What is Gene Linkage and Chromosome Mapping?

Worksheet

Gene linkage means genes on the same chromosome are inherited together more often than expected by chance; the recombination frequency between them, expressed as map units (centiMorgans), is used to build a linkage map showing gene order and relative distance.

Map distance (cM) = @frac{Recombinant offspring}{Total offspring} @

Questions

1. What causes recombinant offspring in a linkage cross?

A) Independent assortment only
B) Crossing over between homologous chromosomes
C) Random mutation
D) Nondisjunction

2. Out of 300 offspring, 30 are recombinant. What is the map distance?

A) 3 cM
B) 10 cM
C) 30 cM
D) 100 cM

3. Genes that are very close together on a chromosome will show

A) High recombination frequency
B) Low recombination frequency
C) No relationship to distance
D) Always 50% recombination

4. A recombination frequency of 50% between two genes usually means

A) They are tightly linked
B) They are on the same locus
C) They assort independently (unlinked or very far apart)
D) They cannot recombine

5. In a testcross of 200 offspring, 18 are recombinant for genes A and B. Find the map distance.

6. A three-point testcross gives distances: A-B = 9 cM, B-C = 3 cM, A-C = 12 cM. What is the gene order?

7. Two genes show a recombination frequency of 50%. What does this tell you about their linkage?

8. Define: What is gene linkage?

9. Define: What causes recombinant offspring?

10. Define: What is a map unit (centiMorgan)?

Answer Key

1. B) Crossing over between homologous chromosomes - Crossing over during meiosis I exchanges segments between homologous chromosomes, creating new allele combinations.

2. B) 10 cM - 30/300 100 = 10 cM.

3. B) Low recombination frequency - The closer genes are, the less likely a crossover happens between them, so recombination frequency is low.

4. C) They assort independently (unlinked or very far apart) - 50% recombination matches the expectation for independent assortment, so the genes behave as unlinked.

5. Recombination frequency = recombinants / total = 18 / 200 = 0.09 Map distance = 0.09 100 = 9 map units (cM) Genes A and B are about 9 cM apart on the chromosome

6. A-C (12 cM) is the largest distance, so A and C are the outer genes A-B + B-C = 9 + 3 = 12 cM, which matches A-C exactly Gene order is A - B - C, with B in the middle

7. 50% recombination frequency is the same as expected from independent assortment (unlinked genes) Either the genes are on different chromosomes, or they are so far apart on the same chromosome that crossing over always occurs between them Map distance calculations become unreliable above about 50% (multiple crossovers hide true distance)

8. Genes on the same chromosome that are inherited together more often than expected, because they don't assort independently.

9. Crossing over between homologous chromosomes during meiosis I, which swaps alleles between linked genes.

10. A unit of genetic distance equal to a 1% recombination frequency between two genes.