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Changing of the guard—research sheds light on how plants breathe

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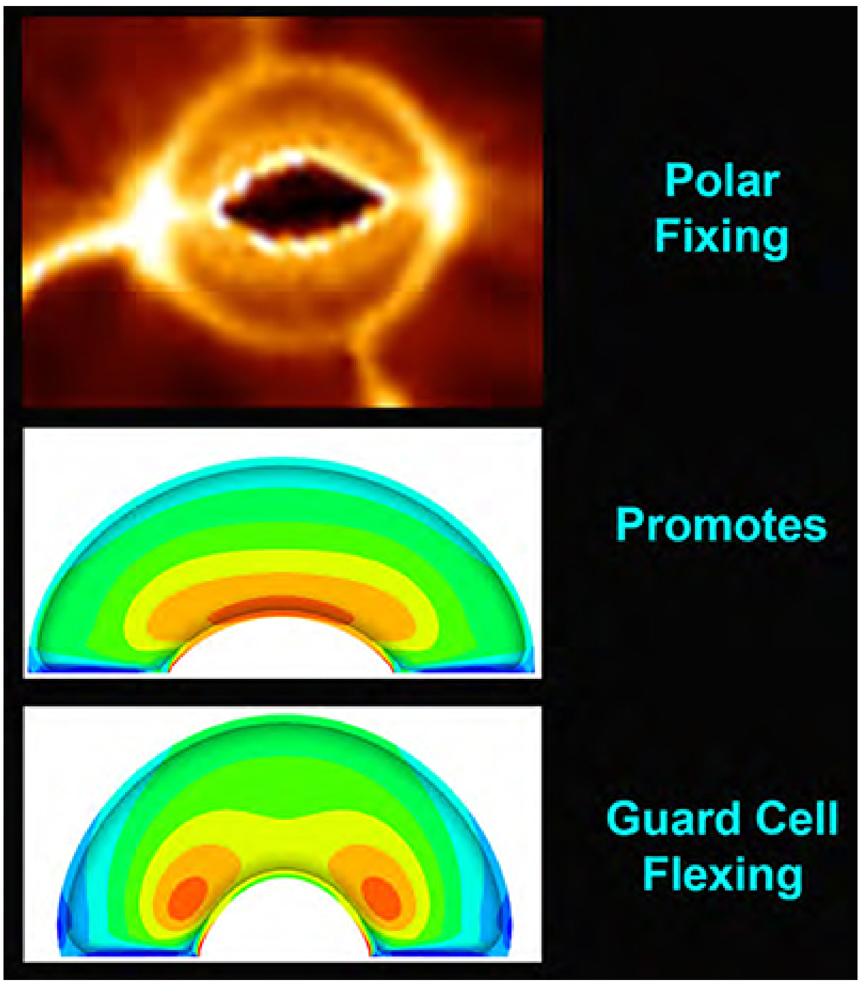

Credit: John Innes Centre

New research is set to change the textbook understanding of how plants breathe.

Previous explanations of how plants take up carbon dioxide and breathe out oxygen have focussed on thickening of the inner walls of guard cells. These cells control the stomata—tiny pores which plants use for gas exchange, water regulation and pathogen defence.

In research published in *Plant Journal*, a team led by Professor Richard Morris from the John Innes Centre, Norwich, Professor Silke Robatzek of The Sainsbury Laboratory, Norwich, and collaborators from the University of Madrid, developed the first full 3D model of a guard cell.

Using a 3D simulation, they discovered three ingredients were necessary for guard cells to work effectively.

Firstly, the level of water or turgor pressure inside the cell, secondly the elasticity of the cell wall, thirdly it's kidney shaped geometry that converts pressure into shape changes.

Professor Richard Morris said, "This work could help us to understand how to make plants more climate resilient."

"Guard cells are also hot-spots for pathogen attack so understanding what controls the opening and closing of the stomata is important for improving plant health."

Additional work, published in *Current Biology*, involving the John Innes Centre, the University of Sheffield and the Sainsbury Laboratory in Cambridge revealed a further secret of guard cell dynamics.

Using atomic force microscopy and computer modelling the team noticed an unexpected stiffening in the guard cell end regions, or poles.

"This polar stiffening reflects a mechanical pinning down of the guard cell ends which prevents stomata increasing in length as they open. This leads to an increased speed of pore opening and larger pores. You get 'better' stomata." explains Prof Jamie Hobbs from Sheffield University.

The same effect was observed in the model plant Arabidopsis and tomato and maize suggesting it is widespread across plant species.

Professor Morris said the team are planning to extend their research to the study of grass stomata which have a different shape and likely a different underlying mechanism.

Despite the importance of guard cells and their function, the underlying mechanics have so far been poorly understood.

Guard cells change shape in response to turgor pressure—the pressure of water inside the cells. When turgor pressure is high the cells swell, bending away from each other, opening the stomata.

As water leaves the cells, the turgor pressure reduces and the cells become flatter, less kidney shaped, which closes the pore.

More information: Sheila McCormick. A 3-dimensional biomechanical model of guard cell mechanics, *The Plant Journal* (2017).
DOI: 10.1111/tpj.13665

Stomatal Opening Involves Polar, not Radial, Stiffening Of Guard Cells, *Current Biology* (2017).

Provided by John Innes Centre