1.2 *Body water*

Water is the major component of the human body and, in any individual, body water content stays remarkably constant from day to day. However, there is considerable variability in the water content of different individuals and this variability is due to differences in the amount of adipose tissue (fat) in different people.

In a 70 kg man of average build, the body water will constitute 63% of the body weight, and thus there will be 451 of total body water (TBW). In a woman of the same weight, only about 52% (361) of the body weight will be water. This difference is due to the fact that women have more adipose tissue than men and the water content of adipose tissue is very low (about 10%).

In obese people, fat is a major constituent of the body (second only to water), and even 'slim' people have considerable quantities of fat. We can regard the fat as non-functional (storage) tissue. The functional tissue of the body can be regarded as fat-free: the percentage of water in the fat-free tissue is extremely constant, both within an individual from day to day and between individuals. The percentage water in this 'lean body mass' is 73%.

1.3 *Body fluid osmolality*

The exchange of water between the different body fluid compartments is facilitated by two forces: hydrostatic pressure and osmotic pressure. In order to understand osmotic pressure, consider a container of water, separated into two compartments by a membrane permeable to water. The water molecules will be moving at random (Brownian motion) and some of them will be moving across the membrane by diffusion; the rate of diffusion in each direction will be equal, so that net flux is zero. Now, suppose that a solute is added to one compartment. The addition of solutes to water reduces the random movement (activity) of the water molecules and, consequently, the diffusion of water from the side containing the solute to the side containing only water will be reduced. There will then be a net flux of water from the pure water side to the solution side of the membrane (Figure 1.1). We can measure this osmotic effect as an **osmotic pressure**, by determining the hydrostatic pressure which must be applied to the compartment containing solute, to prevent the net entry of water. This hydrostatic pressure is equal to the osmotic pressure of the solution.

1.3.1 *Units of osmotic measurement*

From the foregoing, it is apparent that, like hydrostatic pressure, osmotic pressure could be expressed as mmHg. A more useful unit, however, is the osmole, and in physiology osmolality is usually expressed as mosmol/kg H_2O. The

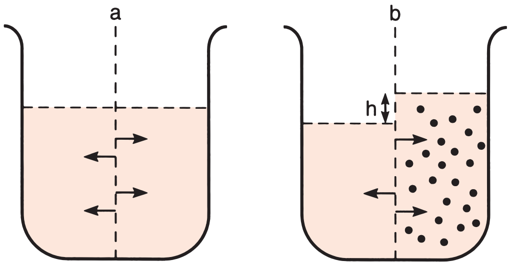

Figure 1.1 A container divided into two compartments by a membrane permeable to water, but impermeable to some solutes. (Such membranes are termed 'semi-permeable'.) (a) When there is only water in the container, the unidirectional water fluxes (represented by the arrows) are equal, so that the net flux of water is zero. (b) If a solute to which the membrane is impermeable is added to one compartment of the container, the activity of the water molecules on the side containing the solute is reduced, so that the unidirectional water flux from that side is reduced. The unidirectional water flux into the solute-containing side continues as before, so that there is a net flux into the solute-containing side, which creates a hydrostatic pressure difference (*h*). This hydrostatic pressure is equal to the **osmotic pressure** of the solution. Alternatively, the osmotic pressure of the solution could be measured by determining the hydrostatic pressure which must be applied to the solute-containing side to prevent the net influx of water to this compartment. Water moves from an area of *low* osmolality to one of *higher* osmolality.

osmole is analogous to the mole (and, for non-dissociable substances, is *identical* to the mole, i.e. it is 1 g molecular weight of the non-dissociable molecule). For molecules which dissociate, each particle derived from the molecule contributes to the osmotic pressure and so, to calculate the osmolality from the molality, it is necessary to multiply by the number of particles. Suppose a molecule dissociates into *n* ions; then osmolality is given by

$$\text{Osmolality (mosmol/kg } H_2O) = n \times \text{molar concentration (mmol/kg } H_2O)$$

It should be noted that the units of osmolality (and molality) refer to the concentration per unit weight of *solvent* (water). This is in contrast to osmolarity (and molarity) which refers to the (os)molar concentration per litre of solution (i.e. water + solute), so units of osmolarity are mosmol/l. Osmolality is the preferred measurement, although in practice the difference between the two terms when dealing with physiological solute concentrations is very small.

1.3.2 *Isotonicity and isosmoticity*

If red blood cells are suspended in distilled water, water enters the cells by osmosis and the cells swell and burst. This is haemolysis. If the cells are