Pearson

13.1: Antifreeze in Frogs

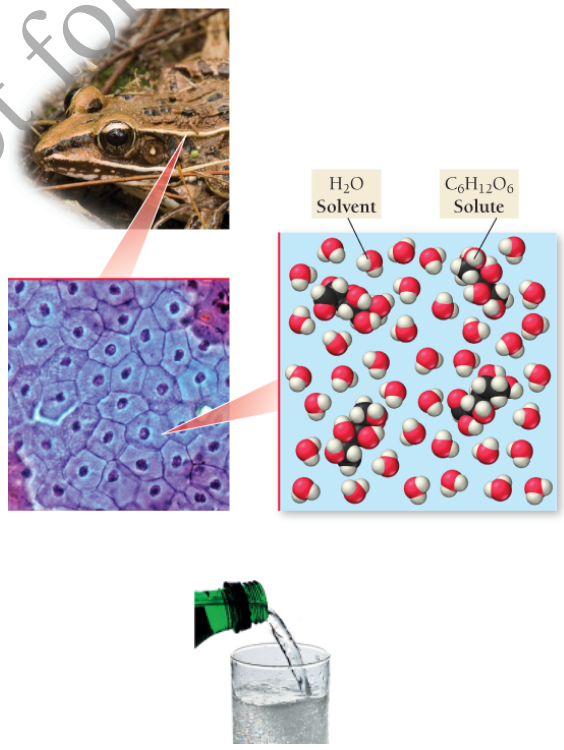
The wood frog *(Rana sylvatica)* looks like most other frogs. It is a few inches long and has characteristic greenish-brown skin. At first glance, the wood frog seems quite unremarkable. But a wood frog survives cold winters in a remarkable way—it partially freezes. In its partially frozen state, a wood frog has no heartbeat, no blood circulation, no breath, and no brain activity. Within 1–2 hours of thawing, however, these vital functions restart, and the frog hops off to find food. How does the wood frog do this?

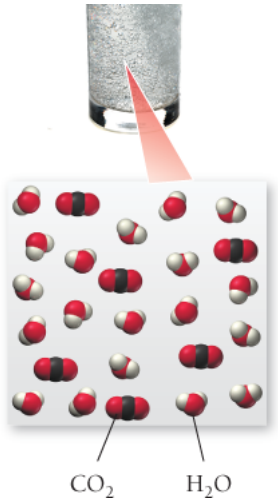
Most cold-blooded animals cannot survive freezing temperatures because the water within their cells freezes. As we learned in Section 11.8, when water freezes, it expands. When the water in cells freezes and expands, it irreversibly damages cells. To prevent this, the wood frog, before hibernating, secretes a large amount of glucose into its bloodstream. The glucose incorporates into the frog's cells, resulting in cells that are filled with a concentrated glucose solution. As we shall see in this chapter, concentrated solutions have a lower freezing point than the corresponding pure liquid. When the temperature drops below freezing, the frog's extracellular body fluids, such as those in its abdominal cavity, freeze solid. Fluids within the frog's cells, however, remain liquid because of the high glucose concentration. In other words, the concentrated glucose solution within the frog's cells acts as antifreeze, preventing the water within the cells from freezing and allowing the frog to survive.

The concentrated glucose and water mixture within the wood frog's cells is a **solution**, a homogeneous mixture of two or more substances or components (Figure 13.1). The majority component in a solution is typically called the **solvent**, and the minority component is the **solute**. In a glucose solution, water is the solvent and glucose is the solute. Solutions form in part because of the intermolecular forces we discussed in Chapter 11. In most solutions, the particles of the solute interact with the particles of the solvent through intermolecular forces.

Figure 13.1 A Glucose Solution in a Wood Frog's Cells

In a glucose solution, glucose ($C_6H_{12}PO_6$) is the solute and water is the solvent.





Club soda is a solution of carbon dioxide and water.