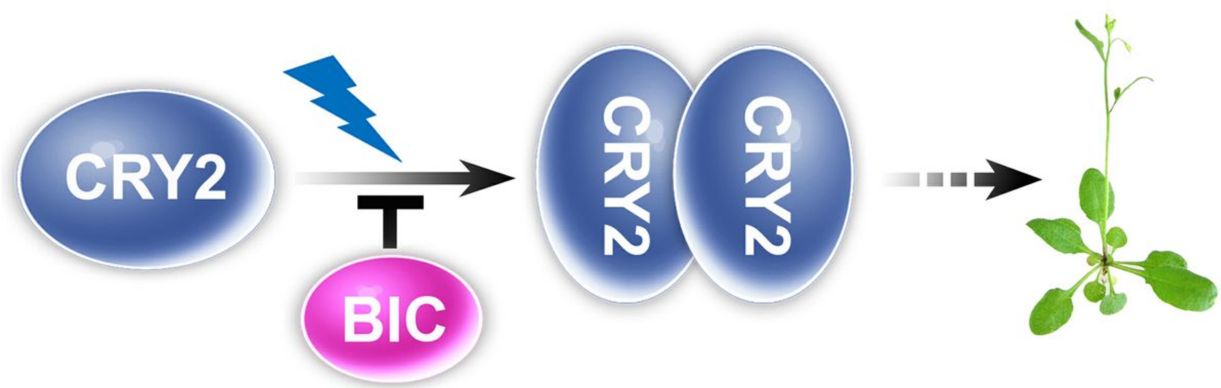
Ancient proteins shown to control plant growth

October 20 2016



This model shows that a cryptochrome exists as a single protein in the dark, and becomes two proteins bound together that regulate plant growth, as depicted by a flowering Arabidopsis plant on the right. The BIC protein inhibits cryptochromes. Credit: Wang Qin/UCLA

A UCLA-led international team of life scientists reports the discovery of mechanisms regulating plant growth that could provide new insights into how the mammalian biological clock affects human health. The research will be published Oct. 21 in the journal *Science*.

In the last two decades, biologists have learned that ancient photoreceptor proteins known as cryptochromes govern the way humans, animals and plants respond to light, as well as their circadian clocks.

These cryptochromes also guide the migration of birds and butterflies, enabling them to travel long distances.

In the new research, the scientists from UCLA, Japan, Korea and China report on a group of proteins they call blue-light inhibitor of cryptochromes—BICs—that inhibit all nine functions of cryptochromes the researchers analyzed in the small mustard plant Arabidopsis.

Senior author Chentao Lin, a UCLA professor of molecular biology who has studied cryptochromes for 25 years, thinks BICs likely have counterparts in the human circadian clock, and in birds and other animals, although that has not yet been discovered in organisms other than plants.

When the scientists removed cryptochromes but kept BICs, Arabidopsis grew at least twice as tall as it does when these cryptochromes are present and flowering occurred later. When the scientists removed BICs but kept cryptochromes from Arabidopsis, the plants grew a little shorter than normal. When they added more BICs, the plants grew taller and flowered later—the same result that occurred when they removed cryptochromes. Thus, BICs inhibit cryptochromes, the researchers concluded.

Cryptochromes were discovered in plants in 1993, and then found in insects, birds, corals and humans. Cryptochromes play a role in sensing light, and in our sleep cycle, along with other circadian clock proteins. They also enable reef-building corals to sense moonlight, allowing them to spawn one week each spring after a full moon, Lin said. Researchers later learned cryptochromes played a role in diseases, including diabetes, bipolar disorder and cancers. When scientists have removed cryptochromes or clock genes, mice have been afflicted with diabetes and other disorders.

Cryptochromes stay inactive in darkness but become active once they absorb photons—particles of light. They are believed to have evolved from an ancient DNA repair enzyme, although they no longer repair DNA, Lin said.

Sunlight contains a full spectrum of light, including blue light, red light, green light and yellow light. Together, we see them as white light, but different colors of light can be separated by a prism. The researchers exposed Arabidopsis to blue light. (For photosynthesis, plants need only blue light and red light, which explains why plant photoreceptors absorb only blue light and red light, which is why most plants appear green.)

In 1995 when he was a postdoctoral scholar Lin discovered the small molecule associated with cryptochromes that absorbs blue photons. Since joining the molecular, cell and developmental biology faculty in 1996, Lin and UCLA students and researchers in his laboratory have made many discoveries about cryptochromes, leading to the new finding.

Scientists still do not know many details about how cryptochromes work in humans, including their role in cancers. Future study of how cryptochromes behave in different organisms may lead to a fuller understanding of various biological phenomena, Lin said, such as how plants control their flowering time, how bird and butterflies guide their seasonal migration and how mammalian biological clock affect human health.

More information: "Photoactivation and inactivation of Arabidopsis cryptochrome 2" *Science*, science.sciencemag.org/cgi/doi … 1126/science.aaf9030

Provided by University of California, Los Angeles