

Why sleep? Scientist delves into one of science's great mysteries

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(PhysOrg.com) -- Bats, birds, box turtles, humans and many other animals share at least one thing in common: They sleep. Humans, in fact, spend roughly one-third of their lives asleep, but sleep researchers still don't know why.

According to the journal *Science*, the function of sleep is one of the 125 greatest unsolved mysteries in science. Theories range from brain "maintenance" — including [memory](#) consolidation and pruning — to reversing damage from oxidative stress suffered while awake, to promoting longevity. None of these theories are well established, and many are mutually exclusive.

Now, a new analysis by Jerome Siegel, UCLA professor of psychiatry and director of the Center for Sleep Research at the Semel Institute for Neuroscience and Human Behavior at UCLA and the Sepulveda Veterans Affairs Medical Center, has concluded that sleep's primary function is to increase animals' efficiency and minimize their risk by regulating the duration and timing of their behavior.

The research appears in the current online edition of the journal *Nature Reviews Neuroscience*.

"Sleep has normally been viewed as something negative for survival because sleeping animals may be vulnerable to predation and they can't perform the behaviors that ensure survival," Siegel said. These behaviors include eating, procreating, caring for family members, monitoring the environment for danger and scouting for prey.

"So it's been thought that sleep must serve some as-yet unidentified physiological or neural function that can't be accomplished when animals are awake," he said.

Siegel's lab conducted a new survey of the sleep times of a broad range of animals, examining everything from the [platypus](#) and the walrus to the

echidna, a small, burrowing, egg-laying mammal covered in spines. The researchers concluded that sleep itself is highly adaptive, much like the inactive states seen in a wide range of species, starting with plants and simple microorganisms; these species have dormant states — as opposed to sleep — even though in many cases they do not have nervous systems. That challenges the idea that sleep is for the brain, said Siegel.

"We see sleep as lying on a continuum that ranges from these dormant states like torpor and hibernation, on to periods of continuous activity without any sleep, such as during migration, where birds can fly for days on end without stopping," he said.

Hibernation is one example of an activity that regulates behavior for survival. A small animal, Siegel noted, can't migrate to a warmer climate in winter. So it hibernates, effectively cutting its energy consumption and thus its need for food, remaining secure from predators by burrowing underground.

Sleep duration, then, is determined in each species by the time requirements of eating, the cost-benefit relations between activity and risk, migration needs, care of young, and other factors. However, unlike hibernation and torpor, Siegel said, sleep is rapidly reversible — that is, animals can wake up quickly, a unique mammalian adaptation that allows for a relatively quick response to sensory signals.

Humans fit into this analysis as well. What is most remarkable about sleep, according to Siegel, is not the unresponsiveness or vulnerability it creates but rather that ability to reduce body and brain metabolism while still allowing that high level of responsiveness to the environment.

"The often cited example is that of a parent arousing at a baby's whimper but sleeping through a thunderstorm," he said. "That dramatizes the

ability of the [sleeping](#) human brain to continuously process sensory signals and trigger complete awakening to significant stimuli within a few hundred milliseconds."

In humans, the brain constitutes, on average, just 2 percent of total body weight but consumes 20 percent of the energy used during quiet waking, so these savings have considerable adaptive significance. Besides conserving energy, sleep invokes survival benefits for humans too — "for example," said Siegel, "a reduced risk of injury, reduced resource consumption and, from an evolutionary standpoint, reduced risk of detection by predators."

"This Darwinian perspective can explain age-related changes in human sleep patterns as well," he said. "We sleep more deeply when we are young, because we have a high metabolic rate that is greatly reduced during sleep, but also because there are people to protect us. Our [sleep](#) patterns change when we are older, though, because that metabolic rate reduces and we are now the ones doing the alerting and protecting from dangers."

Source: University of California - Los Angeles

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