1) Suppose we have a patch of cell membrane stuck on the end of a pipette (tube).
The membrane is permeable to bicarbonate ions, HCO_3^- .

On side (say side A), we have a big reservoir with bicarbonate ions at a concentration of 1 M;
on side B there's a similar reservoir with a concentration of 0.1 M.

Now we connect a power supply across the two sides of this membrane, to create a fixed potential difference,
$\Delta V = V_A - V_B$.

a) What should ΔV be in order to maintain equilibrium (no net ion flow)?

b) Suppose ΔV = 100mV. Which way will bicarbonate ions flow?

2) Pretend that the interior of a bacterium could be adequately modeled as a sphere radius 1 μm, and a cell of your body as a similar sphere of radius 10 μm. Assume that both interiors are similar in composition and density.

About how long does it take for a sudden supply of sugar molecules at, say, the center of the bacterium to spread uniformly throughout the cell? What about for a cell in your body?
Assume the diffusion coefficient of the sugar molecules within the cellular medium to be 1 μm^2/sec.

3) At time $t = 0$, metabolites are released at the the centre of a cell (which is assumed spherical), with a concentration profile of,

$$C(x,t) = \frac{A_o}{\sqrt{4\pi Dt}} \exp\left(-\frac{x^2}{4Dt}\right)$$

At time $t \rightarrow 0$, $C(x, 0)$ can be shown to approach the "Delta Function", $A_0\delta(x)$.

a) Show that $C(x, t)$ follows Fick's Diffusion Equation.

b) Schematically show concentration profile changes with increasing time.