Name: Date:

HANDS-ON ACTIVITY

Modeling Chromosomes in Meiosis

People choose garden plants for a variety of reasons, including plant height, flower color, texture, and size, and leaf color, texture, and size. Plant breeders develop new varieties of plants to give gardeners broad choices in planning their gardens. To do this, breeders must have a good understanding of genes and the way they are inherited.

In a hypothetical case, a team of plant breeders experiments with flower color and leaf texture. One purebred plant has red flowers and fuzzy leaves. Another purebred plant has yellow flowers and smooth leaves. The breeders cross these two plants and collect the seeds. When the breeders plant these seeds, the F_1 generation of plants has red flowers and fuzzy leaves. These plants are heterozygous for both traits. The allele for red flowers (*R*) is dominant over the allele for yellow flowers (*r*). The allele for smooth leaves (*S*) is dominant over the allele for fuzzy leaves (*s*). The genotype of the F_1 plants is *RrSs*.

The plant breeders then cross two of the F_1 plants to see if they can produce plants with yellow flowers and fuzzy leaves. They plant seeds from the F_1 plants. Complete the following Punnett square to see the expected results of this cross.

POSSIBLE MATERIALS

- beads, assorted colors
- connecting beads or cubes, assorted colors
- paper clips, assorted colors
- pipe cleaners, assorted colors
- scissors
- sticky notes, assorted colors
- string
- tape, clear
- wire, assorted colors

	RS	*Rs*	*rS*	*rs*
RS				
Rs				
rS				
rs				

What is the expected phenotype ratio from this cross?

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The plant breeders do not obtain the expected F_2 phenotypes and ratios. There were no F_2 plants with yellow flowers and fuzzy leaves. The numbers of plants of each phenotype are shown in Reference Table 1.

REFERENCE TABLE 1: F_2 GENERATION, FIRST TRIAL

PHENOTYPE	NUMBER OF PLANTS
Red flowers, smooth leaves	450
Red flowers, fuzzy leaves	221
Yellow flowers, smooth leaves	230
Yellow flowers, fuzzy leaves	0

The plant breeders repeat the experiment. The results are similar to the first trial, with one significant difference. This time there is one plant with yellow flowers and fuzzy leaves. The numbers of plants of each phenotype are shown in Reference Table 2.

REFERENCE TABLE 2: F_2 GENERATION, SECOND TRIAL

PHENOTYPE	NUMBER OF PLANTS
Red flowers, smooth leaves	391
Red flowers, fuzzy leaves	198
Yellow flowers, smooth leaves	195
Yellow flowers, fuzzy leaves	1

PREDICT

What might have caused the observed F_1 ratio to be different from the expected F_1 ratio in these plants?

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PROCEDURE

1. Develop a design for a model of chromosomes that can be used to explain your hypothesis. You should plan to show two or three pairs of homologous chromosomes. Your model should show how meiosis could produce the expected F_1 ratio for a dihybrid cross, as well as the ratio that was observed by the plant breeders. Consult with your teacher to make sure that the materials and plan you have chosen are appropriate. In your Evidence Notebook, make a sketch of your design.

2. In your Evidence Notebook, write out a procedure for making your model, taking the following steps:
   - Decide what your model must demonstrate, and consider how you will represent the genes and connect the chromosomes.
   - Select the materials that you will need for your model from those provided by your teacher.
   - Decide what safety procedures are necessary.
3. Have your teacher approve your plan.
4. Obtain the necessary materials and construct your model.
5. Take appropriate safety precautions. Do not let beads roll off the desk. Pick up dropped items immediately to avoid causing someone to slip and fall.
6. With your partner or group, move your model's chromosomes through Metaphase I and Anaphase I of meiosis in a way that will show how the expected F_2 results were obtained.
7. Modify your model to show how the observed F_2 results were obtained in the first trial.
8. Use your model to show how the observed F_2 results were obtained in the second trial.
9. Demonstrate your model for other teams. Elicit their feedback on your design.
10. Optimize your design and test it.

CLEANUP AND DISPOSAL

Clean up your lab station when you are finished with your model. Return all small objects to their original bags and give them to your teacher. Wash your hands thoroughly after all work is finished and before you leave the lab.

ANALYZE

1. Explain why the materials you selected were appropriate for the model.

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2. What difference in chromosomes caused the difference between the expected F_2 ratio and the observed F_2 ratio in the first trial? How did you modify your model to show how this difference affected the results of the breeders' experiments?

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3. What difference in chromosomes caused the difference between the expected F_2 ratio and the observed F_2 ratio in the second trial? How did you modify your model to show how this difference affected the results of the breeders' experiments?

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4. In the space provided, make a series of drawings to illustrate how you used your model to show what happened in Metaphase I of the second trial.

CONCLUDE

1. What can you conclude about the positions of the genes for flower color and leaf texture in the plants used in the experiments?

2. Were you able to use your model to demonstrate the movements of chromosomes in meiosis? Explain why or why not, and give examples of what might be missing from your model.