How plants 'feel' the temperature rise

January 7 2010

Plants are incredibly temperature sensitive and can perceive changes of as little as one degree Celsius. Now, a report in the January 8th issue of the journal *Cell*, a Cell Press publication, shows how they not only 'feel' the temperature rise, but also coordinate an appropriate response -- activating hundreds of genes and deactivating others; it turns out it's all about the way that their DNA is packaged.

The findings may help to explain how plants will respond in the face of climate change and offer scientists new leads in the quest to create crop plants better able to withstand high temperature stress, the researchers say.

"We've uncovered a master regulator of the entire temperature transcriptome," said Philip Wigge of John Innes Centre in the United Kingdom in reference to the thousands of genes that are differentially activated under warmer versus cooler conditions.

Using the model plant Arabidopsis thaliana the researchers show that a key ingredient for plants' temperature sensing ability is a specialized histone protein, dubbed H2A.Z, that wraps DNA into a more tightly packed structure known as a nucleosome. Wigge likens nucleosomes to compact balls of string. As temperatures rise, H2A.Z histones allow DNA to progressively unwrap, leading nucleosomes to loosen up, they show.

"When it gets warmer, the DNA unwraps," he said, which allows some genes to switch on and others to switch off. They aren't yet sure exactly how all that happens, but Wigge suspects the altered nucleosome structure gives access to sites on the DNA where activators of some genes can bind along with repressors of other genes.

"In addition to H2A.Z containing nucleosomes having more tightly wrapped DNA, our results suggest that the degree of unwrapping may also be responsive to temperature," the researchers wrote. "This result suggests a direct mechanism by which temperature may influence gene expression, since it has been shown that RNA Pol II [the enzyme responsible for transcribing DNA into messenger RNA] does not actively invade nucleosomes, but waits for local unwrapping of DNA from nucleosomes before extending transcription. In this way, genes with a paused RNA Pol II will show increased transcription with greater temperature as local unwrapping is increased."
The basic discovery could ultimately prove to have important implications for world food security, the researchers said.

As the number of people and affluence around the world continues to grow, "it is projected that world agriculture will have to increase yields by 70 to 100 percent in the next 100 years," Wigge said. "Under climate change it will be challenging simply to maintain present yields, let alone increase them." Crops such as wheat are particularly vulnerable to very hot and dry summers, he added, as evidenced by the fact that wheat reserves recently fell to their lowest level in 30 years.

He says the new understanding of plants' temperature sensitivity may prove to be critical for breeding more temperature-resistant crops. His team plans to explore this possibility by studying the role of these H2A.Z histones in a model plant that is more closely related to crops.

"We'd like to engineer a plant where we can control the histones in particular tissues such that it is selectively 'blind' to different temperatures," Wigge said. "Obviously you can't make a completely temperature-proof plant, but there is a lot of scope to develop crops that are more resilient to the high temperatures we are increasingly going to experience."

Provided by Cell Press

Citation: How plants 'feel' the temperature rise (2010, January 7) retrieved 18 April 2024 from https://phys.org/news/2010-01-temperature.html