Mapping Hidden Genes

Use recombination data to locate genes on a chromosome.

GEN.4.5 "Enrichment: Construct maps of genes on a chromosome based on data obtained from 2- and/or 3-point crosses or from recombination frequencies."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline the sentence that tells you how to find the middle gene, then number the gene pairs in the table from smallest to largest recombination frequency.

Clues from a Greenhouse

1. A greenhouse team tracks three genes on one chromosome in flowering plants. During meiosis, chromosomes can exchange segments, separating gene versions that were once together. The team compares offspring with the original parental gene combinations to estimate how often each gene pair was separated. These percentages, called recombination frequencies, appear in the table below.

RECOMBINATION IN OFFSPRING

Gene pair	Recombinant offspring (%)
X and Y	8
Y and Z	11
X and Z	19

2. For short stretches, 1 percent recombination is about 1 map unit, called a centimorgan (cM). Smaller frequencies suggest genes lie closer together. To build a three-gene map, compare the largest pairwise distance with the sum of the two smaller distances. If they match, the gene shared by the shorter pairs lies in the middle.

3. A chromosome map gives relative positions, not a photograph of a chromosome. Choose one end as position zero, then add distances as you move to the next genes. Reversing the order gives an equivalent map because left and right have no fixed meaning here. Short regions limit the chance that multiple exchanges will hide recombination.

2 ANSWER WITH EVIDENCE

Use the passage

1. Which two genes are closest? Give the frequency that supports your choice.

2. Which gene belongs in the middle? Show the addition that supports your choice.

3. Write a chromosome map that starts with X at 0 cM. Give the positions of Y and Z.

4. A student proposes the order X, Z, Y. What X-to-Y distance would that order predict, and why does it conflict with the table?

3 YOUR TURN

Your own words

A different plant has recombination frequencies of 4% for K and L, 9% for L and M, and 13% for K and M. Write a chromosome map beginning with K at 0 cM, then explain in one sentence why the middle gene belongs there.

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PART 1 · READ AND MARK

Underline the sentence that tells you how to find the middle gene, then number the gene pairs in the table from smallest to largest recombination frequency. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Which two genes are closest? Give the frequency that supports your choice.	**X and Y are closest, with 8% recombination.**
2	Which gene belongs in the middle? Show the addition that supports your choice.	**Y is in the middle because 8 cM + 11 cM = 19 cM.**
3	Write a chromosome map that starts with X at 0 cM. Give the positions of Y and Z.	**X is at 0 cM, Y is at 8 cM, and Z is at 19 cM.**
4	A student proposes the order X, Z, Y. What X-to-Y distance would that order predict, and why does it conflict with the table?	**It predicts 19 cM + 11 cM = 30 cM between X and Y, but the table gives 8 cM.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

K: 0 cM, L: 4 cM, M: 13 cM. L belongs in the middle because 4 cM + 9 cM = 13 cM.

Accept equivalent map notation. Distances in cM are approximate estimates from the recombination frequencies.