Problem 13-25 Tonicity of solutions

Your task is to prepare 100 cm^3 of isotonic solution. You know that the osmotic pressure of human blood is maintained at the value of 0.75 MPa.

(a) If you weight 1.7 g of natrium chloride (M = 58 g mol^{-1}, in aqueous solution fully dissociated), dissolve in a small amount of water and at 37 °C filled up to volume of 100 cm^3. Will be the resulting solution isotonic, hypertonic, or hypotonic? How will feel the cells immersed into this solution? (Assume the validity of van't Hoff equation at these conditions).

(b) How many grams of urea (M = 60 g mol^{-1}, does not dissociate in an aqueous solution) you must weigh in to prepare 100 cm^3 of isotonic solution??

[isotonic solution: (a) m_{NaCl} = 0.85 g (if your weiht 1.7 g, you forgot, that NaCl dissociates – such solution would be hypertonic, the cells would shrink; (b) $m_{glucose}$ = 1.745 g]

Solution:

T = 37 + 273.15 = 310.15 K

m_2 = ?

V = 100 cm^3

π = 0.75 MPa

$$\pi = i \cdot \frac{RT}{M} \cdot \frac{m_2}{V}$$

Isotonic solution should contain in 100 cm^3

(a) M_{NaCl} = 58 g mol^{-1},

$$m_{NaCl} = \frac{M_{NaCl}}{2RT} \cdot \pi \cdot V = \frac{58}{2 \cdot 8.314 \cdot 310.15} \cdot 0.75 \cdot 10^6 \cdot 100 \cdot 10^{-6} = 0.85 \text{ g}$$

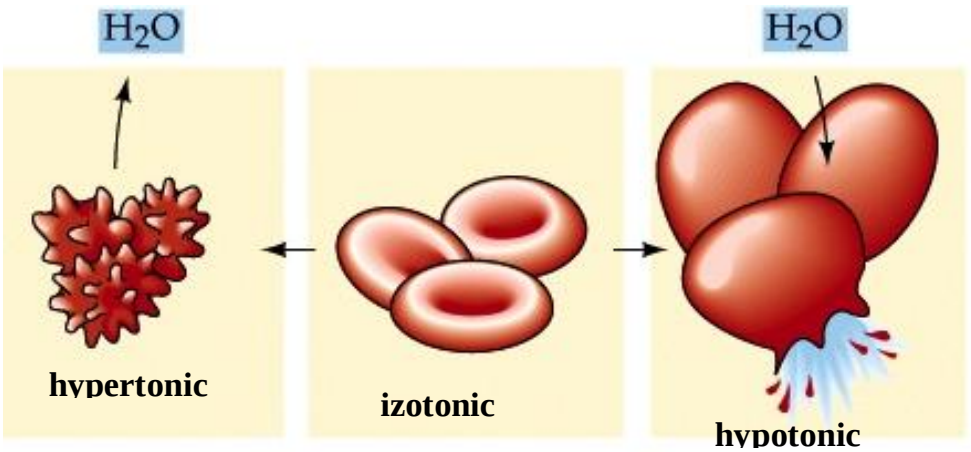
(NaCl = Na^+ + Cl^- (i = 2))

or

(b) M_{urea} = 60 g mol^{-1}

$$m_{glucose} = \frac{M_{urea}}{RT} \cdot \pi \cdot V = \frac{60}{8.314 \cdot 310.15} \cdot 0.75 \cdot 10^6 \cdot 100 \cdot 10^{-6} = 1.745 \text{ g}$$

$$\left[\frac{\text{g mol}^{-1}}{(\text{J K}^{-1}\text{ mol}^{-1}) \cdot \text{K}} \cdot \text{Pa} \cdot \text{m}^3 = \text{g} \right]$$



c(hypertonic) > c(izotonic) > c(hypotonic)