Control of chromosome motion by nuclear envelope remodeling during meiosis

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During meiosis, chromosomes drastically change their location in the nucleus. Telomeres are attached to the nuclear envelope (NE) and move to the vicinity of the centrosome. The movement of telomeres, thus chromosomes, is driven by forces, which is transmitted through NE from cytoplasmic cytoskeltons such as microtubules and actin filaments. Dynamic repositioning of telomeres is a unique feature of meiotic prophase I that is highly conserved among eukaryotes. On entry of S. cerevisiae cells into meiosis, telomeres attach to NE, show dynamic movement on NE, which is accompanied with transient clustering on a limited area near Spindle pole body (SPB; an equivalent to mammalian centrosome) to form a "chromosomal bouquet". Telomere clustering is thought to promote recognition, meiotic recombination, and stable pairing between the homologous chromosomes. However, the molecular basis of telomere attachment and movement as well as its regulation is largely unknown. Previous works suggest that the nuclear envelope (NE) plays a critical role in telomere attachment/movement during meiotic prophase I.

We found that telomere clustering and movement depend on two cell cycle kinases, cyclin- dependent kinase (CDK) and Dbf4-dependent kinase (DDK). Particularly, the impairment of the two kinases during meiosis affect the localization and movement of a component of the SPB of S. cerevisiae, Mps3, which is an inner NE protein with the SUN domain (Sad1-UNC-84). Mps3 protein changes the localization during meiosis; On the other hand, in mitosis, Mps3 is dominantly localized on the SPB, when cells enter meiosis, Mps3 is re-localized from the SPB to nuclear envelopes. Previous reports suggest a role of Rec8, a kleisin component of the meiosis-specific cohesion in telomere dynamics in meiosis. We extended this observation and found that Rec8 also promote Mps3 localization on NEs. Our results suggest a meiosis-specific cohesion, possibly together with DDK, controls NE dynamics and thus chromosome motion during meiosis.