ChromoSock Mitosis

Instructor Protocol

Overview

In this activity, students will use ChromoSocks to model the behavior of chromosomes during mitosis. Students will simulate the movement of chromosomes during cell division. Using a physical manipulative like Chromosocks provides visual clues of student concepts that can be used to address common chromosome misconceptions

Learning Objectives:

Define haploid and diploid
Identify chromosome number at several points during mitosis
Identify mitosis as the division that produces identical 'daughter cells'
Model mitosis
Correctly label centromere, chromosome (both replicated and non-replicated) and chromatids in a diagram

Materials

2 Bags of Chromosocks for each pair of students. Each bag contains:
1 white ChromoSock with an orange stripe labeled "F"
1 white ChromoSock with an orange stripe labeled "f"
1 beige ChromoSock with a green stripe labeled "B"
1 beige ChromoSock with a green stripe labeled "b"
1 grey ChromoSock with a black stripe labeled "N"
1 grey ChromoSock with a black stripe labeled "n"
Rubber bands
ChromoSock Worksheet

Timeframe

This activity is designed to be completed in a single class period.

Introducing Mitosis

1. Distribute a bag containing one set of ChromoSocks to each pair (group) of students.

Remind students that DNA is found in the nucleus of each cell. Somatic (all body cells, except reproductive cells) cells undergo mitosis.

2. Direct students to remove the ChromoSocks and arrange in pairs. Chromosomes, like socks, occur in pairs. These pairs are called homologs. Students will draw the cell and label the chromosome ploidy and number. Students are to use an "I" shape to represent a single chromosome; later in the activity an ")(" shape will be used to represent a replicated chromosome.

Remind students that each individual has one complete set of chromosomes, half of which came from mother and the other half from father. Point out that although the socks may appear slightly different, one can easily determine which two should be paired. Ask students if they can identify which of each pair of chromosomes came from the father and which came from the mother. Answer: No.
Ask students how many total chromosomes are present? Answer: 6(six).
Ask how many pairs of chromosomes are present. Answer: 3(three). These cells are diploid and the diploid chromosome number is 6 for this hypothetical organism.
Using the chart of organisms below, explore concepts of diploid and haploid chromosome number with students.

Chromosome number across various organisms

Organism	**Common Name**	**Diploid Chromosome #**
Giraffa camelopardalis	Giraffe	62
Panthera leo	Lion	38
Zea mays	Maize/Corn	20
Ananas comosus	Pineapple	50
Lumbricus terrestris	Earthworm	36

3. The Chromosocks will now be used to model the phases of mitosis.

Ask students what must occur before a cell can enter any type of cell division. Answer: DNA must be copied or replicated so that each cell receives a copy of the master instructions.

4. Distribute a bag containing a second set of ChromoSocks to each pair (group) of students. The bag contains the materials needed to replicate the Chromosocks.

5. Discuss replicated chromosomes. Students will choose a replicated chromosome in their sketch and label the following: *centromere, chromosome and chromatid.*

> *Introduce the vocabulary terms "replicated chromosome" and "sister chromatid". Point out that although the replicated chromosome contains two sister chromatids, it still behaves as a single chromosome during most of mitosis.*

6. Direct students to match the materials from the second set with the sock chromosome pairs on their desk from the first bag. Attach pairs of socks with rubber bands simulating the connection between sister chromatids at the centromere. Students will sketch the cell following DNA replication**.** Students will label the chromosome ploidy and number. They will use an ")(" shape to indicate each replicated chromosome in the sketches. Students will choose a replicated chromosome in their sketch and label the following: *centromere, chromosome and chromatid.*

> *Ask students how many chromosomes are present. Answer: Six, each of the replicated chromosomes is still counted as a single chromosome. Encourage students to count the number of centromeres rather than the number of sister chromatids to get an accurate chromosome count.*

Mitosis

7. The following steps illustrate how to use the ChromoSocks to model mitosis.

8. At the beginning of mitosis, there is one pile of ChromoSocks representing the chromosomes in the nucleus of a single cell. Direct students to line up the pairs along the middle of the desk or table to represent how chromosomes line up along the equator of the cell (Metaphase). Students will sketch the chromosomes in the cell.

> *Explain that during Metaphase the spindle fibers are attached to the centromere of each chromosome. The centromeres of the sister chromatids behave independently at this step, with a spindle fiber from one pole attaching to the centromere of one sister chromatid and the centromere of the other sister chromatid attaching to a spindle fiber from the opposite pole.*

9. Direct students to remove the rubber bands, simulating the physical change in the centromere that allows chromatids to separate. At this point, the replicated chromosome no longer behaves as a single unit. Separate the sister chromatids by moving one of each of the ChromoSocks to the opposite side of each 'cell' (Anaphase). Students will sketch the chromosomes at the end of the process.

Remind students that once sister chromatids separate, the chromosomes should be sketched as "I" shapes rather than ")(" shapes.

10. Have students collect the ChromoSocks into a tight bundle simulating the reforming of the nuclear membrane (Telophase).

Explain that cytokinesis occurs, dividing each cell into two new cells. Ask students how many cells are formed by the completed process? Answer: two.

11. Have students carefully count the number of chromosomes in each new cell. They will then sketch the chromosomes in each cell and label the chromosome ploidy and number beside each sketch.
They should then answer the following: How does the chromosome number compare to the original cell? How do the types of chromosomes present compare to the original call?

Ask students how many chromosomes are found in each new cell? Answer: Six Ask how these cells compare to the original cell? Answer: exactly the same in chromosome number and type.

12. Students should replace the ChromoSocks in the bags. Each bag should contain 2 long, 2 medium and 2 short ChromoSocks.

Carefully monitor students as they replace ChromoSocks in the bags.