Chapter 21

Question 21.7

(i) By what percentage would the osmotic concentration of extracellular fluids decrease?

The 50 mL intake of water is entirely absorbed from the gut and rapidly distributes through 3.5 L (3500 mL).
Therefore, the total resulting volume of fluids = 50 + 3500 = 3550 (mL)

Hence, the proportional dilution of the body fluids by water intake = 3500/3550 = 0.9859
And, the proportional decrease in osmolality of extracellular fluids (ECF) = 1 – 0.9859 = 0.0141

So, **percent decrease in osmotic concentration of extracellular fluids = 1.41 %**

(ii) How much (in mOsm kg^{-1}) would plasma osmolality decrease after consuming the water?

Proportional dilution of ECF calculated in answering question (i) = 0.0141

Therefore, decrease in ECF osmolality = 0.014 × 300 mOsm kg^{-1} = **4.23 mOsm kg^{-1}**

(iii) The calculated decrease in ECF osmolality is sufficient to reduce secretion of arginine vasopressin, as we learn in Section 21.1.4.

Question 21.12

(i) Rate of Ca^{2+} filtration = GFR × Ca^{2+} concentration in filtrate   Equation 1

The glomerular filtration rate (GFR) is given in the question as 0.2 mL min^{-1}.
The Ca^{2+} concentration in the glomerular filtrate is determined by the total Ca^{2+} concentration of the plasma of the mice (given as 2.5 mmol L^{-1}) of which 60 per cent is stated to be filterable.

Therefore:

Ca^{2+} concentration in the glomerular filtrate = (60/100) × 2.5 (mmol L^{-1}) = 1.5 mmol L^{-1} = 1.5 ÷ 1000 mmol mL^{-1}

Inserting Ca^{2+} and GFR in Equation 1 gives:

Rate of Ca^{2+} filtration (mmol min^{-1}) = 0.2 (mL min^{-1}) × (1.5 ÷ 1000) (mmol mL^{-1})

= 0.0003 mmol min^{-1}

The question asks for calculation of the rate of Ca^{2+} filtration in µmol h^{-1}

To convert rate of Ca^{2+} filtration of 0.0003 mmol min^{-1} to µmol min^{-1} we need to multiply the value by 1000, and to convert value in µmol min^{-1} to µmol h^{-1} we need to multiply value by 60. Therefore:

Rate of Ca^{2+} filtration (µmol h^{-1}) = 0.0003 × 1000 × 60
= 18 µmol h^{-1}

(ii) The question tells us that the distal nephron reabsorbs 9 per cent of the filtered Ca^{2+}

9 per cent of filtered Ca^{2+} = (9/100) × 18 (µmol h^{-1})
= **1.62 µmol h^{-1}**

