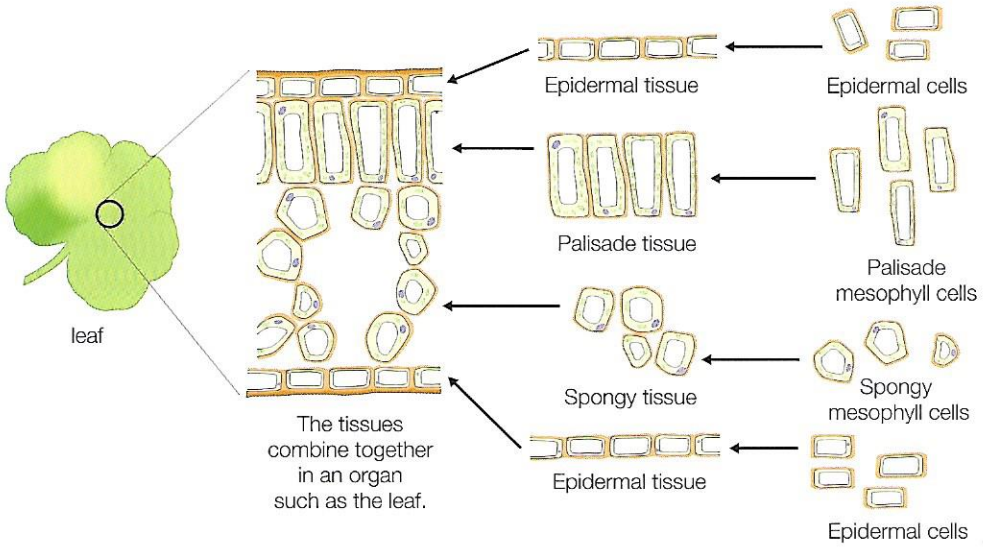

Figure 5.6 Grouping of cells to form tissues in the organ of a leaf.

its systems functioning efficiently and continuously has an advantage for survival – an advantage for life.

ITQ5
Distinguish between unicellular and multicellular organisms, giving two examples of each.

ITQ6
Give an example of each of the following: cell, tissue, organ, system.

Movement of substances into and out of cells

All kinds of reactions take place within a cell. The organelles within a cell require many different substances to carry out these reactions. Waste products are formed during these reactions and must be removed. The substances, needed and produced, must pass into and out of the cell.

There is thus a constant movement of substances into and out of cells, for example:

- substances needed by the cell, like glucose and oxygen, must pass into the cell;
- substances produced by the cell must be passed out of the cell. These may be waste products like carbon dioxide and urea, or substances needed by another cell, like enzymes. This is called secretion.

secretion ▶

Substances can be taken in within small vesicles made from the cell membrane. *Amoeba* takes its food in this way. Substances can also be released from cells when vesicles containing the substance join with the cell membrane (see figure 5.7). Hormones are released from cells like this.

Substances may also enter and leave cells as individual molecules. They do this by various mechanisms including diffusion. Water enters and leaves cells by osmosis.

Movement by diffusion

diffusion ▶

Diffusion is the movement of molecules from a region of high concentration of those molecules to a region of lower concentration of those molecules. Diffusion can happen in gases and in liquids.

concentration gradient ▶

A diffusion gradient or concentration gradient occurs when there is a difference in the number of molecules, or the concentration of molecules between the two regions. For example, when a drop of dye is added to water, the dye molecules move around and between the water molecules and eventually are spread evenly, even when not stirred. In other words, the dye molecules move from where they are plentiful to where they are not so plentiful. We say they diffuse.

permeable ▶

Substances can also diffuse across membranes if the concentrations are different on both sides and the membrane is permeable to those molecules (lets them through).

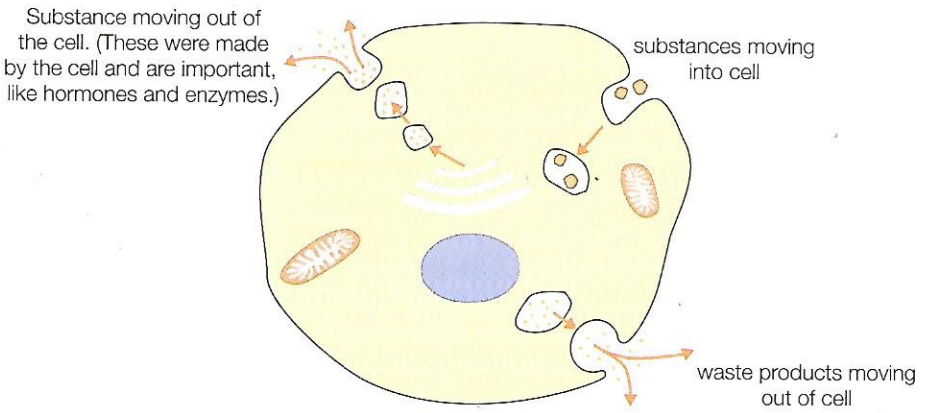

Figure 5.7 Diagram showing substances moving into and out of a cell in small vesicles.

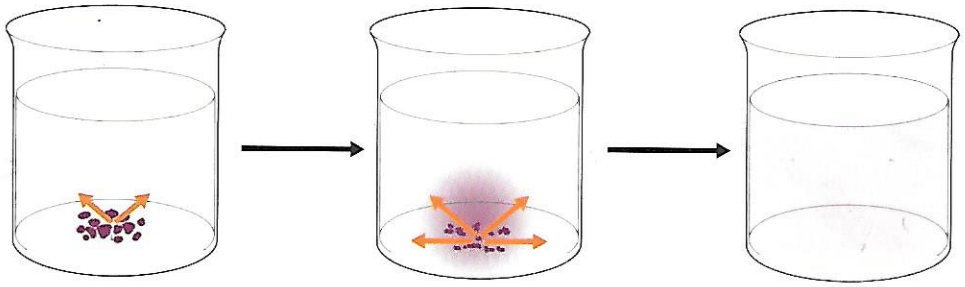

Figure 5.8 Over time the dye molecules diffuse so they are evenly spread throughout the solution.

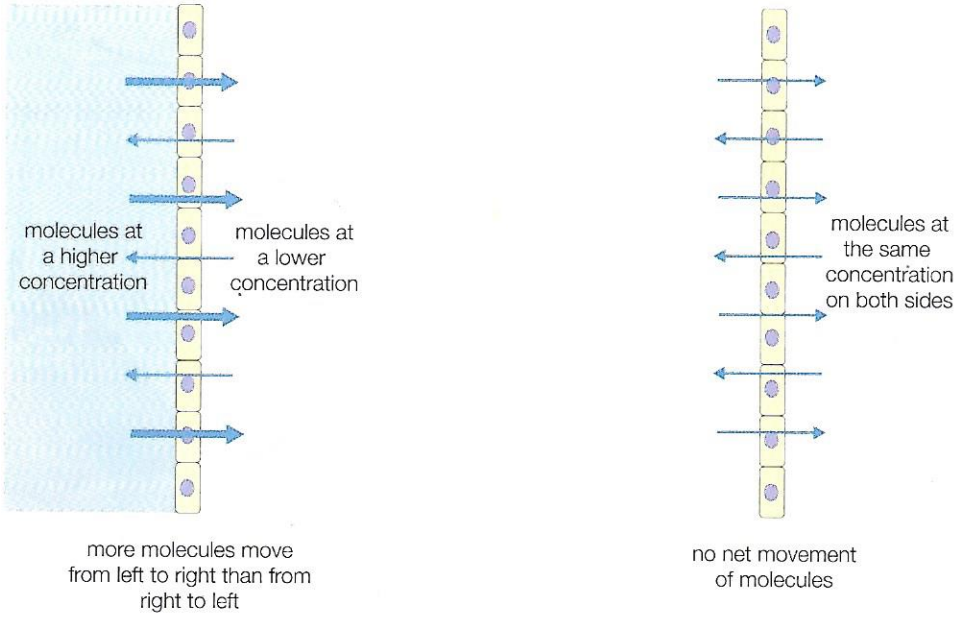

Figure 5.9 Diffusion can occur across thin cell membranes.

Some examples of diffusion in the human body

- After a meal the end-products of digestion are at a high concentration in the gut. They diffuse down their concentration gradient into the blood where they are at a lower concentration.

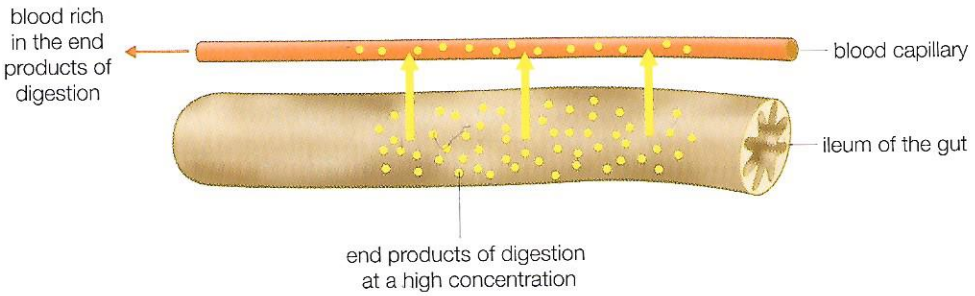

Figure 5.10 Diffusion of small food molecules from gut to blood.

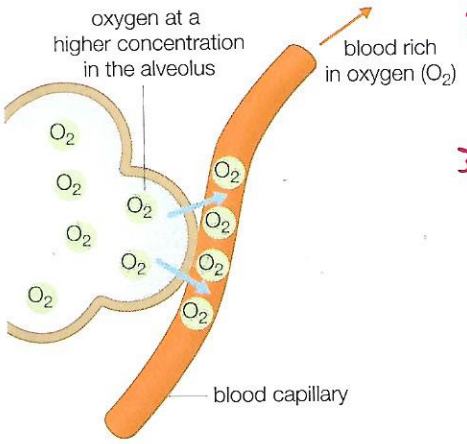

Figure 5.11 Diffusion of gases between the lungs and the blood.

2 • Diffusion occurs in the lungs. Carbon dioxide diffuses from the blood where it is at high concentration into the lung where its concentration is lower. Oxygen diffuses in the other direction because it has a higher concentration in the lungs and a lower concentration in the blood.

3 • When the blood gets near the cells, the oxygen concentration in the blood is higher than in the cells. The blood came from the lungs where it picked up oxygen. The oxygen concentration in the cell is low, since the oxygen that was in the cell was used for respiration. The oxygen in the blood diffuses into the cell, where it can be used for energy production during respiration.

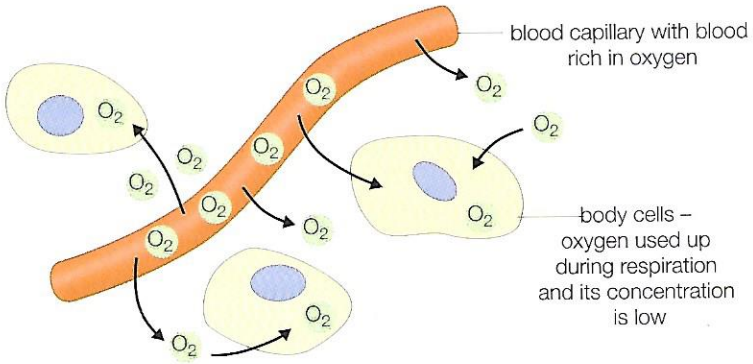

Figure 5.12 Diffusion of oxygen from blood into cells.

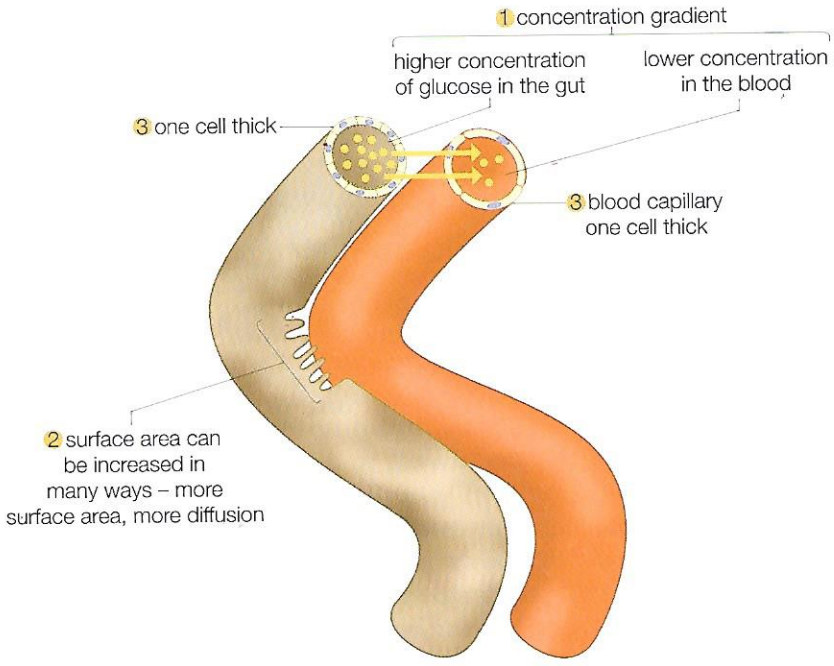

Figure 5.13 Adaptations that help to speed up the rate of diffusion.

3 • In the cells, carbon dioxide builds up as a waste product of respiration. It is at a higher concentration than in the blood. Thus it diffuses out of the cell and into the blood.

4 • Other wastes made by cells, such as ammonia, are at a higher concentration in the cell than in the blood. They also diffuse out of the cell to the blood and are taken away and expelled from the body.

Diffusion is a very slow process unless there is a large concentration gradient over a short distance. Tissues like the lungs and small intestine are especially adapted to maximise the rate of diffusion by:

1 keeping the difference between the concentrations on each side as high as possible (maintaining a steep concentration gradient);
2 having a large surface area to volume ratio so that gases have as large an area of cells as possible to diffuse through;
3 being very thin and thus minimising the distance over which diffusion must take place.

Movement by osmosis

osmosis ▶ Osmosis is a special kind of diffusion. It is the diffusion of water molecules across a selectively permeable membrane. Cell membranes are all selectively permeable membranes. 'Selectively permeable' means that water and some substances can pass through the membrane but other substances do not.

Osmosis in plant cells

isotonic ▶ When a plant cell is put into a solution which has the same concentration as the cell contents (isotonic), some water molecules will move into the cell through the cell membrane and some will move out. There is no concentration gradient so the movements each way are the same and balance each other out. We say there is

net flow ▶ no net movement, or net flow, of water.

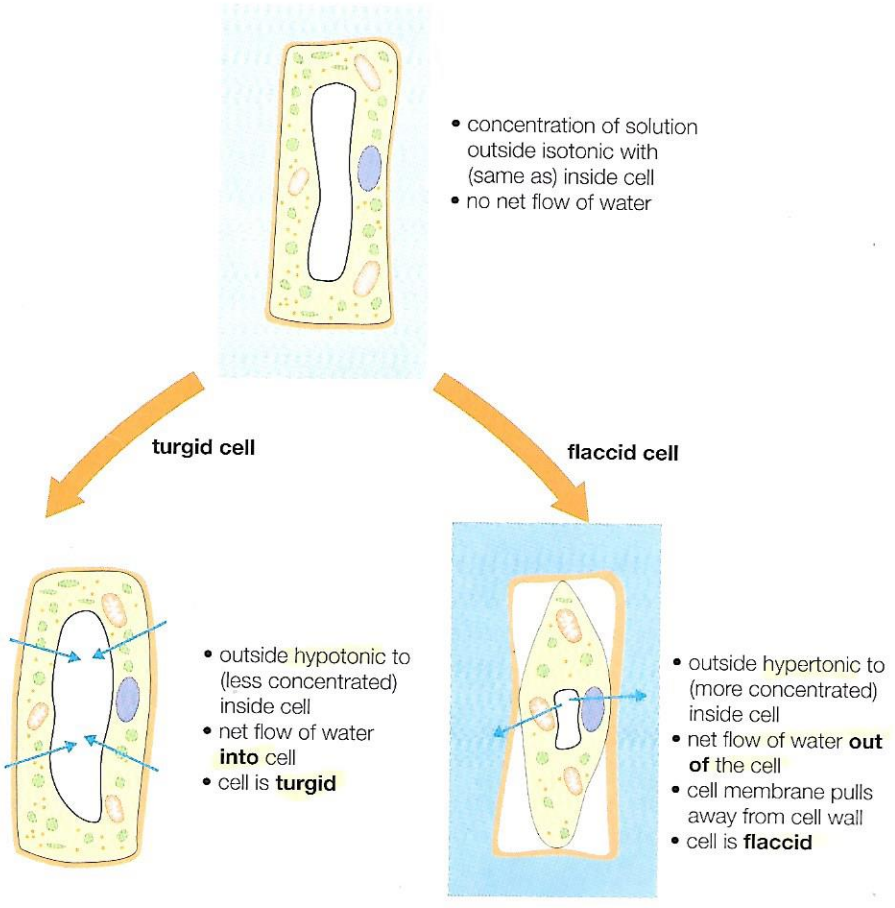

Figure 5.14 The effect of different concentrations of solution on a plant cell.

hypotonic ▶

When a plant cell is put into a solution that is less concentrated (hypotonic) than the cell contents, there is a greater concentration of water molecules outside than inside. Some water molecules move out of the cell but more move into the cell, so there is a net flow of water into the cell. The cell becomes full of water and is described as being turgid.

turgid ▶

hypertonic ▶

When a plant cell is put into a solution that is more concentrated (hypertonic) than the cell contents, there are fewer water molecules outside than inside. A few water molecules will move into of the cell but many more move out of it, so there is a net flow of water out of the cell. The cell loses water and is described as being flaccid. Flaccid cells are easy to distinguish under the microscope because the cell membrane and contents pull away from the cell wall.

flaccid ▶

Osmosis in animal cells

An animal cell has no cell wall like a plant cell, so hypotonic and hypertonic solutions have different effects. In a hypotonic (dilute) solution there is a net flow of water into the cell. With no strong cell wall to prevent the membrane from stretching too far, it eventually bursts. In a hypertonic (concentrated) solution there is a net flow of water out of the cell and the whole cell shrinks.

It is important for cells to be protected from large changes in concentration of the solutions around them. Animal bodies have complex mechanisms to do this called osmoregulation and homeostasis (chapter 12).

ITQ7

An animal cell placed in water will burst. Explain fully why a plant cell will not burst when placed in water.

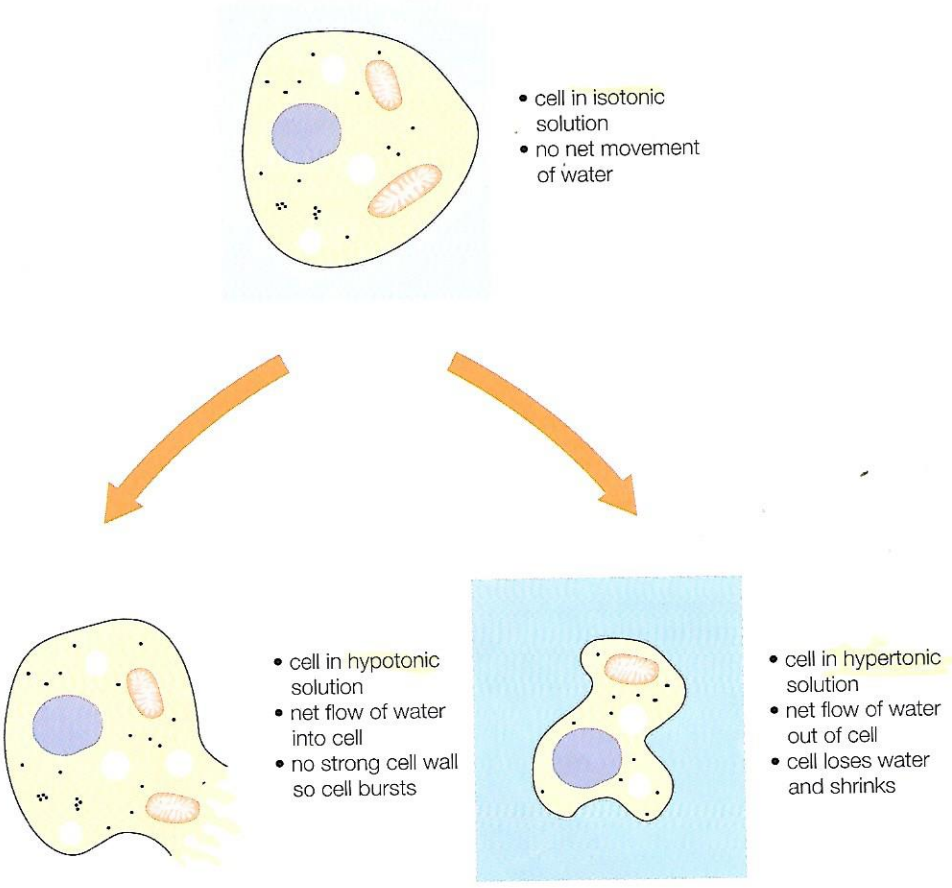

Figure 5.15 The effect of different concentrations of solution on an animal cell.