How to get a copy: plant mitosis and fertilization

To generate a more or less true copy from a successful template represents a central ability of all living beings. This achievement of life becomes manifest on different organizational levels: as semiconservative duplication of DNA, as mitotic division, or, on the level of the whole organism, as sexual or asexual propagation. The reliability of this copy process is vital for evolutionary success, and it is not astonishing that elaborate control mechanisms have developed to ensure that the copy reflects the template faithfully. Four contributions to this issue add to this central topic of general biology. Two of them address the mechanisms that participate in the mitotic copy of a mother cell, the other two highlight cellular aspects of fertilization and the mechanisms that ensure the correct transfer of morphogenetic information from the mother organism to its daughter.

Hidden aspects of mitosis

The separation and redistribution of the chromosomes, followed by the separation of the daughter cells, have been investigated intensively over decades. It seems therefore that our picture of mitosis is quite complete. However, mitosis is much more than that and there are surprising new facettes that are still waiting to be uncovered. The contributions by M. Honda and H. Hashimototo (pp. 127–135) and L. Fabian and A. Forer (pp. 201–213) deal with such hidden aspects of mitosis.

Using the green alga *Klebsormidium flaccidum* as model, Honda and Hashimoto ask the question how other cell organelles are correctly distributed during mitosis. These cells contain only a single microbody along with a single chloroplast. This microbody is oriented perpendicular to the axis of the prospective spindle and associates with one of the centrioles. This orientation is tilted during prophase such that now the microbody is directed parallel with the spindle and then progressively elongates during mitosis maintaining its link with the centrioles. The authors conclude that mitotic microtubule arrays not only are required for the redistribution of DNA but also might ensure that other cellular organelles are faithfully partitioned to the daughter cells.

Whereas the textbook view of mitosis has been centered around microtubules and their reorganization, the role of actin has not attracted the same degree of attention. However, evidence accumulates that the acto-myosin system participates in mitosis. Extending their previous work on the role of actomyosin in crane-fly mitosis to a different system, locust spermatocytes, Fabian and Forer investigate the effect of actin and myosin inhibitors on the chromosome movement in anaphase. They can show that latrunculin B or cytochalasin D affect the movement in a complex manner, whereas the myosin inhibitor 2,3-butanedione monoxime arrests the movement. They further demonstrate that latrunculin B reduces the gap in acetylation at the kinetochore, indicating that microtubule flux along kinetochore fibres depends on actin. These results confirm and extend models for the function of actin in mitosis.

Countdown for fertilization in gymnosperms

Plant evolution culminated in the dominance of quasi-diplontic organisms, the angiosperms, that derived from heterophasic, haplodiplont ancestors. Whereas a haploid lifestyle is the rule for most algae and is still predominant in the amphibic bryophytes, it was then progressively reduced during cormophyte evolution. Gymnosperms assemble interesting and sometimes exotic transitions on this long path. The potential of gymnosperms for our understanding of plant cell and developmental biology is far from being exploited – in angiosperms, several organelles or structures have been reduced to a degree that it is quite difficult to understand their biological function. It is therefore worthwhile to have a closer look on some of the evolutionary rudiments found in gymnosperms because they might tell us more about some of the enigma of plant, or more correct, angiosperm, cell biology. The contributions by D. Li et al. (pp. 173–181) and F. Guo et al. (pp. 239–243) contribute to such approaches.

In *Ginkgo biloba*, where the egg cell-synergid apparatus present in angiosperms is still elaborated as an archegonium, Li et al. analyzed the formation of the archegonium chamber that guides the archaic, still flagel-

late, spermatozoid towards the waiting egg cell. They provide evidence that this chamber forms by programmed cell death as concluded from characteristic markers such as terminal deoxynucleotidyl transferase-mediated dUTP nick end labeling (TUNEL) or the formation of DNA ladders. By electron microscopy they can show that this apoptotic death is preceded by the release of calcium from the mitochondria in those nucellar cells that are doomed to death. This finding is also interesting when it is projected on the angiosperm duplicate fertilization – it is still unknown what processes commit one of the three micropylar cells of the embryo sack to become an egg cell (that will survive) and not a synergid (that will die).

Once the egg cell is fertilized, it will divide asymmetrically to give rise to a large, vacuolated precursor of the suspensor, and a small, dense precursor of the embryo proper. This first cell division is formative in character, because mutants in which this division is symmetric (most prominently, the thale cress *gnom* mutant) are not able to establish a normal body plan. The cellular base of this formative division is still far from understood – there must be morphogenetic factors that are tethered or transported in a controlled manner, and this indicates an important role of the cytoskeleton. This is the background to understand the relevance of the work by Guo et al., who have a closer look on the fine structure of fertilized eggs of Chinese pine (*Pinus tabulaeformis*). They observe polysomes that are associated with microtubules and thus provide direct evidence for a microtubule-based intracellular localization of mRNA and ribosomes. These polysome-transporting microtubules seem to emanate from the nuclear envelope and to merge with the cortical microtubules that are oriented parallel to the long axis of the zygote. The colocalization with the mRNA-binding protein hnRNP indicates that the mRNAs are loaded to the microtubules immediately after their export from the nucleus and might then, via the longitudinally oriented cortical microtubules move on to the polar region of the cell.

P. Nick