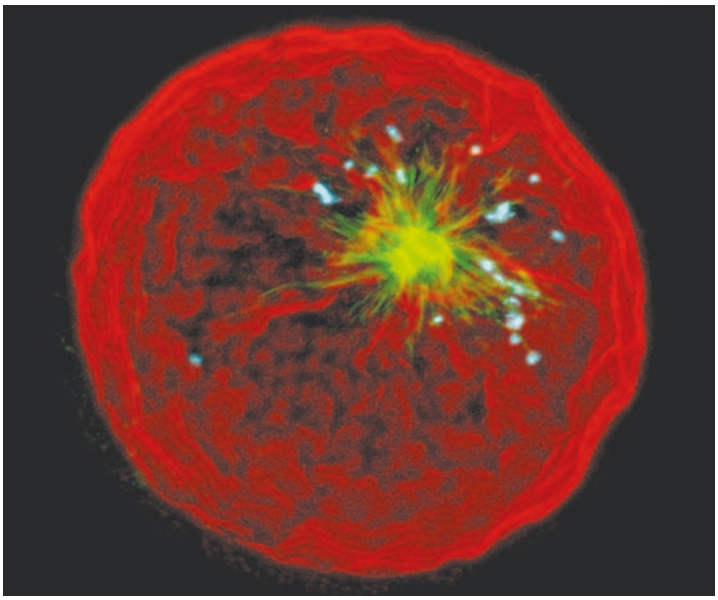
CELL DIVISION

A helping hand



The actin net (red) collects chromosomes (blue) in the large oocyte nucleus and moves them to within capture range of the microtubule asters (green). Image courtesy of Jan Ellenberg, EMBL, Heidelberg, Germany.

Microtubules are widely known to capture chromosomes and align them on the spindle in dividing cells. But Jan Ellenberg and colleagues have now discovered that a contractile actin network provides a helping hand in catching those chromosomes that are beyond the ~40 μm capture range of microtubule asters.

Reporting in *Nature*, the Ellenberg team studied starfish oocytes as they contain a large (~80 μm) nucleus. By imaging microtubules and chromosomes during meiosis I, they showed that all chromosomes — including distal ones — move towards the centrosomes immediately after the nuclear envelope breaks down, but before microtubules contact the distal chromosomes. In addition, they found that chromosome congression proceeded almost normally in the presence of a microtubule-depolymerizing drug. This indicated that another, microtubule-independent, mechanism exists.

To identify the mechanism that is responsible for long-distance chromosome capture, Ellenberg and colleagues treated cells with an actin-depolymerizing drug. Of these cells, 75% had defective chromosome congression. When cells were treated with both an actin- and a microtubule-depolymerizing drug, chromosome congression failed completely. By tracking chromosome movements, the authors showed that chromosome movement occurs in two distinct phases — the initial, slow phase of chromosome movement is actin dependent, and the second, faster phase is microtubule dependent.

Next, the Ellenberg group showed that actin polymerization starts just before fragmentation of the nuclear envelope, as visualized by the entry into the nucleus of large fluorescent dextran molecules. They suggest that nuclear envelope breakdown triggers actin polymerization, possibly by the mixing of nuclear and cytoplasmic compartments.

Using a fluorescent probe to visualize the actin network, the authors showed the presence of a filamentous (F)-actin network with dense patches around the chromosomes. These F-actin patches are present during the initial slow chromosome movement and then disappear, to be followed by fast microtubule-mediated chromosome capture.

The F-actin network collapses towards the animal pole (where the centrosomes are) over time, which could be caused by actin depolymerization. This was indeed the case, as treatment of cells with actin-stabilizing drugs caused severe chromosome loss. The authors envisage that contraction could result in the 'pulling in' of the actin network from the animal pole, carrying with it the attached chromosomes, thereby delivering them within reach of the microtubule asters.

Given that many animal species have oocytes with large nuclei, the authors speculate that a similar actin-dependent mechanism for chromosome congression is also likely to function in vertebrates and mammals.

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References and links

ORIGINAL RESEARCH PAPER Lénárt, P. *et al.* A contractile nuclear actin network drives chromosome congression in oocytes. *Nature* 13 July 2005 (doi:10.1038/nature03810)

WEB SITE

Jan Ellenberg's laboratory: http://www.embl-heidelberg.de/ExternalInfo/ellenberg/