Name _____ Class _____ Date _____

CHAPTER 11 Meiosis and Sexual Reproduction

SECTION 2

Meiosis

KEY IDEAS

As you read this section, keep these questions in mind:

- What occurs during the stages of meiosis?
- How does the function of mitosis differ from the function of meiosis?
- What are three mechanisms of genetic variation?

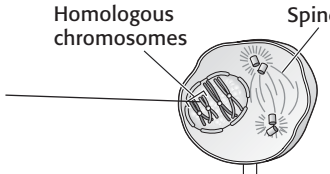
How Do Gametes Form?

Recall that gametes are haploid cells. Haploid gametes form from diploid cells through the process of meiosis. **Meiosis** is a form of cell division that produces daughter cells with half as many chromosomes as the parent cell.

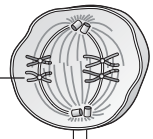
During meiosis, a diploid cell goes through two divisions to form four haploid cells. There are two main parts of meiosis: meiosis I and meiosis II. Each part is, in turn, made up of several stages. The figures below and on the next page show the stages of meiosis. ☑

Meiosis I

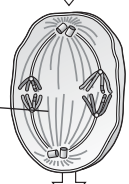
Meiosis I begins with a cell that has copied its chromosomes. The first stage of meiosis I is prophase I. During prophase I, the chromosomes condense. Homologous chromosomes pair up. The membrane around the nucleus breaks down.



The second stage of meiosis I is metaphase I. During metaphase I, the pairs of homologous chromosomes move to the equator of the cell.



The third stage of meiosis I is anaphase I. During anaphase I, the homologous chromosomes separate. The spindle fibers pull one chromosome from each pair to each pole of the cell.



The fourth stage of meiosis I is telophase I. During telophase I, the cytoplasm divides (cytokinesis). Two new cells form. Each cell contains one chromosome from each pair of homologous chromosomes.

READING TOOLBOX

Summarize After you read this section, draw a flowchart showing what happens during each stage of meiosis.

READING CHECK

1. Identify How many times does a diploid cell divide during meiosis?

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Critical Thinking

2. Apply Concepts Does meiosis produce germ cells or somatic cells?

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LOOKING CLOSER

3. Describe What happens during metaphase I?

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Talk About It

Compare In a small group, compare the stages of meiosis I, meiosis II, and mitosis. What happens during each stage? How are the stages similar? How are they different?

Background

Recall that a *chromatid* is one of a pair of duplicated chromosomes that are joined in the middle at a *centromere*.

LOOKING CLOSER

4. Describe What happens during prophase II?

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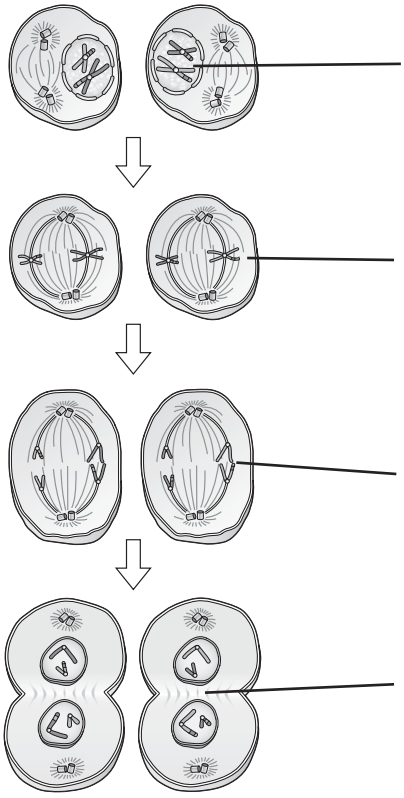
Meiosis II



Meiosis II begins with the two cells formed at the end of meiosis I. The chromosomes are not copied at the end of meiosis I. The first stage of meiosis II is prophase II. During prophase II, a new spindle forms.

The second stage of meiosis II is metaphase II. During metaphase II, the chromosomes move to the equators of the cells.

The third stage of meiosis II is anaphase II. During anaphase II, the centromeres divide and the chromatids in each chromosome separate. The spindle fibers pull one chromatid from each pair to the pole of each cell.

The fourth stage of meiosis II is telophase II. During telophase II, the cytoplasm in each cell divides (cytokinesis). Four new haploid cells form. Each cell contains one chromatid from each pair of homologous chromosomes.

How Are Mitosis and Meiosis Different?

It can be easy to confuse mitosis and meiosis. The table below shows how they are different.

Process	Description	Function
Mitosis	produces two genetically identical diploid cells	makes new cells for growth, development, repair, and asexual reproduction
Meiosis	produces four genetically different haploid cells	makes sex cells (gametes) for sexual reproduction

LOOKING CLOSER

5. Identify What is the function of meiosis?

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Talk About It

Infer With a partner, talk about ways that genetic variation might help a species survive changes in the environment. Remember that an organism's genes affect its traits.

Why Is Sexual Reproduction Helpful?

Asexual reproduction allows organisms to reproduce quickly. In contrast, organisms that reproduce sexually must spend a great deal of time and energy looking for a mate. However, sexual reproduction produces much more genetic variation than asexual reproduction. Genetic variation is important to a species. It can allow members of the species to survive changes in their environment.

CROSSING-OVER

Three processes that contribute to genetic variation during sexual reproduction are crossing-over, independent assortment, and random fertilization. **Crossing-over** occurs during prophase I, when homologous chromosomes form pairs. ☑

During crossing-over, an arm of one chromatid crosses over the same arm on another chromatid. The chromatids break at the point of the crossover. The chromatid pieces are exchanged. When each chromatid re-forms, it contains a piece of the other chromatid.

READING CHECK

6. Identify During which stage of meiosis does crossing-over occur?

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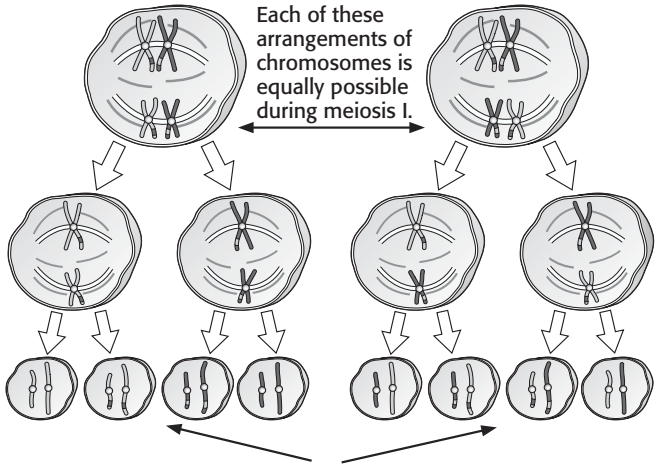
INDEPENDENT ASSORTMENT

During metaphase I, chromosomes line up randomly along the equator. This random distribution of homologous chromosomes during meiosis is called **independent assortment**. This process produces gametes with different genetic information, as shown below.



The alleles that each gamete contains depend on how the chromosomes were arranged at the beginning of meiosis. Different arrangements of chromosomes produce gametes with different alleles.

LOOKING CLOSER

7. Infer If the diploid cell in the figure had four pairs of homologous chromosomes instead of two, would there be more or fewer possible gene combinations in the gametes?

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RANDOM FERTILIZATION

Fertilization is a random process. It can increase genetic variation. For example, because of independent assortment, there are more than 8 million possible chromosome combinations for a human female gamete. There are also more than 8 million possible chromosome combinations for a human male gamete. Therefore, there are more than $(8 \text{ million})^2 = 64$ trillion possible chromosome combinations in each human zygote.

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Section 2 Review

SECTION VOCABULARY

crossing-over the exchange of genetic material between homologous chromosomes during meiosis; can result in genetic recombination **independent assortment** the random distribution of the pairs of genes on different chromosomes to the gametes	**meiosis** a process in cell division during which the number of chromosomes decreases to half the original number by two divisions of the nucleus, which results in the production of sex cells (gametes or spores)

1. Compare Describe the difference between what happens during anaphase I and what happens during anaphase II.

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2. Identify Fill in the blank spaces in the table below.

Stage of meiosis	Description
	Chromosomes condense, homologous chromosomes pair up, and crossing-over occurs.
	Cytokinesis occurs, and two new cells form.
	Pairs of sister chromatids move to the equators of the two cells.
	Cytokinesis occurs, and four new cells form.

3. Describe Give two differences between meiosis and mitosis.

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4. Identify What are three processes that contribute to genetic variation during sexual reproduction?

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5. Explain Why is sexual reproduction helpful to a species?

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