

# The Outside Story

## Hibernation: Winter Survival by Chilling Out

By Douglas Facey

Mammals and birds are endotherms, which means they generate their own body heat through relatively high metabolic rates. That high metabolism requires energy, which these animals garner from food. We typically think of endotherms as warm-blooded; however, some of them are not warm all of the time.

Most active birds and mammals maintain relatively high and stable body temperatures – often around 100 degrees. But they also lose heat to the surrounding environment, especially during the cold winter months. The heat loss is greater for small endotherms because they have a large surface area compared to their size, and although fur and feathers certainly help retain heat, there is a limit to how much insulation a small animal can carry. So how do they manage to make it through the winter?



Many animals rely on various forms of torpor – a physiological state of lowered metabolism that decreases body temperature. Heat loss partly depends on the temperature difference between an animal's body and the surrounding environment – the bigger the difference, the more quickly heat is lost. Therefore, decreasing body temperature reduces heat loss and saves energy, similar to us lowering the household thermostat at night.

Some animals, including many birds, use daily torpor, lowering body temperatures at night to conserve energy when they are not feeding. Hibernation is a more extreme form of torpor, but not all hibernators experience the same extent of decreased metabolism and body temperature. Bears, for example, show a relatively mild degree of hibernation; body temperature decreases by several degrees and they are a bit sluggish, but can become active and alert quickly – so do not disturb!

Some small mammals, such as chipmunks, exhibit a much more extreme degree of hibernation characterized by dramatic reduction of metabolism and body temperature. To prepare for this, chipmunks consume more calories during the fall to increase body fat needed for insulation and energy. They also store food in their burrows. When days get shorter and cold weather sets in, hormonal changes drive chipmunks to spend more time in their burrows in periods of prolonged sleep and decreased metabolism, and they eventually curl into a ball and enter a state of deep hibernation.

During hibernation, a chipmunk's heartbeat has slowed from around 350 beats per minute to fewer than 10, breathing has decreased from around 60 breaths per minute to under 20, and body temperature has dropped from around 100 degrees to the mid 40s or even lower. This animal is certainly not "warm-blooded" throughout this hibernation period, and therefore does not lose much heat to the surrounding burrow. The burrow's temperature also remains higher than the above-ground temperatures, in part because it retains some of the heat lost by the chipmunk. Snow cover adds additional insulation from winter's frigid air temperatures.

Throughout the winter, the hibernating chipmunk experiences somewhat regular periods of arousal, during which it warms up and becomes active in its burrow. Warming is fueled by masses of specialized energy-rich cells often referred to as brown fat (or brown adipose tissue, BAT for short). BAT is often concentrated in the chest, and when activated warms critical organs such as the heart. Warmed blood is then pumped around the body, gradually warming the entire animal. Warming also relies partly on shivering, which generates heat through muscle contractions.

Once the chipmunk has warmed, it can move around its burrow, eat some of its stored food, void its bladder, and defecate. The animal can then lower its metabolism and re-enter its hibernation state. A chipmunk will go through numerous cycles of cooling and rewarming throughout the winter hibernation period. Although periodic rewarming uses a lot of calories, fewer calories are used over the entire winter by hibernating than would be needed if the animal remained active. The duration of the hibernation period can depend on food availability – with shorter hibernation periods when food is abundant and longer hibernation when food is scarce.

One remaining mystery of hibernation is how hibernating animals remain inactive for so long without dramatic weakening of their muscles (atrophy), such as we see in humans requiring extended periods of bed-rest for medical reasons. Researchers continue to study this question – we have much to learn from our hibernating neighbors.

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