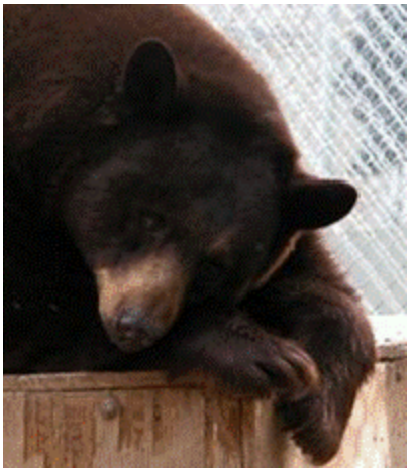
SOUTHWEST WILDLIFE
Rehabilitation & Educational Foundation Inc.



Hibernation

Say the word “hibernation”, and most people think about bears sleeping through the cold winter months. However, for years there was disagreement within the scientific community as to whether or not bears really do hibernate.

Warm-blooded Animals in Winter

It is vital that warm-blooded animals, such as mammals and birds, maintain a certain minimum body temperature in order to survive. In winter months, this basal temperature is usually much higher than the surrounding, ambient temperature. To maintain a minimum basal temperature, especially when they are losing body heat to the surrounding air, their metabolisms must operate at a high rate. To maintain a high metabolic rate requires energy. Energy comes from the foods these animals eat. Smaller animals lose body heat more quickly, so they require much more food energy to maintain their basal metabolic rates and temperatures than larger animals.

Although it may be difficult at times, many animals (deer, wolves, foxes, mountain lions, and some birds) are able to find adequate food during the winter months to maintain a minimum basal temperature. In the case of birds, many migrate to warmer climates with better food sources during the winter. For some animals, food is scarce or entirely unavailable and migration is not an option. Their solution for surviving the cold winter months: hibernation.

Warm-blooded Hibernators

Hibernation is a state of torpor, commonly compared to a deep sleep or dormancy, during which time an animal’s body temperature and basal metabolic rate decrease in order to conserve the body’s energy reserves. Torpor patterns vary greatly between species. In general, however, basal metabolism slows to 2-4% of normal; heart rate is slowed to 3-5 beats per minute; respiration is reduced to 4-6 breaths per minute, sometimes stopping entirely for brief periods; renal function may be greatly reduced or discontinued completely; and basal temperature varies between 2-10°C (35.6-50.0°F).

Non-hibernating warm-blooded animals are not capable of surviving such levels of hypometabolism and hypothermia. However, the artic ground squirrel is able to survive hibernation with basal temperatures below

freezing—0°C (32.0°F)!

Some animals remain in a state of torpor during the entire hibernation season. For many animals, however, torpor is interrupted by periods of normal metabolic activity and temperature that typically last 12-24 hours. During these periods of arousal animals must excrete waste products, which are generated despite low metabolic rates, and may eat if food is available.

Animals that experience periods of torpor that last several days to several weeks (some species of bats, hedgehogs, and the poorwill) or for the entire season (groundhogs, chipmunks, woodchucks, some species of mice, and some species of ground squirrels) are often referred to as "true" or "deep" hibernators. Because it can be difficult to wake true hibernators from torpor, they can be quite defenseless during these times. If temperatures become too low, past the point from which they could generate enough warmth to revive themselves, most true hibernators will awaken, shivering, in an effort to raise their body temperatures.

Some animals (hummingbirds, skunks, raccoons, badgers, opossums, and shrews) enter a state of torpor for only 8-12 hours each day, often during the coldest nighttime hours, or during episodes of severe weather. Their basal temperatures during torpor are higher than that of true hibernators, typically above 15°C (59°F), and they are usually easy to wake. They are considered "torpor" hibernators. In areas with mild winter climates, animals that would be true hibernators in traditionally colder winter areas may behave more like torpor hibernators or not hibernate at all.

All warm-blooded hibernators must prepare for winter. Some store fat by eating as much food as possible during the plentiful times of summer and fall. During hibernation they metabolize the stored fat instead of carbohydrates. To survive the winter, these fat-storing hibernators must nearly double their weight from the time they emerge in the spring until they begin hibernating again in the fall. Other animals cache food for winter use. They ingest and metabolize this food during their periodic arousals from torpor.

Bears

Once they enter their dens for the winter, bears will not eat or drink until exiting them in the spring—sometimes up to 6 months later. While in its winter den, a bear will not excrete any waste products at all, despite the fact that its metabolic rate is about 50% of normal. Its heart rate is reduced to 8-12 beats per minute. However, its body temperature is maintained at 31.1°C (88°F), which is not much lower than its active summer temperature of 37.8°C (100°F). Although bears' metabolic rates are significantly reduced during the winter, they have been considered by many to not be true hibernators because their basal temperatures drop only slightly.

As knowledge about how bears spend the winter has increased, however, bears have come to be recognized as highly efficient hibernators or "super" hibernators. A bear's body heat is lost slowly because of its highly insulated pelt and low surface-to-mass ratio. Not only do they metabolize fat to supply themselves with water and up to 4,000 calories each day, but they break down muscle and organ tissues to supply themselves with protein. Bears are uniquely able to do this because, unlike other mammals, their bodies can restore muscle and organ tissue.

Cold-blooded Animals & Insects

Reptiles, amphibians, and fish are cold-blooded animals, which depend entirely upon warmth from the environment for their body heat. This means that they have no way to keep their bodies warm in the winter and must become dormant as day lengths decrease and temperatures drop. Reptiles usually spend the winter in underground burrows. Many amphibians, as well as many fish, spend the winter in a dormant state at the bottom of bodies of water, where the colder water contains higher levels of oxygen, which they can absorb through their skin.

Some frogs actually freeze solid—their hearts stop and they don't breathe—only to revive when warmed up. Ice crystals form in their body cavities and between cells; up to 65% of the water in the frogs' bodies may be

frozen. However, they secrete massive amounts of glucose (more than enough to kill a human!), which enters the cells and serves as a sort of "anti-freeze". Because the water within cells does not freeze, the cells remain intact, and the frog survives this frozen state of suspended animation.

Insects are also cold-blooded. They spend the winter in a dormant state known as diapause. Because insects' life cycles vary by species, they may spend diapause as eggs, larvae, pupae, or adults, depending upon the species.

Both the diapause of insects and the dormancy experienced by fish, reptiles, and amphibians are considered a form of hibernation.

Triggering Hibernation

Biologists have long searched for the trigger(s) for hibernation. They have considered shorter days, dropping ambient temperatures, and scarcity of food as potential triggers. Recently, a substance called Hibernation Induction (or Inducement) Trigger (HIT) was found in the blood of hibernating animals. HIT is a type of opiate, chemically related to morphine. Research suggests that it is HIT that triggers hibernation: if blood is drawn from a hibernating squirrel during the winter and injected into a normally active squirrel the following spring, the second squirrel will begin hibernating. It is still not understood how HIT works.

In the past, hibernation was narrowly defined as a sleeplike state with low metabolic rates and basal temperatures near freezing. Recent research has led to a broader definition of hibernation: specialized adaptations accompanied by reduced metabolism in response to food unavailability and low environmental temperatures. However, research has been unable to explain how or why HIT works when it does; how animals rouse themselves from torpor when temperatures drop too low or periodically to excrete wastes and, in some cases, eat stored foods; or how and why hibernating warm-blooded animals don't die from hypothermia and/or permanent cellular damage.