Sleep Drive and Your Body Clock

Most people notice that they naturally experience different levels of sleepiness and alertness throughout the day, but what causes these patterns? Sleep is regulated by two body systems: *sleep/wake homeostasis* and the *circadian biological clock* .

When we have been awake for a long period of time, sleep/wake homeostasis tells us that a need for sleep is accumulating and that it is time to sleep. It also helps us maintain enough sleep throughout the night to make up for the hours of being awake. If this restorative process existed alone, it would mean that we would be most alert as our day was starting out, and that the longer we were awake, the more we would feel like sleeping. In this way, sleep/wake homeostasis creates a drive that balances sleep and wakefulness.

Our internal circadian biological clocks, on the other hand, regulate the timing of periods of sleepiness and wakefulness throughout the day. The circadian rhythm dips and rises at different times of the day, so adults' strongest sleep drive generally occurs between 2:00-4:00 am and in the afternoon between 1:00-3:00 pm, although there is some variation depending on whether you are a “morning person” or “evening person.” The sleepiness we experience during these circadian dips will be less intense if we have had sufficient sleep, and more intense when we are sleep deprived. The circadian rhythm also causes us to feel more alert at certain points of the day, even if we have been awake for hours and our sleep/wake restorative process would otherwise make us feel more sleepy.

Changes to this circadian rhythm occur during adolescence, when most teens experience a sleep phase delay. This shift in teens' circadian rhythm causes them to naturally feel alert later at night, making it difficult for them to fall asleep before 11:00 pm. Since most teens have early school start times along with other commitments, this sleep phase delay can make it difficult to get the sleep teens need -- an average of 9 1/4 hours, but at least 8 hours. This sleep deprivation can influence the circadian rhythm; for teens the strongest circadian “dips” tend to occur between 3:00-7:00 am and 2:00-5:00 pm, but the morning dip (3:00-7:00 am) can be even longer if teens haven’t had enough sleep, and can even last until 9:00 or 10:00 am.

The circadian biological clock is controlled by a part of the brain called the Suprachiasmatic Nucleus (SCN), a group of cells in the hypothalamus that respond to light and dark signals. From the optic nerve of the eye, light travels to the SCN, signaling the internal clock that it is time to be awake. The SCN signals to other parts of the brain that control hormones, body temperature and other functions that play a role in making us feel sleepy or awake.

In the mornings, with exposure to light, the SCN sends signals to raise body temperature and produce hormones like cortisol. The SCN also responds to light by delaying the release of other hormones like melatonin, which is associated with sleep onset and is produced when the eyes signal to the SCN that it is dark. Melatonin levels rise in the evening and stay elevated throughout the night, promoting sleep.

In teenagers, research has shown that melatonin levels in the blood naturally rise later at night than in most children and adults. Since teens may have difficulty going to bed early to get enough sleep, it can help to keep the lights dim at night as bedtime approaches. It can also help to get into bright light as soon as possible in the morning.

Circadian disruptions such as jet lag put us in conflict with our natural sleep patterns, since the shift in time and light cues on the brain forces the body to alter its normal pattern to adjust. This is why jet lag can leave travelers feeling poorly and having more difficulty thinking and performing well. But these symptoms can also occur in everyday life, when the circadian rhythm is disrupted by keeping long and irregular hours. Because of this, it is important to keep a regular sleep schedule and allow plenty of time for quality sleep, allowing these two vital biological components -- the sleep/wake restorative process and the circadian rhythm -- to help us perform at our best.