Meiosis Madness

Many biological events are easier to understand when models explain them. In this investigation, you will use a model to duplicate the events of meiosis.

Materials (per team of 2)

modeling clay, red and blue
4 2-cm pieces of pipe cleaner
large piece of paper

PART A Basic Meiosis

Procedure

1. Use the clay to form two blue and two red Chromatids, each about 5 cm long and about as thick as a pencil. DO NOT PLAY WITH THE CLAY. Give your team one minute to make these clay chromatids
2. Repeat Procedure 1, this time making longer ones of about10-cm long.
3. Place the pairs of similar Chromatid (Two long reds, two short reds, etc.) side by side. Use short pieces of pipe cleaners to represent the centromeres. Press a piece of pipe cleaner across the centers of the two red, 5-cm Chromatids. This represents a chromosome that has replicated itself during the S phase. Do the same for the other three replicated chromosomes. (This is Metaphase I)
4. On a sheet of paper, draw a spindle large enough to contain the chromosomes you have made. Assume that the spindle and the Chromatids have been formed, and the nuclear membrane has disappeared.
5. Pair the two 5-cm chromosomes so that the centromeres touch. Pair the two 10-cm chromosomes in the same way. Assume that the red chromosome of each pair was derived from the female parent and its matching chromosome, the blue one, came from the male parent.
6. Arrange the two chromosome pairs along the equator (middle) of the spindle so that the red chromosomes are on one side and the blue on the other. (Metaphase I)
7. Holding on to the centromeres, pull the chromosomes of each matching pair toward opposite poles of the spindle. (Anaphase I) Once the chromosomes have been moved to the two poles, the first meiotic division is completed. (Telophase I)
8. Draw two more spindles on the paper. These new spindles should be centered on each of the poles of the first meiotic division. Both spindles should be perpendicular to the first spindle. Your model is now ready for the second division of meiosis.
9. Place the chromosomes from each pole along the equator of each of the two new spindles. (Metaphase II) Unfasten the centromere of each chromosome. Grasp each Chromatid at the point where the centromere had been attached. Pull the chromatids to opposite poles of their spindle. (Anaphase II) Try to move all the chromatids at once, as occurs in a living cell. Draw a circle around each group of chromosomes that you have.

Discussion

1. How many cells were there at the start of meiosis? How many cells are formed at the end of meiosis?
2. How many chromosomes were in the cell at the beginning of meiosis? How many chromosomes were in each of the cells formed at the end of meiosis?
3. At the end of meiosis, what are the cells called?
4. How many of your cells at the end of meiosis had only red chromosomes in them? How many had only blue in them?

PART B Effects of Chromosome Position – Repeat Meiosis Again.

Although the red chromosomes (from the Mom) may be on one side and the blue (Dad) may be on the other when they line up at the equator, there is an equal chance that one red and one blue Chromosome will be on the same side. Place the chromosomes on your paper in the position they were in at the beginning of meiosis (Metaphase I), except this time put one red and one blue chromosome are on each side. Now complete Meiosis and check out the chromosomes in the new cells that you made.

Discussion

1. How do these gametes compare with those you made earlier?
2. What difference does this make in terms of genetic variation in the offspring?
3. How many different types of gametes could be made if there were three sets of chromosomes instead of just two?

PART C Effects of Crossing-Over

Reassemble your Chromosomes as they would be arranged during Prophase I. To show crossing-over exchange a small part of the clay from a chromatid making up one chromosome with an equal part from a chromatid of it's matching pair. See crossing-over diagrams in your textbook for help if needed.

Place your chromosomes along the equator, showing Metaphase I.

Complete meiosis as before and note the chromosomes now found in the gametes.

Discussion

1. How many different types of gametes did you form? Did you form any different ones from those formed by others in the class?
2. In general, how do you think crossing-over affects the number of different types of gametes that are formed?
3. In crossing-over, what actually is exchanged between the chromatids?
4. What are some of the advantages of using a model to visualize a process?
5. How did this model improve your understanding of the process of meiosis?
6. What are some disadvantages of this model?