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Mitotic chromosome compaction via active loop extrusion.[1] ANTON GOLOBORODKO, MAXIM IMAKAEV, Massachusetts Inst of Tech-MIT, JOHN MARKO, Northwestern University, LEONID MIRNY, Massachusetts Inst of Tech-MIT, MIT-NORTHWESTERN TEAM — During cell division, two copies of each chromosome are segregated from each other and compacted more than hundred-fold into the canonical X-shaped structures. According to earlier microscopic observations and the recent Hi-C study, chromosomes are compacted into arrays of consecutive loops of ˜100 kilobases. Mechanisms that lead to formation of such loop arrays are largely unknown. Here we propose that, during cell division, chromosomes can be compacted by enzymes that extrude loops on chromatin fibers. First, we use computer simulations and analytical modeling to show that a system of loop-extruding enzymes on a chromatin fiber self-organizes into an array of consecutive dynamic loops. Second, we model the process of loop extrusion in 3D and show that, coupled with the topo II strand-passing activity, it leads to robust compaction and segregation of sister chromatids. This mechanism of chromosomal condensation and segregation does not require additional proteins or specific DNA markup and is robust against variations in the number and properties of such loop extruding enzymes.

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