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Light, circadian rhythms affect vast range of physiological, behavioral functions

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A new study of the genetic basis of circadian rhythms - the biological responses related to daily light exposure - has found that a few minutes of light exposure in a fungus directly affects a huge range of its biological functions, everything from reproduction to coloring and DNA repair.

Prior to this, five "DNA binding sites" in this fungus were known to be responsible for gene activation by light exposure. Through advanced "high throughput" DNA sequencing, researchers discovered that light actually affects not just a few but more than 300 binding sites, ultimately controlling 2,500 of the 10,000 genes in the fungus Neurospora crassa.

The research, done by four universities in the U.S. and Germany, has revealed for the first time how specific metabolic pathways can be directly activated by light in this fungus, which has long served as a model to understand gene regulation by light, and circadian rhythms in animals and humans.

"You have one factor, light exposure, to start with," said Michael Freitag, an assistant professor of biochemistry and biophysics at Oregon State University. "In just a few minutes, this turns on genetic mechanisms that influence everything from spore development to stress response, pigmentation, carbon metabolism, the cell cycle, nitrogen regulation, DNA repair and many other functions."

This new research shows that light exposure affects 24 "transcription

factors" that function as master genetic regulators, which in turn activate dozens of other genes that control everything from behavior to physiology in this fungus. For instance, if the fungus is grown in the dark, it will be white - but with just two minutes of exposure to light, it turns orange and stays that way permanently, its gene for pigmentation having been activated.

Although not all of the genes involved are identical, many genes perform similar functions in humans, Freitag said, and the effect of light exposure on human metabolism is probably more similar to than different from this fungus.

Researchers are continuing to learn more about the phenomenal scope of biological and metabolic functions that are related to light and the natural rhythms of day and night. Disruptions in these rhythms can have a significant range of physical and health effects, scientists have found.

This fungus, *Neurospora*, has been studied for decades in genetic research, along with other model systems such as fruit flies, laboratory rodents and other models. It was first identified as a "red bread mold" in the 1800s and studied by the famous French microbiologist Louis Pasteur, and is still especially useful for research on circadian rhythms and gene regulation.

The research was published in *Eukaryotic Cell*, a professional journal, in work supported by the National Institutes of Health, National Science Foundation, and the American Cancer Society. Collaborators on the study were from OSU, the University of California/Berkeley, University of California/Riverside, and the laboratories of Deborah Bell-Pedersen at Texas A&M University and Michael Brunner at Universität Heidelberg.

"Light signaling pathways and circadian clock are inextricably linked

and have profound effects on behavior in most organisms," the researchers wrote in their study. "Our findings provide links between the key circadian activator and effectors in downstream regulatory pathways."

Provided by Oregon State University