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Not all nuclear pores created equal

Pore-making process isn't identical in interphase and mitosis.

There's more than one way to make a nuclear pore, as Dultz and Ellenberg show (1). Depending on where they are in the cell cycle, cells change the order in which they put the pore components together and how long the job takes. Cells can therefore follow more than one procedure to build the same complex structure.

Cells manufacture new nuclear pores in two situations (2). All pores disassemble during mitosis because the nuclear membrane dissolves to allow the chromosomes to separate. The end of mitosis triggers a building boom. Within about 10 minutes, the cell fashions close to 1,000 pores and installs them in the reforming nuclear membrane. New pores also form in interphase, although scientists know less about this process (3). During this period, the cell stockpiles the nucleoporins, or Nups, it will need to rebuild its pores during mitosis by putting them into new nuclear pores.

Researchers assumed that nuclear pores are pretty much the same, regardless of when they are made. But a recent study revealed that some Nups perform different functions during pore production in mitosis and interphase (4), suggesting different construction plans.

Dultz and Ellenberg took a closer look at the issue by tracking GFP-labeled pore proteins in living cells. Catching a pore in the act of forming is tricky, says senior author Jan Ellenberg. "It happens at unpredictable times and places across the nucleus." But by observing the nuclear membrane at high resolution throughout interphase, they were able to see it happen around 150 times.

One big difference the researchers noted is that interphase assembly is much slower. Building a pore at the end of mitosis requires no more than about 10 minutes, whereas in interphase the process takes 10 times as long. This expanded schedule also holds for individual Nups. At the end of mitosis, the Nup Pom121 binds to the forming pore within about 90 seconds, but in interphase this step requires nearly 30 minutes.

To their surprise, Dultz and Ellenberg found that the two stages differed in another way: the order in which certain Nups attach to the pore. At the end of mitosis, Nup107 joins the nascent pore before Pom121. But the sequence is reversed in the interphase-made pores.

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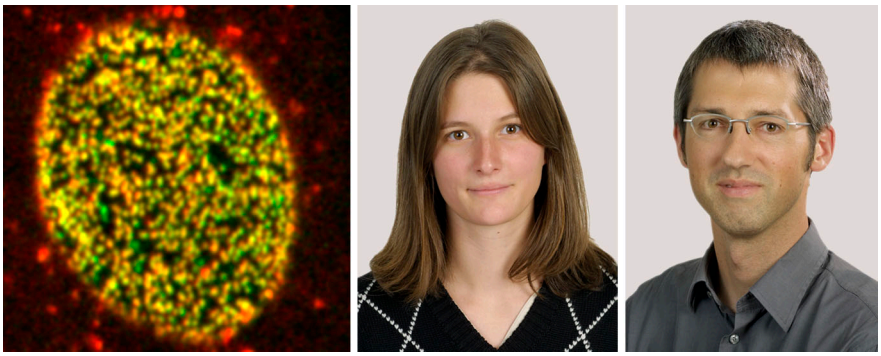
Why these disparities in order and duration? They might reflect distinct conditions at the two stages of the cell's life. Late in mitosis, it might pay to rush out a load of pores so that the cell can quickly restore nuclear transport to normal. Interphase assembly, by contrast, can be leisurely. Moreover, pore construction during this time is probably slower because the pore has to slip into the nuclear membrane without disrupting it.

Focal Point



Are all the nuclear pores speckling this interphase nucleus (left) the same, no matter when they were made? Cells don't always stick to the pattern when they craft new nuclear pores. Elisa Dultz (center) and Jan Ellenberg (right) find that the timing and assembly order differed for pores made in mitosis and interphase.

"This is the first time that anyone has demonstrated that multiprotein machinery can be made in two ways," says Ellenberg. Researchers now need to determine how the cell can follow two blueprints yet ensure that all pores work the same. The results might help scientists better understand the assembly of other complex cellular structures.

The study also raises the possibility that nondividing cells might run out of pores. Dultz and Ellenberg noticed that pores sometimes spontaneously break down. Scientists had assumed that the structures remained in place for life, potentially lasting for decades. But if pores decay over time, transportation across the nuclear membrane might decline in older cells, possibly contributing to aging, Ellenberg says.

1. Dultz, E., and J. Ellenberg. 2010. *J. Cell Biol.* doi:10.1083/jcb.201007076.
2. Antonin, W., et al. 2008. *FEBS Lett.* 582:2004–2016.
3. Iino, H. K., et al. 2010. *Genes Cells.* 15:647-60.
4. Doucet, C.M., et al. 2010. *Cell.* 141:1030–1041.