Hibernation Works for Bears. Could It Work for Us, Too?

By Devi Lockwood The New York Times, Nov 15, 2019

Big brown bear (Ursus arctos) in the mountain

There are three major seasons in the life of a bear: the active season, beginning in May; a period of intense eating, in late September; and hibernation, from January into spring.

Physiologically, the hibernation period is the strangest, and the most compelling, to researchers. When a bear hibernates, its metabolic rate and heart rate drop significantly. It does not defecate or urinate. The amount of nitrogen in its blood rises sharply, without damaging the kidneys or liver. The animal becomes resistant to insulin but doesn't suffer from fluctuations in its blood sugar levels.

A human experiencing those conditions — every year for several months at a time — could easily end up with diabetes, obesity, bone loss, atrophied muscles or worse. But each spring, the bear emerges no worse for wear, albeit a little groggy.

“Even when they are very fat, it’s a healthy obesity,” said Brian Barnes, who studies black bear hibernation in Alaska. “They don’t suffer from the same kinds of pathologies that occur in people.”

Why not? A group of researchers at Washington State University published a study in Communications Biology in September that sought to better understand what goes on in the cells of hibernating grizzly bears. The university is home to the WSU Bear Center, the only grizzly bear research center in the U.S.; it houses 11 bears that were either raised in captivity or relocated to the center after being identified as problem bears in the wild.

Researchers took samples from the liver, fat and muscle of six captive grizzly bears at three times during the year. In the lab, a team of researchers analyzed the DNA to understand the changes that occur in the cells over the course of the year.

“The effect of hibernation on each tissue is different,” said Joanna Kelley, an evolutionary biologist at Washington State University and one of the paper’s authors. “Hibernation is not just as simple as hibernating and not hibernating. There are transitional things happening throughout the year.”

The team found that the bears’ fatty tissues changed the most during hibernation, whereas the muscle tissue hardly changed at all. The muscle cells remained active through the hibernation period, which might help explain why those tissues do not atrophy.

Most surprising to Heiko Jansen, the study’s lead author, was that the bears’ fat contained a large number of genes that change their level of expression over the course of the year.

“It’s in the thousands,” he said.

In contrast, when dwarf lemurs in Madagascar hibernate, only a few hundred genes in their fat tissues change their level of expression seasonally.

“Hibernation isn’t a one-size-fits-all phenomenon,” Jansen said. “Different genes are utilized by different species.”

In the early days of hibernation studies, researchers were on the lookout for a physiological trigger, something singular and obvious that set the process in motion — something, perhaps, that scientists could isolate and “inject into a non-hibernating animal, and have them fall over and go to sleep,” said Charles Robbins, director of the WSU Bear Center. “Now we realize that there are an enormous number of genes changing.”

Other animals hibernate, too, like mountain pygmy possums in Australia, thirteen-lined ground squirrels in North American grasslands, and various species of bat. Their activity has long been of interest to researchers, who are eager to learn how a state of suspended animation might be applied to human health.

Matt Andrews, a molecular biologist at the University of Nebraska-Lincoln, studied the biology of hibernating ground squirrels and later helped develop a treatment for hemorrhagic shock.

In the early 2000s, during the military conflicts in Iraq and Afghanistan, Andrews learned that victims of roadside bombings were at high risk of death from blood loss. Such incidents are survivable if the patient has access to a tourniquet and transfusion, but in remote areas, the victims could not reach help quickly enough.

Andrews noticed that hibernating squirrels use melatonin, a potent antioxidant, to protect the cells when blood flow increases after months of inactivity. His team put together a cocktail of melatonin and ketones that might be injected into a person experiencing hemorrhagic shock, to reduce damage to tissues when blood supply returns. The treatment so far has passed tests with rats and pigs, and the team has met with the U.S. Food and Drug Administration to plan future clinical trials.

The physiology of hibernation might also be applicable to organ transplants. A waiting kidney or liver can be preserved in cold solutions for 24 hours, but after that it can’t be used; a heart or a lung is only viable for four to six hours.

“Transplantations have to be very well-planned out, and there’s no such thing as organ banks,” Andrews said. Individuals in need must wait for a donation. But if organs could be induced to enter something like hibernation, with a lower metabolic rate, that might allow organ donation banks to exist.

Hibernation could also be handy during extraterrestrial travel. With current-day propulsion technology, a round trip to Mars takes about 2½ years — and a lot of food, air, water and medical supplies for the astronauts. Induced torpor might be just what humans need to get us permanently off our earthbound behinds.

“We’re a long way from that,” Jansen said. “But we know we can manipulate the energetic profiles of a cell in cell cultures.”

Hibernation may yet be something that humans learn to master, fully or in part. In the meantime, wildlife researchers are keen to emphasize how important hibernation is to the survival of the animals that can already do it.

“We are all better off having these animals in the wild,” Jansen said.