Box 10.1 the relationship between body mass, fat storage ability and fast duration

A body has a limited capacity to store energy, so it is not feasible for most animals to store an entire winter's worth of energy in this manner, even if it stores all its energy as fat. The maximum amount of fat (as adipose tissue in the body) that an animal can store is about 40-50 per cent of its body mass. Hence a small bat weighing 10 g can store a maximum of 4-5 g of adipose tissue, while a large herbivore weighing 100 kg can store 40-50 kg. Measurements of the energy requirements in winter for small mammals such as rodents weighing around 30 g indicate that they expend each day around 80-100 kJ (Chapter 2 explains how daily energy demands can be calculated). How much adipose tissue would a small rodent need to store to get it through a winter of 120 days (the energy density of fat is **35.6 kJ g^{-1}**)?[1]

The amount of adipose tissue required by a 30 g rodent over 120 days is calculated as follows:

- If it is assumed that the daily expenditure is 90 kJ, the rodent uses 90 kJ day^{-1} × 120 days = **10,800 kJ** of energy over the 120 day winter period.
- This is equivalent to 10,800 kJ/35.6 kJ g^{-1} = **303 g** of adipose tissue

This amount of adipose tissue is 10 times the rodent's own body mass.

The situation is better for larger animals because the demands for energy do not increase in direct proportion to their body masses, which we discuss in Chapter 2.

- For example, a deer (*Cervus* sp) weighing 100 kg, has an estimated energy requirement during winter of **21 MJ day^{-1}**.
- So, to get through a winter of 120 days it needs to store 120 × 21 MJ of energy, which is **2520 MJ**.
- The amount of adipose tissue required to provide 2520 MJ of energy is:

(2520 × 1000) kJ/35.6 kJ g^{-1} = 70786 g, or **70.8 kg** of adipose tissue.

This would probably still be impossible, as the maximum amount of adipose tissue the deer could store is about 45 kg, but it is evident that the deer could get much closer to its total demands for the entire winter than the small rodent, We see, therefore, how a reliance on internally stored reserves becomes progressively more feasible with larger animals.

[1] Energy density of fat is discussed in Section 2.2.1