Understanding Cytokinesis Through Synthetic Rewiring and In Vitro Reconstitution

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Cytokinesis is the terminal step in the cell cycle during which two daughter cells are generated from one. In many eukaryotes, cytokinesis requires the function of an actomyosin contractile ring, which generates the forces for cytokinesis. The fission yeast is an attractive organism to study cytokinesis since it divides using an actomyosin ring and is amenable to methods of genetics and high-resolution imaging.

In fission yeast, cytokinesis occurs in the medial plane of the cell and the positioning requires the anillin-related protein Mid1p. The precise roles of Mid1p are not fully understood, given that it appears to perform multiple functions. Using a synthetic reconstruction approach, we have elucidated molecular pathways that can support normal cytokinetic ring positioning even in the absence of Mid1p. However, despite correct positioning of the actomyosin ring in these rewired cells, they display other cytokinesis-related defects. These studies provide detailed information on the mechanism of actomyosin ring positioning and assembly and the multiple roles performed by Mid1p.

To understand ring constriction mechanisms, we have established a permeabilized cell system in which preexisting actomyosin rings constrict upon addition of adenosine triphosphate. We are using this system to further understand molecular determinants of ring constriction. Surprisingly, we find that in vitro constriction of the actomyosin ring depends on myosin II motor activity, but not on actin disassembly. These studies strongly suggest that a "sarcomeric" mechanism can account for proper constriction of the actomyosin ring.