**Grade 12 Ontario Biology Textbook**
Citation: Di Giuseppe, M., Vavitsas, A., Ritter, B., Fraser D., Arora, A., and Lisser, B. 2003. **Biology 12**, Nelson Thomson, Toronto, pp. 340-341.

**Figure 3**
The frog's cells contain a cellular antifreeze that prevents damage during freezing and thawing.

## Research in Canada: Freezing Cells

Anthropologists huddle around the figure of a primitive person frozen in ice. As the figure in the ice begins to thaw, one of the scientists comments that the figure must look much like it did nearly 3000 years ago. Suddenly, the figure's arm moves.

The scene just described is that of science fiction—no human has ever returned to life following prolonged freezing. However, the phenomenon of suspended animation can be viewed every spring. Frogs, frozen solid in blocks of ice (**Figure 3**), are capable of continuing their existence once the ice thaws.

As cells or organs freeze, ice crystals form. Acting much like microscopic knives of ice, these ice crystals pierce and slash their way through cell membranes. Many important nutrients and cell organelles leak through the injured membrane. The cells collapse and die. The damage to large organs is especially devastating. Blood vessels rupture, nerves are crushed, and supporting structures are destroyed by ice. Thawing can be even more dangerous. As cells approach melting temperature, ice crystals may melt together, causing cells to fill with water and push against one another. Sturdy cells, such as muscle cells, broaden, while more delicate cells are crushed.

If ice is so destructive, how is it possible for some animals to survive freezing? In 1957, the Norwegian-born American physiologist Per Scholander speculated about a type of antifreeze in fish that he was studying. Scholander found that the temperature of the salt water off the coast of Baffin Island in the Canadian Arctic was often below the freezing point of the blood of the fish. A decade later, other scientists identified a protein in these fish that prevented ice crystals from forming. By interfering with the formation of the ice crystals, the protein was able to prevent cell damage. Although important, the protein is not the only way in which cells can protect themselves from extreme cold.



Dr. Kenneth G. Storey (**Figure 4**) of Carleton University, a world authority on wood frogs, has shown that high levels of glucose, a simple sugar, can act as antifreeze in the blood. Glucose levels of a frog exposed to freezing temperatures can exceed normal levels in humans by as much as 100 times. Scientists have found that the wood frog may lose as much as 60% of its cell water during freezing, reducing the dangers posed by ice crystals.

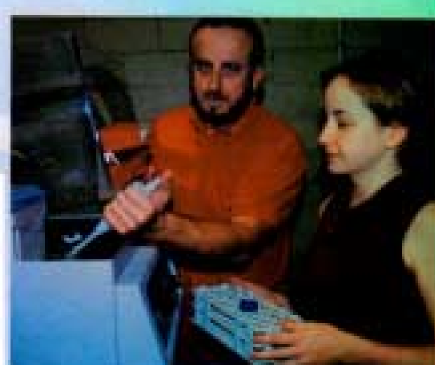

**Figure 4**
Dr. Kenneth G. Storey