chapter 10 Sexual Reproduction and Genetics

section 3 Gene Linkage and Polyploidy

Before You Read

Genetics is like a game of cards. In meiosis, chromosomes are shuffled and sorted. On the lines below, explain the chances of a player getting the same cards two games in a row. In this section, you will learn about the independent assortment of chromosomes that occurs during meiosis.

MAIN Idea

Crossing over of linked genes is a source of genetic variation.

What You'll Learn

- how meiosis produces genetic recombination
- how gene linkage is used to make chromosome maps
- why polyploidy is important

Read to Learn

Mark the Text

Main Ideas Highlight the main ideas under each heading. State each main point in your own words.

Genetic Recombination

During meiosis, genes are combined in new ways. **Genetic recombination** occurs when crossing over and independent assortment produce new combinations of genes.

Recall that independent assortment occurs in meiosis when chromosomes separate randomly. The number of possible gene combinations due to independent assortment can be calculated using the formula 2^n, where n equals the number of chromosome pairs.

Pea plants have 7 pairs of chromosomes. The possible combinations of these chromosomes would be 27, or 128. Fertilization further increases the number of combinations. During fertilization, any possible male gamete can fertilize any possible female gamete. The number of combinations after fertilization would be $2^n \times 2^n$. For peas, this number is 16,384, or 128×128.

In people, the possible combinations of chromosomes are $2^{23} \times 2^{23}$—over 70 trillion. Crossing over increases genetic recombination even more.

Applying Math

1. Calculate The fruit fly has four chromosome pairs. How many possible combinations of chromosomes can be produced by meiosis and fertilization?

Gene Linkage

Chromosomes contain many genes. Genes that are located close together on the same chromosome are said to be linked. This means they usually travel together during gamete formation. Linked genes do not segregate independently. They are an exception to Mendel's law of independent assortment.

Occasionally, linked genes separate due to crossing over. Crossing over occurs more frequently between genes that are far apart than between genes that are close together.

Reading Check

2. Explain What event causes linked genes to separate?

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What does a chromosome map show?

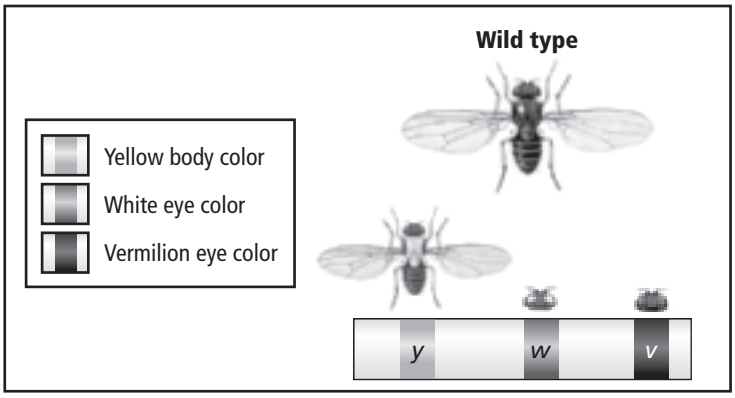
The relationship between crossing over and chromosome distance is very useful. The distance between two genes can be estimated by the frequency of crossing over that occurs between them. Scientists use cross-over data to create a drawing of genes along a chromosome. The drawing, called a chromosome map, shows the order of genes on a chromosome. The first chromosome maps were published in 1913 for fruit-fly crosses. One is shown in the figure below.

Picture This

3. Identify Which two genes are not likely to cross over? (Circle your answer.)

a. yellow body color and vermilion eye color

b. white eye color and vermilion eye color



Polyploidy

Most organisms have diploid cells—cells with two chromosomes in each cell. Some species have polyploid cells. **Polyploidy** (PA lih ploy dee) means the cells have one or more extra sets of all chromosomes. For instance, a triploid organism has three complete sets of chromosomes in each cell. It is designated $3n$.

Polyploidy occurs in only a few animals, such as earthworms and goldfish. It is always lethal in humans. Polyploidy is common in flowering plants. Polyploid plants are often bigger and more vigorous. Many food plants, such as wheat ($6n$), oats ($6n$), and sugarcane ($8n$), are polyploidy.

Reading Check

4. Identify Name two organisms that have polyploidy.

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