

11.4 Meiosis

Lesson Objectives

- 🔑 Contrast the number of chromosomes in body cells and in gametes.
- 🔑 Summarize the events of meiosis.
- 🔑 Contrast meiosis and mitosis.
- 🔑 Describe how alleles from different genes can be inherited together.

Lesson Summary

Chromosome Number **Homologous** chromosomes are pairs of chromosomes that correspond in body cells. One chromosome from each pair comes from each parent.

- ▶ A cell that contains both sets of homologous chromosomes has a **diploid** number of chromosomes (meaning “two sets”).
- ▶ **Haploid** cells contain only one set of chromosomes. Gametes are haploid.

Phases of Meiosis **Meiosis** is the process that separates homologous pairs of chromosomes in a diploid cell, forming a haploid gamete. The phases are as follows:

- ▶ Meiosis I, which is preceded by a replication of chromosomes. Its stages are
 - Prophase I: Each replicated chromosome pairs with its corresponding homologous chromosome forming a **tetrad**. During tetrad formation, alleles can be exchanged between chromatids, a process called **crossing-over**.
 - Metaphase I: Paired homologous chromosomes line up across the center of the cell.
 - Anaphase I: Spindle fibers pull each homologous pair toward opposite ends of the cell.
 - Telophase I: A nuclear membrane forms around each cluster of chromosomes. Cytokinesis then occurs, resulting in two new cells. The resulting daughter cells contain chromosome sets that are different from each other and the parent cell.
- ▶ Meiosis II: Chromosomes do not replicate.
 - Prophase II: Chromosomes, each consisting of two chromatids, become visible.
 - Metaphase II, Anaphase II, Telophase II, and Cytokinesis: These phases are similar to meiosis I. Four haploid cells form. They are the gametes. During fertilization, two gametes unite forming a **zygote**.

Comparing Meiosis and Mitosis

- ▶ Mitosis is one cell division that results in two genetically identical diploid cells.
- ▶ Meiosis is two cell divisions that result in four genetically different haploid cells.

Gene Linkage and Gene Maps

- ▶ Alleles tend to be inherited together if they are located on the same chromosome.
- ▶ Chromosomes, not genes, segregate independently.
- ▶ The farther apart genes are on a chromosome, the more likely is cross over.
- ▶ Information on linkage and the frequency of crossing-over lets geneticists construct maps of the locations of genes on chromosomes.

Chromosome Number

For Questions 1–8, write True if the statement is true. If the statement is false, change the underlined word to make the statement true.

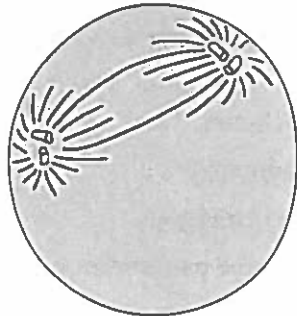
- _____ 1. The offspring of two parents obtains a single copy of every gene from each parent.
- _____ 2. A gamete must contain one complete set of genes.
- _____ 3. Genes are located at specific positions on spindles.
- _____ 4. A pair of corresponding chromosomes is homozygous.
- _____ 5. One member of each homologous chromosome pair comes from each gene.
- _____ 6. A cell that contains both sets of homologous chromosomes is haploid.
- _____ 7. The gametes of sexually reproducing organisms are haploid.
- _____ 8. If an organism's haploid number is 6, its diploid number is 3.

Phases of Meiosis

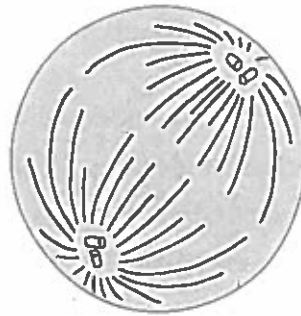
On the lines provided, identify the stage of meiosis I or meiosis II in which the event described occurs.

- _____ 9. Each replicated chromosome pairs with its corresponding homologous chromosome.
- _____ 10. Crossing-over occurs between tetrads.
- _____ 11. Paired homologous chromosomes line up across the center of the cell.
- _____ 12. Spindle fibers pull each homologous chromosome pair toward an opposite end of the cell.
- _____ 13. A nuclear membrane forms around each cluster of chromosomes and cytokinesis follows, forming two new cells.
- _____ 14. Chromosomes consist of two chromatids, but they do not pair to form tetrads.
- _____ 15. A nuclear membrane forms around each cluster of chromosomes and cytokinesis follows, forming four new cells.

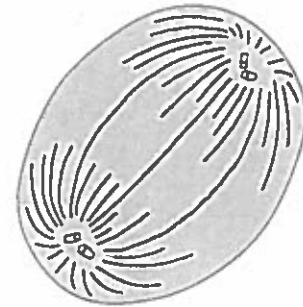
16. **THINK VISUALLY** Draw two homologous pairs of chromosomes (in different colors if you have them) in these diagrams to illustrate what happens during these three phases of meiosis.



Prophase I

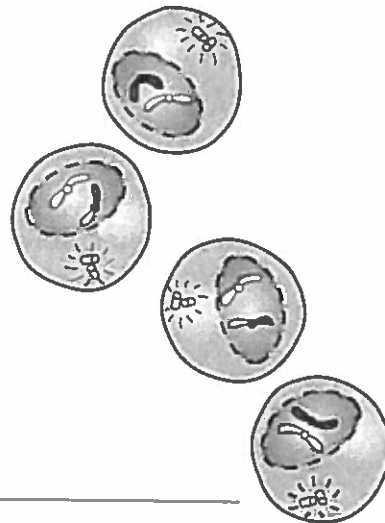
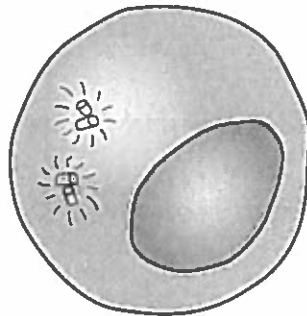


Metaphase I



Anaphase II

17. Identify which phase of meiosis is shown in the diagrams below.

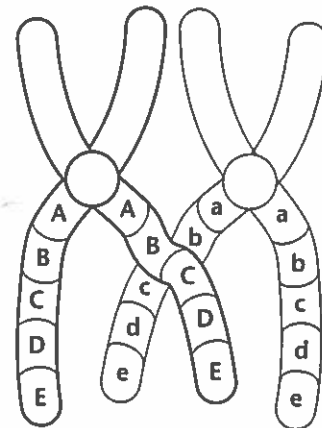


Use this diagram to answer Questions 18–20.

18. What does the diagram show?

19. During what phase of meiosis does this process occur?

20. What is the result of this process?



Comparing Meiosis and Mitosis

21. Complete the table to compare meiosis and mitosis.

	Mitosis	Meiosis
Form of reproduction		
Number of daughter cells		
Change in chromosome number		
Number of cell divisions		
Difference in alleles between parent cell and daughter cells		

For Questions 22–27, complete each statement by writing the correct word or words.

22. A diploid cell that enters mitosis with 16 chromosomes will divide to produce _____ daughter cells. Each of these daughter cells will have _____ chromosomes.
23. If the diploid number of chromosomes for an organism is 16, each daughter cell after mitosis will contain _____ chromosomes.
24. A diploid cell that enters meiosis with 16 chromosomes will pass through _____ cell divisions, producing _____ daughter cells, each with _____ chromosomes.
25. Gametes have a _____ number of chromosomes.
26. If an organism's haploid number is 5, its diploid number is _____.
27. While a haploid number of chromosomes may be even or odd, a diploid number is always _____.

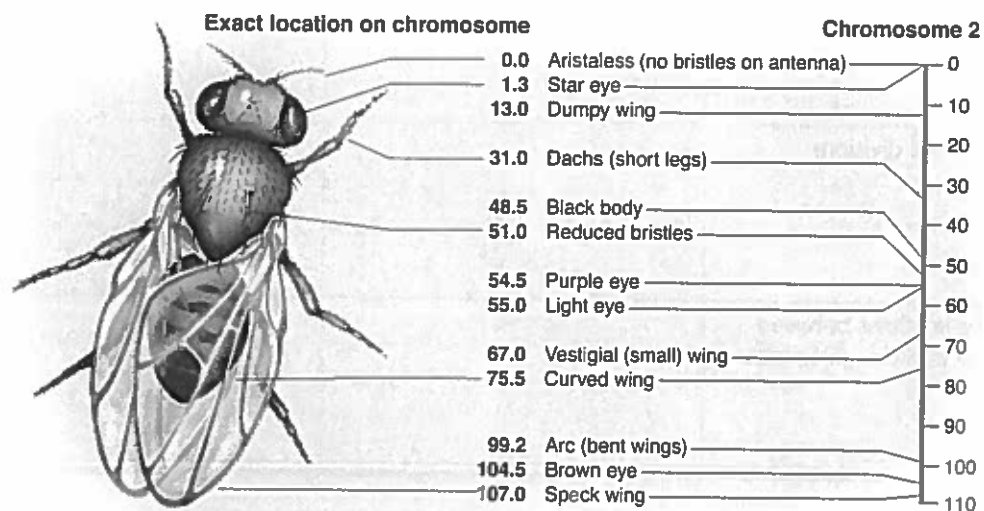
Gene Linkage and Gene Maps

28. What did Thomas Hunt Morgan discover that seemed to violate Mendel's principles?

29. How did Morgan explain his finding?

30. How did Alfred Sturtevant use gene linkage to create gene maps?

Use this diagram to answer Questions 31–34.



31. What does the diagram show?

32. How was the information in this diagram gathered?

33. Which pairs of characteristics are more likely to cross over: curved wing and dumpy wing; or curved wing and vestigial (small) wing? Why?

34. Which pair of genes shown is least likely to cross over? How do you know?

39. Some housecats have orange fur with darker orange stripes. The traits of these *tabby* cats are usually seen in male cats. *Tortoiseshell* cats have patches of many different colors. “Torties,” as they are called, are almost always female. What does this tell you about the way cellular information about color and sex are passed on in cats?

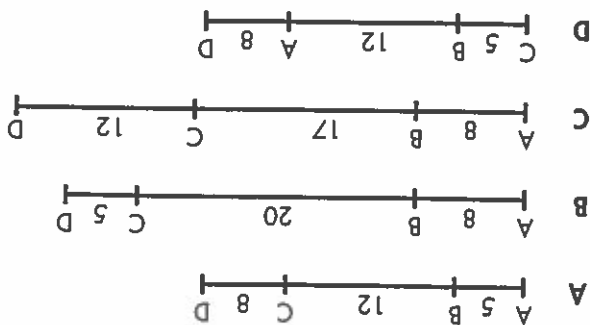
Apply the Big Idea

35. In which gene map is the probability of crossing-over between A and D greatest?

36. In which gene map is the probability of crossing-over between A and D the least?

37. In which map are genes C and D most closely linked?

38. In map D, which genes are least likely to cross over?



Use this diagram to answer Questions 35–38.