Sexual plant reproduction: Male and female talk in the same way as do cells in your brain

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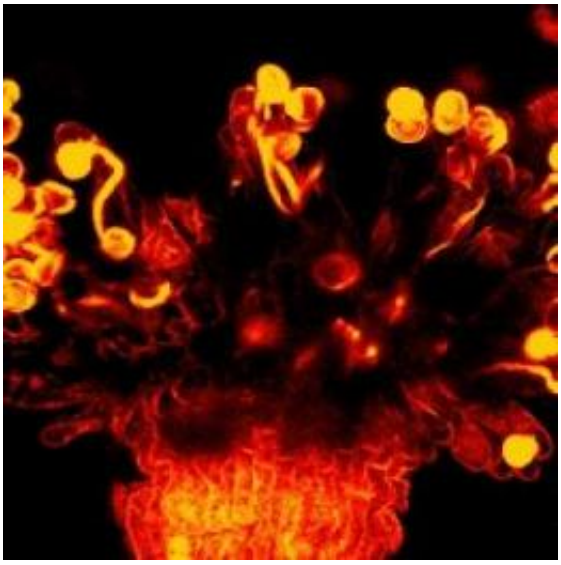

This is a microscope image of the pollen grains germinating at the stigma of the weed *Arabidopsis Thaliana*. Credit: Jose Feijo / Instituto Gulbenkian de Ciencia

A team of researchers at the Instituto Gulbenkian de Ciencia (IGC), Portugal, discovered that pollen, the organ that contains the plant male gametes, communicate with the pistil, their female counterpart, using a mechanism commonly observed in the nervous system of animals. This study not only reveals a new mechanism which underlies reproduction in plants, but also opens an exciting new avenue in the study of how cell-cell communication is conserved between animals and plants. The research is to be published this week in *Science Express*.

For many years biologist have observed regular oscillations in several parameters that control growth of pollen tubes, such as pH (concentration of proton ions) and calcium ions, but the actual molecular channels that control these oscillations and their physiological output have remained elusive. Led by José Feijó, group leader at the IGC and Professor at Lisbon University, this international team have now discovered that the oscillations of calcium ions in the growing pollen tubes of tobacco and the weed Arabidopsis are facilitated by channels called Glutamate receptors-like (GLRs), and that these channels are opened by, amongst other components, a rare aminoacid, D-serine (D-Ser). Both D-Ser and GLRs are key molecular players in cell-cell communication in the animal central nervous systems, at various levels: they play a central role in memory and learning processes in the brain, and have been implicated in a wide range of neurodegenerative diseases such as multiple sclerosis, Alzheimer, Huntington's disease and others. And now, surprisingly, they also have a role in reproduction of plants.

Working in the IGC laboratories, the team used an extensive combination of genetic, pharmacologic and electrophysiological techniques to reveal the role of glutamate receptor-like (GLRs) genes and D-serine in pollen grains, and their physiological impact on plant reproduction. In proving that GLRs are calcium channels, the team also solved two long-standing riddles in plant biology: the molecular nature of calcium channels in the outer membrane of plant cells, a central question in plant physiology elusive for more than 20 years, and what are the functions of GLRs genes in plants, a fact that has puzzled biologists ever since the first genome of the model plant Arabidopsis was sequenced.

Plant reproduction is a complex and highly coordinated process. Pollen grains, which contain the plants' male gametes (sperm cells), are carried from the male organ of the flower (the stamen) to the female organ (the pistil). Here the pollen germinates and grows a pollen tube, which extends and is guided to the ovary, where it releases the sperm. The

sperm fuse with the egg cells, giving rise to an embryo, part of the seed.

In this study, the researchers showed that impairing the GLR functions in male gametes leads to partial male sterility: fewer seeds are produced by the plant, and the pollen tubes are abnormal. Furthermore, D-serine activates the GLRs on the tips of pollen tubes, allowing calcium ions to flow into the tube. They took their research a step further demonstrating that D-serine is indeed produced in the female sexual organs, and that absence of D-serine in these organs also leads to deformed pollen tubes. Together, these findings strongly suggest that D-serine, produced in the female sexual organs may have a role in guiding pollen tubes to their final target.

José Feijó says, "Pollen tubes are a model system for cellular tip-growth, a process common to fission yeast, filamentous fungi, the root hairs of plants and nerve cells. Our findings, implicating analogous genes in growth processes in both plants and animals, underscores how evolution re-uses successful mechanisms, over and over again. We feel that our research, performed in Arabidopsis and tobacco, now opens doors for the study of conserved cell-cell communication processes, across plant and animals species".

Provided by Instituto Gulbenkian de Ciencia