Chapter 6

Question 6.3

- All values are provided in mg so TEWL should be calculated in mg.
- Water loss of mammals occurs by evaporation (TEWL), by excretion of urine, and in the faeces.
- If water balance is maintained, water losses are balanced by water intake in food, in drinking water, and by the generation of metabolic water.

Bringing these factors together we obtain Equation 1:
TEWL + (water loss in urine) + (water in faeces) = (pre-formed water in food) + (water intake by drinking) + (metabolic water)
(Equation 1)

Rearranging Equation 1 gives:
TEWL = (preformed water in food) + (water intake by drinking) + (metabolic water) − (water loss in urine) − (water loss in faeces)
(Equation 2)

The question tells us that over the 24 h period the mammal lost 2 mg body mass. We can assume this loss of body mass reflects water loss and therefore enter 2 mg on the right hand side of Equation 2 when calculating TEWL (remembering that the animal was not given any drinking water).

Inserting the values provided in the question into Equation 2 gives:

TEWL (mg) $= 2 + 100 + 0 + 480 - 160 - ((10 \div 100) \times 200)$
= 402 mg

A more accurate value could be obtained if the loss of carbon as CO_2, due to food oxidation, had also been monitored in the experiment. The loss in body mass recorded (2 mg) may incorporate some C loss. Hence, TEWL will be very slightly overestimated (by up to 2 mg).

Question 6.7

Water vapour retrieved by cooling of expired air
= Water vapour added during inspiration (mg L^{-1}) − Water vapour in expired air (mg L^{-1})
(Equation 1)

Water vapour added to air during inspiration (mg L^{-1})
= Water vapour in saturated air at body temperature (mg L^{-1}) − Water vapour of inspired air (mg L^{-1})
(Equation 2)

By referring to Figure 6.3, we can obtain a value for water vapour density of saturated air in the lungs at body temperature. From Figure 6.3, the water vapour density at 100% relative humidity (saturated air) in the lungs, at 38 ^{o}C = 46 g m^{-3}

= 46 g per 1000 L (since 1 m^{-3} = 1000 L)
= 46 mg L^{-1}.

We can now use Equation 2 to calculate the water vapour added during inspiration by inserting the value obtained from Figure 6.3, and the value provided in the question, which tells us that the kangaroo rat is breathing air (at 30°C) containing water vapour at 12.3 mg L^{-1}.

Water vapour added to air during inspiration (mg L^{-1})
= 46 − 12.3
= 33.7 mg L^{-1}

The question tells us that expired air is at 25 °C. Reading off from Figure 6.3 we find that at 25 °C saturated air contains water vapour at 21.7 g m^{-3} = 21.7 mg L^{-1}.

We can now insert values in Equation 1 to calculate water vapour retrieval due to cooling of expired air:

Water vapour retrieved by cooling of expired air
= Water vapour added during inspiration (mg L^{-1}) − Water vapour in expired air (mg L^{-1})

= 33.7 − 21.7
= 12.0 mg L^{-1}

Expressed as a proportion of the potential loss of water, the water retrieval due to cooling

$$= \frac{\text{Water vapour retrieved by cooling of expired air } \left(\text{mg L}^{-1}\right)}{\text{Water vapour added during inspiration } \left(\text{mg L}^{-1}\right)}$$

$$= \frac{33.7 - 21.7}{33.7} = \frac{12.0}{33.7} = 0.356$$

= **35.6 %**