

Problem 13-21 Osmotic pressure of body fluids

What is the difference between the osmotic pressure of capillary blood and of lymph at the temperature of 310 K? Concentration of low-molecular substances in both fluids is approximately the same, but the concentrations of proteins are different. Whereas this concentration in lymph is insignificant, in blood plasma it amounts to about 7 g/100 cm³. Mean molar mass of protein is 66 kg mol⁻¹.

$$[\Delta\pi = 2.73 \text{ kPa}]$$

Solution:

$$\Delta\pi = (\Sigma c_{\text{plasma}} - \Sigma c_{\text{lymph}}) \cdot R T$$

$$T = 310 \text{ K}$$

$$\left. \begin{array}{l} m_{\text{protein}} = 7 \text{ g} \\ M_{\text{protein}} = 66 \text{ kg mol}^{-1} = 66000 \text{ g mol}^{-1} \end{array} \right\} n_{\text{protein}} = m_{\text{protein}} / M_{\text{protein}} = 7/66000$$

$$V = 100 \text{ cm}^3 = 1 \cdot 10^{-4} \text{ m}^3$$

$$(\Sigma c_{\text{plasma}} - \Sigma c_{\text{lymph}}) \cong c_{\text{protein in plasma}} = \frac{7}{66000 \cdot 1 \cdot 10^{-4}}$$

$$\Delta\pi = \frac{7}{66 \cdot 10^3 \cdot 100 \cdot 10^{-6}} \cdot 8.314 \cdot 310 = 2733.5 \text{ Pa}$$

$$\Delta\pi = 2.73 \text{ kPa}$$

Note:

Oncotic pressure, or **colloid osmotic pressure**, is a form of osmotic pressure exerted by proteins in a blood vessel's plasma (blood/liquid) that usually tends to pull water into the circulatory system. It is the opposing force to hydrostatic pressure.

Throughout the body, dissolved compounds have an osmotic pressure. Because large plasma proteins cannot easily cross through the capillary walls, their effect on the osmotic pressure of the capillary interiors will, to some extent, balance out the tendency for fluid to leak out of the capillaries. In other words, the oncotic pressure tends to pull fluid into the capillaries. In conditions where plasma proteins are reduced, e.g. from being lost in the urine (proteinuria) or from malnutrition, there will be a reduction in oncotic pressure and an increase in filtration across the capillary, resulting in excess fluid buildup in the tissues (edema).

