

# THE GREAT OUTDOORS



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## Freeze Frame

*The frog's version of antifreeze allows it to survive temperatures as low as 3 degrees F.*

By J. Morton Galetto, CU Maurice River

I remember as a child that, when ponds still froze thick enough to ice-skate, we would sometimes see a frog, immobile in the thin ice on the side, and watch its heart beating. So this begs the question, "Where do frogs hang out in the winter?" And what was I witness to?

In the winter frogs, unlike turtles, do not bury themselves partially in the mud of ponds, streams, and rivers.

Instead they lie exposed on the bottom, reliant on the levels of dissolved oxygen in high-quality water because they breathe through their skin.

In warmer months they easily get enough oxygen to fill their lungs through their nostrils, but in winter months they retain more body heat by staying deeper in the water, so they need contact with the oxygen-carrying water to breathe.

Reptiles and amphibians enter a state of brumation - a hibernation of sorts. In brumation they slow down their heartbeat and therefore do not need the amount of oxygen that nostrils provide. But breathing through their skin is only possible because their energy demands are lower in this altered state. Even though they decrease their metabolism they still need some energy resources and rely on stored fat beneath their skin.

So what did I witness as a child? Well, the answer could vary from species to species. It seems to me this frog should have been at the pond's bottom. While some frogs have cryoprotectants in their blood - substances that protect body tissues from becoming damaged in frozen conditions - the frog I saw was not yet frozen and its heart beat was visible but weak. And it was not

one of the species that I will discuss next. Possibly my memory is as poor as my ice-skating skills!

Some species of frogs don't winter on the watercourse's bottom but instead shelter beneath leaf litter, although not deeply enough to avoid freezing. In North America five species of frogs are known to be "freeze-tolerant" (Live Science 2012). Four of these are native to our region: the wood frog, the Cope's or southern gray tree frog, the eastern or northern gray treefrog, and spring peepers.



Icy woodfrog. photo credit: Jan Storey

Once it is below 32 degrees a frog is vulnerable to freezing. Wood frogs have been heavily studied in this regard. There are special cells in their blood called nucleating proteins that make them able to tolerate an icy body state. These proteins come from storing urine. Further, when freezing begins the frog's liver converts sugars to

glucose. This is then circulated through the bloodstream of the frog and acts as the cryoprotectant. All of this is the frog's version of antifreeze, allowing it to survive temperatures as low as 3 degrees. The frog's heart can actually stop completely so that it no longer needs oxygen. Researchers Layne and Lee noted that 70 percent of these amphibians' bodies can be in this "frosicle" state which is somewhat freeze-dried. They can actually thaw and refreeze and still survive for months. When things begin to warm up they rehydrate.



Rehydrated woodfrog.  
Photo credit Brian Gratwicke, Wikipedia

You may be wondering about some other amphibians. Toads are land-based and rely primarily on digging burrows. In colder climates they may dig three feet into the ground. Salamanders, which do not dig, must

seek old burrows or rotted root systems that present ground access.

How might this apply to human health? Professor of Biology Ken Storey of Carleton University in Ottawa, Canada studies extreme environmental stresses, especially cold and the metabolic changes that allow animals to suspend body functions during whole-body freezing. His research group believes their work will have applicability in extending the preservation of human transplant organs. So when you think of a frozen frog, think about how, one day, it might save the life of someone you know - or even you.

Sources: Live Science, Smithsonian and Carleton University