PHYS.ORG

Fundamental plant chemicals trace back to bacteria

August 7 2014, by David Tenenbaum

Hiroshi Maeda's research sheds new light on the bacteria that makes lignin, a compound that gives wood — such as the maple trees in this forest near Minocqua, Wisconsin — its strength. Credit: Bryce Richter

A fundamental chemical pathway that all plants use to create an essential amino acid needed by all animals to make proteins has now been traced to two groups of ancient bacteria. The pathway is also known for making hundreds of chemicals, including a compound that makes wood strong and the pigments that make red wine red.

"We have been trying to unravel the source of the phenylalanine amino acid for some time," says Hiroshi Maeda, an assistant professor of botany at the University of Wisconsin-Madison. "Plants use this pathway to make natural products that are vital to plants and also to our food, medicine, fiber and fuel. One of the most important is lignin, found in the plant cell wall, which allows trees to stand tall and transport water."

Other scientists have traced plant metabolic pathways to fungi, "which are pretty close to plants in terms of evolution," Maeda says. "But in this case, the source is bacteria, which are more distant relatives."

In a study recently published in the online journal *The Plant Cell*, Maeda and his colleagues described how they traced the phenylalanine pathway to two groups of bacteria. "Our question was how plants can produce so many different kinds and amounts of these aromatics, particularly the phenylalanine-derived compounds," Maeda says.

During the study, Maeda and his colleagues, including John Jelesko of the Virginia Polytechnic Institute, compared the genetic sequence for the plant phenylalanine pathway enzymes to a genetic database covering numerous organisms. "We asked the computer to fish out similar sequences, and we got thousands of sequences," Maeda says. "We took the closer sequences and did phylogenetic analysis. Essentially we were asking, 'Who is your closest sibling?'"

They found that the plant sequence was most similar to a class of bacteria called Chlorobi and Bacteroidetes. "This was surprising because when people do a similar analysis for other plant genes, they usually find the closest sequence in fungi, or in cyanobacteria whose ancestor came into plants and now make plants green and photosynthetic. Our results did not fit what people expected."

During follow-up experiments, the researchers arranged the protein sequences from other organisms according to how closely they resembled the plant sequence, and identified two amino acid sites that are crucial for phenylalanine production.

Because the phenylalanine pathway is critical to the production of so many valuable plant products, Maeda says the study may eventually have practical benefits. "We hope this might help increase production of nutrients and medicinal compounds."

In terms of basic science, he adds, "Our study provides examples of the complex evolution of plant chemical pathways." During evolution, the need to survive and reproduce forces organisms to continue adapting to their circumstances, he notes. "Plants have had multiple opportunities to adopt different genes (and enzymes) during evolution to meet the challenges of the environment.

"The enzyme that plants adopted from the ancient bacteria was helpful to them when they acquired it, and plants ended up maintaining it, rather than other types from fungi or cyanobacteria. This enzyme and its pathway are now seen across the plant kingdom and allow plants to make such a large variety and quantity of phenolic compounds."

Provided by University of Wisconsin-Madison

Citation: Fundamental plant chemicals trace back to bacteria (2014, August 7) retrieved 7 May 2024 from https://phys.org/news/2014-08-fundamental-chemicals-bacteria.html