Question 1
What is the most important conclusion derived from the **Frye & Edidin** experiment?

a. the plasma membrane thickness is 7 nm.

b. the plasma membrane is made of 2 layers of phospholipids.

c. the plasma membrane is fluid at 37 ºC.

d the plasma membrane is a sandwich: phospholipids are between 2 layers of proteins.

Question 2
What is the most important conclusion derived from the Gorter and Grendel experiment?

a. the plasma membrane thickness is 7 nm.

b. the plasma membrane is made of 2 layers of phospholipids.

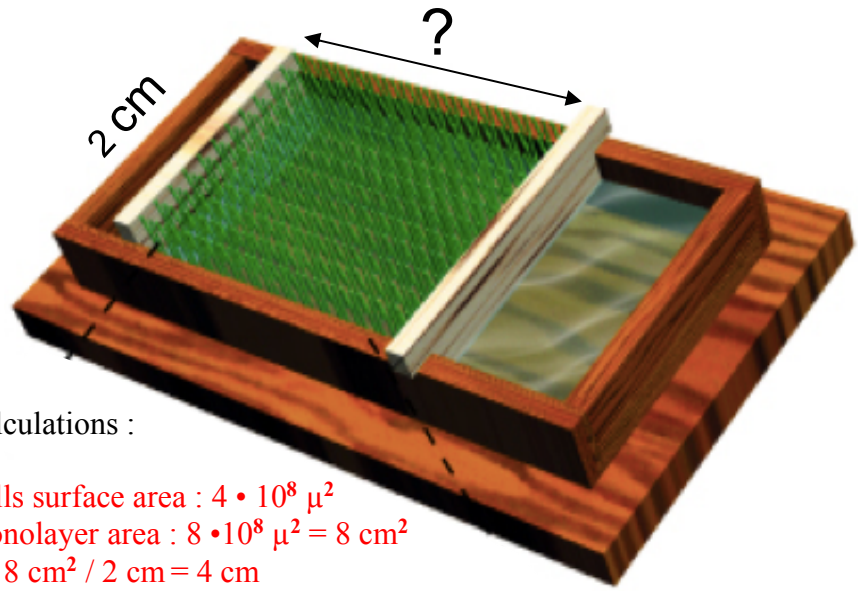
c. the plasma membrane is fluid at 37 ºC.

d the plasma membrane is a sandwich: phospholipids are between 2 layers of proteins.

Question 3
In an experiment, a blood sample is drawn from a healthy human being.
1 µL of this blood is found to contain $4 \cdot 10^6$ red blood cells (RBC).
Membrane lipids are extracted for the RBC obtained from 1 µl of blood and then spread on water in a 2-cm-wide Langmuir through.
What is the distance $\ell$ between the barriers when the cohesive forces between the lipid molecules signal that a monolayer has been formed?

The surface area of a human red blood cell = 100 $\mu^2$.
Lipid extraction yield (efficiency) = 100 %

$\ell$ = _____ 4 cm _____




Calculations :

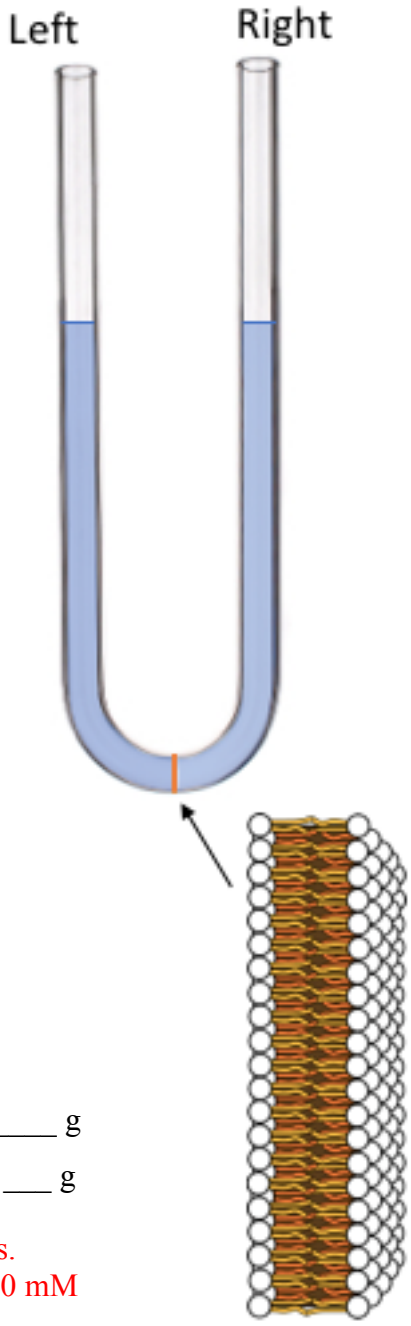
Cells surface area : $4 \cdot 10^8\ \mu^2$
Monolayer area : $8 \cdot 10^8\ \mu^2 = 8\ cm^2$
$\ell = 8\ cm^2 / 2\ cm = 4\ cm$

Question 4
Phospholipids are purified from human Red Blood Cells and then spread as a monolayer in a Langmuir trough.
Phospholipids from how many Red Blood Cells must be purified to obtain a 1 $cm^2$ monolayer in the Langmuir trough ?
(Assume the purification yield is 100% and a human Red Blood Cell has a 100 $\mu^2$ surface)

_ $5 \times 10^5$ _____ red blood cells

1 $cm^2 = 10^8 \mu^2$ ; cell surface is half the monolayer area = $5 \cdot 10^7 \mu^2$ ; cells number = $5 \cdot 10^5$

Question 5




Let's consider a U-shaped tube with an phospholipids bilayer separating the tube into 2 parts (L and R). This separation is a synthetic membrane made of phospholipids only, no protein, no cholesterol.

You fill both part of the tube (L and R) with 0.1 L of water.
The height of the liquid is identical in the L and the R parts.

Table salt (NaCl) and sugar (sucrose) are available for experiments.
Atomic weight of Na + : 23
Atomic weight of Cl- : 35.5
Molecular weight of sucrose : 342
Molecular weight of Sodium Chloride : 23 + 35.3 = 58.5
You dissolve 0.585 g of Sodium Chloride in the 0.1 L of water of the L part.

◊ what is the $Na^+Cl^-$ concentration in the L part? __ 100 _____ mM

◊ what is the osmolality in the L part? 200 mOS
100 mOs for $Na^+$ + 100 mOs for $Cl^-$

After 4 hours, you observe that
a. nothing has change, same water levels in the L and R part.
a. water molecules have moved from the R part to the L part
a. water molecules have moved from the L part to the R part

You would like to bring back the water levels were they were initially.

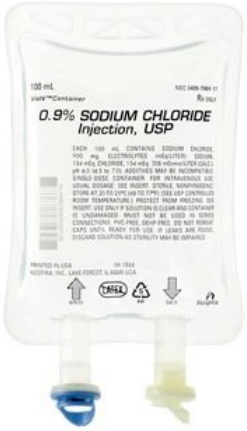
To achieve that,

- how much $Na^+Cl^-$ should you add to the water in the R part? __0.585 ____ g

- how much table sugar (sucrose) should you add to the R part? _ 6.84 ___ g

Water in part R is isotonic (isoosmolar) with part L when it has 200 mOs.
342 g in 1 L → 1 M ; 34.2 g in 1 L → 100 mM ; 3.42 g in 0.1L → 100 mM
6.84 g in 0.1 L → 200 mM and 200mOs.

Question 6




On the site of an accident, an intra-venous (i.v.) line is frequently given to patients. The infused liquid is 0.9 % sodium chloride.

0.9 g / 100g or 9g / kg or 9 g/L

What is the osmolality of 0.9 % sodium chloride ? ___ 308 mOs___

58.5 g/L → 1M

9 g/L → 0.154 M or 154 mM

How does this osmolality compare with the osmolality of the human plasma ?

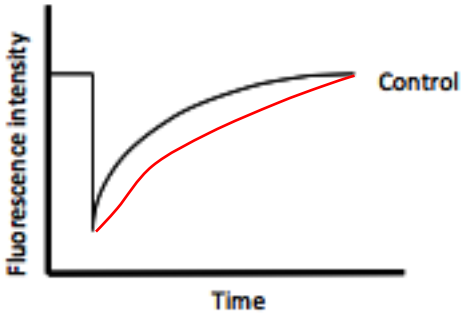
usual (normal) human plasma osmolality: 275 - 300 mosmol/kg water

**The infused solution is isotonic with human plasma**

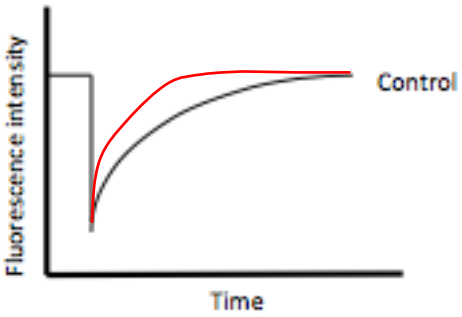
Question 7

You wish to study how membrane composition affects fluidity using Fluorescence Recovery After Photobleaching (FRAP). On the following graphs, a control FRAP curve has been drawn. Please draw how you predict the **FRAP curve would change for each of the following experiments**

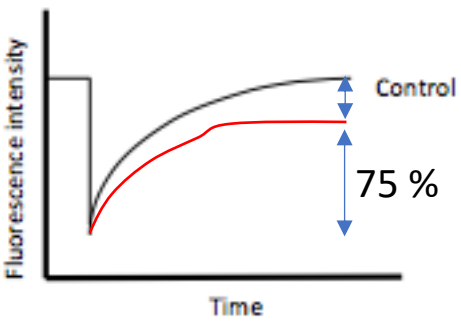
A. You add an enzyme which saturates lipid hydrocarbon chains.



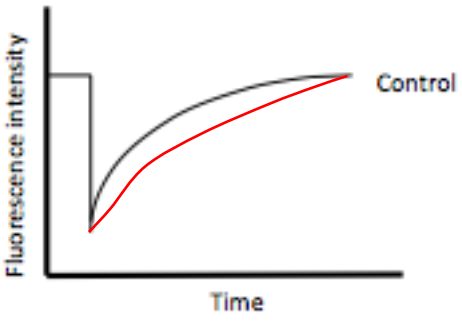

B. You raise the temperature.




C. You add a drug that prevents 25% of the lipids from diffusing



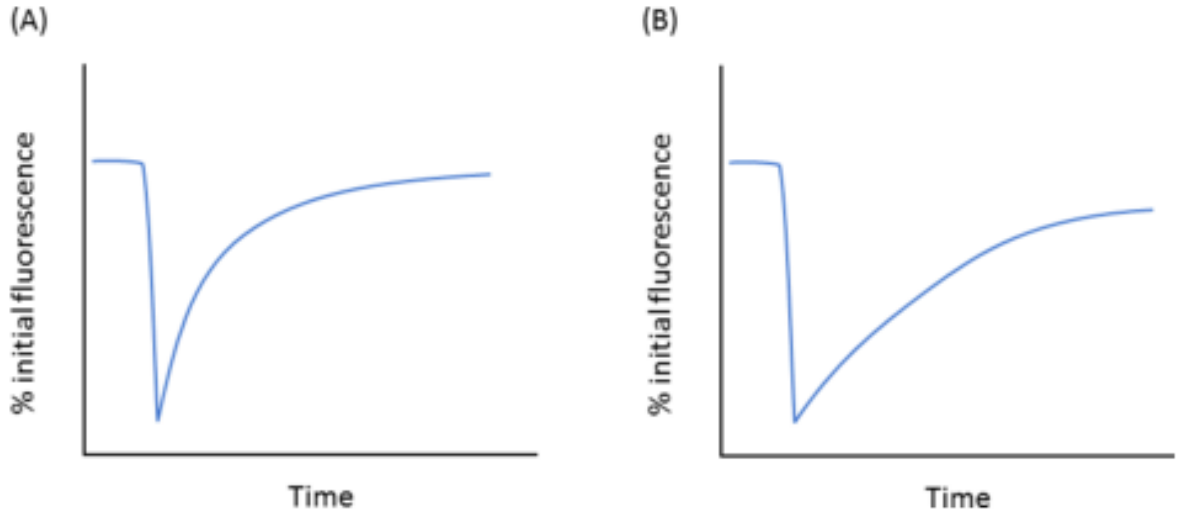

D. You add an enzyme that makes lipid hydrocarbon chains 10 carbon atoms longer



Question 8

**Experiment 1.** Two sets of cells are subjected to a FRAP experiment. One cell has a lipid bilayer that includes cholesterol, which makes it less fluid; and the other cell has a membrane made purely of phospholipids. The results are shown below. Which curve, A or B, was obtained from cells with a membrane that includes cholesterol?

A B




**Experiment 2.** Membrane fluidity decreases as the temperature cools. If you conducted two FRAP experiments with the same cell, one experiment at warm temperature, and the other at a cooler temperature, which of the FRAP curves above best represents the cell at the warmer temperature?

A B

Notes :
Measures made at 37 °C (> Tm) : cholesterol decreases fluidity (= increases viscosity)
Measures made at T < Tm : cholesterol increases fluidity (decreases viscosity)