Chapter 1: Cell membrane

1.1 SECTION REVIEW

1 A differentially permeable membrane allows some substances to pass across it, but not others.

2 **a** Membrane receptor proteins
b Cholesterol
c Protein channels in cell

3 Channel proteins in cell membranes form channels within membranes to allow the passage of some substances across the membrane.

4 **a** The phospholipid bilayer of the cell membrane is described as fluid and membrane proteins form the mosaic part.
b The lipid bilayer is described as fluid because it has the ability to flow and change shape, like a two-dimensional fluid, and membrane proteins are referred to as a mosaic because they are embedded in the lipid in various patterns like a mosaic.

1.2 SECTION REVIEW

1 Water is the solvent; salt is the solute.

2 Increasing the concentration gradient or temperature will increase the rate of diffusion.

3 Facilitated diffusion occurs when charged particles or relatively large molecules are helped to across the membrane, e.g. glucose, amino acids, sodium ions and chloride ions.

4 Plant cells do not burst when placed in a hypotonic solution because they have cell walls.

5 The pathway of a water molecule would be from external environment into cytoplasm, into contractile vacuole and then out to external environment. The contents of the contractile vacuole would be hypertonic to cytoplasm.

6 Chemicals from the cooking food move by diffusion, from high concentration in the kitchen to a lower concentration outside the kitchen.

7 If red blood cells were kept in pure water, the water would diffuse into the cells (from high to low concentration of water) and they would burst.

8 To restore the crispness of limp salad greens, soak lettuce in cool water. This is because water diffuses from outside the lettuce into the cytoplasm of the cells from a high to low concentration of water. Water then diffuses into the vacuole, pressing outwards and making the cells turgid.

9 Isotonic sports drinks have a similar concentration of dissolved substances to blood.

10 **a** Solution Z was hypertonic to the animal cell.
b Cells in solution Y were isotonic with the solution.
c In solution X, plant cells would be turgid and swollen, in solution Y they would not change size and in solution Z plant cells would become flaccid and plasmolysed, meaning the cell membrane would pull away from the cell wall.

1.3 SECTION REVIEW

1 Membrane carrier proteins

2 ATP

3 (1) In active transport, moves substances up their concentration gradient, across a cell membrane, using energy, but in simple diffusion substances move down their concentration gradient without energy being used. (2) Diffusion is not necessarily movement across a cell membrane.

4 Intestinal cells actively transport glucose into the body from digested food to ensure it is not excreted and seaweeds actively uptake essential minerals such as iodine that are in low concentrations in the sea.

5 Passive and active cellular uptake of glucose molecules are similar because both actions require a membrane carrier protein. They are different because active uptake requires energy and moves glucose from a low to a high concentration, whereas passive transport moves glucose from a high to a low concentration and requires no energy.

1.4 SECTION REVIEW

1 Substances taken into cells by endocytosis are usually large and/or polar molecules.

2 During endocytosis, the cell membrane flows around the substance and when projections of the membrane meet, membrane fusion occurs, resulting in formation of a vesicle inside cytoplasm.

3 Certain white blood cells are known as phagocytes because they engulf invading bacteria by phagocytosis.

4 Phagocytosis is said to be a selective process because macrophages use recognition proteins in the plasma membrane of the cells they encounter to discriminate between invading bacteria and body cells.

5 Phagocytosis is a type of endocytosis. Endocytosis includes taking in both solid and liquid material in vesicles, while phagocytosis refers only to the uptake of solid material.

6 Endocytosis should decrease the area of the cell membrane because vesicles bud off the membrane and enter the cytoplasm.

1.5 SECTION REVIEW

1 Size and shape of the substance

2 Ions and ethanol cannot enter cells in the same way because they are chemically different. Ethanol is an uncharged molecule so it crosses membranes by dissolving in the phospholipid bilayer, whereas ions are charged particles that are hydrophilic and so cannot pass through the hydrophobic interior of membrane.

3 A high concentration gradient of oxygen between the inside and outside of a cell causes high rate of diffusion of oxygen, while a low concentration gradient causes low rate of diffusion.

4 **a** If an *Amoeba* is washed into the sea during a storm, water diffuses out of cytoplasm of *Amoeba*, from a high concentration of water inside the cell, out into the sea where the water is in a lower concentration because of the presence of salt in the sea.

b Respiration will increase the concentration of carbon dioxide inside working muscle cells therefore it will diffuse out of cells towards a lower concentration.

c Chloroform moves into cells (low concentration) from a high concentration in lungs.

d Sodium and chloride ions cannot diffuse across membranes because they are hydrophilic.

5 During dialysis, for the wastes to continue diffusing out of the dialysis tube, the surrounding solution must be replaced with fresh solution that does not contain wastes. If this is not done, the wastes in the blood would be at the same concentration (isotonic) at the solution and they would stop diffusing out of the blood.

1.6 SECTION REVIEW

1 Surface area of a cube $= 6 \times (\text{length of side})^2$
$= 6 \times 2 \times 2 = 24 \text{ cm}^2$

Volume of a cube = length × width × height
$= 2 \times 2 \times 2 = 8 \text{ cm}^3$

Surface area : volume $= 24 : 8$

$= 3 : 1$

2 Surface-area-to-volume ratio reduces as cells enlarge.

3 Cells can increase the rate of diffusion of substances across their cell membrane by removing it from inside the cell, by either using the substance or by converting it to another substance.

4 Being long, thin or flat increases a cell's surface-area-to-volume ratio.

5 As a cell increases in size, both surface area and volume increase, but volume grows faster than surface area, causing a reduction in surface-area-to-volume ratio. The actual rate of diffusion does not change, but the cell reaches a point where exchange of essential substances and wastes across the membrane are not fast enough to service the increased volume of the cell.

6 Table 1.6.1 shows that with a diameter of 1 cm, the object would have a SA:V ratio of 6:1. This drops significantly (halves) to 3:1 with an increase of diameter to 2 cm, and with another increase in diameter to 3 cm, the SA:V ratio drops to 2:1. This data shows there is not a linear relationship between size and surface-area-to-volume ratio.

CHAPTER REVIEW QUESTIONS

1 Osmosis only occurs across a differentially permeable membrane.

2 Osmosis is caused by a difference in the concentration of water across a differentially permeable membrane.

3 Water diffuses from a high concentration of water across a membrane to a low concentration of water.

4 Cells may swell or shrink as a result of osmosis. Animal cells may burst as a result of swelling during osmosis.

5 Solutions that contain a high concentration of solutes have a low concentration of water. This means that water will diffuse by osmosis from a solution of low solute concentration to a solution of high solute concentration.

6 Osmosis occurs across cell membranes and artificial differentially permeable membranes.

7 The random movement of particles in liquids results in osmosis.

8 Water diffuses from a high concentration of water outside the cubes to a lower concentration of water inside the potato cells, increasing the mass of the tissue.

9 The smaller the potato cube, the faster it will gain mass by osmosis when submerged in water.

10 Boiled potato cubes would not change mass in water.

11 Boiling would destroy the cell membrane, meaning that osmosis could not occur.

12 Yes, cubes of other vegetables would also gain mass in water.

13 Boiling for a short period of time would probably still destroy the membrane and boiling for longer would not do further damage. Quickly dipping the potato cube into hot water would probably not heat the tissue enough to destroy the membrane.

END-OF-CHAPTER EXAM

1 D
2 B
3 D
4 D
5 Phagocytosis
6 Plasmolysis
7 The contractile vacuole removes excess water from the cytoplasm.
8 If red blood cells are stored in water, the water would diffuse into the cells by osmosis and the cells would burst.
9 **a**

	CUBE A	CUBE B	CUBE C	CUBE D
Dimensions (cm)	1 × 1 × 1	2 × 2 × 2	3 × 3 × 3	4 × 4 × 4
Surface area (cm^2)	6	24	54	96
Volume (cm^3)	1	8	27	64
Surface-area-to-volume ratio	6:1	3:1	2:1	3:2

b Surface-area-to-volume ratio decreases as cube size increases, but not in a linear way.
c The larger organism would need to have a very large surface area. This could be achieved by a change in shape. It could be very long, thin and/or flat, or could have many projections.