



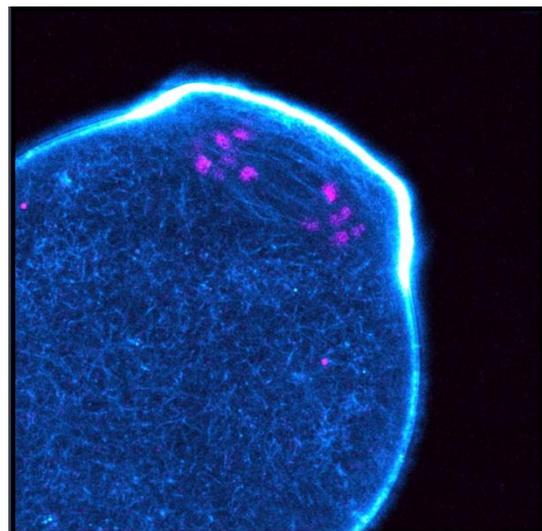
Press Release

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Properly sorted – error-free chromosome segregation in egg cells requires actin

The maturation process of mammalian egg cells is highly error-prone. If in humans, for instance, chromosomes are not reliably segregated during egg maturation, this may lead to spontaneous abortion or chromosomal anomalies such as Down Syndrome. Scientists at the Max Planck Institute (MPI) for Biophysical Chemistry now show in the mouse model that the structural protein actin protects egg cells from mistakes during chromosome segregation. (*Science, August 25, 2017*)

When an egg is fertilized by a sperm, maternal and paternal chromosomes unite – a new life begins. However, a healthy embryo can only develop when egg and sperm cells contain exactly one copy of each chromosome. The precursor cells of eggs, the so-called oocytes, harbor – as all other cells in our body – two copies of each chromosome. In the course of maturation, they divide their set of chromosomes in half via a specialized cell division termed meiosis. During this process, the paired chromosomes are segregated by a complex machinery – the spindle. Before segregation, the chromosome pairs are first aligned in the middle of the spindle. Then, they are separated from each other and transported to the spindle's two opposing sides.



Max Planck Researchers from Göttingen have now found that actin fibers play a central role in meiosis. “Actin protects mammalian oocytes from defects during chromosome segregation,” points out Melina Schuh, Director of the Department of Meiosis at the institute. “For a long time, actin fibers have been known for their importance in moving and shaping

Spindle actin in a mouse egg. Actin is depicted in blue, segregating chromosomes in magenta.
(Image: Binyam Mogessie / Max Planck Institute for Biophysical Chemistry)

cells. It was surprising that actin fibers are also involved in segregating chromosomes in eggs, because chromosome segregation is generally thought to rely solely on another type of protein fiber, called microtubules, which make up the spindle.” In their experiments, the scientists analyzed mouse oocytes using super-resolution microscopy. “We were able to see that in meiosis, actin fibers form a structure that infiltrates the microtubules inside the spindle,” explains Binyam Mogessie, researcher in Schuh’s lab and first author of the paper that is now published in the renowned journal *Science*.



Dr. Melina Schuh and Dr. Binyam Mogessie in the microscopy lab of the Department of *Meiosis*.
(Picture: Irene Böttcher-Gajewski / Max Planck Institute for Biophysical Chemistry)

The researchers could demonstrate that the amount of actin inside the spindle is highest when chromosomes are pulled to the opposing sides of the spindle. To investigate the role of actin in the spindle, the scientists made use of oocytes that had reduced or increased amounts of actin and analyzed possible defects during meiosis.

Actin likely promotes spindle fiber formation

“Oocytes with reduced actin tend to have chromosome segregation errors. The cells need longer to align the chromosomes in the middle of the spindle. Moreover, in these cells, chromosomes are often retained at the spindle poles and do not correctly move to the center. These defects frequently give rise to eggs with an incorrect number of chromosomes,” Schuh comments on her department’s latest research findings. “We found similar defects in cells with increased actin in the spindle. Strikingly, these cells had more spindle fibers bound to chromosomes,” Mogessie adds. The researchers conclude that actin most likely promotes the formation of the specialized spindle fibers which first align the chromosomes in the middle of the spindle and thereafter separate them.

The scientists were able to detect such actin fibers not only in mouse egg cells but also in the meiotic spindles of human, sheep, and pig eggs. “In the future, we want to find out whether actin also protects human eggs from chromosome segregation errors,” Schuh says. (ad/fk)

Original publication

Binyam Mogessie, Melina Schuh: Actin protects mammalian eggs against chromosome segregation errors. Science 357, 772 (2017).

Further information

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