Chromosome Swap

Trace how crossover changes allele combinations.

BIO.12.a "Construct an explanation of how new genetic combinations and variations occur during crossover."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline where DNA is exchanged, circle the two new allele combinations, and number the events that lead from the exchange to those combinations.

A Swap Before Sperm Form

1. Imagine a cell preparing to make sperm. One chromosome inherited from one parent carries three gene versions in this order: A, B, C. Its matching chromosome carries a, b, c at the same three positions. These letters stand for different alleles, not for stronger or weaker traits. Before meiosis, each chromosome is copied, so each matching chromosome has two identical sister chromatids. During early meiosis, the matching chromosomes pair closely. Their aligned positions make it possible for one chromatid from each matching chromosome to exchange DNA without losing the genes at those positions.

2. A crossover occurs when two nonsister chromatids, one from each matching chromosome, break and rejoin at corresponding points. Suppose their exchange happens between positions B and C. The chromatid that began as A B C gains a segment carrying c and becomes A B c. Its partner began as a b c, gains the segment carrying C, and becomes a b C. These are new combinations of alleles already present in the cell. Each chromatid still has one allele at each of the three gene positions because the swapped pieces cover matching stretches of DNA.

3. The two chromatids that did not exchange pieces remain A B C and a b c. After meiosis is complete, each resulting sperm cell receives one chromatid from this chromosome pair, so sperm can carry A B C, a b c, A B c, or a b C at these positions. Crossover does not create a new allele here; it rearranges existing alleles on chromosomes. If fertilization joins sperm and egg, different allele combinations can contribute to differences among offspring. Without the exchange in this example, this chromosome pair would supply only the two original combinations to its sperm cells.

2 ANSWER WITH EVIDENCE

Use the passage

1. Why must the chromatids exchange DNA at corresponding points to make new combinations without leaving out a gene?

2. Suppose the two chromatids in the passage cross over between A and B instead. What two new allele combinations would form? Explain how one forms.

3. Why can this cell produce sperm with both the original and the new allele combinations after the crossover?

4. How could this crossover contribute to differences among offspring even though it creates no new alleles?

3 YOUR TURN

Your own words

In a different cell, one chromatid carries M n P, and its nonsister partner carries m N p. They cross over between the first and second gene positions. Write 3 to 4 sentences identifying both new allele combinations and explaining how this exchange could increase variation among gametes without creating new alleles.

Chromosome Swap

PART 1 · READ AND MARK

Underline where DNA is exchanged, circle the two new allele combinations, and number the events that lead from the exchange to those combinations. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Why must the chromatids exchange DNA at corresponding points to make new combinations without leaving out a gene?	**Corresponding points align the same gene positions, so swapping matching stretches rearranges alleles while leaving one allele at each position.**
2	Suppose the two chromatids in the passage cross over between A and B instead. What two new allele combinations would form? Explain how one forms.	**The new combinations would be A b c and a B C. A b c forms when the chromatid that began A B C receives the segment carrying b and c.**
3	Why can this cell produce sperm with both the original and the new allele combinations after the crossover?	**Only two nonsister chromatids exchange segments. The other two retain their original combinations, and each sperm receives one chromatid from the pair.**
4	How could this crossover contribute to differences among offspring even though it creates no new alleles?	**It produces sperm with different combinations of existing alleles. Fertilization can pass those different combinations to offspring.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

The chromatid that began M n P becomes M N p after it receives the segment carrying N and p. The chromatid that began m N p becomes m n P after it receives the segment carrying n and P. Gametes can carry these new combinations as well as the original ones, increasing variation without producing new alleles.

Accept equivalent explanations that identify which segments are exchanged and distinguish new allele combinations from new alleles. Letter order must match the three gene positions.