Name _____ Class _____ Date _____

10.1 Cell Growth, Division, and Reproduction

Lesson Objectives

- Explain the problems that growth causes for cells.
- Compare asexual and sexual reproduction.

Lesson Summary

Limits to Cell Size There are two main reasons why cells divide:

- Information "overload": The larger a cell gets, the more demands it places on its DNA. Eventually, the cell's DNA cannot meet the cell's needs.
- Exchange of materials: Cells take in nutrients and eliminate wastes through the cell membrane.
  - The larger a cell's volume, the more materials it needs to function and the more waste it creates.
  - A cell's volume increases at a faster rate than its surface area. As a cell grows, its surface-area-to-volume ratio becomes too small.
  - The larger a cell gets, the harder it is for enough materials to move across its cell membrane.
- **Cell division** solves the information overload and materials exchange problems.

Cell Division and Reproduction Cell division is part of both types of reproduction:

- **Asexual reproduction**:
  - produces genetically identical organisms.
  - occurs in many single-celled organisms and in some multicellular organisms.
  - allows rapid reproduction of organisms in favorable environments.
- **Sexual Reproduction**:
  - produces organisms with genetic information from both parents.
  - occurs in most animals and plants and in many single-celled organisms.
  - increases genetic diversity, which aids species survival in changing environments.

Limits to Cell Size

For Questions 1–4, write True if the statement is true. If the statement is false, change the underlined word or words to make the statement true.

1. As a cell's size increases, its amount of DNA <u>also increases</u>. — *stays the same*
2. The amount of activity in a cell is related to its <u>volume</u>. — *True*
3. The smaller the cell, the <u>smaller</u> its ratio of surface area to volume. — *larger*
4. The <u>information crisis</u> in a cell is solved by the replication of the DNA before cell division. — *True*

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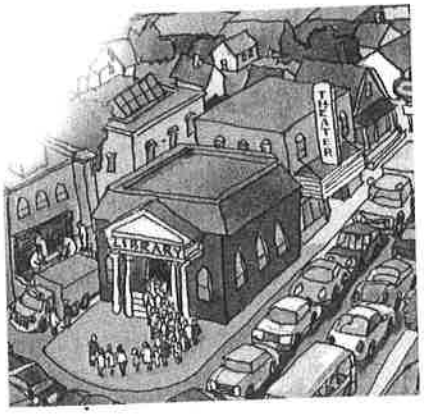
5. **VISUAL ANALOGY** In the visual analogy of the growing town, what does the library represent? Identify two characteristics that make it a good choice for this analogy.

SAMPLE ANSWER: *The library represents the cell's DNA. It is a good choice because a library contains information and typically there is only one per small town.*



Cell Division and Reproduction

For Questions 6–8, complete each statement by writing the correct word or words.

6. ***Reproduction*** is the formation of new individuals.

7. For single-celled organisms, cell division is a form of ***asexual*** reproduction.

8. Most multicellular organisms reproduce by ***sexual*** reproduction.

9. Use the table to compare and contrast asexual and sexual reproduction.

Asexual and Sexual Reproduction	
Similarities	**Differences**
Both produce new organisms. Both involve the transfer of genetic material from parent to offspring.	***The offspring of asexual reproduction are genetically identical to their parents. The offspring of sexual reproduction have some genetic information from each parent. In asexual reproduction, cells separate to form a new individual. In sexual reproduction, two cells fuse.***

Apply the Big idea

10. Vascular tissue helps plants transport water against the force of gravity. Because of this, plants that lack vascular tissue do not grow very tall. How is this situation similar to the information you have learned in this lesson? Explain.

SAMPLE ANSWER: *Plants that lack vascular tissue cannot grow very tall because they cannot transport water very far. A cell cannot grow very large because if it did, it would be unable to transport needed materials into the cell and transport wastes out.*

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10.2 The Process of Cell Division

Lesson Objectives

- Describe the role of chromosomes in cell division.
- Name the main events of the cell cycle.
- Describe what happens during the four phases of mitosis.
- Describe the process of cytokinesis.

Lesson Summary

Chromosomes Packages of DNA called **chromosomes** hold a cell's genetic information.

- Prokaryotic chromosomes consist of a single, circular strand of DNA.
- Eukaryotic chromosomes are highly organized structures.
  - The DNA winds around histone proteins, forming **chromatin**.
  - Chromosomes make the precise separation of DNA possible during cell division.

The Cell Cycle The **cell cycle** is the series of events in the growth and division of a cell.

- In the prokaryotic cell cycle, the cell grows, duplicates its DNA, and divides by pinching in the cell membrane.
- The eukaryotic cell cycle has four stages (the first three of which are referred to as **interphase**):
  - In the G_1 phase, the cell grows.
  - In the S phase, the cell replicates its DNA.
  - In the G_2 phase, the cell produces organelles and materials for division.
  - In the M phase, the cell divides in two stages—**mitosis**, the division of the nucleus, and **cytokinesis**, the division of the cytoplasm.

Mitosis The division of the nucleus, mitosis, occurs in four stages:

- **Prophase**: a cell's genetic material condenses, a spindle starts to form, and the nuclear envelope breaks down.
- **Metaphase**: the duplicated chromosomes line up and spindle fibers connect to the **centromeres**.
- **Anaphase**: sister **chromatids** separate and move toward the **centrioles**.
- **Telophase**: the chromosomes begin to unwind and a nuclear envelope reforms.

Cytokinesis Division of the cytoplasm differs in plant cells and animal cells.

- In animal cells, the cell membrane draws in and pinches off.
- In plant cells, a cell plate forms, followed by a new cell membrane, and finally a new cell wall forms.

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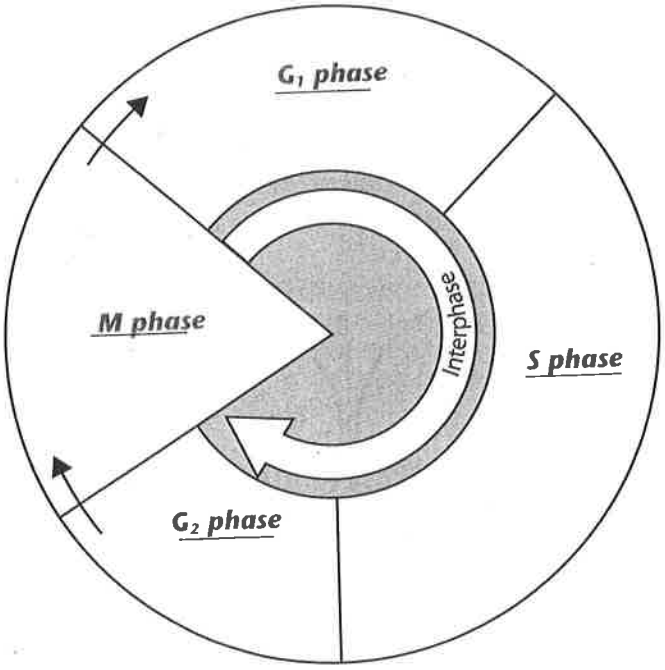
Chromosomes

For Questions 1–5, complete each statement by writing the correct word or words.

1. Cells carry genetic information in packages of DNA called ***chromosomes***.
2. Most ***prokaryotes*** have only one circular strand of DNA.
3. In eukaryotic cells, the genetic structure consists of DNA and a tightly wound protein, which together form a substance called ***chromatin***.
4. The beadlike structures formed by DNA wrapped around ***histone*** molecules are called nucleosomes.
5. ***Chromosomes*** make possible the precise separation of DNA during cell division.

The Cell Cycle

6. What is the name of the type of cell division that occurs in the prokaryotic cell cycle?
Cell division in prokaryotes is called binary fission.
7. What happens during interphase?
The cell grows, copies its DNA, and prepares for cell division.
8. Complete the cell cycle diagram by writing the correct name of a phase on each line.



9. In eukaryotic cells, what happens in the G_1 phase that differs from the G_2 phase?
In the G_1 phase, the cell grows. In the G_2 phase, the cell gets ready for mitosis.
10. In eukaryotic cells, what are the two main stages of cell division?
Mitosis and cytokinesis are the two main stages of cell division.

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Mitosis

11. During prophase, when cell chromosomes become visible, what are the duplicated strands of DNA called? What is the name for the area in which these duplicated strands are joined?

Duplicated strands of chromosomal DNA are called chromatids, or sister chromatids, and they are joined by a centromere.

12. What structures are spindle fibers attached to that help pull the paired chromosomes apart?

The spindle fibers are attached to centrioles that move toward the poles of the cell, pulling the chromatids apart.

For Questions 13–16, match the description of the event with the phase of mitosis in which it occurs. Each phase may be used more than once.

Event

___D___ 13. The chromosomes separate and begin to move to opposite sides of the cell.

___B___ 14. The chromosomes become visible. The centrioles take up positions on opposite sides of the nucleus.

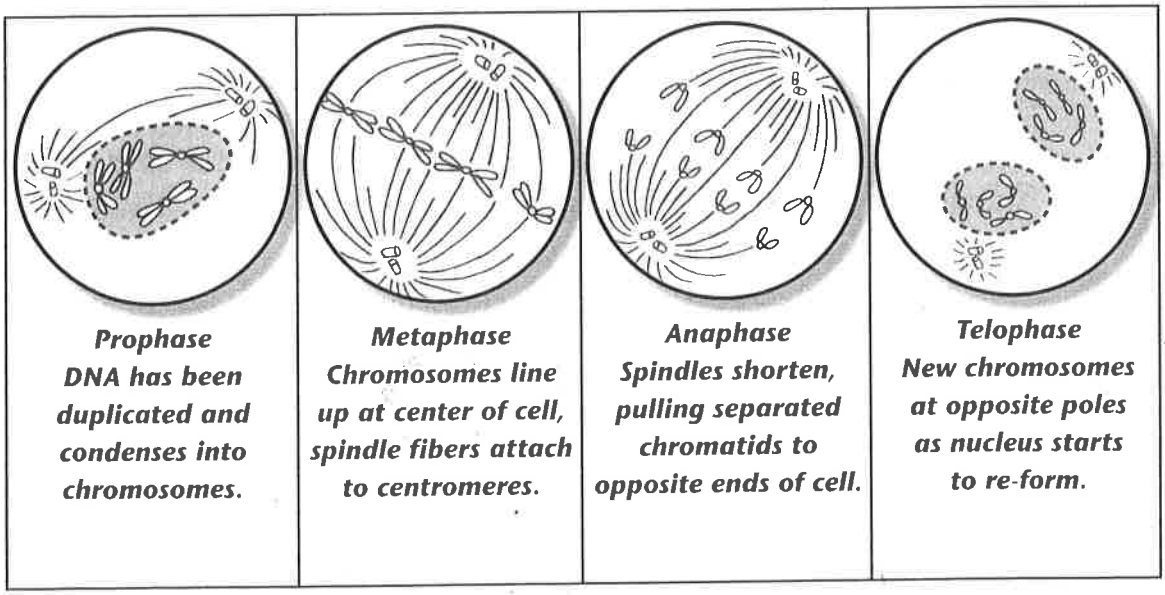
___A___ 15. A nuclear envelope re-forms around each cluster of chromosomes. The nucleolus becomes visible in each daughter nucleus.

___C___ 16. The chromosomes line up across the center of the cell.

Phase of Mitosis

A. Telophase
B. Prophase
C. Metaphase
D. Anaphase

17. THINK VISUALLY The four circles below represent the nucleus of a cell going through mitosis. Draw four chromosomes as they go through each phase. Label each phase and describe what is happening to the DNA.



Prophase
DNA has been duplicated and condenses into chromosomes.

Metaphase
Chromosomes line up at center of cell, spindle fibers attach to centromeres.

Anaphase
Spindles shorten, pulling separated chromatids to opposite ends of cell.

Telophase
New chromosomes at opposite poles as nucleus starts to re-form.

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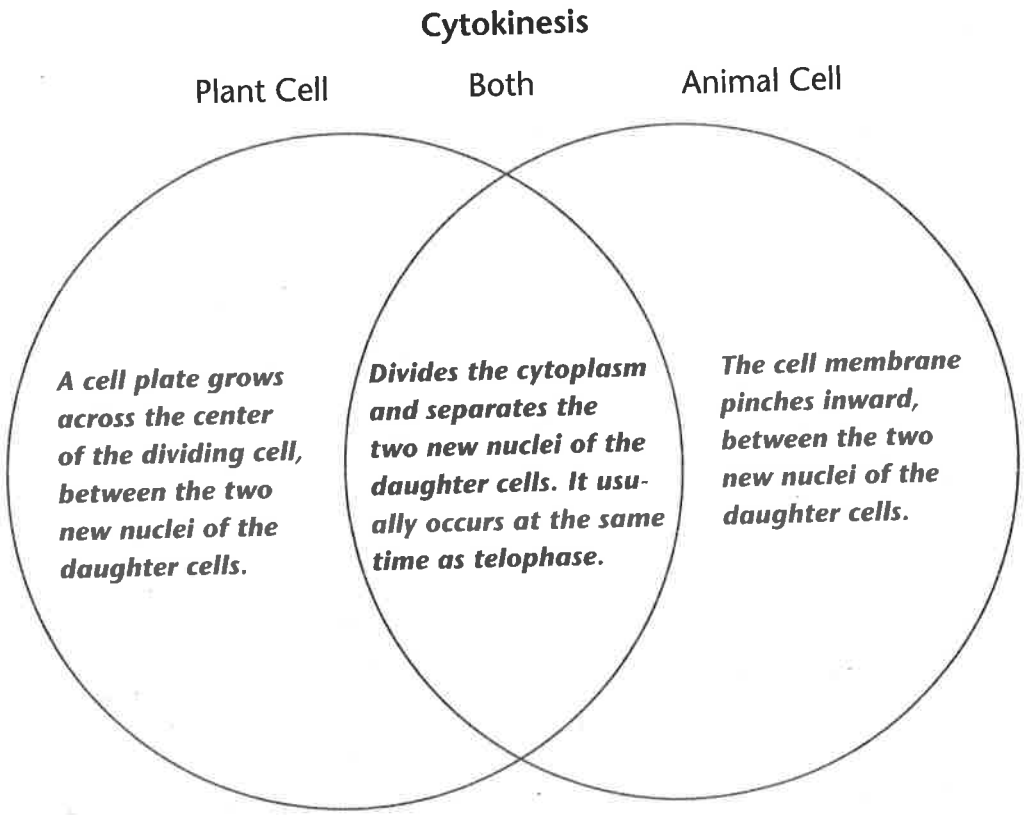
Cytokinesis

18. What is cytokinesis?

Cytokinesis is the final step of cell division. It completes the M phase of the cell cycle by dividing the cytoplasm of the original cell between the two new cells.

19. Use the Venn diagram to compare and contrast cytokinesis in animal cells with cytokinesis in plant cells.



Apply the Big idea

20. During certain stages of their life cycle, some cells repeatedly undergo mitosis but do not undergo cytokinesis. What would you expect to see if you looked at such cells, or a tissue made up of such cells, under a microscope? Explain your answer.

Under microscopic examination, a tissue whose cells complete all parts of the cell cycle except cytokinesis would appear to be made up of a mass of cytoplasm with many nuclei scattered in it.

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7. Complete the cause-and-effect chart by giving an example of an effect caused by each type of regulatory protein.

Factors Affecting the Cell Cycle	
Cause	**Effect**
Cyclins	SAMPLE ANSWER: *Tell a cell when to begin steps of the cell cycle (e.g., growth, DNA synthesis, mitosis, cytokinesis).*
Internal regulatory proteins	SAMPLE ANSWER: *Stop a cell from going to the next stage of the cell cycle if internal events have not occurred (e.g., prevent a cell from entering mitosis until chromosomes are replicated).*
External regulatory proteins	SAMPLE ANSWER: *Speed up the cell cycle (e.g., for embryonic growth and wound healing) or slow down the cell cycle (e.g., so that one body tissue's growth does not disrupt another's).*

Cancer: Uncontrolled Cell Growth

8. What is cancer?

Cancer is a disorder in which some of the body's own cells lose the ability to control growth.

9. What are the two basic types of tumors? Explain how they are different.

Tumors may be malignant or benign. A malignant tumor is cancerous and will invade and destroy healthy tissue around it or in other parts of the body. A benign tumor is noncancerous and does not spread into surrounding tissues or to other parts of the body.

10. Why can cancer be life threatening?

Rapidly dividing cancer cells take nutrients away from healthy tissues. This leads to a disruption of the proper functioning of body organs that causes illness and may lead to death.

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11. What is the cause of cancer?

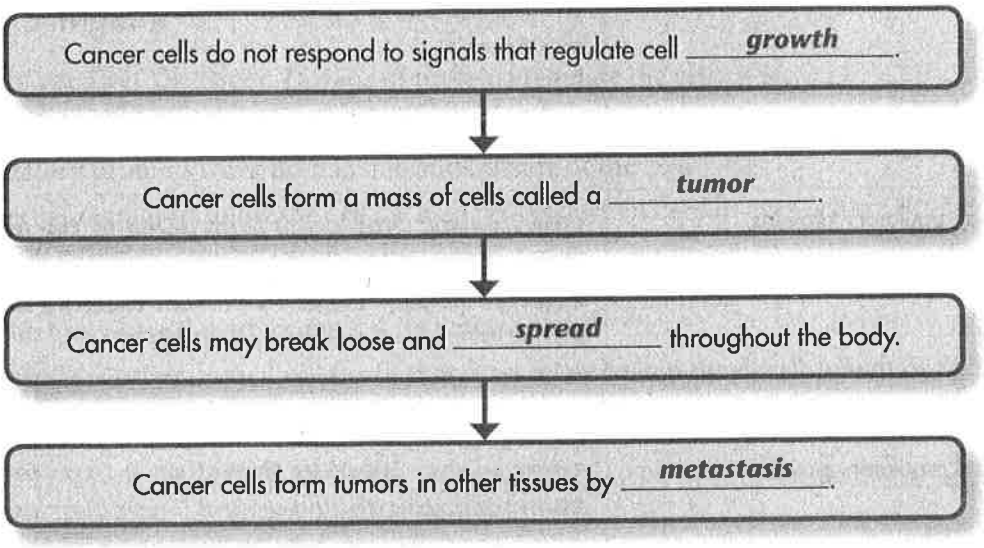
Defects in genes that regulate cell growth and division cause cancer.

12. How do radiation and chemotherapy affect cancer cells?

Radiation disrupts the cancer cell cycle by interfering with the copying of DNA.

Chemotherapy kills cancer cells.

13. Fill out the flowchart by completing each statement with the correct word or words.



Apply the Big idea

14. Hair grows from hair follicles, pockets of continually dividing cells in the outer layer of the skin. New cells are added to the base of a hair shaft, inside each follicle. Use what you have learned in this lesson to explain why cancer patients often lose their hair when receiving chemotherapy and grow more hair after chemotherapy stops.

SAMPLE ANSWER: ***The chemicals stop cell division in both cancer cells and healthy cells, such as the ones that produce hair. When no new cells are being added to the hair shafts, the shafts break and the hairs fall out. When chemotherapy stops, cell division in the hair follicles resumes and hair starts to grow again.***

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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.

True 1. The offspring of two parents obtains a single copy of every gene from each parent.

True 2. A gamete must contain one complete set of genes.

chromosomes 3. Genes are located at specific positions on spindles.

homologous 4. A pair of corresponding chromosomes is homozygous.

parent 5. One member of each homologous chromosome pair comes from each gene.

diploid 6. A cell that contains both sets of homologous chromosomes is haploid.

True 7. The gametes of sexually reproducing organisms are haploid.

12 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.

Prophase I 9. Each replicated chromosome pairs with its corresponding homologous chromosome.

Prophase I 10. Crossing-over occurs between tetrads.

Metaphase I 11. Paired homologous chromosomes line up across the center of the cell.

Anaphase I 12. Spindle fibers pull each homologous chromosome pair toward an opposite end of the cell.

Telophase I 13. A nuclear membrane forms around each cluster of chromosomes and cytokinesis follows, forming two new cells.

Prophase II 14. Chromosomes consist of two chromatids, but they do not pair to form tetrads.

Telophase II 15. A nuclear membrane forms around each cluster of chromosomes and cytokinesis follows, forming four new cells.

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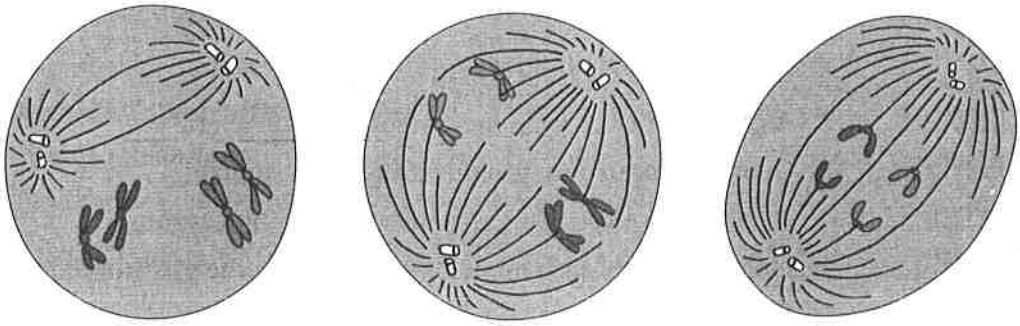
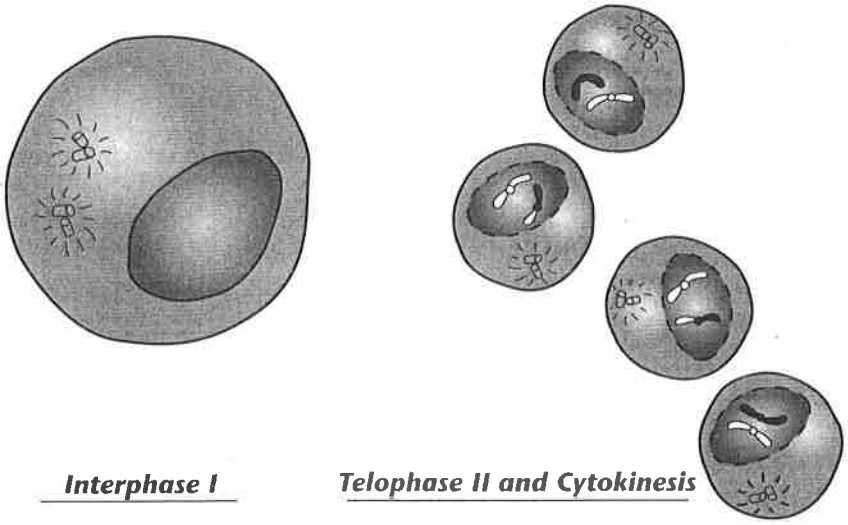
16. **THINK VISUALLY** Draw two homologous pairs of chromosomes (in different colors if you have them) in these diagrams to illustrate what happens during these three phases of meiosis.



Prophase I | Metaphase I | Anaphase II

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



Interphase I | *Telophase II and Cytokinesis*

Use this diagram to answer Questions 18–20.

18. What does the diagram show?

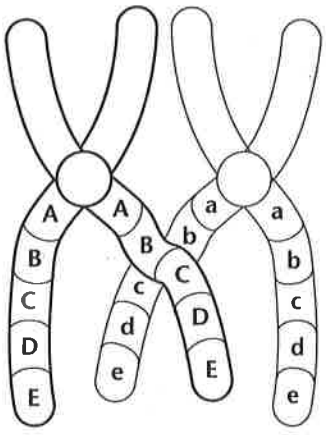
It shows crossing-over of genes between a pair of homologous chromosomes.

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

It occurs during prophase I of meiosis.

20. What is the result of this process?

The result is a new combination of alleles.



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Comparing Meiosis and Mitosis

21. Complete the table to compare meiosis and mitosis.

	Mitosis	Meiosis
Form of reproduction	*Asexual*	*First stage in sexual*
Number of daughter cells	*2*	*4*
Change in chromosome number	*No change; stays diploid*	*Cut in half to haploid*
Number of cell divisions	*1*	*2*
Difference in alleles between parent cell and daughter cells	*None*	*Each of the four daughter cells is genetically different from the parent.*

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 _____*2*_____ daughter cells. Each of these daughter cells will have _____*16*_____ chromosomes.

23. If the diploid number of chromosomes for an organism is 16, each daughter cell after mitosis will contain _____*16*_____ chromosomes.

24. A diploid cell that enters meiosis with 16 chromosomes will pass through _____*2*_____ cell divisions, producing _____*4*_____ daughter cells, each with _____*8*_____ chromosomes.

25. Gametes have a _____*haploid*_____ number of chromosomes.

26. If an organism's haploid number is 5, its diploid number is _____*10*_____.

27. While a haploid number of chromosomes may be even or odd, a diploid number is always _____*even*_____.

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