Abdelhafid Boussouf University Center - Mila **Academic year 2025–2026**

Institute of Natural and Life Sciences

Department of Biotechnology

Module: Biophysics

Series 4: Diffusion phenomena

Exercise: 1

A porous membrane with a total pore surface area S=0.05m^2 separates two compartments containing sucrose at concentrations of 0.5 and 0.2 mol/L, respectively. These concentrations are maintained constant during the diffusion of sucrose molecules through the membrane. It is assumed that a steady-state regime is established.

- What is the value of the flow rate?

Given: diffusion coefficient of sucrose $D=8\times10^{-10}$ m^2/s, membrane thickness e=10 μm.

Exercise: 2

Let there be a porous membrane with a thickness e and a surface area S=50cm^2 separating two compartments. At time t=0, 2 liters of pure water are introduced into the first compartment and 2 liters of an aqueous solution with a solute concentration of 1 mole/L are introduced into the second compartment. If after 30 seconds the concentration in the first compartment is 10^{-6}mole/cm^3

- Determine the thickness e of the membrane, assuming that the concentration gradient remains linear across the thickness e. Given: $D=5.344\times10^{-5}$cm^2/s

Exercise: 3

The diffusion coefficient of insulin in aqueous solution at 25°C is equal to 8.2×10^{-11}m^{2}s^{-1}.

1. Calculate the radius of this molecule, assumed to be spherical.
2. Deduce the molar mass of insulin from this result.
3. What would be the diffusion coefficient of insulin at 0°C?
4. What would be the diffusion coefficient of urea in aqueous solution at 0°C?

The given data is: The density of insulin: 1300 kg/m³, η_{H2O}: 1 mPa·s, K=1.38×10^{-23}J/K, M_{urea}: 60 g/mol

Exercise:4

A reservoir is divided into two compartments by a porous membrane with a surface area of 3 cm² and a thickness of 0.1 mm. In one of the compartments, an aqueous solution of 2 mmol/L is placed, and in the other, pure water. The initial molecular diffusion flux of the solute is 4.2×10^{-12}mol/s.

1. Calculate the permeability coefficient $P$of the membrane for the molecule.
2. Deduce the molecular diffusion coefficient from this.