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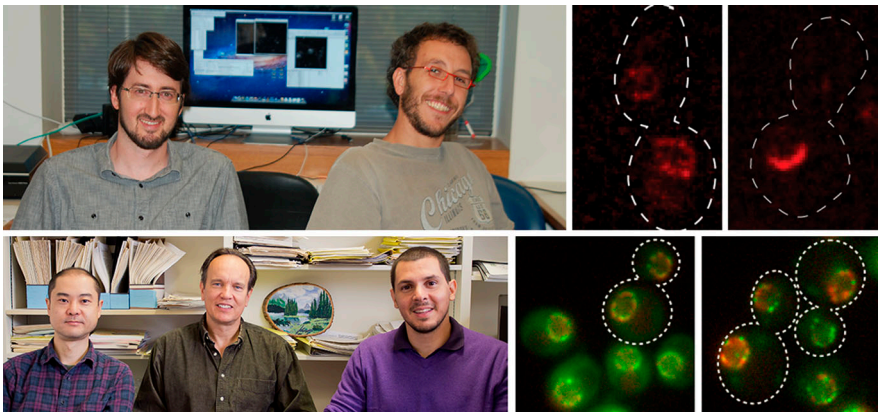
Ensuring that yeast cells get their inheritance

A nucleoporin allows nuclear pore complexes access to daughter cell during mitosis.

Focal Point



LUSK AND COLOMBI PHOTO COURTESY OF ELIZABETH SCOTT; WOZNIAK ET AL. PHOTO COURTESY OF DIEGO LAPETINA

Two research teams converged on the discovery that the protein Nsp1 promotes the inheritance of nuclear pore complexes. (Tow row) Patrick Lusk (left), Paolo Colombi (right), and colleagues (not pictured) found that a cytoplasmic pool of Nsp1 moves into the daughter cell during mitosis, allowing nuclear pore complexes (red, left) to follow. If they trapped Nsp1 in the mother cell, the complexes stayed behind (right). (Bottom row) Tadashi Makio (left), Richard Wozniak (center), and Diego Lapetina (right) determined that damaged pore complexes aren't passed on. As these two images taken six hours apart show, NPCs missing part of the Nsp1 complex (red) remain in the mother cells, whereas intact NPCs (green) are able to spread to the daughters.

Along with its DNA, a fungal cell might also hand down nuclear pore complexes (NPCs) to its offspring. A nuclear pore protein paves the way for the complexes to move from mother cell to daughter, Makio et al. and Colombi et al. reveal (1, 2).

Researchers think that vertebrate cells don't transfer intact NPCs to their progeny. The roughly 30 proteins, or nucleoporins, that make up a pore complex disperse when the nuclear envelope breaks down and then reassemble when the membrane reforms in the daughter cells. However, some fungi undergo a different style of mitosis in which the nuclear envelope remains intact, and the question of whether fungal daughter cells inherit entire NPCs has been controversial. Some work suggests that NPCs move too slowly to account for the number of complexes in daughter cells, implying that the offspring make new ones (3, 4). In contrast, other researchers argue that the pores are actively inherited (5). Understanding the movements of NPCs might provide insights into the mechanism that controls the number of NPCs that cells contain. Makio et al. and Colombi et al. uncovered evidence that NPCs are indeed transmitted from parent to offspring in budding yeast.

Colombi et al. used a method called recombination-induced tag exchange that enabled them to distinguish new nucleoporins from old ones. They followed dividing cells through anaphase and observed that old nucleoporins appeared in the daughter cells, indicating that NPCs are inherited. Although most nuclear pore proteins were evenly distributed between mother and daughter cells during division, one nucleoporin, Nsp1, amassed in the daughter cell. A cytoplasmic pool of Nsp1, not associated with NPCs, followed endoplasmic reticulum (ER) tubules into the bud, helped along by the motor protein myosin-2. Whether Nsp1 travels along the ER tubules or just hitches a ride remains unclear. But Colombi et al. found that the protein promotes the inheritance of NPCs. When they shackled this pool of Nsp1 and its nucleoporin partners to the plasma membrane, few NPCs reached the daughter yeast. "This is a new mechanism that controls the number of nuclear pore complexes," says senior author Patrick Lusk.

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Makio et al. also implicated Nsp1 in NPC inheritance. They tracked NPC movement in cells lacking various nucleoporins. NPCs failed to make the trip from mother to daughter in cells lacking Nsp1. Within NPCs, Nsp1 forms a complex with several other nucleoporins. The researchers determined that, in cells depleted of other members of this complex, the number of NPCs inherited by the daughter cells declined by more than 50% during mitosis.

NPCs lacking Nsp1 appeared to get stuck in the narrow bud neck that connects mother and daughter cells. To probe why some NPCs stay behind in the mother, Makio et al. gradually removed one member of the Nsp1 complex, Nup82, from mitotic yeast cells. NPCs that contained Nup82 were equally distributed between mother and daughter cells, whereas NPCs that lacked Nup82 (and presumably Nsp1) accumulated in the mother. The researchers concluded that NPCs missing Nsp1 are filtered out during mitosis. "It's a quality control mechanism for restricting the movement of pores that are defective in certain ways," says senior author Richard Wozniak. That function could explain why some previous studies inferred that NPCs weren't inherited, he says, because tagging the pore complexes with GFP can hamper their function and cause them to remain in the mother cell.

The two studies agree that a barrier prevents NPCs from crossing the bud neck. The Nsp1 complex appears to overcome this obstacle so that NPCs can exit the mother cell. What researchers now need to determine is what creates the barrier and how Nsp1 opens the way for NPC inheritance.

1. Makio, T., et al. 2013. *J. Cell Biol.* http://dx.doi.org/10.1083/jcb.201304047.
2. Colombi, P., et al. 2013. *J. Cell Biol.* http://dx.doi.org/10.1083/jcb.201305115.
3. Boettcher, B., et al. 2012. *J. Cell Biol.* 197:921–937.
4. Shcheprova, Z., et al. 2008. *Nature*. 454:728–734.
5. Khmelinskii, A., et al. 2010. *Nature*. 466:E1.