Meiosis and Genetic Variation

One of the major outcomes of meiosis and sexual reproduction is the resulting increased genetic diversity within a species. Genetic variation refers to differences in the genetic material of individuals in a population.

FIGURE 12: Genetic variation is responsible for the different versions of traits you see in this cat's offspring.

Mechanisms of Genetic Variation

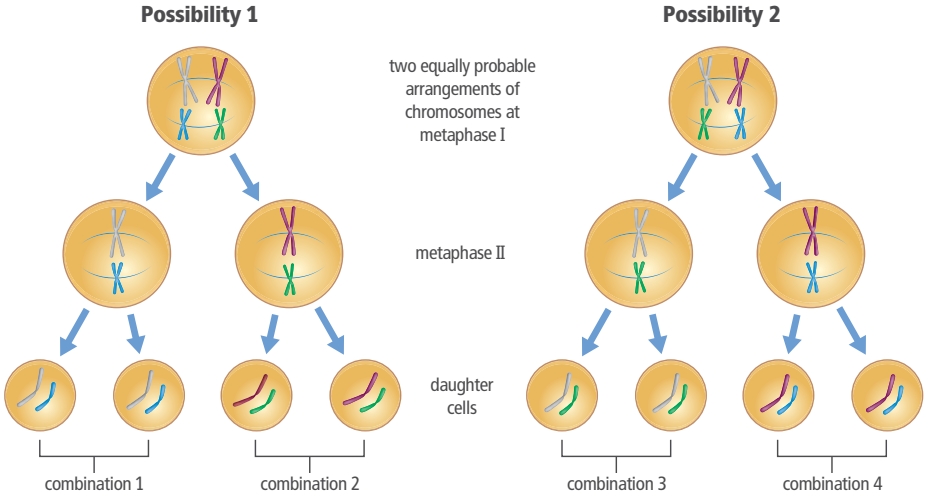
Meiosis and sexual reproduction increase genetic diversity, or genetic variation, within a population. Gametes have different combinations of genes than their parent cells due to crossing over and independent assortment, which both occur during meiosis.

Independent Assortment

When homologous chromosomes pair up in metaphase I of meiosis, the chromosomes from your father and the chromosomes from your mother line up randomly on either side of the cell's equator. This assortment of chromosomes is a matter of chance. The arrangement of any one homologous pair does not depend on the arrangement of any other homologous pair. Therefore, it is referred to as independent assortment.

FIGURE 13: Independent Assortment

Explore Online



Problem Solving

To determine the number of possible chromosome combinations that can result from independent assortment, you can use this formula:

$$\text{Combinations} = 2^n$$

where n = number of different chromosomes.

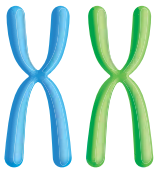
1. What is the number of possible chromosome combinations for a human cell with 23 different chromosomes?
2. How does your answer to Question 1 support the claim that independent assortment increases variation in an organism's offspring?

Crossing Over

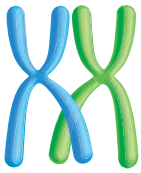
Crossing over is the exchange of chromosome segments between homologous chromosomes. It occurs during prophase I in meiosis I, and it is a regulated process. At this stage of meiosis, each chromosome has been duplicated, the sister chromatids are still connected, and homologous chromosomes have paired up. Some of the chromatids are very close to each other. Part of one chromatid from a chromosome may break off and reattach to the other chromosome. Because crossing over results in new combinations of genes, it is an example of genetic recombination.

FIGURE 14: Crossing Over

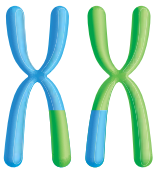
Explore Online



1 Two homologous chromosomes pair up with each other during prophase I in meiosis.



2 In this position, some chromatids are very close to each other and segments cross.



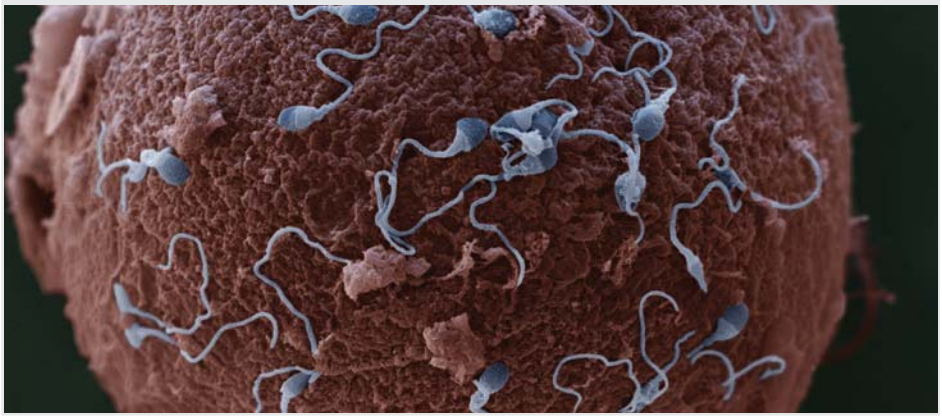
3 Some of these segments break off and reattach to the other homologous chromosome.

Explain How does crossing over contribute to genetic diversity?

Fertilization

Once mature gametes have formed during the process of gametogenesis, the gametes are ready for fertilization. In fertilization, two gametes of different types fuse, producing a zygote with a complete set of DNA—half from one parent and half from the other. The zygote formed will have a unique combination of genes. The mixing and matching of genetic material during meiosis and fertilization is responsible for the genetic variation in sexually reproducing organisms.

FIGURE 15: Fertilization results in a genetically unique organism.



Explain Use what you have learned about meiosis and sexual reproduction to construct an explanation for why offspring are not exact replicas of their parents. In your answer, include a discussion of sexual reproduction, independent assortment, and crossing over.