Answers

1. This plant cell was placed in hypotonic solution such as distilled water. Because the plant was placed in a hypotonic solution, water would move more the external environment where solutes are in low concentration into the plant cell where solute concentration would be considerably higher in comparison. This would account for the plant cell swelling or bulging.
2. (b)
3. (c)
4. Water moves across a semipermeable membrane in osmosis because there is a difference in solute concentration between the inside of the cell and the outside of the cell.

Glossary

aquaporin: channel protein that allows water through the membrane at a very high rate

active transport: the method of transporting materials into or out of a cell that requires energy

concentration gradient: an area of high concentration across from an area of low concentration

diffusion: a passive process of transport where solutes move from an area of high concentration to an area of low concentration until equilibrium is met

facilitated transport: a process by which solutes moves down a concentration gradient (from high to low concentration) using integral membrane proteins

hypertonic: describes a solution in which extracellular fluid has a higher osmolarity than the fluid inside the cell

hypotonic: describes a solution in which extracellular fluid has a lower osmolarity than the fluid inside the cell

isotonic: describes a solution in which the extracellular fluid has the same osmolarity as the fluid inside the cell

osmolarity: the total amount of substances dissolved in a specific amount of solution

osmosis: the transport of water through a semipermeable membrane from an area of low solute concentration to an area of high solute concentration. Water also moves from an area of high water concentration to an area of low water concentration until equilibrium is met.

passive transport: a method of transporting material that does not require energy

selectively permeable: the characteristic of a membrane that allows some substances through but not others

simple diffusion: a process where solutes move directly through the membrane from an area of high concentration to an area of low concentration until equilibrium is met

solute: a substance dissolved in another to form a solution

tonicity: the amount of solute in a solution

5.3 Active Transport

Learning objectives

By the end of this section, you will be able to:

- *Explain active transport*
- *Describe endocytosis, including phagocytosis, pinocytosis, and receptor-mediated endocytosis*
- *Understand the process of exocytosis*
- *Be able to define and explain all bolded terms*

All of the transport methods described in the preceding section shared one important commonality—the cell did not have to use energy, ATP, to move materials. During **active transport** energy is required to move a substance across a membrane, often with the help of integral proteins, and usually against its concentration gradient. If a material must be moved out of the cell against its concentration gradient, that means the concentration of the material outside of the cell is greater than the concentration of the material inside the cell (Figure 5.13).

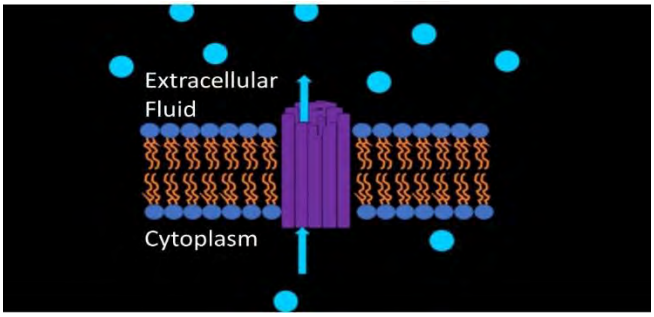

Figure 5.13 The blue circles are moving against their concentration gradient through a transport protein that requires energy. (credit: Modified by Elizabeth O'Grady original work of Emma Dittmar Wikimedia)

One of the most common types of active transport involves proteins that serve as pumps. The word "pump" probably conjures up thoughts of using energy to pump up the tire of a bicycle or a basketball. Similarly, energy from ATP is required for these membrane proteins to transport substances such as molecules or ions across the membrane.

For example, some cells have a high concentration of potassium (K^+) and a low concentration of sodium (Na^+) inside the cell when compared to that of the extracellular fluid. The sodium-potassium pump transports sodium out of a cell while moving potassium into the cell (Figure 5.14). Both ions are being pumped against their concentration gradients; therefore, energy must be used to accomplish this. The Na^+/K^+ pump is an important ion pump found in the membranes of many types of cells. These pumps are particularly abundant in nerve cells, which are continually pumping out sodium ions and pulling in potassium ions to maintain a gradient across their cell membranes.

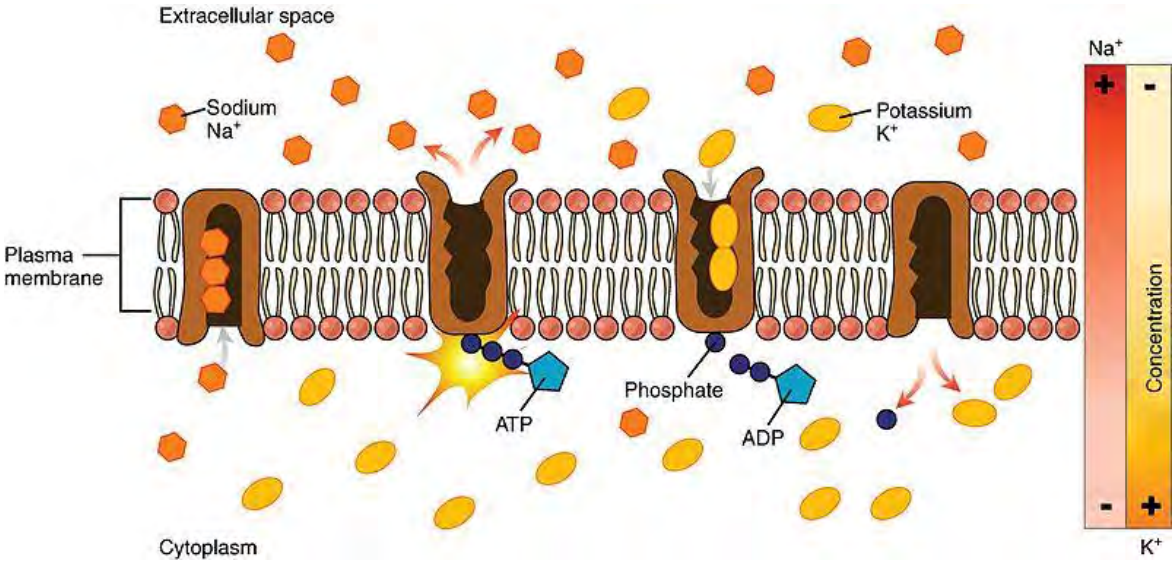

Figure 5.14 The sodium-potassium pump, which is powered by ATP, is found in the plasma membrane of many cells. (credit: Betts et al. / Anatomy and Physiology OpenStax)

Active transport can also occur when electrons are passed through a series of chemical reactions. Protein complexes can pass electrons, and as they do, small amounts of free energy are given off. This energy can then be used to transport ions or other materials across a plasma membrane. This type of active transport will be discussed in chapters six and seven when electron transport chains are used in cellular respiration and photosynthesis.

Endocytosis

Endocytosis is a type of active transport that moves large molecules into the cell. These large molecules, which can include cell parts and foreign cells, cannot be moved through integral proteins because of their large size. There are three different variations of endocytosis, however they all share a common characteristic: the plasma membrane of the cell invaginates, forming a pocket around the target substance. The pocket pinches off, resulting in the material being contained in a newly created vesicle or vacuole (Figure 5.15).