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Means to an end

Bacteria use DNA segregation machinery to position polarity protein.

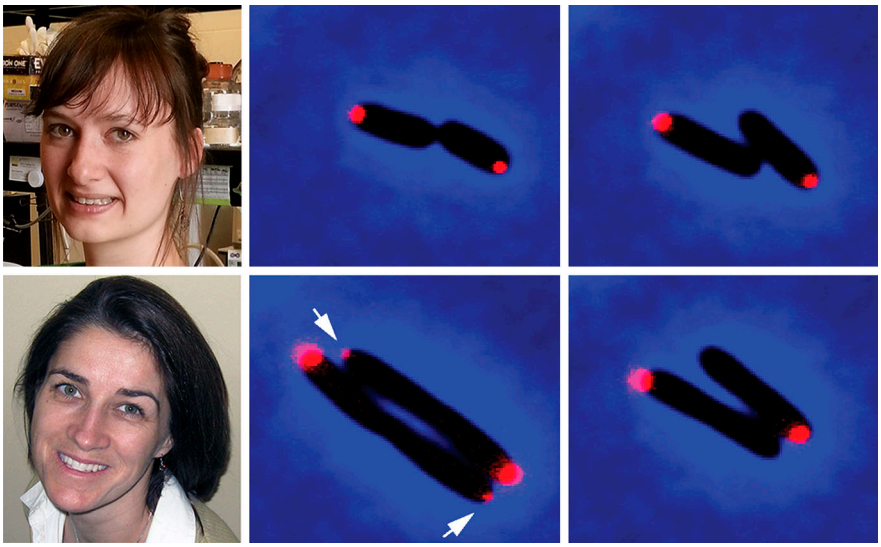
Like some explorers, the bacterial protein PopZ is at home at the poles. Laloux and Jacobs-Wagner identify a novel mechanism that enables PopZ to collect at one pole as a bacterium prepares to divide (1).

In a *Caulobacter crescentus* bacterium, PopZ accumulates at one end of the cell. Multiple PopZ molecules interweave, forming a mesh-like material that moors the bacterium's DNA at that pole (2). This connection is indirect; PopZ links to the protein ParB, which in turn fastens to a DNA segment known as *parS*. PopZ's distribution alters when the cell is ready to divide. After the bacterium's DNA is copied, one of the ParB–*parS* tandems heads for the opposite pole of the cell (3). The PopZ mesh then pops up at this end of the cell and hooks onto the traveling ParB–*parS* complex (4). If PopZ doesn't anchor the DNA at both tips of the bacterium, the cytokinetic ring that cleaves the cell doesn't form properly, leading to abnormal division. However, the mechanism that enables PopZ to accumulate at the new end of the cell remains unclear.

Laloux and Jacobs-Wagner found that the ability of PopZ molecules to interconnect was crucial. The researchers analyzed the protein's structure and determined that it contains three regions: an N-terminal domain, an amorphous midsection, and a C-terminal domain that sports three α helices, which they dubbed H2, H3, and H4. They tested shortened versions of the protein and discovered that versions lacking the H3 and H4 regions didn't gather at the poles, raising the possibility that these two segments home in on the cell tips. However, a PopZ fragment consisting of only the H3 and H4 segments didn't accumulate there either. Instead, the team's results indicate that the H3 and H4 segments enable PopZ molecules to stick to each other, spawning oligomers that are the building blocks of the mesh. Without this interaction, PopZ doesn't gather at the cell's ends.

"Local concentration of ParA triggers PopZ localization."

Focal Point



PHOTOS COURTESY OF MATT JACOBS-WAGNER (JACOBS-WAGNER) AND HOONG CHUIN LIM (LALOUX)

Géraldine Laloux (top left) and Christine Jacobs-Wagner (bottom left) probed how the DNA-anchoring protein PopZ shifts to the opposite end of a bacterial cell before division. This time series (clockwise from top center) shows *E. coli* cells that carry a version of PopZ (red) linked to a protein that homes in on the cell ends. PopZ initially appears only at one end of the cell but expands to the opposite end (arrows) as division nears. The researchers found that the accumulation of ParA, a part of the DNA segregation apparatus, in one end of the cell ensures that PopZ can condense there as well.

But oligomer assembly isn't the whole story. The researchers engineered *E. coli* bacteria—which lack the gene for PopZ—to manufacture the protein. Laloux and Jacobs-Wagner showed that PopZ self-assembled in these cells as well, but the mesh could take shape at either pole.

To guarantee that PopZ amasses at the new pole, *Caulobacter* takes advantage of the protein ParA, which is part of the machinery that separates the chromosomes. After DNA duplication, the new bacterial chromosome starts moving toward the opposite end of the cell, causing ParA to accumulate there. ParA and PopZ adhere to each other, so the rising amounts of ParA might cause PopZ to coalesce. To test whether ParA's polar build-up enables PopZ to form a mesh there, the team modified *E. coli* cells to produce a ParA variant that is tethered to a bacterial protein that homes in on the poles. Instead of spreading around the DNA-deficient portions of the cell, the PopZ mesh was mainly confined to the poles.

The findings suggest a simple explanation for PopZ's appearance at the new pole, says senior author Christine Jacobs-Wagner. "Local concentration of ParA triggers PopZ localization." Without ParA's help, PopZ oligomers would be too diffuse at the new pole to allow mesh formation. But by gathering the oligomers, ParA enables them to reach a high enough concentration to interlink and assemble into the mesh. This mechanism ensures that the PopZ anchor appears at the right location at the right time, Jacobs-Wagner says. "You really have a nice coupling between PopZ localization and DNA segregation." Cells might use a similar mechanism to concentrate proteins in other situations.

1. Laloux, G., and C. Jacobs-Wagner. 2013. *J. Cell Biol.* http://dx.doi.org/10.1083/jcb.201303036.
2. Bowman, G.R., et al. 2008. *Cell.* 134:945–955.
3. Ptacin, J.L., et al. 2010. *Nat. Cell Biol.* 12:791–798.
4. Ebersbach, G., et al. 2008. *Cell.* 134:956–968.