

How a plant regulates its growth

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If the growth processes of plants are disturbed, the roots no longer grow to the center of the earth and flower and seed formation is massively disrupted. Credit: U. Hammes/TUM

Plants grow towards the light. This phenomenon, which already fascinated Charles Darwin, has been observed by everyone who owns houseplants. Thus, the plant ensures that it can make the best use of light to photosynthesize and synthesize sugars. Similarly, the roots grow into the soil to ensure that the plant is supplied with water and nutrients.

These [growth processes](#) are controlled by a hormone called [auxin](#), which plays a key role in the formation of polarity in [plants](#). To do this, auxin is

transported in the plant body polar, from the shoot through the plant body into the roots. In this process, a family of polar transport proteins distributes the auxin throughout the plant. To better understand this process, the research team investigated it in more detail with the help of a chemical.

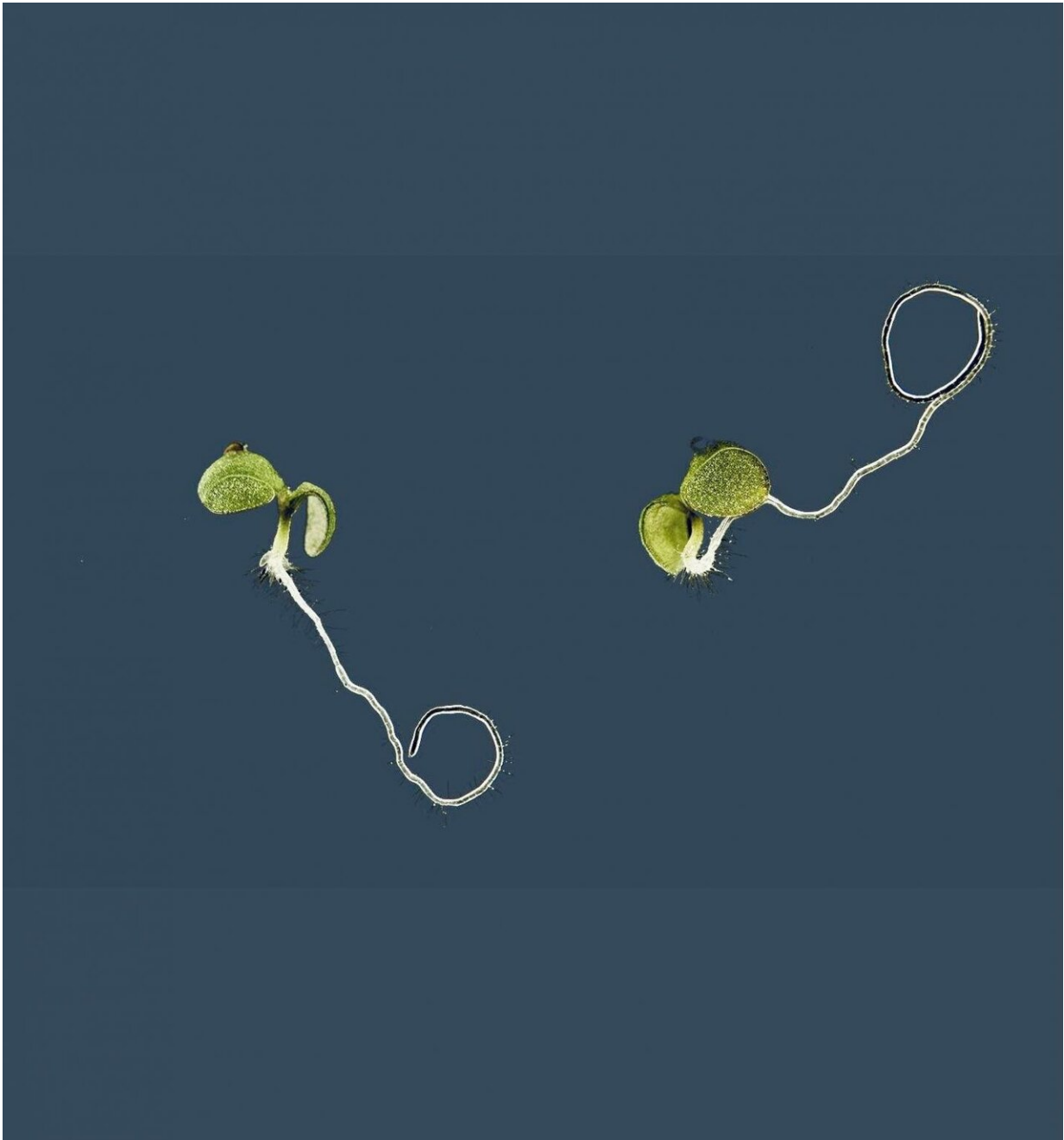
How the herbicide naptalam works

Scientists around the world are studying transporter proteins in more detail due to their central role in plant development processes. Naptalam (NPA) is an important tool to elucidate the structure of the transporters.

Naptalam is the registered name of Naphthylphthalic acid. It inhibits the directional flow of auxin, thus severely inhibiting plant growth. It was used in in the European Union until 2002, and the sodium salt of naptalam is still used in the USA as a pre-emergence herbicide to control broadleaf weed in cucurbits and nursery stock.

"We wanted to know how naptalam exerts its effects," says PD Dr. Ulrich Hammes, the study's principal investigator. "Our studies show that the activity of the auxin transporters is really completely shut down by the inhibitor." When NPA binds to the [transporter proteins](#), auxin can no longer get out of the cell, and thus the plant is no longer able to grow polarly. The roots no longer grow to the center of the earth, and flowers and seed formations are massively disrupted.

An effect of the inhibitor NPA on the activators of the transporters, known as kinases, could be ruled out through collaboration with Claus Schwechheimer, Professor of Plant Systems Biology of at the TUM, where the work was carried out. He explains, "This makes it clear that the inhibitor NPA acts directly on the transport proteins."



Plant seedlings with NPA Credit: U. Hammes/TUM

How transport proteins contribute to plant development

"We can now clearly explain the molecular mechanism by which polar plant growth can be disrupted pharmacologically," says Ulrich Hammes.

The research groups in Vienna were able to show that naptalam not only binds the transporters, but also prevents the transporters from binding to each other. "This mechanism of binding to each other seems to apply universally in the family of auxin transporters, as we observed the effect in all transporters studied," says Martina Kolb, first author of the study.

Better understanding of molecular relationships

Overall, the study provides a significant step forward in understanding the mechanism of the molecular machinery of plant polarity. The new findings make it possible to study polar growth more precisely and to understand the [molecular mechanism](#) of auxin [transport](#).

More information: Lindy Abas et al, Naphthylphthalamic acid associates with and inhibits PIN auxin transporters, *Proceedings of the National Academy of Sciences* (2020). [DOI: 10.1073/pnas.2020857118](https://doi.org/10.1073/pnas.2020857118)

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