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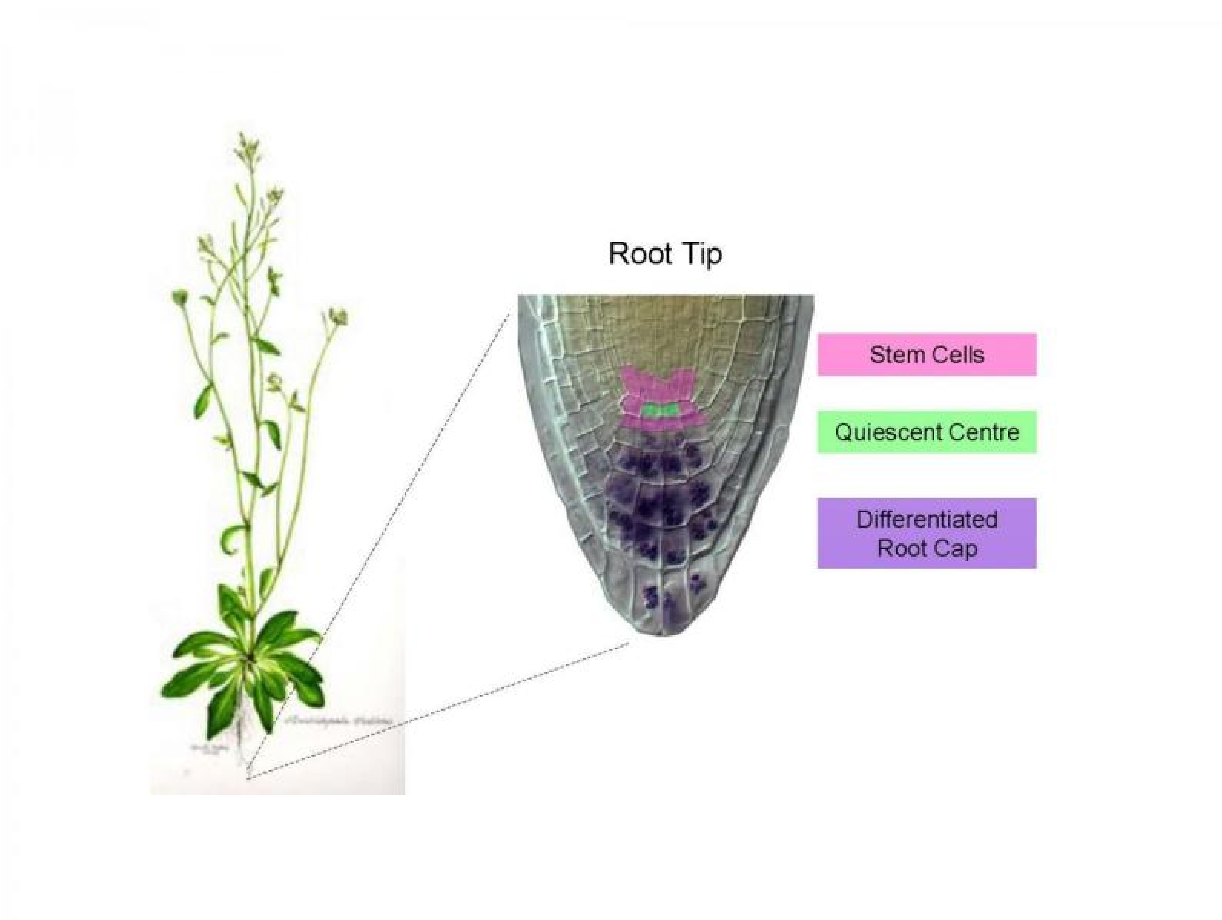
Biologists demonstrate how signals in plant roots determine the activity of stem cells

May 29 2015



The quiescent center in the root of the rock cress generates signals, thanks to which stem cells remain pluripotent and only certain daughter cells differentiate. Credit: Photograph by Working Group Laux

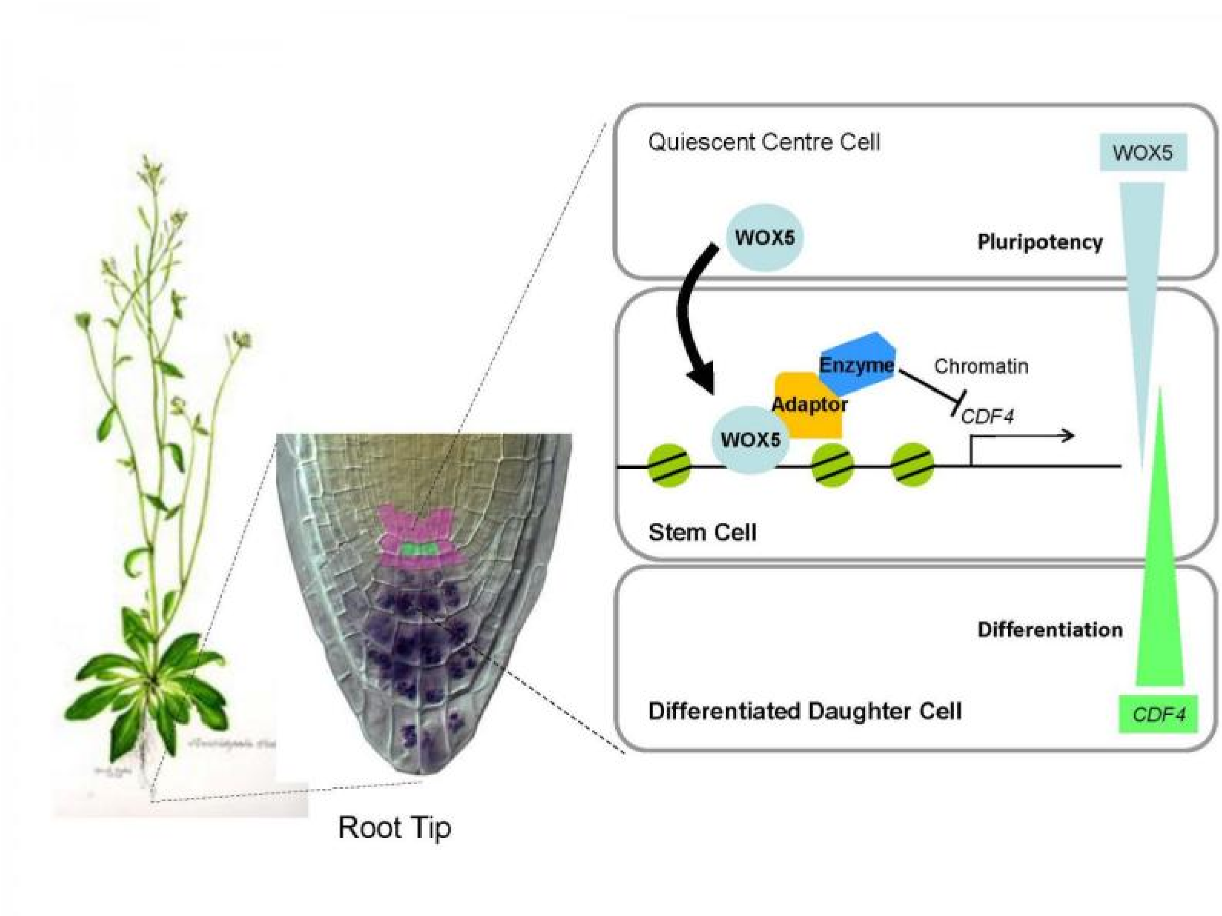
The roots of a plant are constantly growing, so that they can provide the plant with water and minerals while also giving it a firm anchor in the ground. Responsible for these functions are pluripotent stem cells. In order to avoid differentiation and to remain pluripotent, these stem cells are dependent on signals from their neighbouring cells. These signals are generated by only a small group of slowly dividing cells in the so-called quiescent centre inside the root. An international consortium under the leadership of Prof. Dr. Thomas Laux, a biologist from the University of Freiburg, has identified the transcription factor WUSCHEL HOMEOBOX (WOX) 5 as the signal molecule, showing that it moves through pores from the cells inside the quiescent centre into the stem cells. The team of researchers has published their findings in the professional journal *Developmental Cell*.

"Solving the mechanism by which signals within the root control stem cell activity has implications for the general workings of the stem cell regulation in plants and humans," Laux said. He also explained that this will allow scientists to study how plant growth adjusts to different environmental conditions, adding that, 'this is a fascinating field of research in the era of climate change."

Of all the cells in plants and animals, pluripotent stem cells are the most multi-functional. When they divide, they produce two types of daughter cells: some become new stem cells, while others differentiate to replace tissue or form new organs. To maintain its stem cells, the organism generates the signals that block differentiation inside special stem cell niches. These niches are the only place where stem cells can exist. For blood stem cells, for example, the stem cells reside in the bone marrow.

Laux's group of researchers had previously discovered the transcription factor WOX5, which is necessary for generating signals, in the cells of the root's quiescent centre. However, what its precise role is has remained unclear until now. Laux's team studied the stem cells in the model organism of the Arabidopsis plant, or rock cress, which is part of the *Brassicaceae* family of plants, including mustard and cabbage. Studies have already shown, however, that many of these findings also apply to crops such as rice. When the signal WOX5 enters the stem cells through pores, it binds at specific DNA sequences, the promoters, of target genes and recruits an enzyme via a so-called adaptor protein. This enzyme changes the DNA's protein shell, the chromatin, causing the respective gene to be no longer effectively readable.

But why does WOX5 switch off its target gene CDF4 in stem cells? Laux's team of researchers has shown that the CDF4's function is to initiate the differentiation of the stem cell's daughter cells. If the concentration of the CDF4 protein would be too high in the stem cells, then the stem cells would also be forced to differentiate and the plant would have to stop root growth. Where the concentration of WOX5 is high enough, the stem cell niche is able to maintain the pluripotent stem cells. Where the concentration of WOX5 is low, the concentration of CDF4 rises and the cells differentiate into root tissue. This balance is the secret to the life-long activity of a stem cell niche.



Where the concentration of WOX5 is high enough, the stem cell niche is able to maintain pluripotent stem cells. Where the concentration of WOX5 is too low, the concentration of CDF4 rises and the cells differentiate into root tissue. Credit: Working Group Laux

Provided by University of Freiburg