Name Period Date

SECTION 5.1

THE CELL CYCLE

Study Guide

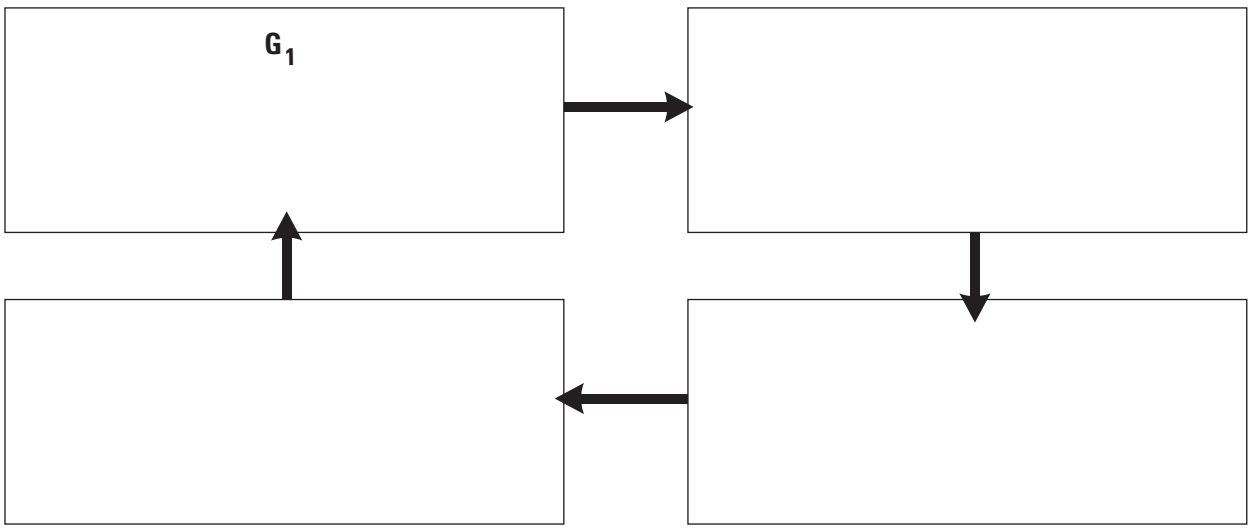
KEY CONCEPT

Cells have distinct phases of growth, reproduction, and normal functions.

VOCABULARY	
cell cycle	cytokinesis
mitosis	

MAIN IDEA: The cell cycle has four main stages.

Summarize what happens during each stage of the cell cycle in the boxes below.



1. How did the G_1 and G_2 stages get their names?

2. Cells must pass through a critical checkpoint during which two stages of the cell cycle?

3. Where does DNA synthesis happen in eukaryotic cells?

4. What two processes make up the M stage?

STUDY GUIDE, CONTINUED

MAIN IDEA: Cells divide at different rates.

5. Among different types of cells, which stage of the cell cycle varies most in length?

6. Why does a skin cell divide more often than a liver cell?

7. What is G_0?

MAIN IDEA: Cell size is limited.

8. Write an analogy to explain why cell size is limited.

9. Which typically increases faster as a cell grows, surface area or volume?

10. For cells to stay the same size from generation to generation, what two things must be coordinated?

Vocabulary Check

11. Think of an example of a cycle. What does this cycle have in common with the cell cycle?

12. What process divides a cell's cytoplasm? How do the two word parts of your answer help you remember it?

13. What process divides the cell nucleus and its contents?

Name Period Date

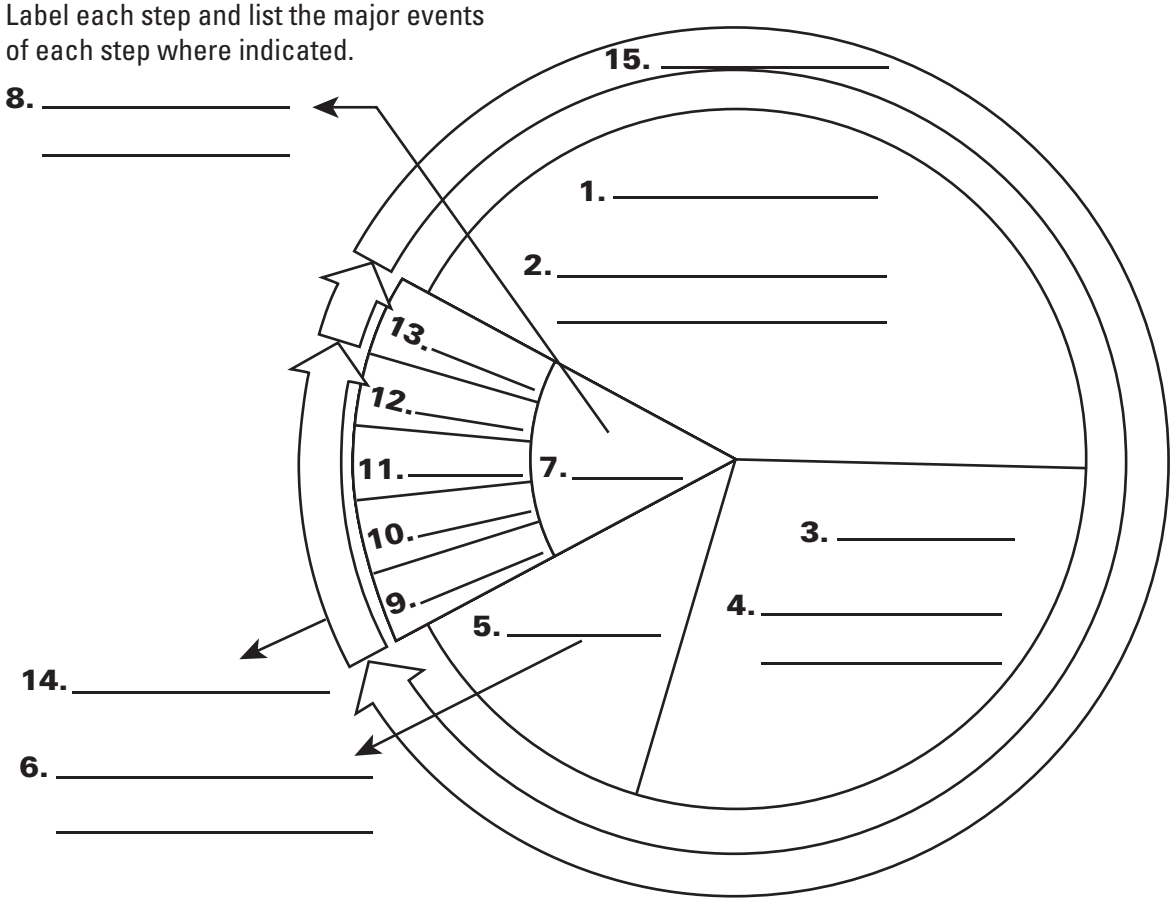
SECTION **5.1**

THE CELL CYCLE

Power Notes

Cell Cycle

Label each step and list the major events of each step where indicated.

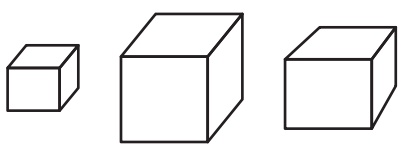


Cells divide at different rates.

Cell size is limited.

-
-
-

Circle the cube with the greatest surface area-to-volume ratio.



Name Period Date

SECTION 5.1

THE CELL CYCLE

Reinforcement

KEY CONCEPT Cells have distinct phases of growth, reproduction, and normal functions.

Cells have a regular pattern of growth, DNA duplication, and division that is called the **cell cycle.** In eukaryotic cells, the cell cycle consists of four stages: gap 1 (G_1), synthesis (S), gap 2 (G_2), and mitosis (M). G_1, S, and G_2 are collectively called interphase.

- During gap 1 (G_1), a cell carries out its normal functions. Cells may also increase in size and duplicate their organelles during this stage. Cells must pass a checkpoint before they can progress to the S stage.
- During synthesis (S), cells duplicate their DNA. At the end of the S stage, a cell contains two complete sets of DNA.
- During gap 2 (G_2), a cell continues to grow and carry out its normal functions. Cells must pass a checkpoint before they can progress to the M stage.
- The mitosis (M) stage consists of two processes. **Mitosis** divides the cell nucleus, creating two nuclei that each have a full set of DNA. **Cytokinesis** divides the cytoplasm and organelles, resulting in two separate cells.

Cells divide at different rates to accommodate the needs of an organism. For example, cells that receive a lot of wear and tear, such as the skin, have a life span of only a few days. Cells making up many of the internal organs have a life span of many years.

Cells tend to stay within a certain size range. To maintain a suitable size range, cell growth must be coordinated with cell division. Cell volume increases much faster than cell surface area for most cells. All materials that a cell takes in or secretes enter and exit through the membrane. The cell's surface area must be large enough relative to its overall volume in order for the cell to get its necessary materials. Therefore, most cells tend to be very small.

1. What are the four stages of the cell cycle?

_____

2. What two processes make up the M phase of the cell cycle?

_____

3. Why don't cells all divide at the same rate?

_____

_____

_____

Name Period Date

SECTION 5.2

MITOSIS AND CYTOKINESIS

Study Guide

KEY CONCEPT

Cells divide during mitosis and cytokinesis.

VOCABULARY		
chromosome	centromere	metaphase
histone	telomere	anaphase
chromatin	prophase	telophase
chromatid		

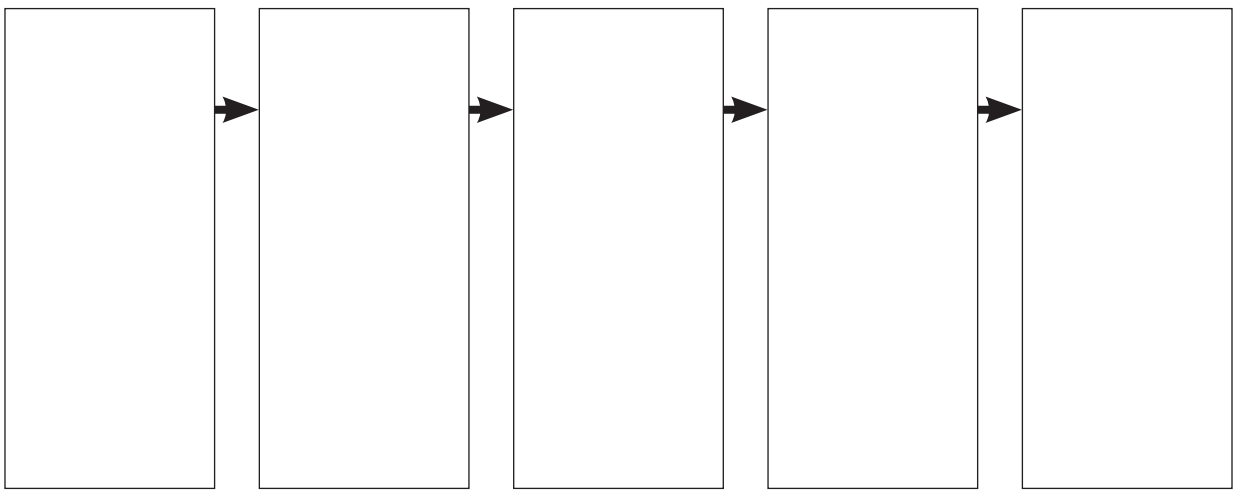
MAIN IDEA: Chromosomes condense at the start of mitosis.

1. What is a chromosome?

2. Why do chromosomes condense at the start of mitosis?

3. Why are chromosomes not condensed during all stages of the cell cycle?

Refer to Figure 5.5 to sketch how DNA goes from a long stringy form to a tightly condensed form. Label the parts of the condensed, duplicated chromosome.



MAIN IDEA: Mitosis and cytokinesis produce two genetically identical daughter cells.

4. How does interphase prepare a cell to divide?

STUDY GUIDE, CONTINUED

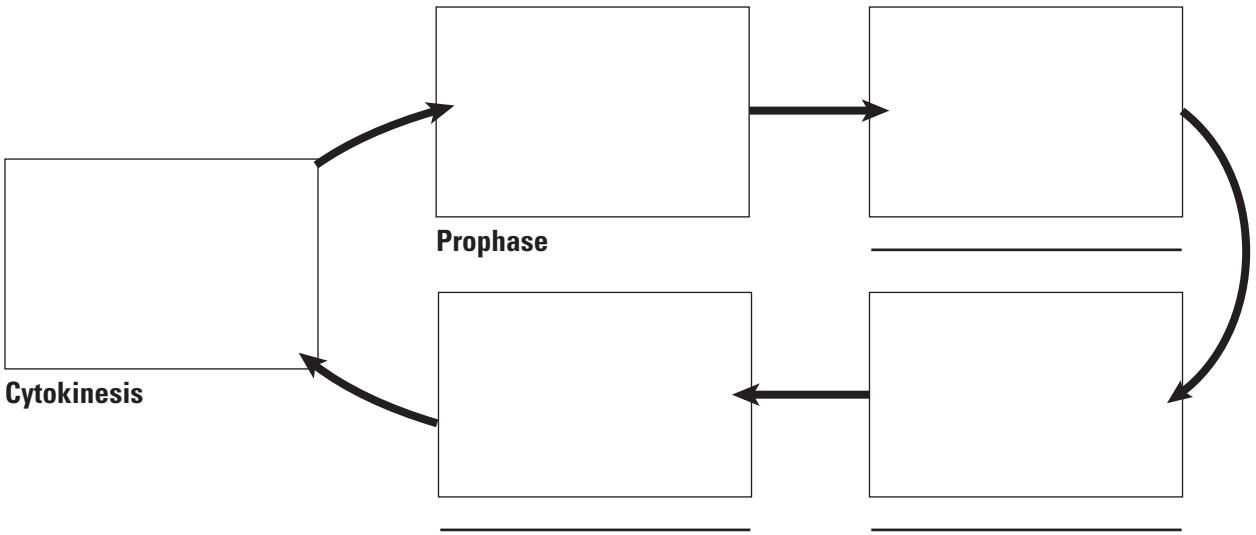
5. Mitosis occurs in what types of cells?

_____

6. Develop a device, such as a short sentence or phrase, to help you remember the order of the steps of mitosis: prophase, metaphase, anaphase, telophase.

_____

Complete the diagram illustrating the four phases of mitosis and one phase of cytokinesis.



7. How does cytokinesis differ between plant and animal cells?

_____

_____

Vocabulary Check

8. DNA wraps around organizing proteins called _____ .

9. The suffix *-tin* indicates that something is stretched and thin. _____ is the loose combination of DNA and proteins that looks sort of like spaghetti.

10. Sister chromatids are held together at the _____ , which looks pinched.

11. The ends of DNA molecules form structures called _____ that help prevent the loss of genes.

Name Period Date

SECTION 5.2

MITOSIS AND CYTOKINESIS

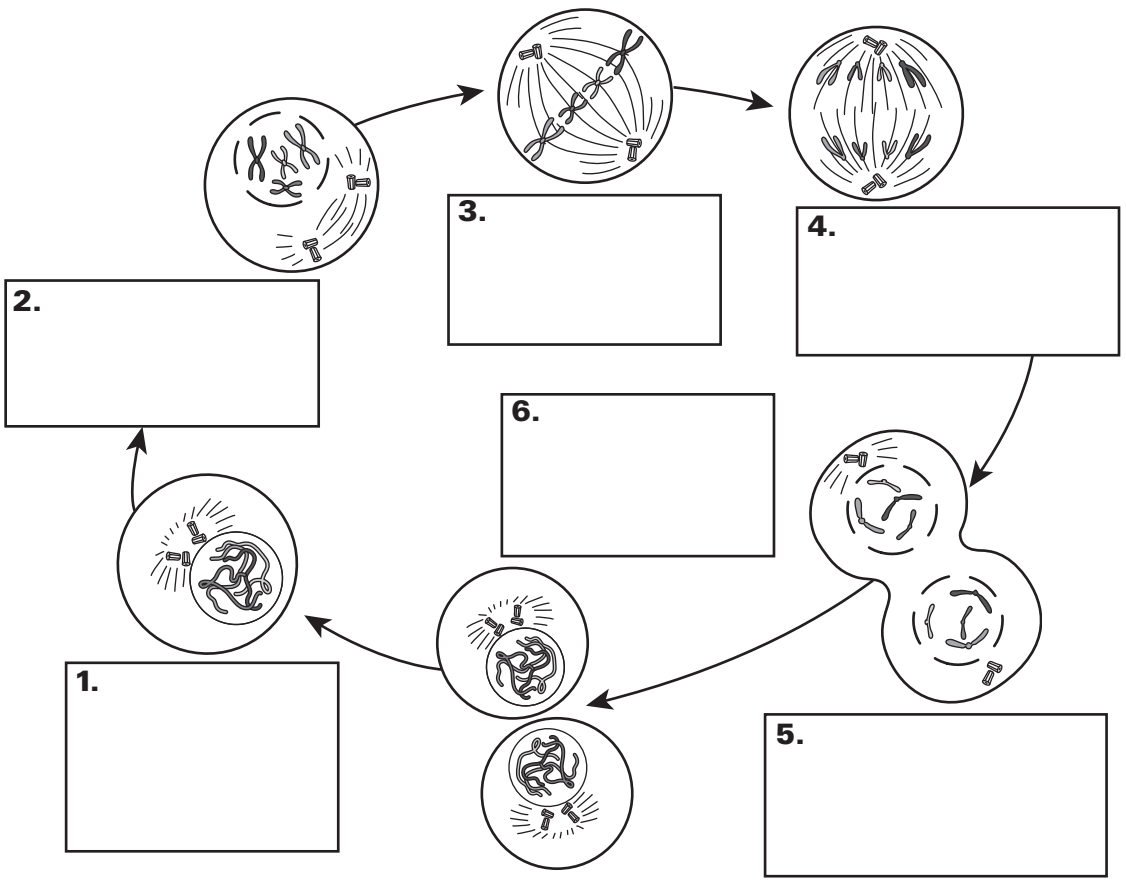
Power Notes

Chromosome structure:

-
-
-
-

Cell Cycle in Detail

Identify the steps below and list the major events of each step.



Name Period Date

SECTION 5.2

MITOSIS AND CYTOKINESIS

Reinforcement

KEY CONCEPT Cells divide during mitosis and cytokinesis.

During interphase, a cell needs access to its DNA to make use of specific genes and to copy the DNA. During mitosis, however, the DNA must be condensed and organized so that it can be accurately divided between the two nuclei. DNA is a long polymer made of repeating subunits called nucleotides. Each long continuous thread of DNA is called a **chromosome,** and each chromosome has many genes.

During interphase, DNA wraps around organizing proteins called **histones** and is loosely organized as **chromatin,** which looks sort of like spaghetti. As a cell prepares for mitosis, however, the DNA and histones start to coil more and more tightly until they form condensed chromosomes. Each half of the duplicated chromosome is called a **chromatid.** Both chromatids together are called sister chromatids, which are attached at a region called the **centromere.** The ends of DNA molecules form **telomeres,** structural units that do not code for proteins. Telomeres help prevent chromosomes from sticking to each other.

Mitosis is a continuous process, but scientists have divided it into phases for easier discussion.

- During **prophase** the chromatin condenses into chromosomes, the nuclear envelope breaks down, and spindle fibers start to assemble.
- During **metaphase** spindle fibers align the chromosomes along the middle of the cell.
- During **anaphase** spindle fibers pull the sister chromatids away from each other and toward opposite sides of the cell.
- During **telophase,** the nuclear membranes start to form around each set of chromosomes, the chromosomes start to uncoil, and the spindle fibers fall apart.
- Cytokinesis divides the cytoplasm into two separate cells. In animal cells, the cell membrane pinches together. In plant cells, a cell plate forms between the two nuclei. It will eventually form new cell membranes for the cells and a new cell wall.

1. What role do histones play in a cell?

_____

2. What is a chromatid?

_____

3. During which phase of mitosis are sister chromatids separated from each other?

_____

Name Period Date

SECTION 5.3

REGULATION OF THE CELL CYCLE

Study Guide

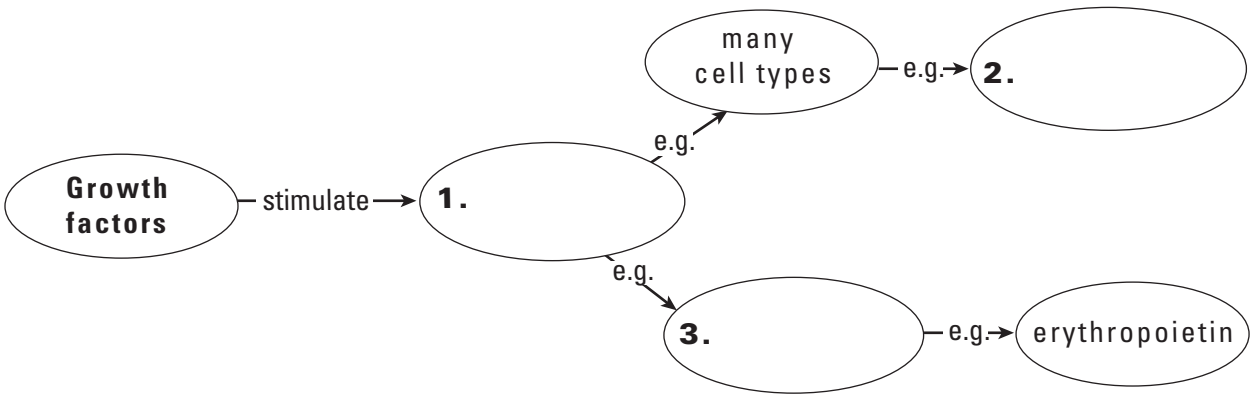
KEY CONCEPT

Cell cycle regulation is necessary for healthy growth.

VOCABULARY		
growth factor	benign	carcinogen
apoptosis	malignant	
cancer	metastasize	

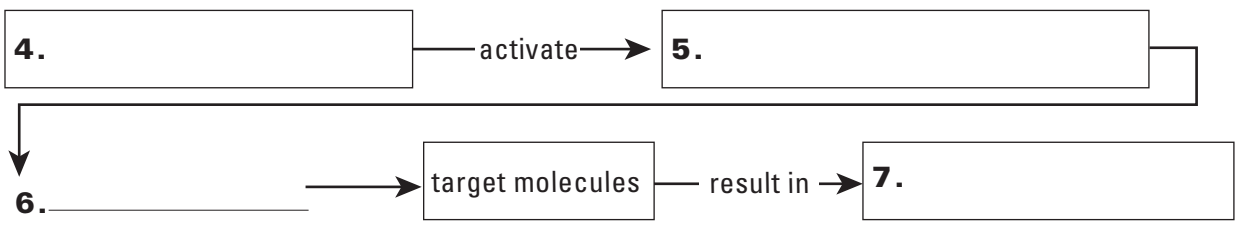
MAIN IDEA: Internal and external factors regulate cell division.

Complete the concept map below to show important ideas about growth factors.



Use the word bank to complete the sequence diagram below.

kinases	cell division	phosphorylate	cyclins



8. What is apoptosis?

_____

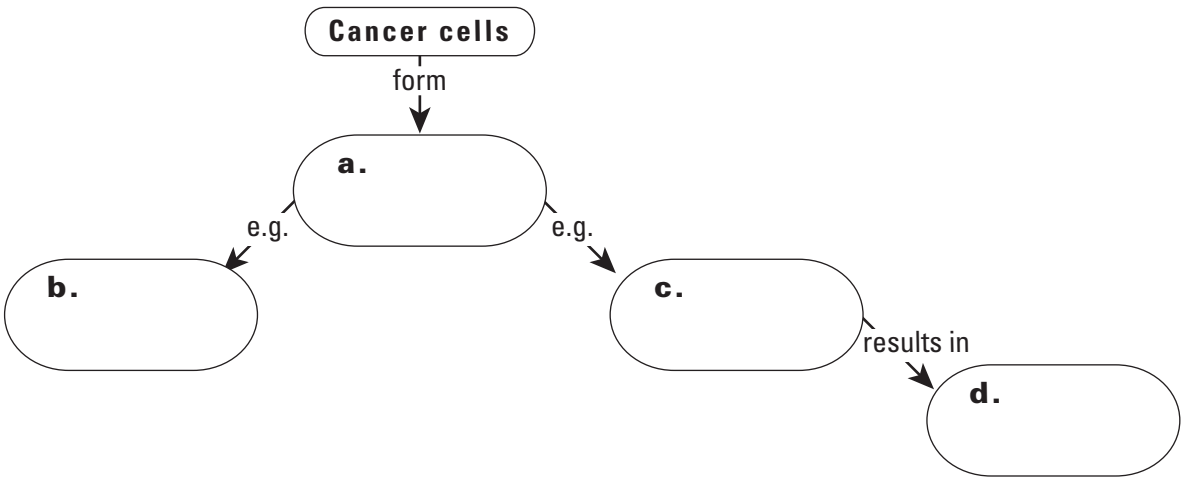
MAIN IDEA: Cell division is uncontrolled in cancer.

9. What type of disease may result if cell division is not properly regulated?

_____

STUDY GUIDE, CONTINUED

Complete the concept map below about cancer cells.



10. List three ways mutations can occur in genes involved in cell-cycle regulation.

Vocabulary Check

11. What does metastasize mean?

12. What is a substance known to produce or promote the development of cancer?

13. Draw a cartoon to help you remember the difference between benign and malignant.

Name Period Date

SECTION 5.3

REGULATION OF THE CELL CYCLE

Power Notes

Internal factors:

External factors:

Cell Cycle

Carcinogens:

• Examples:

Cancer cells

may form

may be killed by

Tumors

Malignant

Benign

Apoptosis

Examples of apoptosis in healthy organisms:

•

•

Name Period Date

SECTION 5.3

REGULATION OF THE CELL CYCLE

Reinforcement

KEY CONCEPT Cell cycle regulation is necessary for healthy growth.

The cell cycle is regulated by both external and internal factors. External factors come from outside the cell. These include cell–cell contact, which prevents further growth of normal cells, and chemical signals called growth factors. **Growth factors** stimulate cells to divide. Most cells respond to a combination of growth factors, not just one. Some growth factors affect many different types of cells. Others specifically affect one cell type. Internal factors come from inside the cell. Very often, an external factor triggers the activation of an internal factor. A cyclin is a type of internal factor. It activates kinases, which in turn, add a phosphate group to other molecules that help drive the cell cycle forward.

Cells not only regulate growth, but also death. **Apoptosis** is programmed cell death. Apoptosis plays important roles in development and metamorphosis.

When a cell loses control over its cycle of growth and division, **cancer** may result. Cancer cells can continue to divide despite cell–cell contact or a lack of growth factors. Cancer cells form disorganized clumps of cells called tumors. **Benign** tumors tend to remain clumped together and may be cured by removal. **Malignant** tumors have cells that break away, or **metastasize,** and spread to other parts of the body, forming new tumors. Malignant tumors are more difficult to treat than benign tumors. Radiation therapy and chemotherapy are common treatments for cancer. However, both treatments kill healthy cells as well as cancer cells.

Cancer cells can arise from normal cells that have experienced damage to their genes involved in cell cycle regulation. Damage may arise from inherited errors in genes, from mutations carried by viruses, and from carcinogens. **Carcinogens** are substances known to produce or promote the development of cancer. These include substances such as tobacco smoke and other air pollutants.

1. List two examples of external factors that influence the cell cycle.

2. What is apoptosis?

3. How does a benign tumor differ from a malignant tumor?

Name Period Date

SECTION 5.4

ASEXUAL REPRODUCTION

Study Guide

KEY CONCEPT

Many organisms reproduce by cell division.

VOCABULARY
asexual reproduction
binary fission

MAIN IDEA: Binary fission is similar in function to mitosis.

1. Offspring resulting from asexual reproduction and those resulting from sexual reproduction differ in one major way. What is the difference?

Sketch the steps of binary fission in the boxes below. Beside each sketch, write a brief description of what is occurring.

2. _____

3. _____

4. _____

STUDY GUIDE, CONTINUED

Fill in chart below to highlight the advantages and disadvantages of asexual reproduction.

Advantages	Disadvantages
5.	
6.	
7.	

MAIN IDEA: Some eukaryotes reproduce through mitosis.

8. If a eukaryotic organism reproduces through mitosis, what is true about the offspring and the parent organism?

_____

9. In what types of organisms is mitotic reproduction most common?

_____

10. List three examples of mitotic reproduction.

_____

11. What forms of reproduction does the sea anemone use?

_____

Vocabulary Check

12. Write a word that starts with the letters "bi." Explain what is similar between the meaning of the word you wrote and the meaning of "binary fission."

_____

_____

13. What is the creation of offspring from only one parent organism called?

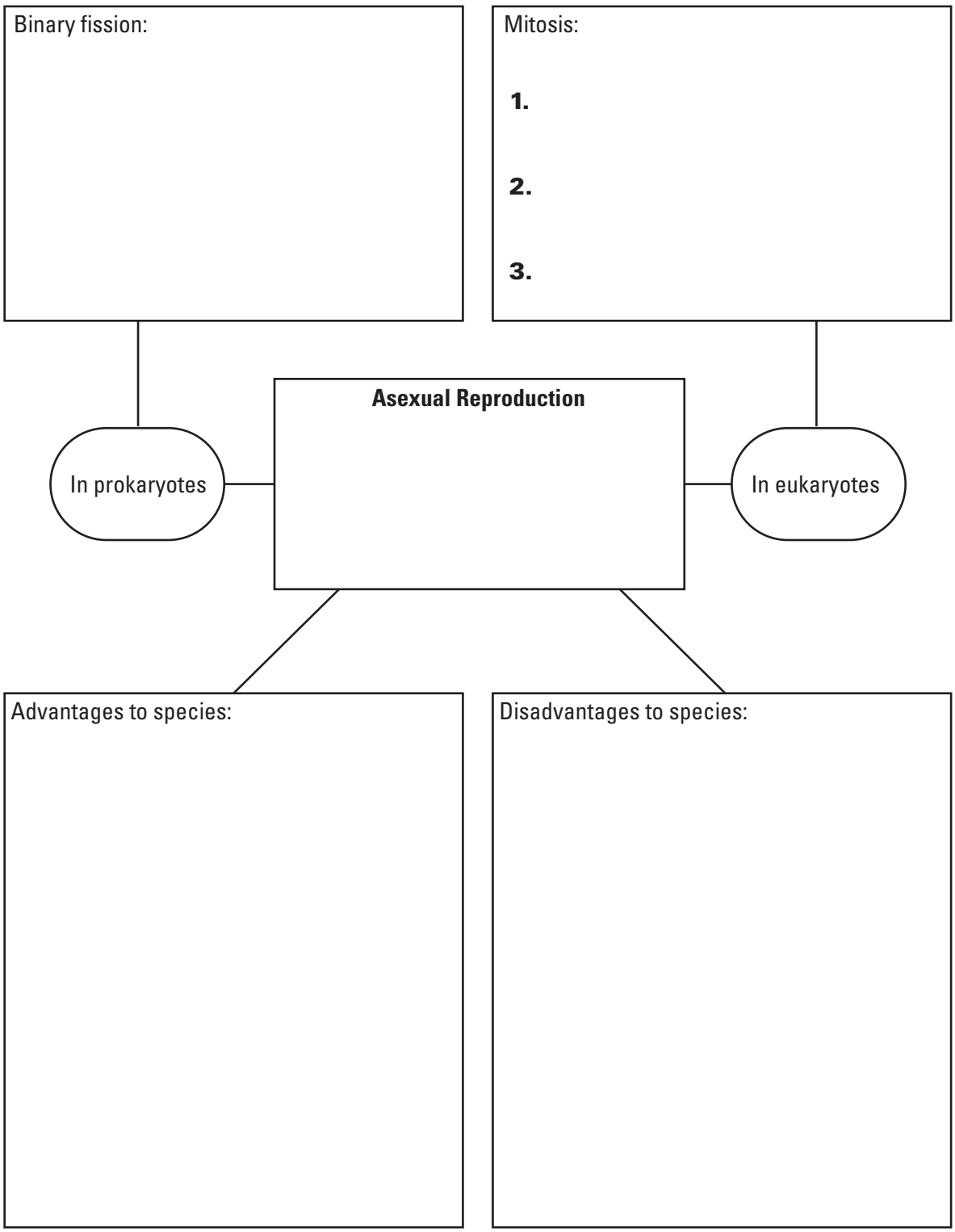
_____

Name Period Date

SECTION **5.4**

ASEXUAL REPRODUCTION

Power Notes



Name Period Date

SECTION 5.4

ASEXUAL REPRODUCTION

Reinforcement

KEY CONCEPT Many organisms reproduce by cell division.

Asexual reproduction is the production of offspring from a single parent and does not involve the joining of gametes. The resulting offspring are genetically identical to the parent organism and to any other offspring that are produced, barring any mutations.

Two main mechanisms of asexual reproduction include binary fission and mitosis. Most prokaryotes reproduce through binary fission. **Binary fission** is the asexual reproduction of a cell by division into two roughly equal parts. The bacterial chromosome consists of one loop of DNA. During binary fission, this chromosome is duplicated and attached to the cell membrane. As the cell grows and elongates, the chromosomes are separated from each other. When the cell is about twice its original size, the membrane pinches inward, and a new cell wall is laid down between the two chromosomes.

Single-celled eukaryotic organisms and some simpler plants and animals reproduce through mitosis, which takes a variety of forms. It includes budding, fragmentation, and vegetative reproduction. Budding is the formation of a new individual by the growth of a small projection on the surface of the parent organism. The new organism may live attached or independently. Fragmentation is the growth of a new organism from a piece that has split off from the parent organism. Vegetative reproduction is the growth of a new organism from a modified stem or underground structure coming from the parent organism. The new organism often stays connected to the original organism through these structures.

Asexually reproducing populations can grow rapidly under favorable, stable conditions. All asexually reproducing organisms are potentially capable of reproducing, and they don't waste any energy in trying to attract a mate. In changing conditions, however, the variety of genetically unique offspring produced by sexual reproduction makes it more likely that some offspring will survive. Some organisms can reproduce both sexually and asexually.

1. What type of offspring are produced by asexual reproduction?

_____

2. What is the major difference between binary fission and mitosis?

_____

_____

3. What is an advantage of asexual reproduction?

_____

_____

Name Period Date

SECTION 5.5

MULTICELLULAR LIFE

Study Guide

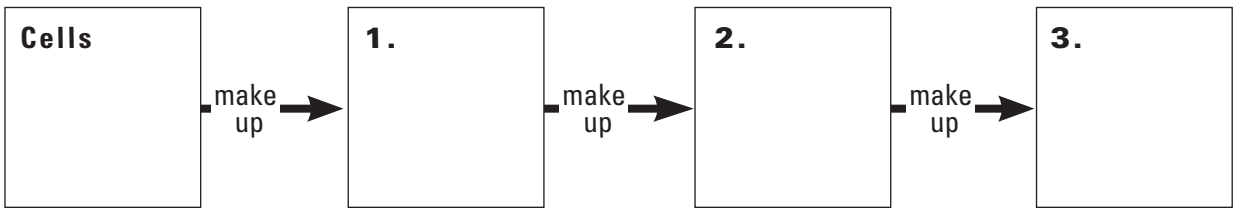
KEY CONCEPT

Cells work together to carry out complex functions.

VOCABULARY		
tissue	organ system	stem cell
organ	cell differentiation	

MAIN IDEA: Multicellular organisms depend on interactions among different cell types.

Complete the diagram below that represents organization in multicellular organisms.



4. List two examples of tissues found in plants.

5. List two examples of organ systems found in plants.

6. How does an organism benefit from organ systems that work together and communicate?

MAIN IDEA: Specialized cells perform specific functions.

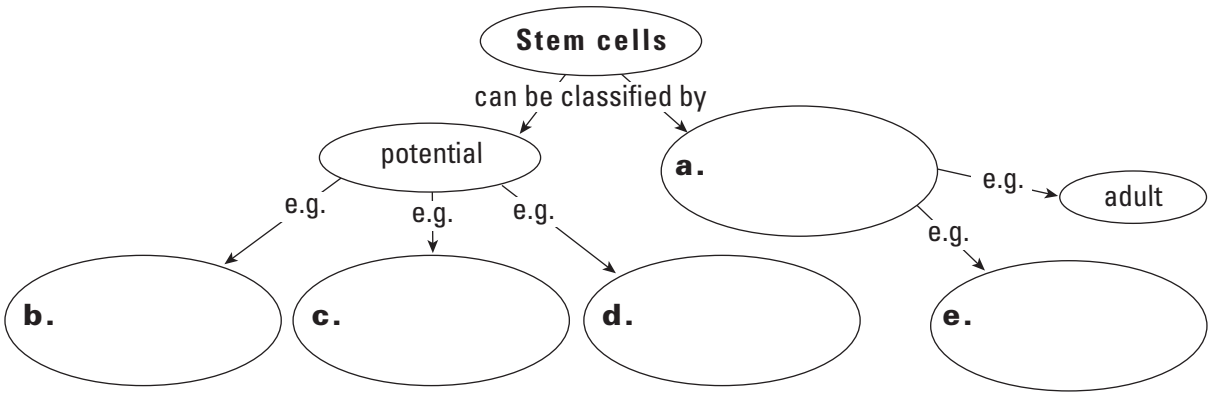
7. What is the process by which unspecialized cells develop into specialized cells?

8. Do different types of cells have different DNA? Explain.

9. What role does cell location play within a developing embryo?

STUDY GUIDE, CONTINUED

MAIN IDEA: Stem cells can develop into different cell types.
Complete the concept map below about stem cell classification.



10. List the three identifying characteristics of stem cells.

11. List one advantage of using adult stem cells and one advantage of using embryonic stem cells.

Vocabulary Check

12. What is cell differentiation?

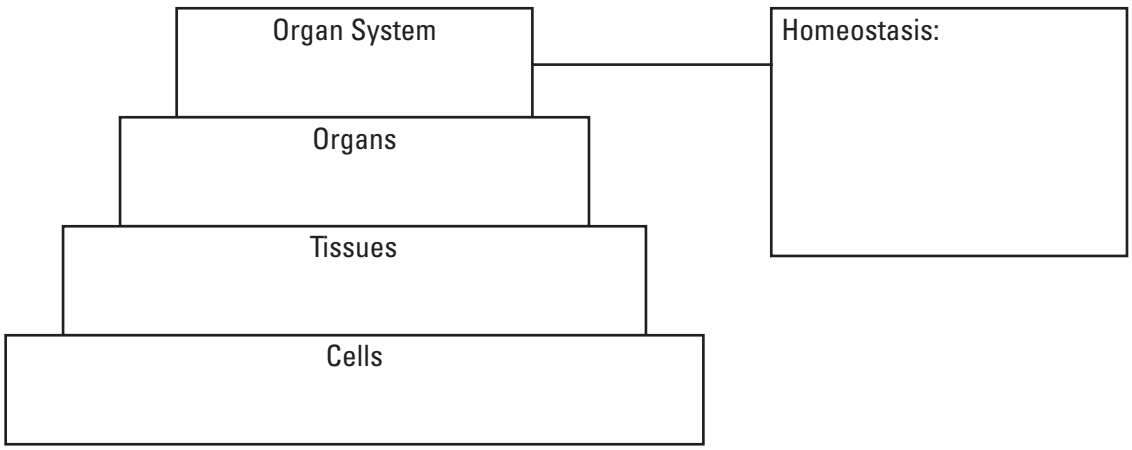
13. Write the following words in order from the largest structure to the smallest structure: cell, organ, organ system, tissue

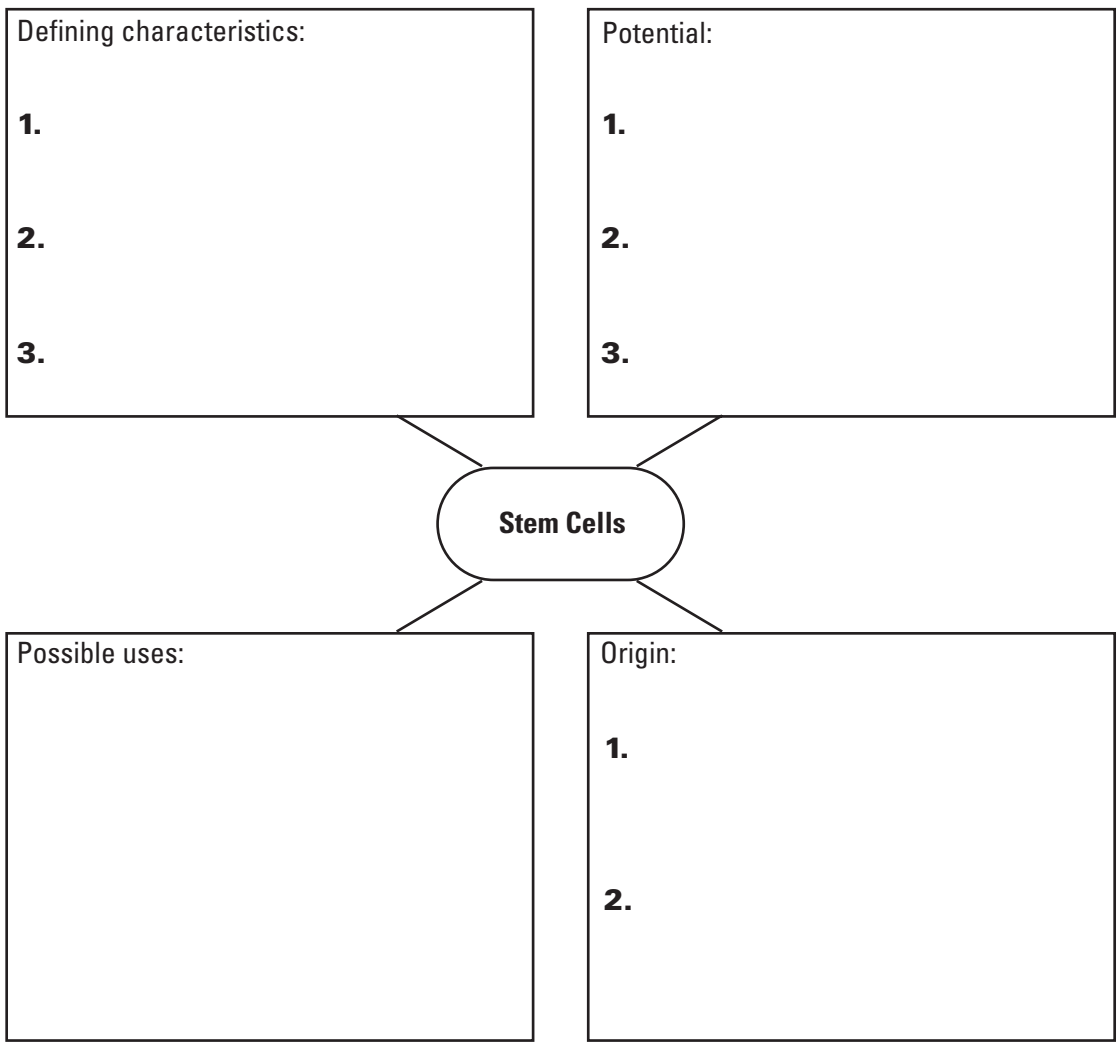
Name Period Date

SECTION 5.5

MULTICELLULAR LIFE

Power Notes





Name Period Date

SECTION 5.5

MULTICELLULAR LIFE

Reinforcement

KEY CONCEPT Cells work together to carry out complex functions.

Your body began as a single fertilized egg. Since that time, your cells have not only gone through millions of cell divisions, but those cells have also undergone the process of **cell differentiation** by which unspecialized cells develop into their mature form and function. Groups of cells that work together to perform a similar function make up **tissues.** Groups of tissues that work together to perform a similar function make up **organs.** Groups of organs that carry out related functions make up **organ systems.** The interaction of multiple organ systems working together helps organisms maintain homeostasis.

An organism's body plan is established in the very earliest stages of embryonic development. In both animals and plants, a cell's location within the embryo helps determine how that cell will differentiate. In animals, cells migrate to specific areas that will determine how they specialize. Plant cells cannot readily migrate because of their cell walls. However, the cells remain very adaptable throughout the life of the plant.

Stem cells are a unique type of body cell characterized by three features:

- They divide and renew themselves for long periods of time.
- They remain undifferentiated in form.
- They can develop into a variety of specialized cell types.

Because of their ability to develop into other types of cells, stem cells offer great hope for curing damaged organs and currently untreatable diseases. However, they also raise many ethical concerns. Stem cells can be categorized by their developmental potential, as totipotent, pluripotent, or multipotent. Stem cells can also be classified by origin, as adult or embryonic.

1. What is cell differentiation?

_____

_____

2. What are three distinguishing characteristics of stem cells?

_____

_____

_____

Name Period Date

CHAPTER 5

CONSTRUCTING DATA TABLES

Data Analysis Practice

Colchicine is a drug used to help treat patients with gout, a condition in which people have too much uric acid build up in their blood and joints. Although colchicine can be used successfully to reduce inflammation, some patients experience side effects, including diarrhea, vomiting, hives, ulcers in the mouth, and blood in the urine.

Suppose you are asked to organize the results of a hypothetical experiment that calculated the percentage of patients who experienced side effects from taking colchicine at different dosages. The information from the experiment is as follows: at 0.5 mg dosage, 2% of patients had side effects; at 1.0 mg dosage, 5% of patients reported side effects; at 1.5 mg dosage, 7% of patients experience side effects; at 2.0 mg dosage, 10% of patients had side effects; at 2.5 mg dosage, 11.5% of patients had side effects; at 3.0 mg dosage, 13% of patients felt side effects; at 3.5 mg dosage, 15% of patients had side effects; at 4.0 mg dosage, 17.5% of patients reported side effects; at 4.5 mg dosage, 20% of patients experienced side effects; at 5.0 mg dosage, 23% of patients had side effects; at 5.5 mg dosage, 27.5% of patients had side effects; at 6.0 mg dosage, 32% of patients felt side effects.

1. **Organize Data** Construct and complete a data table that organizes the data.

2. **Analyze** According to the data, what is the relationship between dosage amounts and side effects felt by patients?

Name Period Date

CHAPTER 5

SPINDLES AND MITOSIS

Pre-AP Activity

In Chapter 5, you have learned about the stages of mitosis. For mitosis to occur, sister chromatids must move to opposite poles. This allows the DNA to be equally distributed and two genetically identical daughter cells to be produced. In this activity, you will learn how spindle fibers grow and shrink.

PROPHASE

At prophase, each chromosome consists of two sister chromatids held together at the centromere. Two disk-shaped regions, called kinetochores, are located on opposite sides of the centromere, with each kinetochore attached to a chromatid.

In the cytoplasm, the spindle apparatus begins to form. Spindle fibers are made up of microtubules, hollow cylinders composed of the protein tubulin. It is likely that the spindle is assembled from microtubule components of the cell's cytoskeleton. Formation of the spindle takes place in the two centrosomes, organelles that organize microtubules. The centrosomes, with bundles of forming spindle fibers trailing behind them, move to opposite poles of the cell, called the spindle poles. One end of the fiber in a spindle fiber bundle becomes attached to a chromosome at the chromosome's kinetochore. Remember that the other end of the fiber bundle is attached to a spindle pole. The number of microtubules in a bundle attaching to each kinetochore varies in different species; there may be only one or two or more than 100 microtubules on each kinetochore.

METAPHASE

When the spindle apparatus has completely formed, the two chromatids of each chromosome are attached to opposite spindle poles by microtubules. During metaphase, the chromosomes begin to move in jerky motions as the spindle fibers pull them into position at the cell's equator. You can think of this movement as a tug-of-war with each chromosome being pulled in two directions by the spindle poles.

ANAPHASE

Anaphase begins suddenly when the centromere splits. The separated chromatids, now called chromosomes, are dragged to opposite poles of the cell by the spindle fibers attached to the kinetochores.

THE ROLE OF SPINDLE FIBERS

The microtubules that make up spindle fibers alternate between growing (polymerization) during prophase and shrinking (depolymerization) during anaphase. This process, called dynamic instability, is achieved by either adding or losing tubulin subunits made of α–tubulin (alpha tubulin) and β–tubulin (beta tubulin) proteins. The polarity of the subunits produces regular, parallel orientation along the microtubule. The α–tubulin end is the negative end and the β–tubulin end is the positive end. The growing and shrinking of the microtubules is thought to be controlled by GTP, guanosine triphosphate.

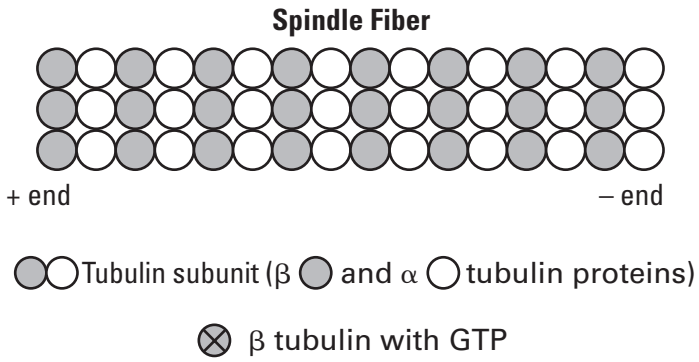
- Growing free tubulin subunits contain a tightly bound GTP molecule that is hydrolyzed into GDP (guanosine diphosphate) when the subunit attaches to the free end (positive end) of the microtubule. If polymerization occurs quickly, the GTP in the newly added tubulin subunit may not be able to be hydrolyzed as quickly and build up. This results in

the positive end of the microtubule being composed of only GTP-containing tubulin subunits. These subunits bind tightly together forming a GTP cap which prevents depolymerization.

- Shrinking is possible when the tubulin subunit at the free end of the microtubule hydrolyzes the GTP before the next tubulin subunit is added. If this happens, then the tubulin subunits at the end of the microtubule will be composed of only GDP. Since GDP-containing tubulin molecules are less tightly bound and are more easily released, the microtubule will shrink.

Answer the following questions on a separate piece of paper.

1. In what stages of mitosis would you expect to find mostly polymerization taking place? mostly depolymerization? Explain your answers.
2. The drug colchicine binds tightly to free tubulin subunits and prevents polymerization. The drug taxol binds tightly to microtubules and prevents them from losing tubulin subunits but allows new molecules to attach. Explain how these drugs would affect spindle fibers and the process of mitosis.
3. How could the use of colchicine and taxol be beneficial in the treatment of cancer?
4. Using the diagram of a microtubule below, illustrate how polymerization changes the size of the microtubule. Include in your illustration a GTP cap that stops growth (see key).



Name Period Date

CHAPTER 5

HeLa CELLS

Pre-AP Activity

In Chapter 5, you have learned that cancer is a disease that results from a breakdown in the regulation of the cell cycle. A great deal of scientific research has been—and is being—carried out on cancer cells so scientists can learn more about these diseases. Where did these cancer cells come from?

STANDARD CELL LINES

To avoid introducing an additional variable in their experiments and to make their experiments repeatable, researchers use standard cell lines—cells that have been cultured in the lab and are available to the scientific community. Most cells live for a short time outside the body, then age and die. A few cell lines are considered to be immortal because they continue to grow and divide indefinitely when provided with the correct culture conditions. HeLa cells are an example of an immortalized cell line. They have been grown under laboratory conditions for thousands of cell generations and are used extensively in medical research. HeLa cells are human epithelial cells from a fatal cervical tumor. Here is their story.

HeLa CELLS

In 1951, Henrietta Lacks, a 31-year-old, African-American mother of five children, died of cervical cancer in Baltimore. Before she died, doctors removed some of the cells from her tumor and delivered them to Dr. George Gey, head of tissue culture research at the Johns Hopkins University. Dr. Gey was looking for cells that would continue to grow and divide in the lab. He grew the tumor cells in his test tubes and was amazed at how fast they divided and how strong they were. Within a few months of Henrietta's death, her cells were still alive, and Dr. Gey was using them to grow polio viruses. But neither Henrietta nor her family knew that her cells had been taken and that they lived on.

Gey named the cells *HeLa* after the first two letters of Henrietta's first and last names. HeLa cells were—and still are—among the strongest cells known to science. Especially valuable was their ability to divide every 24 hours. Dr. Gey sent them to researchers around the world. Demand grew, and the cells were soon mass-produced. And still Henrietta's family did not know of their existence. The cells were used in cancer and AIDS research, in creating a polio vaccine, in gene mapping, in testing the effects of radiation and drugs, and in many other types of medical research. HeLa cells were even sent to space on the space shuttle at one point.

By the early 1970s, some researchers began to suspect that HeLa cells had contaminated their other cell lines. They couldn't be sure because they had little information about the identity of HeLa cells. DNA testing was unknown in the 1950s, when the HeLa line originated. At about the same time, Henrietta's children discovered by accident that their mother's cells still existed. They contacted the Johns Hopkins University and were asked to donate blood and tissue samples.

Researchers say the family was told that the tissue samples were needed so the HeLa cells could be genetically identified. Family members say they were told that the samples were needed to see if they were at risk of developing the same kind of cancer that killed Henrietta. They tried to get information from the researchers, but their questions went unanswered. To this day, the Lacks family has not received any compensation for the widespread use of Henrietta's cells.

Name Period Date

ETHICAL CONSIDERATIONS

Several ethical questions about the HeLa-cell story can be raised. Who owns Henrietta's cells? Do researchers need consent to take and use cells from a person? Does it matter that the cells are cancerous? Should Henrietta's family have been compensated for use of her cells? How do you place a monetary value on cells? Should this value vary according to their commercial value? Are cells worth more if they are used to develop a profitable vaccine?

BIOMEDICAL ETHICS

Today, people who work in the field of biomedical ethics try to answer or address the questions and concerns raised by situations such as Henrietta's. When patients go into a hospital for surgery, many will sign a form to indicate whether their tissues can be used for research, and they are promised that these samples will not be taken without their consent. However, many issues have not yet been resolved. Hospitals have thousands of blood and tissue samples already stored, and there are no rules governing who has access to these samples. Some bioethicists want laws passed that will require researchers to get permission before using tissue samples for research. Many researchers think that this requirement will slow or prevent scientific research.

The issue of who owns your cells and whether you can sell them also can be confusing. For example, you can sell your blood and your eggs or sperm, but you cannot sell your kidney. Does the human body have a price tag?

DEBATE

Consider the many ethical questions raised by the HeLa story. Conduct library or Internet research on these issues and the different points of view. Decide whether you think a person owns his or her cells or whether you think researchers should be able to use them freely. Consider whether a patient's identity should be protected or whether he or she should be identified.

Now, consider whether you would argue for or against some kind of monetary compensation for the use of Henrietta Lacks' cells, or what kind of legislation you think should be passed to deal with these matters. Imagine that you are a lawyer and you are making opening remarks to a judge or jury on this issue, or you are an advocate testifying before the government on what kind of laws should be written to resolve such issues. What are the main issues? What is at stake?

Name Period Date

CHAPTER 5

CELL GROWTH AND DIVISION

Vocabulary Practice

cell cycle	prophase	metastasize
mitosis	metaphase	carcinogen
cytokinesis	anaphase	asexual reproduction
chromosome	telophase	binary fission
histone	growth factor	tissue
chromatin	apoptosis	organ
chromatid	cancer	organ system
centromere	benign	cell differentiation
telomere	malignant	stem cell

A. Analogy Vocabulary Set Write the numbers of the definitions and analogies next to each word.

DEFINITIONS	WORD	ANALOGIES
D1. makes offspring from one parent	**1.** benign _____	**A1.** a twisty tie
D2. protein that DNA wraps around	**2.** chromatin _____	**A2.** weeding
D3. loosely organized combination of DNA and proteins	**3.** asexual reproduction _____	**A3.** fertilizer
D4. constricted region of DNA where sister chromatids are attached	**4.** organ system _____	**A4.** making a copy
D5. tumor that remains in a clump	**5.** centromere _____	**A5.** the cardboard tube inside a roll of toilet paper
D6. group of organs that work together to carry out a complex function	**6.** apoptosis _____	**A6.** the United Nations
D7. programmed cell death	**7.** growth factor _____	**A7.** a shy person who won't leave the house
D8. stimulates cell division	**8.** histone _____	**A8.** tangled yarn

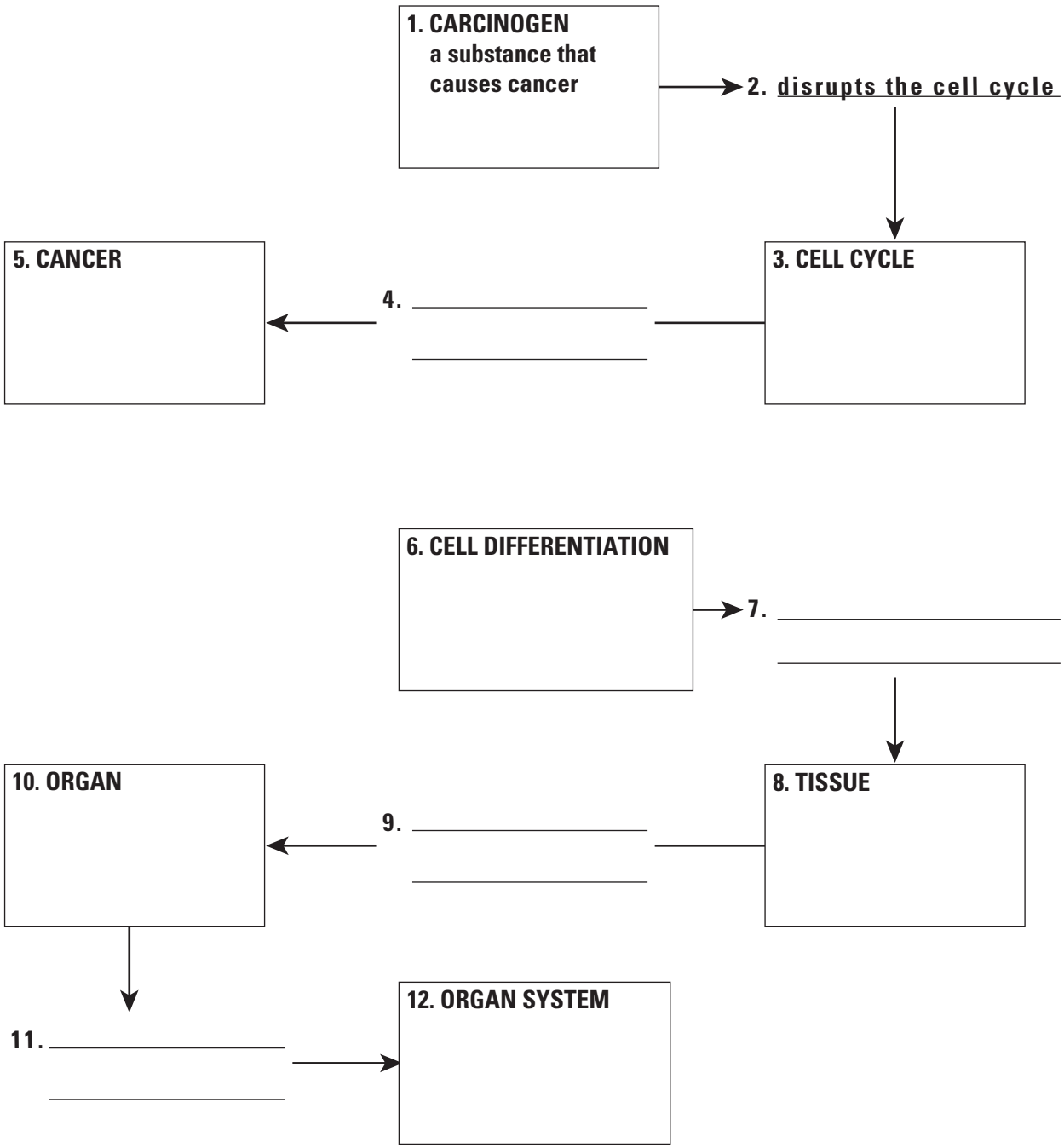
VOCABULARY PRACTICE, CONTINUED

B. Compound Word Puzzle Read the phrase and write the word that it most closely describes. Then write another phrase that describes the same word in a different way.

PHRASE 1	WORD	PHRASE 2
one half of a condensed, duplicated chromosome	**Example** chromatid	separates from sister chromatid during anaphase in mitosis
first phase of mitosis	**1.**	
may be categorized as totipotent, pluripotent, or multipotent	**2.**	
duplicated chromosomes line up along the cell equator	**3.**	
last phase of mitosis	**4.**	
spindle fibers pull the sister chromatids apart	**5.**	
a disease caused by a mutation in genes that control the cell cycle	**6.**	
divides a cell's cytoplasm	**7.**	
condenses at the start of mitosis	**8.**	

VOCABULARY PRACTICE, CONTINUED

C. Vector Vocabulary Define the words in the boxes. On the line across each arrow, write a phrase that describes how the words in the boxes are related to each other.



VOCABULARY PRACTICE, CONTINUED

D. Word Origins Circle the Greek and Latin word parts in each vocabulary term. Then use the Greek and Latin meanings to construct a very basic definition of the vocabulary word.

bi-	=	two	mal-	=	bad, evil	pro-	=	at the start
centro-	=	middle	-mere	=	part, segment	telo-	=	end
cyto-	=	cell	meta-	=	change; occurring after			
kin-	=	movement	mitos-	=	thread			

WORD	DEFINITION
1. malignant	
2. prophase	
3. telomere	
4. cytokinesis	
5. telophase	
6. binary fission	
7. centromere	
8. mitosis	
9. metastasize	
10. metaphase	