

Build a Chromosome

Abstract

Students use paper cut-outs of DNA and histones to build a 3-D model of a chromosome.

Learning Objectives

- Chromosomes are made of DNA and histones.
- DNA is coiled around histones to keep it condensed and organized.
- DNA is coiled especially tightly around histones during cell division.

Estimated time

- Prep time: 15 min.
- Class time: 45 min.

Materials

- Per student or pair of students:
 - Copy of student instructions (copies are re-usable)
 - Cut outs, printed single-sided
 - Scissors
 - Clear tape
 - Paper clips

Instructions

1. *Set up* – Prepare cut-outs and student instructions.
2. Distribute materials and have students begin.

Discuss

During cell division, chromosomes are moved in a very organized way.

- Why do you think it is important that DNA is tightly coiled during these events?
- What could happen if a cell began dividing with loosely wound DNA?
- Why do chromosomes return to a more relaxed state following cell division?

Supplemental Information

The following information might be useful as you talk about chromosomes with your students.

Interesting facts about DNA and chromosomes

- If you uncoiled the DNA from a single human cell, it would be about two meters long. That's over 1.5 times the length of the paper DNA strand used in this activity.
- Inside the cell, histones organize DNA into a space of about 6 micrometers—about 1/10th the size of the tip of a human hair.
- Histones do their job of organizing DNA so well that they are nearly identical in all organisms (except for bacteria, which have only a single chromosome).
- In a real cell, DNA and histones have additional levels of organization. A complex of DNA wound around a histone is called a nucleosome. As this model shows, nucleosomes coil into fibers. Then, with the help of additional proteins, the coils fold into loops, and the loops form even bigger loops. Ultimately, in a condensed chromosome, DNA and proteins form a very organized, very compact structure.

Vocabulary and concepts for advanced students

- Chromatin: the material that makes up a chromosome.
- Nucleosome: A subunit of chromatin. Each nucleosome is about 146 base pairs of DNA wrapped around eight histone proteins.
- Most nucleosomes contain a set of eight histone proteins that work together. Usually, this is two copies each of the histones H2A, H2B, H3, and H4.

Extensions

- Now that students have made chromosomes, use the set to model mitosis and meiosis. Some ideas include having students move with their "sister chromatid" through mitosis, or pairing to exchange DNA pieces to demonstrate recombination during meiosis.
- Make a large chromosome. As students finish their models, pool them together to better represent how much DNA is coiled on a single chromosome in a cell. Even better, combine models from several classes. Be sure to connect the DNA ribbons. Human chromosomes vary in size, but it would take about 60,000 combined models to represent chromosome 22 (one of the smallest).

Additional Resources

- "How DNA is Packaged (Advanced)" <https://www.youtube.com/watch?v=gbSIBhFwQ4s>
- "A Pathway for Mitotic Chromosome Formation" https://www.youtube.com/watch?time_continue=84&v=YUrTxc2QgwQ

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