

How plants make aerial roots

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Ficus tree. Credit: Hebrew University

Sometimes, to see the roots, you have to look up.

Roots are normally associated with things that live underground, in the damp and the dark. Think of turnips, radishes and yams. However, many [plants](#) make their roots above ground. Ivy uses its roots to climb on buildings and the mighty ficus tree uses them to support their large branches. What makes plants form roots in the "wrong place," so to speak? That would be like us humans sprouting legs from our shoulders.

In a study published this week in the journal *Science*, Hebrew University of Jerusalem (HU) Professor Idan Efroni and his team found the hidden mechanism that enables aerial roots to happen. By decomposing the stem to [individual cells](#), the team identified the extremely rare cells that, when conditions are ripe, cause roots to grow in the air.

"Superficially, these look like other plant cells which is why they evaded detection for so long," Efroni explained. "We used new techniques to closely screen thousands of cells, one-by-one. We knew that by finding the cells that can make roots, we would be able to look for the 'switch' that turns them on."

Plants make roots from small organs called meristems. By closely examining these unique [cells](#), Dr. Naama Gil-Yarom, a research associate at the HU lab, was able to catch them in the act of making a meristem and to identify the genes that are active right at the transition point. One gene in particular stood out, and when the HU Ph.D. student Moutasem Omary used CRISPR to delete this gene, the plants lost their ability to make aerial roots.

When Efroni and his team studied the genome, they were in for a surprise. Right next to the gene that controlled aerial roots production

was a very similar gene. "We recognized it immediately from previous studies as the gene that controls the formation of underground roots," shared Efroni, "I remember thinking that we have just stumbled upon the central hub that controls root formation." Indeed, when the researchers disabled all of these genes, the plants could not grow any roots at all.

By tracing the evolution of these genes, the team found that many major crops, such as [sweet potatoes](#), beans, tomato, rice, maize and wheat, share this dual root-control-system. "The ability to make aerial roots is highly advantageous to the plant," explained Efroni. "In the event that the underground roots are flooded or damaged, the plant can grow aerial roots and survive the assault," he added. Plants evolved this ability early on and never forgot how to do it.

Nevertheless, what is helpful in nature may actually come as a disadvantage in agriculture. Many plants are grafted, meaning they have the root system of one plant and the aboveground system of another. This allows farmers to grow plants that are resistant to soil disease. However, if the top part of the graft grows an aerial root, it will bypasses the soil-resistance and make all the effort of grafting useless. However, thanks to Efroni and his team's discovery, we know which [genes](#) to target and can create plants with no aerial roots, making the practice of grafting that much more effective.

Looking ahead, the group plans to modify the DNA code at the root control cluster to make customized above- and below- ground [root](#) systems. As Efroni concluded, "here in Israel, to make the most use of the land we've got, we need to optimize the way our food crops grow and utilize resources. Doing that is a daunting and complex task, but, step by step, we're getting there."

More information: Moutasem Omary et al, A conserved superlocus

regulates above- and belowground root initiation, *Science* (2022). [DOI: 10.1126/science.abf4368](https://doi.org/10.1126/science.abf4368)

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