

Circadian Rhythms



NIH National Institute of General Medical Sciences

What are circadian rhythms?

Circadian rhythms are physical, mental, and behavioral changes that follow a daily cycle. They respond primarily to light and darkness in an organism's environment. Sleeping at night and being awake during the day is an example of a light-related circadian rhythm. Circadian rhythms are found in most living things, including animals, plants, and many tiny microbes. The study of circadian rhythms is called chronobiology.

What are biological clocks?

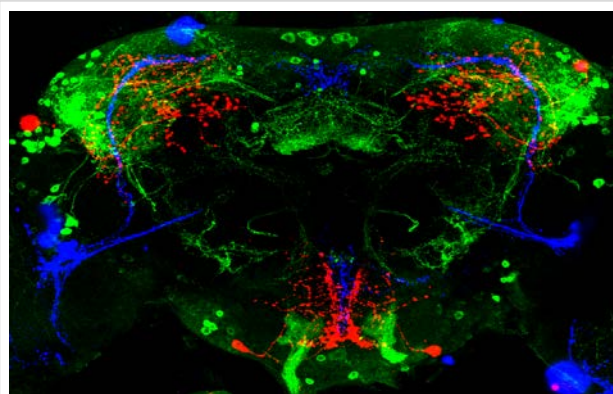
Biological clocks are an organism's innate timing device. They're composed of specific molecules (proteins) that interact in cells throughout the body. Biological clocks are found in nearly every tissue and organ. Researchers have identified similar genes in people, fruit flies, mice, fungi, and several other organisms that are responsible for making the clock's components.

Are biological clocks the same thing as circadian rhythms?

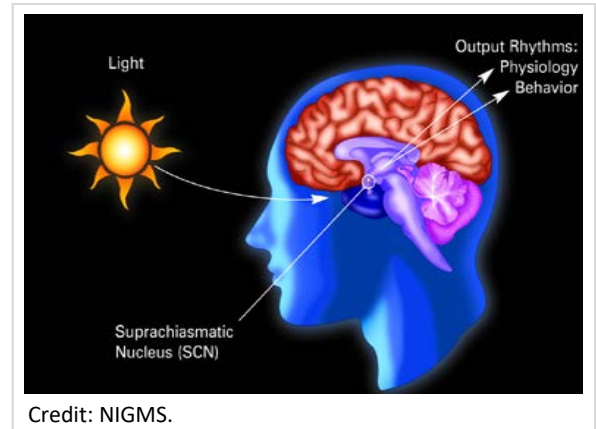
No, but they are related. Biological clocks produce circadian rhythms and regulate their timing.

What is the master clock?

A master clock in the brain coordinates all the biological clocks in a living thing, keeping the clocks in sync. In vertebrate animals, including humans, the master clock is a group of about 20,000 nerve cells (neurons) that form a structure called the suprachiasmatic nucleus, or SCN. The SCN is located in a part of the brain called the hypothalamus and receives direct input from the eyes.



Studies using fruit flies have been key to finding the molecular gears of biological clocks and the cells that control circadian rhythms. This image shows how time-of-day information flows in the fruit fly brain: Clock neurons (stained in blue, mid-left and right) communicate with other nerve cells (stained in red, inner top right, left, and bottom), which then signal to additional neurons (stained in green, outer top right, left, and bottom). Credit: Matthieu Cavey and Justin Blau, New York University.



Credit: NIGMS.

Does the body make and keep its own circadian rhythms?

Natural factors within the body produce circadian rhythms. However, signals from the environment also affect them. The main cue influencing circadian rhythms is daylight. This light can turn on or turn off genes that control the molecular structure of biological clocks. Changing the light-dark cycles can speed up, slow down, or reset biological clocks as well as circadian rhythms.

Do circadian rhythms affect body function and health?

Yes. Circadian rhythms can influence sleep-wake cycles, hormone release, eating habits and digestion, body temperature, and other important bodily functions. Biological clocks that run fast or slow can result in disrupted or abnormal circadian rhythms.

Irregular rhythms have been linked to various chronic health conditions, such as sleep disorders, obesity, diabetes, depression, bipolar disorder, and seasonal affective disorder.

How are circadian rhythms related to sleep?

Circadian rhythms help determine our sleep patterns. The body's master clock, or SCN, controls the production of melatonin, a hormone that makes you sleepy. It receives information about incoming light from the optic nerves, which relay information from the eyes to the brain. When there is less light—like at night—the SCN tells the brain to make more melatonin so you get drowsy. Researchers are studying how shift work as well as exposure to light from mobile devices during the night may alter circadian rhythms and sleep-wake cycles.

How are circadian rhythms related to jet lag?

People get jet lag when travel disrupts their circadian rhythms. When you pass through different time zones, your biological clocks will be different from the local time. For example, if you fly east from California to New York, you “lose” 3 hours. When you wake up at 7:00 a.m. on the east coast, your biological clocks are still running on west coast time, so you feel the way you might feel at 4:00 a.m. Your biological clocks will reset, but this often takes a few days.

How do researchers study circadian rhythms?

Scientists learn about circadian rhythms by studying humans or by using organisms with similar biological clock genes, including fruit flies and mice. Researchers doing these experiments can control the subject's environment by altering light and dark periods. Then they look for changes in gene activity or other molecular signals. This research helps us understand how biological clocks work and keep time.

Scientists also study organisms with irregular circadian rhythms to identify which genetic components of biological clocks may be broken.

How does circadian rhythm research contribute to human health?

Understanding what makes biological clocks tick may lead to treatments for sleep disorders, obesity, mental health disorders, jet lag, and other health problems. It can also improve ways for individuals to adjust to nighttime shift work. Learning more about the genes responsible for circadian rhythms will also help us understand biological systems and the human body.

NIGMS is a part of the National Institutes of Health that supports basic research to increase our understanding of biological processes and lay the foundation for advances in disease diagnosis, treatment, and prevention. For more information on the Institute's research and training programs, see <https://www.nigms.nih.gov>.

Content revised March 2020

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[A Light on Life's Rhythms: Profile of Cara Altimus](#) in *Findings* Magazine

[Studying Genes](#) Fact Sheet

Other Resources

[Circadian Rhythm and Your Health Podcast](#) (NIEHS)

[NIH Grantees Win 2017 Nobel Prize in Physiology or Medicine](#) News Release (NIH)

[Sleep Disorders](#) (MedlinePlus, NIH)

[Brain Basics: Understanding Sleep](#) (NINDS, NIH)

[International Space Station Circadian Rhythms Experiment](#) (NASA)