

# Stress hormone helps control the circadian rhythm of brain cells

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Credit: University of Copenhagen

As day turns into night, and night turns into day, the vast majority of living organisms follow a fixed circadian rhythm that controls everything from sleep needs to body temperature.

This [internal clock](#) is found in everything from bacteria to humans and is controlled by some very distinct hereditary genes, known as clock genes.

In the brain, clock genes are particularly active in the so-called [suprachiasmatic nucleus](#). It sits just above the point where the [optic nerves](#) cross and sends signals to the brain about the surrounding light level. From here, the suprachiasmatic nucleus regulates the rhythm of a number of other areas of the body, including the cerebellum and the cerebral cortex.

However, these three areas of the brain are not directly linked by neurons, and this made researchers at the University of Copenhagen curious. Using test [rats](#), they have now demonstrated that the circadian rhythm is controlled by means of signalling agents in the blood, such as the stress hormone corticosterone.

"In humans, the hormone is known as cortisol, and although the sleep rhythm in rats is the opposite of ours, we basically have the same hormonal system," says Associate Professor Martin Fredensborg Rath of the Department of Neuroscience.

He explains that recent years have seen an increasing, scientific focus on research on clock genes, one reason being that previous research on clock [genes](#) has found a correlation between depression and irregularities in the body's circadian rhythms.

### **New Method with Medical Micropumps**

In the study with the stress hormone corticosterone, the researchers removed the suprachiasmatic nucleus in a number of rats. As expected, this removed the circadian rhythm of the animals.



Cross-section of rat brain. To make sure that the suprachiasmatic nucleus had been properly deactivated, the researchers subsequently examined several histologies such as this one. Credit: Department of Neuroscience, University of Copenhagen

Among other things, the body temperature and activity level of the rats went from circadian oscillations to a more constant state. The same was true of the otherwise rhythmic [hormone](#) production.

However, the circadian rhythm of the cerebellum was restored when the rats were subsequently implanted with a special programmable micropump, normally used to dose medication in specific quantities.

In this case, however, the researchers used the pump to emit carefully metered doses of corticosterone at different times of the day and night, similar to the animals' natural [rhythm](#).

"Nobody has used these pumps for anything like this before. So

technically, we were onto something completely new," says Martin Fredensborg Rath.

For that reason, the researchers spent the best part of a year carrying out a large number of control tests to ensure that the new method was valid.

## **Interaction Between Neurons and Hormones**

As mentioned, the new method paid off. With the artificial corticosterone supplement, researchers were again able to read a rhythmic activity of [clock genes](#) in the cerebellum of the rats, even though their suprachiasmatic nucleus had been removed.

"This is hugely interesting from a scientific point of view, because it means that we have two systems—the nervous system and the hormonal system—that communicate perfectly and influence one another. All in the course of a reasonably tight 24-hour programme," says Martin Fredensborg Rath.

With the test results and the new method in the toolbox, the researchers' next step is to study other rhythmic hormones in a similar manner, including hormones from the thyroid gland.

**More information:** Tenna Bering et al, Rhythmic release of corticosterone induces circadian clock gene expression in the cerebellum, *Neuroendocrinology* (2019). [DOI: 10.1159/000503720](https://doi.org/10.1159/000503720)

Provided by University of Copenhagen

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