Hibernation Articles

Hibernation

Hibernation is a state of inactivity, in which an animal's heart rate, body temperature, and breathing rate are decreased in order to conserve energy through the cold months of winter. A similar state, known as estivation, occurs in some desert animals during the dry months of summer.

Hibernation is a technique that animals have developed in order to adapt to harsh climates. When food is scarce, an animal may use up more energy maintaining its body temperature and in searching for food than it would receive from consuming the food. Hibernating animals use 70 to 100 times less energy than when active, allowing them to survive until food is once again plentiful.

Many animals sleep more often when food is scarce, but only a few truly hibernate. Hibernation differs from sleep in that a hibernating animal shows a drastic reduction in metabolism, and then awakes relatively slowly. (Metabolism is the process by which cells in an organism break down compounds to produce energy.) By contrast, a sleeping animal decreases its metabolism only slightly, and can wake up almost instantly if disturbed. Also, hibernating animals do not show periods of rapid eye movement (REM), the stage of sleep associated with dreaming in humans.

Bears, which many people think of as the classic hibernating animals, are actually just deep sleepers. They do not significantly lower their metabolism and body temperature. True hibernation occurs only in small mammals, such as bats and woodchucks, and a few birds, such as poorwills and nighthawks. Some species of insects show periods of inactivity during which growth and development cease and metabolism is greatly reduced. This state is generally referred to as diapause, although when correlated with the winter months, it would also fit the definition of hibernation.

Preparing for hibernation

Animals prepare for hibernation in the fall by storing enough food to last them until spring. Chipmunks accomplish this task by filling their burrows with food, which they consume during periodic awakenings from hibernation throughout the winter. Most animals, however, store energy internally, as fat. A woodchuck in early summer may have only about 5 percent body fat. However, as fall approaches, changes occur in the animal's brain chemistry that cause it to feel hungry and to eat constantly. As a result, the woodchuck's body fat increases to about 15 percent of its total weight. In other animals, such as the dormouse, fat may comprise as much as 50 percent of the animal's weight by the time hibernation begins. A short period of fasting usually follows the feeding frenzy, to ensure that the digestive tract is completely emptied before hibernation begins.

Entering hibernation

Going into hibernation is a gradual process. Over a period of days, an animal's heart rate and breathing rate drop slowly, eventually reaching rates of just a few times per minute. Their body temperature also drops from levels of 37° to 38°C (99° to 100°F) to 10° to 20°C (50° to 70°F). The lowered body temperature makes fewer demands on metabolism and food stores.

Electrical activity in the brain almost completely ceases during hibernation, although some areas remain active. These areas are those that respond to external stimuli such as light, temperature, and noise. Thus, the hibernating animal can be awakened under extreme conditions.

Awakening

Periodically, perhaps every two weeks or so, the hibernating animal awakes and takes a few deep breaths to refresh its air supply, or in the case of the chipmunk, to grab a bite to eat. If the weather is particularly mild, some animals may venture above ground. These animals, including chipmunks, skunks, and raccoons, are sometimes called shallow hibernators.

Awakening begins with an increase in the heart rate. Blood vessels dilate, particularly around the heart, lungs and brain, leading to an increased breathing rate. Eventually, the increase in circulation and metabolic activity spreads throughout the body, reaching the hindquarters last. It usually takes several hours for the animal to become fully active.

What's the Difference Between Hibernation and Sleep?

A common definition of hibernation is a long-term state in which body temperature is significantly decreased, metabolism slows drastically and the animal enters a coma-like condition that takes some time to recover from. By this definition, bears don't hibernate, because their body temperature drops only slightly and they awake relatively easily. Not everyone accepts this narrow definition, however. For the purposes of this article, we'll use the term hibernation to describe any long-term reduction in body temperature (**hypothermia**) and metabolism during winter months.

When an animal enters a hibernation-like state during the summer, it's known as **estivation**. It's much less common than hibernation. Hibernation in reptiles is sometimes called **brumation**. It differs from mammalian hibernation because reptiles are cold-blooded -- they can't control their own body temperature, so they need to spend the winter in a place that will stay warm enough.

Torpor is another word that causes some confusion. It's usually used to describe short-term periods of reduced body temperature that occur as often as every day and only for a few hours at a time.

So is hibernation basically a really long nap? No. These animals aren't just sleeping, they're undergoing physiological changes that can be very drastic. The most significant element of hibernation is a drop in body temperature, sometimes as much as 63°F. It's sufficient to say that a hibernating animal's vital signs are very different from the vital signs of an awake animal.

Sleep, by contrast, is a mostly mental change. There are physiological aspects of sleep that are similar to hibernation, such as a reduced heart and breathing rate and lowered body temperature, but these changes are very slight compared to hibernation. Sleep is also pretty easy to break out of -- if you're awakened from even your deepest sleep, you can be fully awake within several minutes. Sleep is primarily characterized by changes in brain activity. In fact, the brain waves of hibernating animals closely resemble their wakeful brain wave patterns, though they're somewhat suppressed. When an animal awakes from hibernation, it exhibits many signs of sleep deprivation and needs to sleep a lot over the next few days to recover.

Hibernation in Humans?

Scientists at the University of Alaska, Fairbanks have successfully caused a group of arctic ground squirrels, naturally hibernating animals, to wake from and then go back into hibernation. It's the first time anyone has ever managed to induce hibernation, and it could have some pretty amazing medical benefits for humans as well.

Why is hibernation important? Hibernating animals can reduce their metabolism severely, which reduces heart rate and blood flow, enabling them to consume much less oxygen and survive in environments (especially in cold winters) that a non-hibernating animal would not be able to cope with.

These researchers discovered that the molecule that induces hibernation is adenosine, which is produced by all animals, including humans. When adenosine attaches itself to receptors in the brain, it causes the animal to feel sleepy. But in hibernating animals like the arctic ground squirrel, during hibernation season the body produces a huge amount of adenosine, which triggers a much more intense form of sleep--torpor, or hibernation. From that discovery, the scientists created an artificial form of adenosine as well as a synthetic version of caffeine, which was expected to have the opposite effect.

The results were actually a little mixed; the scientists definitely did managed to induce and reverse torpor in the ground squirrels, but that success was partly dependent on the season. During the middle of the hibernation season, torpor was successfully induced in every case, but only a third of the squirrels could be put back into hibernation during the early part of the hibernation season. The scientists are not quite sure yet how the season affects the animal's susceptibility to the drug.

Next up is an attempt with rats, which will give a better sense of how the drug might work on humans. And there are indeed some serious medical uses for induced hibernation: After intense episodes like a heart attack or stroke, many lives could be saved if highly reduced blood flow could be induced.