Doing the Meiosis Shuffle

Sara Krauskopf

What's the difference between Prophase I and II? Why didn't I inherit the same genes as my sister? Isn't "replication" the same as a "homologous pair"?

Meiosis can be one of the more confusing topics covered in biology. The "Meiosis Shuffle," named for the playing cards used, not for a chromosome dance, helps students simulate the process of meiosis. Homologous cards representing chromosomes pair up, line up and split apart. By the end of the shuffle, one parent cell of playing card chromosomes has divided into four daughter cells. After much student laughter and movement, and the answering of numerous questions, I have reinforced our introductory lecture or reading on meiosis.

Duration

10 to 15 minutes

Materials

- One deck of playing cards for up to 26 students
- Classroom space
- Two mops, brooms, meter sticks, or length of rope (optional)

Procedure

In this model, the color and number of the playing card are important; the suit is not. Individual cards represent individual chromosomes of double-stranded DNA. This organism has up to 13 homologous pairs of chromosomes.

1. Give each student a pair of cards of the same number and same color (e.g. two red queens or two black sevens). Be sure someone else in the room has the opposite colored pair (i.e. the two black queens and the two red sevens).
2. Each student should hold up one card and show it to the rest of the class. Explain that each card represents a chromosome—the number and color are important, the suit is not. Count the number of chromosomes in the classroom. Determine the diploid chromosome number for this organism.
3. Review the stages of meiosis and use the cards to model the stages in Table 1 below.

Table 1. Stages of meiosis.

Stage	Major Activity in Cell	Card Model—Student Action
Interphase I	• Chromosomes are invisible. • Chromosomes replicate and remain invisible.	• Put the card up your sleeve or in a pocket. • Put the second "identical" (same color, same number) card up your sleeve or pocket with the first.
Prophase I	• Chromosomes become visible. • Homologous chromosomes pair up.	• Hold up your cards. • Each student finds his/her pair—the person with the same number, but opposite-colored cards. • Review the concept of homologs. Black cards are from the mother, red from the father.
Metaphase I	• Homologs line up in the center of the cell.	• Students line up in the center of the classroom (use a broom or length of rope to designate the center) across from their homologous pair. • Should all of the red cards be on one side and all of the black on the other? (No—discuss independent assortment, diversity among siblings).
Anaphase I	• Homologs are pulled apart.	• Student homologs back away from one another. (Say goodbye to your homolog!)
Telophase I	• Divide into two cells.	• Form two groups of students.
Interphase II (*optional phase)	• Chromosomes become invisible. • No DNA replication occurs.	• Put the cards up your sleeve or in a pocket. • No need to replicate because students are still holding two copies of the same card/chromosome.
Prophase II	• Chromosomes become visible.	• Hold up cards.
Metaphase II	• Chromosomes align in center.	• Students in each cell may straddle a broom, holding one card on either side of their body.
Anaphase II	• Chromosome replicates split apart.	• Students stretch out their arms, moving their two "identical" cards away from one another.
Telophase II	• Four cells form with half of the original number of chromosomes.	• Collect the cards from each new cell and display the chromosomes.

Discussion Questions

1. What will each of these new cells become?
   (Gametes)
2. How many chromosomes are in these new cells? How does this compare to the number of chromosomes in the parent cell?
   (Half the original number)
3. Are all four of the new daughter cells genetically identical? Why or why not? (Explain how in this model there are two sets of identical cells, but in actual meiosis, crossover during Metaphase I prevents the creation of identical daughter cells.)
4. How many different ways could homologs align themselves during Metaphase I in this organism? How many different combinations of chromosomes are possible in one person's sperm or egg cell? (2^{23} possibilities in humans—8.3 million combinations). So if one person has 8.3 million combinations and mates with someone with another 8.3 million combinations, why is it unlikely that they would have two children who look exactly alike?

Extension

To connect meiosis to Mendelian Genetics, ask students to create a Meiosis Shuffle for two parents. Assign specific genes and inherited traits to each chromosome. Follow the genotypes and phenotypes of the parents to the children. Predict the outcome and compare with actual results.

Conclusion

Students respond well to this simulation. They comment that by "participating" in the process of meiosis they are better able to conceptualize what the chromosomes do and how independent assortment causes genetic variation.

Sara Krauskopf is a Biology teacher at Madison East High School, Madison, WI 53703; e-mail: skrauskopf@madison.k12.wi.us.