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Reconstruction of the kinetochore: a prelude to meiosis

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Abstract

In eukaryotic organisms, chromosomes are spatially organized within the nucleus. Such nuclear architecture provides a physical framework for the genetic activities of chromosomes, and changes its functional organization as the cell moves through the phases of the cell cycle. The fission yeast *Schizosaccharomyces pombe* provides a striking example of nuclear reorganization during the transition from mitosis to meiosis. In this organism, centromeres remain clustered at the spindle-pole body (SPB; a centrosome-equivalent structure in fungi) during mitotic interphase. In contrast, during meiotic prophase, centromeres dissociate from the SPB and telomeres cluster to the SPB. Recent studies revealed that this repositioning of chromosomes is regulated by mating pheromone signaling. Some centromere proteins disappear from the centromere in response to mating pheromone, leading to dissociation of centromeres from the SPB. Interestingly, mating pheromone signaling is also required for monopolar orientation of the kinetochore which is crucial for proper segregation of sister chromatids during meiosis. When meiosis is induced in the absence of mating pheromone signaling, aberrant chromosome behaviors are observed: the centromere proteins remain at the centromere; the centromere remains associated with the SPB; and sister chromatids segregate precociously in the first meiotic division. These aberrant chromosome behaviors are all normalized by activating the mating pheromone signaling pathway. Thus, action of mating pheromone on the centromere is important for coherent behavior of chromosomes in meiosis. Here we discuss repositioning and reconstruction of the centromere during the transition from mitosis to meiosis, and highlight its significance for proper progression of meiosis.

Background

Eukaryotic chromosomes are spatially organized within the nucleus. While such nuclear architecture provides a physical framework for the genetic activities of chromosomes, this framework however is dynamic, able to change its functional organization during the cell cycle or developmental stages. Local chromatin structures change as chromosomes undergo processes such as replication, transcription, recombination and repair. During chromosome segregation, a specialized structure called kinetochore is formed on the centromeric DNA. Global organization of chromosomes within the nucleus can also change in association with their activities. A prominent example of reconstruction of the nuclear and chromosomal frameworks is observed during the transition from mitosis to meiosis.

Meiosis is a process that produces haploid gametes from parental diploid germ cells in sexually reproducing organisms. In this process, a single round of chromosome rep-