_B \left\{ \frac{5}{2} - \ln\left(\frac{PN_A}{RT} \cdot \left(\frac{h}{(2\pi m K_B T)^{1/2}}\right)^3\right) \right\}$

$P \approx 10^5$ pa, $N_A = 6.022 \times 10^{23}$, $T = 273$k, $R = 8.31 \frac{J}{mol.K}$, $m = 3.32 \times 10^{-27}$ kg (hydrogen molecule)

$K_B = 1.38 \times 10^{-23} \frac{m^2 kg}{s^2 K}$, $h = 6.62 \times 10^{-34} \frac{J}{Hz}$

$\rightarrow \frac{S_{gas}}{K_B} = \frac{5}{2} - \ln(\quad) = 13.91 \gg \frac{PV}{K_B T} = 1$ (per molecule $N = 1$)

$$\ln \frac{CMC}{690} = -1.15 n_c$$

7.3) according to Figure 7.9, for single chain lipids the CMC is found from function:

$$CMC\ (molar) = 690 \times e^{-1.15 n_c} \quad \text{molar} \rightarrow n_c = -\frac{1}{1.15} \ln \frac{CMC}{690}$$

for lauroyl PC $\rightarrow n_c = -\frac{1}{1.15} \times \ln \frac{7 \times 10^{-4}}{690} = 12$

for myristoyl PC $\rightarrow n_c = 14$

for palmitoyl PC $\rightarrow n_c = 16$

for $T = 300k$, $m = 500$ Da $\rightarrow \gamma = ?$

eq 7.6 $$\rho_{agg} = \left(\frac{(2\pi m k_B T)^{1/2}}{h}\right)^3 e^{5/2} \exp\left(\frac{-2\pi n_c R_{hc} l_{cc} \gamma}{k_B T}\right)$$

7.4) $V_{hc}^{[nm]^2} = 0{,}2\, l_{hc}^{[nm]}$ for a single hydrocarbon chain

the a_o epected for lipid bilayer formation with 1,2,3 chains is found from

$$\frac{1}{2} < \frac{V_{hc}}{a_o l_{hc}} \leq 1$$

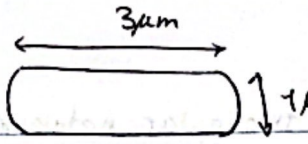
for single chain: $\frac{1}{2} < \frac{0{,}2}{a_o} \leq 1 \rightarrow 0{,}2\,nm^2 < a_o \leq 0{,}4\,nm^2$

" double chain: $\frac{1}{2} < \frac{0{,}4}{a_o} \leq 1 \rightarrow 0{,}4\,nm^2 < a_o \leq 0{,}8\,nm^2$

triple chain: $\frac{1}{2} < \frac{0{,}6}{a_o} \leq 1 \rightarrow 0{,}6\,nm^3 < a_o \leq 1{,}2\,nm^2$

the results are slightly smaller than those of Koeing but still close enough to be reasonable for a triple chain.

7.5) $K_b = K_G = 10\, K_B T$



The spherocylinder is constructed from two half spheres and a cylinder with

$L = 2\mu m$  & $R = 0.5\mu m$

$$E_{bending} = E_{spheres} + E_{cylinder} = 4\pi(2K_b + K_G) + \frac{\pi L}{R} K_b$$

$$= (120\pi + 40\pi) K_B T = 160\pi K_B T$$

Bending energy for daughter cells:

$$E_{bending} = 2x\left((2K_b + K_G) \times 4\pi + \frac{\pi L}{R} K_b\right) \longrightarrow L = ?\quad R = ?$$

and diameter

Since the total volume remains constant:

$$V_i = (2\mu m \times \pi R^2) + \left(\frac{4}{3}\pi R^3\right) = 2x\left[(L' \times \pi R^2) + \left(\frac{4}{3}\pi R^3\right)\right]$$

$$2\pi R^2 + \frac{4}{3}\pi R^3 = 2L'\pi R^2 + \frac{8}{3}\pi R^3 \xrightarrow{R=0.5} L' = \frac{2\pi R^2 - \frac{4}{3}\pi R^2}{2\pi R^2} = \frac{4}{3}\mu m$$

$$E_{bend} = 2x\left(120\pi + \frac{80\pi}{3}\right) K_B T = \frac{880\pi}{3} K_B T$$

7.6) in a triangular network (6-fold symmetry):

$K_A = \left(\frac{\sqrt{3}}{2} K_{sp}\right)$ · zero temprature & zero stress · $\mu = \frac{\sqrt{3}}{4} K_{sp}$

$\mu = 10^{-5} \frac{\mu}{m2} \rightarrow K_{sp} = \frac{4}{\sqrt{3}} \mu \rightarrow K_A = 2 K_{sp} \mu = 2 \times 10^{-5} \frac{\mu}{m2}$

$k_b \rightarrow = \frac{2 \times 10^{-5} \times (25 \times 10^{-9})^2}{12} = 1.04 \times 10^{-21} = 0.25\ K_B T$

the structure helps with the flexibility of the RBC

k_b diMPC ~ 5-33 $K_B T$