Chromosomes in Motion

Trace how meiosis creates variation and how evidence explains traits.

BIO.12 "Develop and use an evidence-based model to illustrate the formation of reproductive cells through the process of meiosis. a. Construct an explanation of how new genetic combinations and variations occur during crossover. b. Obtain..."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline the steps from chromosome pairing to the four sperm, and circle the two different causes of trait differences in paragraph 3. Use your marks to distinguish chromosome changes from environmental effects.

What Changes During Meiosis?

1. Imagine two homologous chromosomes in a cell that will make sperm. One came from each parent. On a short stretch of these chromosomes, use A and B for gene versions on one homolog and a and b for versions on the other. Before meiosis, each chromosome is copied into two sister chromatids. During meiosis I, homologs pair. Nonsister chromatids can break and exchange matching segments between the two genes. This crossover leaves two original combinations, AB and ab, and creates two new combinations, Ab and aB. Each chromatid carries one combination.

2. Next, the paired homologs separate in meiosis I, and sister chromatids separate in meiosis II. In this simplified example, the four sperm each receive one of the four chromatids. Fertilization joins one sperm with one egg, so a new gene combination in a sperm can become part of an offspring's genome. A sketch showing the paired chromosomes, the exchange point, and the four final cells would explain where variation enters. The letters stand for gene versions, not for traits that must appear. Other genes and the environment also influence which traits are observed.

3. Separation can also go wrong. If chromosome 21 fails to separate properly during egg formation, one egg may receive two copies instead of one. If a typical sperm adds one more copy, the resulting embryo has three copies of chromosome 21. The extra genetic material can affect development and traits. A chromosome count supports this explanation; a trait alone does not prove how the error happened. Environment matters too: sunlight can increase melanin production in skin cells, darkening skin without changing the chromosome combination in an egg or sperm. Evidence about chromosomes and environmental exposure answers different questions.

2 ANSWER WITH EVIDENCE

Use the passage

1. Which two sperm combinations are new after crossover? Explain how they form.

2. In a model of this meiosis, what must happen after crossover for each sperm to receive one of the four chromatids?

3. An embryo has three copies of chromosome 21. Explain an egg-formation error that could produce this count, and name evidence that would support the explanation.

4. A student says darker skin after time in sunlight proves that crossover changed their sperm. Evaluate this claim using the passage.

3 YOUR TURN

Your own words

In two panels, model normal separation and a separation error for chromosome 21 during egg formation. Label the number of copies in each egg and in the embryo after a typical sperm adds one copy, then explain why sunlight cannot cause this chromosome-count difference.

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PART 1 · READ AND MARK

Underline the steps from chromosome pairing to the four sperm, and circle the two different causes of trait differences in paragraph 3. Use your marks to distinguish chromosome changes from environmental effects. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Which two sperm combinations are new after crossover? Explain how they form.	**Ab and aB are new. They form when nonsister chromatids exchange matching segments between the two genes.**
2	In a model of this meiosis, what must happen after crossover for each sperm to receive one of the four chromatids?	**Homologous chromosomes separate in meiosis I, then sister chromatids separate in meiosis II.**
3	An embryo has three copies of chromosome 21. Explain an egg-formation error that could produce this count, and name evidence that would support the explanation.	**Chromosome 21 failed to separate properly, leaving two copies in an egg. A typical sperm added one copy. A chromosome count showing three copies supports the explanation.**
4	A student says darker skin after time in sunlight proves that crossover changed their sperm. Evaluate this claim using the passage.	**The claim is not supported. Sunlight can increase melanin production in skin cells without changing chromosome combinations in sperm.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

Panel 1: The chromosome 21 pair separates normally. Egg: 1 copy. Typical sperm: 1 copy. Embryo: 2 copies.
Panel 2: The chromosome 21 pair fails to separate. Egg: 2 copies. Typical sperm: 1 copy. Embryo: 3 copies.
Sunlight can affect melanin production in skin cells, but it does not add a chromosome to an egg.

Accept a separation error in either meiosis I or meiosis II if the model correctly shows an egg with two copies of chromosome 21. Students should distinguish a changed chromosome count from an environmental effect on a trait.