

How hibernators could help humans treat illness, conserve energy and get to Mars

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Researchers will gather today to discuss the potential for hibernation and the related process, torpor, to aid human health in spaceflight at the American Physiological Society's (APS) Comparative Physiology: Complexity and Integration conference in New Orleans.

To survive times when food is scarce and temperatures are low, some animals enter hibernation—a physiological process that reduces their normal metabolism to low levels for days or weeks at a time. These periods of low metabolism, known as torpor, allow the animal's body temperature to fall to just above the surrounding air temperature, thus conserving energy. Humans do not naturally undergo torpor, but scientists are interested in the idea of producing states of "synthetic" torpor in certain situations, including spaceflight, explained symposium co-chair Hannah Carey, Ph.D., from the University of Wisconsin School of Veterinary Medicine. "Harnessing naturally evolved torpor to benefit human spaceflight." "Synthetic torpor could protect astronauts from space-related health hazards and simultaneously reduce demands on spacecraft mass, volume and power capacities," said Matthew Regan, Ph.D., also from the University of Wisconsin School of Veterinary Medicine and symposium co-chair.

The symposium will explore how synthetic torpor might be induced by the brain, its similarities and differences to sleep, and how it could benefit astronauts. Speakers will include Carey; Matteo Cerri, MD, Ph.D., from the University of Bologna in Italy; Vladyslav Vyazovskiy, Ph.D., from the University of Oxford in the U.K.; and astronaut Jessica



Meir, Ph.D., from NASA.

Studying hibernation in mammals—how they are able to safely lower their body temperature and metabolism for extended periods of time—may also aid treatment of people experiencing traumatic medical events, such as stroke, cardiac arrest and severe blood loss. Animals that use torpor have a natural resistance to various injuries that can happen due to lack of blood flow. They are also resistant to radiation injury—such a resistance would be especially beneficial to humans in deep space. Carey will discuss why use of synthetic torpor based on the biology of natural hibernators is preferable to current medical practices that use hypothermia-based methods to treat trauma patients. She will also discuss how hibernation research can identify how to create synthetic torpor for space travel.

How the nervous system reduces metabolic activity during torpor is unknown. However, many of the organs that regulate metabolism are controlled by nerve cells (neurons) located in the raphe pallidus, an area of the brainstem that controls the production of heat in mammals. "For an animal to enter torpor, the neurons within the raphe pallidus have to be inhibited," Cerri explained. If function in these cells is not suppressed, "their activity would counteract the hypothermia induced by torpor," he said. Cerri will present preliminary results identifying neurons projecting to the raphe pallidus and involved in torpor-related activity.

Defining the relationship between sleep and torpor has been fraught with controversy, but the two states appear to be intimately linked because of the neuronal connections they share. Research suggests that lack of available food sources may cause mammals to conserve energy and lower their body temperature, two hallmark characteristics of torpor. However, "less is known about the specific fasting-related signals which initiate entry into torpor," Vyazovskiy said. He will discuss the



connection between sleep and torpor and why more research is needed to determine how torpor affects brain function in animals.

Some of the physiological adaptations that animals exhibit—such as the low-oxygen environments that seals and penguins experience with deep diving or that birds experience on a high-altitude flight—are impossible for humans. Understanding how animals adapt in extreme conditions may play a positive role in human medical science, especially in the "extreme environment of space," Meir said. The increasingly real possibility of traveling to Mars—once just a science fiction story—emphasizes the need to resolve factors that have hampered the feasibility of long-duration spaceflight, including having an ample supply of food, water and breathable air. Finding a way to induce torpor in humans could help eliminate limiting factors as well as protect astronauts from harmful radiation. Meir's talk will provide insight from her unique perspective and experience as an astronaut, discussing the architecture for NASA's current and future human spaceflight missions.

More information: The symposium "Harnessing naturally evolved torpor to benefit human spaceflight" will be held on Saturday, October 27, at the Astor Crowne Plaza-New Orleans French Quarter.

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