Experiment 1: Following Chromosomal DNA Movement through Meiosis

In this experiment, you will model the movement of the chromosomes through meiosis I and II to create gametes.

Materials

2 Sets of Different Colored Pop-it® Beads (32 of each - these may be any color)

(8) 5-Holed Pop-it® Beads (used as centromeres)

Procedure

Part 1: Modeling Meiosis without Crossing Over

As prophase I begins, the replicated chromosomes coil and condense…

1. Build a pair of replicated, homologous chromosomes. 10 beads should be used to create each individual sister chromatid (20 beads per chromosome pair). The five-holed beads represent each centromere. To do this...
    a. Start with 20 beads of the same color to create your first sister chromatid pair. Five beads must be snapped together for each of the four different strands. Two strands create the first chromatid, and two strands create the second chromatid with a 5-holed bead at the center of each chromatid. This creates an "I" shape.
    b. Connect the "I" shaped sister chromatids by the 5-holed beads to create an "X" shape. See Figure 3.
    c. Repeat this process using 20 new beads (of a different color) to create the second sister chromatid pair.

Figure 3: ***Bead set-up. The blue beads represent one pair of sister chromatids and the black beads represent a second pair of sister chromatids. The black and blue pair are homologous.***

2. Assemble a second pair of replicated sister chromatids; this time using 12 beads, instead of 20, per pair (six beads per each complete sister chromatid strand). See Figure 4.
3. Pair up the homologous chromosome pairs created in Step 1 and 2. DO NOT SIMULATE CROSSING OVER IN THIS TRIAL. You will simulate crossing over in Part 2.
5. Configure the chromosomes as they would appear in each of the stages of meiotic division (prophase I and II, metaphase I and II, anaphase I and II, telophase I and II, and cytokinesis).

Figure 4: ***Second set of replicated chromosomes.***

6. Diagram the corresponding images for each stage in the sections titled "Trial 1 - Meiotic Division Beads

Diagram". Be sure to indicate the number of chromosomes present in each cell for each phase.

7. Disassemble the beads used in Part 1. You will need to recycle these beads for a second meiosis trial in Steps 8 - 13.

Trial 1 - Meiotic Beads Diagram:

Prophase I

Metaphase I

Anaphase I

Telophase I

Prophase II

Metaphase II

Anaphase II

Telophase II

Cytokinesis

Part 2: Modeling Meiosis with Crossing Over

8. Build a pair of replicated, homologous chromosomes. 10 beads should be used to create each individual sister chromatid (20 beads per chromosome pair). Two five-holed beads represents the centromere. To do this...
    a. Start with 20 beads of the same color to create your first sister chromatid pair. Five beads must be snapped together for each of the four different strands. Two strands create the first chromatid, and two strands create the second chromatid with a 5-holed bead at the center of each chromatid. This creates an "I" shape.
    b. Connect the "I" shaped sister chromatids by the 5-holed beads to create an "X" shape.
    c. Repeat this process using 20 new beads (of a different color) to create the second sister chromatid pair.
9. Assemble a second pair of replicated sister chromatids; this time using 12 beads, instead of 20, per pair (six beads per each complete sister chromatid strand). Snap each of the four pieces into two five-holed beads to complete the set up.
10. Pair up the homologous chromosomes created in Step 8 and 9.
11. SIMULATE CROSSING OVER. To do this, bring the two homologous pairs of sister chromatids together (creating the chiasma) and exchange an equal number of beads between the two. This will result in chromatids of the same original length, there will now be new combinations of chromatid colors.
12. Configure the chromosomes as they would appear in each of the stages of meiotic division (prophase I and II, metaphase I and II, anaphase I and II, telophase I and II, and cytokinesis).
13. Diagram the corresponding images for each stage in the section titled "Trial 2 - Meiotic Division Beads Diagram". Be sure to indicate the number of chromosomes present in each cell for each phase. Also, indicate how the crossing over affected the genetic content in the gametes from Part1 versus Part 2.

Trial 2 - Meiotic Division Beads Diagram:

Prophase I

Metaphase I

Anaphase I

Telophase I

Prophase II

Metaphase II

Anaphase II

Telophase II

Cytokinesis

Post-Lab Questions

1. In this experiment, how many chromosomes were present when meiosis I started?

2. In this experiment, how many nuclei are present at the end of meiosis II? How many chromosomes are in each?

3. What is the ploidy of the DNA at the end of meiosis I? What about at the end of meiosis II?

4. How are meiosis I and meiosis II different? List two reasons.

5. Why do you use non-sister chromatids to demonstrate crossing over?

6. What combinations of alleles could result from a crossover between BD and bd chromosomes?

7. Identify two ways that meiosis contributes to genetic recombination.

8. Why is it necessary to reduce the number of chromosomes in gametes, but not in other cells?

9. Blue whales have 44 chromosomes in every cell. Determine how manychromosomes you would expect to find in the following:
Sperm Cell:
Egg Cell:
Daughter Cell from Mitosis:
Daughter Cell from Meiosis II:

10. Research and find a disease that is caused by chromosomal mutations. When does the mutation occur? What chromosomes are affected? What are the consequences?

11. Diagram what would happen if sexual reproduction took place for four generations using diploid (2n) cells.