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EDITORIAL

The same, but different—a bird's-eye view on mitosis

Peter Nick

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Replication—the generation of a true copy—represents the core element of life and is a key requirement for biological evolution. The complementary structure of DNA allows the production of a genetic copy by relatively simple mechanisms. In order to transform the genetic into a cellular copy, the duplicated DNA is equally distributed to the daughter cells by a microtubule-based spindle. Spindle assembly is so fundamental that the textbooks often overlook that many facettes of this process still have remained far from being understood. The observation that mitotic microtubule arrays differ conspicuously between different organisms corresponds to a severe blind spot in a central biological problem. For instance, preprophase band-like microtubules, a characteristic feature of plant mitosis, are not found in meiotic divisions. However, in bryophyte meiosis, preprophase bands do exist and, in addition, even vary between different taxa (Brown and Lemmon 2009). A process as central as mitosis is expected to be evolutionarily conserved. How to explain then the tremendous differences in organisation and establishment of mitotic spindles? It is very unlikely that cells evolved completely new and separate motility systems for mitosis, but there is evidence that components present already in the interphase cell are redefined and recruited to exert a new function. For instance, the so-called matrix model (Pickett-Heaps and Forer 2009) derives the interaction of actomyosin in the spindle matrix with microtubules during anaphase A from the actin-based cleavage of unwalled cells.

The review by Wadsworth et al. (2011) in the current issue adopts a comparative approach searching for the common theme between the different variations focussing on the acentriolar nucleation of microtubules. They point out that even in cells endowed with centrioles, spindle microtubules can form in the absence of a centriole. This acentriolar nucleation is present in all cell types and can, depending on the organism, emanate from the chromosomes or from the nuclear envelope. Centrosomal microtubules simply modify and promote this acentriolar nucleation—it is their visual dominance that has led to the misconception that centrioles are a conditio sine qua non for spindle formation. In the search for conserved principles, the authors define a two-stage mechanism comprising the assembly of coalescence of short microtubules around the chromatin and, as the second step, microtubular sorting by the activity of molecular motors. For each of the two stages exist several alternative and mutually complementing pathways that safeguard the functionality of mitosis against challenging conditions. The molecular players that drive this two-step mechanism can differ; it is the combination of microtubule bundling and sorting that seems to be constant.

The work by Yasuhara and Oe (2011) in the current issue represents something like a comment to this concept. The authors investigate a plant homologue of the XMAP215 family that in animals and yeast is central for spindle assembly. Using the cell-cycle synchronisation amenable in this experimental model, they show upregulation of TMBP200 at entry into mitosis and address cellular functions of this protein by inducible RNA interference. They observe severe defects in bi-polar

Handling Editor: Peter Nick

P. Nick (✉)
Botanical Institute, Molecular Cell Biology,
Karlsruhe Institute of Technology,
Kaiserstrasse 2,
76131 Karlsruhe, Germany
e-mail: peter.nick@bio.uka.de

spindle formation followed by the formation of multinucleated cells with variable-sized nuclei. Interestingly, the microtubules as such are not disrupted. However, the bundle of microtubules associated with the chromosomes was small and not adherent. The authors conclude that it is most likely the defective microtubule bundling disturbing spindle bipolarity. In the concept of the above-mentioned two-stage model, it would be the first step of microtubule coalescence, where the function plant XMAP215 homologue is located.

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