Researchers provide proof of the helical coiling of condensed chromosomes

Press Release

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Gatersleben, 02.03.2023 **In early cytological studies chromatids of metaphase chromosomes were suggested to coil into a spiral called chromonema. This assumption was recently supported by chromosomce conformation capture sequencing. Still, the direct visualization of the coiled chromonema confirming the helical model was lacking. Now, for the first time an international research team led by the IPK Leibniz Insititute and the Institute of Experimental Botany of the Czech Academy of Science provides the direct proof of the helical coiling of condensed chromatids via super-resolution microscopy of specifically labelled chromonema regions. Today, the results have been published in the journal "Nucleic Acids Research".**

The iconic X-shaped organization of metaphase chromosomes is frequently presented in textbooks and other media. The drawings explain in captivating manner that the majority of genetic information is stored in chromosomes, which transmit it to the next generation. "These presentations suggest that the chromosome ultrastructure is well-understood. However, this is not the case", says Dr. Veit Schubert from IPK's research group "Chromosome structure and function".

Several models have been proposed to describe the higher-order structure of metaphase chromosomes based on data obtained using a range of molecular and microscopy methods. These models are categorized as helical and non-helical. Helical models assume that the chromatin in each sister chromatid at metaphase is arranged as a coil, whereas non-helical models suggest that chromatin is folded within the chromatids without forming a spiral.

The researchers revived the term 'chromonema' which was used for the first time at the beginning of the 20th century. Now, the IPK and IEB researchers provided a detailed description of its ultrastructure. Different experimental approaches, including chromosome conformation capture sequencing (Hi-C) of isolated mitotic chromosomes, polymer modelling, and microscopic observations of sister chromatid exchanges and oligo-FISH labelled regions at the super-resolution level provided an independent proof for the coiling of the chromonema. "Our multidisciplinary approach demonstrates that the coiled chromatid organization and its organizational unit, the chromonema, can be confirmed independently by different methods." says Dr. Veit Schubert.

"To study the higher-order structure of mitotic chromosomes, the large chromosomes of barley (*Hordeum vulgare*) were used as a model. A single helical turn covers 20–38 Mb,

creating a ~400 nm thick fiber, which we identify as the chromonema", says Dr. Amanda Camara, one of the first authors of the study.

The model proposes a general mechanism for the formation of condensed mitotic chromosomes, which is applicable to all eukaryotes across a broad range of genome sizes. "We expect that following our study, chromonema coiling will be confirmed in a larger number of plant and animal species containing large chromosomes. The identification of the principle of chromosome condensation in this work is the stepping stone to understanding chromatin dynamics during the course of the cell cycle", says Dr. Amanda Camara.

Original publication:

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