Cell Cycle

Mitosis

Protein Synthesis

Standards **Biology/Life Science**

CELL BIOLOGY

1. **Fundamental life processes of plants and animals depend on a variety of chemical reactions, that are carried out in specialized areas the organism's cells.** As a basis for understanding this concept, students know
   d. the Central dogma of molecular biology outlines the flow of information, from transcription of RNA in the nucleus to translation of proteins on ribosomes in the cytoplasm.

GENETICS

4. **Genes are a set of instructions, encoded in the DNA sequence of each organism, specifying the sequence of amino acids in proteins characteristic of that organism.**
   a. the general pathway by way in which ribosomes synthesize proteins, using tRNA to translate genetic information in mRNA.
   b. how to apply the genetic coding rules to predict the sequence of amino acids from sequence of codons in RNA.
   c. how changes in or mutations in the DNA sequence of a gene may (or may not) affect the sequence of amino acids in the encoded protein, or the expression of the gene.
   d. specialization of cells in multicellular organisms is usually due to different patterns in gene expression rather than to differences in the genes themselves.
   e. various proteins differ from one another in the number and sequence of amino acids.

5. **The genetic composition of cells can be altered by incorporation of exogenous DNA into the cells.** As a basis for understanding this concept, students know:
   a. the general structures and functions of DNA, RNA, and protein.
   b. how to apply base-pairing rules to explain precise copying of DNA during semi-conservative replication, and transcription of information form DNA into mRNA.

Meiosis

GENETICS

2. **Mutation and sexual reproduction lead to genetic variation in a population.** As a basis for understanding this concept, students know;
   a. meiosis is an early step in sexual reproduction in which the pairs of chromosomes separate and are segregated randomly during cell division to produce gametes containing only one chromosome of each type.
   b. that only certain cells in a multicellular organism undergo meiosis.

H

Mitosis Videos

Vocabulary: Mitosis

Name _____

Word Part	Meaning	Vocabulary Word
kines	to move	cytokinesis
inter	between	interphase
pro	before	prophase
ana	opposite	anaphase
meta	middle	metaphase
tele (o)	far, distant	telophase
chrom	color	chromosome
som	body	somatic
equa	equal	equator
centr	a point	centriole
mer (e.	part	centromere

Format

Word	Part of speech	Word parts
Definition		

cytokinesis		

interphase		

prophase		

anaphase		

metaphase		

telophase		

chromosome		

somatic		

equator		

centriole		

centromere		

The Cell Cycle

I.A. The _____ of events that occurs in a _____ to another cell _____

Interphase:
Period of cell _____ and _____

Cytokinesis:
Division of _____ and _____.

_____ - Found in _____ also called _____

_____ - Found in _____ also called _____

IPMAT

Mitosis: _____ of cell _____

II. Interphase

A. G1 phase: cell _____; _____ and _____ roughly double in number.

B. S phase: _____ replicates. : Loose tangles called _____.

C. G2 phase: cell undergoes rapid _____; makes necessary _____ and cell _____

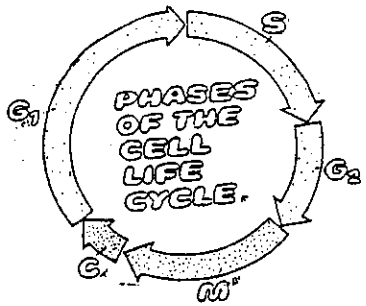
III. Mitosis

A. Prophase

1. _____ form

Why do We Need New Cells?

Most of the cell's life is spent in _____ (about 20 hours per cycle)



Inter: _____
phase: _____

SUMMARY
Organelles double and cell grows

Mitos: _____
Pro: _____
_____ - small part

* coiled tightly becoming _____ and _____
* found near _____ of cell.
* two _____ copies of chromosomes are called _____
* sister chromatids held together at _____.

2. _____ and nuclear _____ disappears.
3. Two _____ appear next to nuclear membrane.
   * bundles of _____
   * not found in _____ cells
   * move to _____ ends of the cell.
   * _____ are _____ that stretch from _____ to centriole.
   * the end of the spindle fibers are called _____.

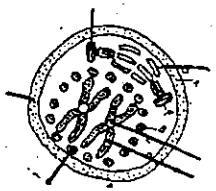
B. Metaphase

1. Sister _____ become attached to the _____ at the _____
2. Sister _____ line up at the _____ of the cell - called _____.
3. _____ most condensed and distinct.

C. Anaphase

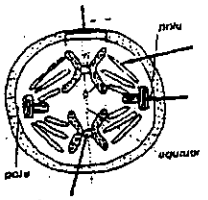
1. _____ divide; _____ chromatids separate.
2. _____ pulls sister chromatids apart.
3. Separate sister chromatids move to _____ poles

SUMMARY
* _____
* _____
* centriols appear at poles



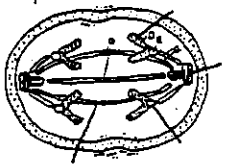
meta: _____

SUMMARY
* chromatids line up at cell equator



ana: _____

SUMMARY
* Sister chromatids separate



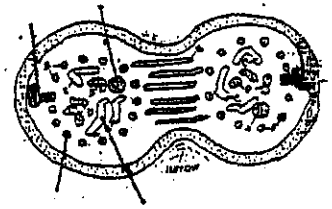
D. Telophase

1. Chromosomes arrive at _____
2. Spindle fibers _____.
3. New _____ forms around chromosomes.
4. _____ and _____ become tangled mass of _____again.
5. _____ re-forms.
6. _____ resumes.

Telos: _____

SUMMARY

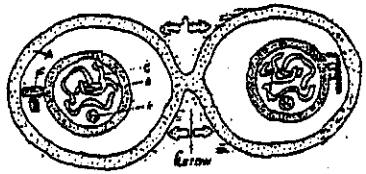
* Nuclear membranes form
* Protein synthesis resumes: bones, muscles



cyto: cell

E. Cytokinesis

1. Division of _____
2. In animal cells _____ pinch cell membrane together until _____.
3. Each cell receives _____ nucleus and about half the cell's contents including _____, membranes, & _____.
4. In plant cells, _____ forms dividing cell in two,



Summary

I _____

P _____

M _____

A _____

T _____

Cytokinesis _____

Surface to Volume RATIO

Put the sugar cubes together to form the following blocks.
DO NOT EAT THE SUGAR CUBES

Record your data in the tables.

Surface Area = length X width X number of sides

Table 1 **Surface Area (SA)**

Cubes per side	length	width	number of sides	Total
1 cm				
2 cm				
3 cm				

Volume = length X width X height

Table 2 **Volume (V)**

Cubes per side	length	width	number of sides	Volume	RATIO SA/V
1 cm					
2 cm					
3 cm					

What happens to the surface area, volume, and their ratio as a cell gets larger.

WHY does a cell replicate?

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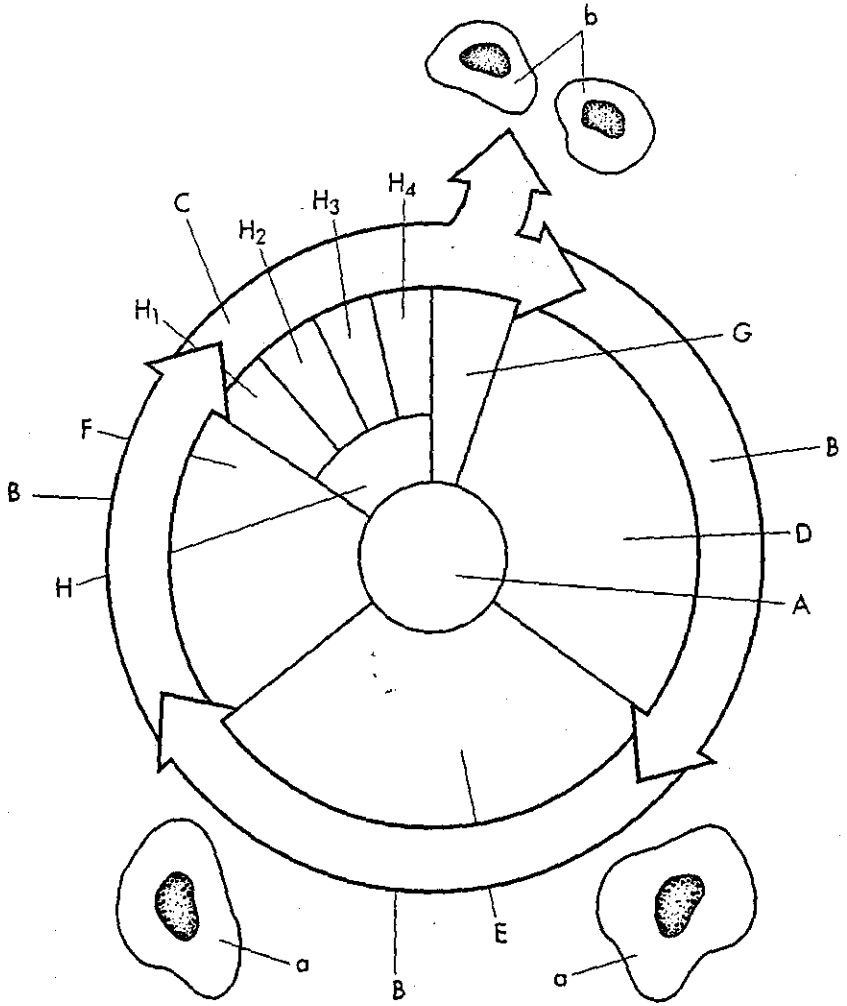
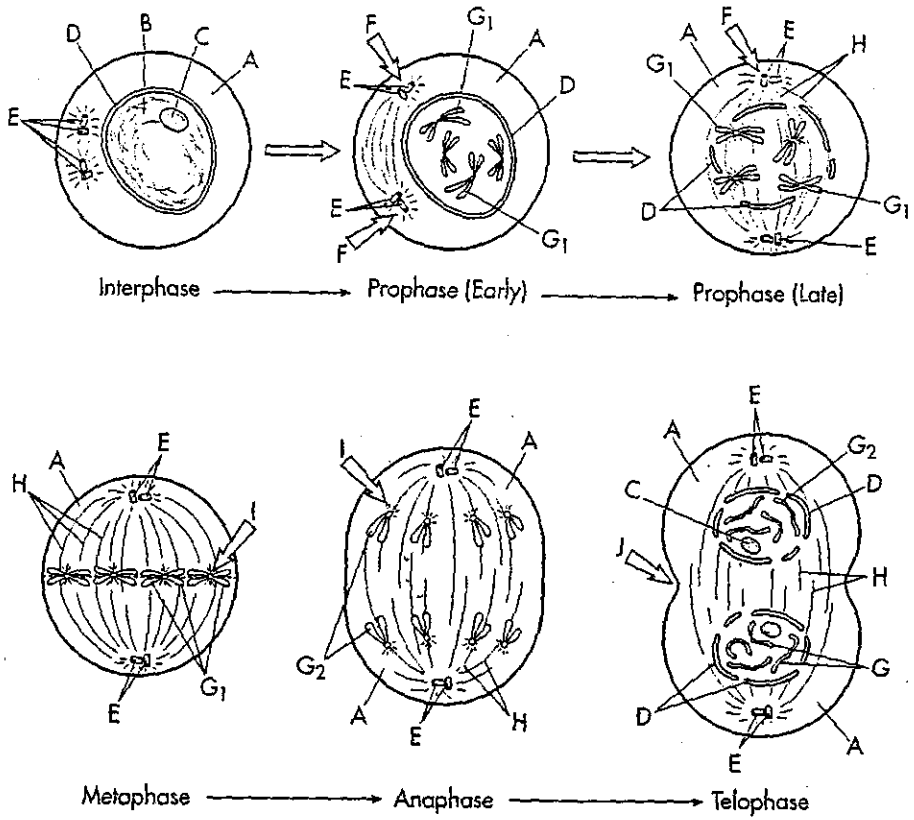


The Cell Cycle

- ○ The Cell Cycle .....A
  - ○ Interphase .....B
  - ○ M Phase (Cell Division) C
  - ○ G_1 Phase .....D
  - ○ S Phase .....E
  - ○ G_2 Phase .....F
  - ○ Cytokinesis .....G
  - ○ Mitosis .....H
- Phases of Mitosis
  - ○ Prophase .....H_1
  - ○ Metaphase.....H_2
  - ○ Anaphase .....H_3
  - ○ Telophase.....H_4
- ○ Mother Cell .....a
- ○ Daughter Cells .....b



Mitosis

- ○ Cytoplasm.....A
- ○ Nucleus (Chromatin).....B
- ○ Nucleolus.....C
- ○ Nuclear Membrane .....D
- ○ Centrioles .....E
- ○ Asters .....F
- ○ Chromatids .....G_1
- ○ Chromosomes.....G_2
- ○ Spindle Fibers .....H
- ○ Kinetochore.....I
- ○ Cleavage Furrow.....J

SH

THE CELL CYCLE

1. The cells of all living things grow and multiply though a cycle that's made up of four phases. During three of these phases, the cell is growing and is metabolically active. During the fourth phase, it is undergoing division, which yields two new cells. In this plate, we examine the four phases of the cell cycle and note the important characteristics and subdivisions of each phase. A subsequent plate explores the phases of mitosis in detail.

2. The cell cycle takes place over different periods of time in different types of cells, and as you know, different types of cells coexist in many organisms. For example, in human fibroblast cells, the cell cycle may encompass about fifteen hours, while in brain cells, the cycle may take many years to complete.

3. The two major periods of the cell cycle are interphase and the M phase (also known as the phase of cell division (C)). As the plate indicates, interphase encompasses three smaller periods and is the period of time between cell division. The same bold color may be used for all three portions of interphase, and a different color should be used for the M phase. Reds, blues, greens, or purples are suggested.

4. During interphase, the cell is extremely active and carries on routine cellular and physiological activities. Foe examples, cells of the pancreas are actively producing insulin, which facilitates the passage of glucose molecules into the cell. During M phase of cell division, the rate of metabolism is reduced and the cell undergoes division to form tow cells.

5., Three shorter phases make up the interphase period of the cell cycle. The first phase is known as the G1 phase (D). During this time period, metabolism is occurring at a high rate, many proteins are synthesized, and cell growth is vigorous; the G stands for growth. The cell's organelles also increase in number of size.

6. The second phase of interphase is the S phase (E.) In the S phase, some activities related to cell division take place (S stands for synthesis). The cell's DNA replicates, ensuring that future cells obtain similar copies of its hereditary material, and proteins associated with the DNA are produced during this phase.

7. The cell prepares to reproduce during the G2 phase (F). More of the proteins that are essential for cell division are produced during this brief phase, and these proteins move to appropriate sites. The centrioles used for cell division complete their replication during this phase. In addition to these activities, the cell continues its growth and many of its physiological processes. Not all the cells continue the cell cycle at this point; some cells leave the cell cycle and do not undergo cell division. Red blood cells (erythrocytes) are an example.

8. At the conclusion of the G2 phase, the cell enters its M (mitosis) phase of cell division. This phase consists of two main processes: the first is mitosis (H), in which the chromosomes separate and segregate themselves on opposite sides of the cell, and the second is cytokinesis (G), in which the cell actually splits. The results of cytokinesis and mitosis are shown in the plate.

9. Mitosis occurs as a series of events that are separated into four phases, and the process is continuous through these four phases. During prophase (H), distinct chromosomes appear as a result of the uncoiling of the chromatin material (which is made up of DNA and protein). During metaphase (H2), the chromosomes line up along the equator. During anaphase (H3), the chromosomes separate, and one member of each pair moves to opposite poles of the cell. Lastly, during telophase (H4), the chromosomes arrive at the opposite poles of the cell and two distinct nuclei to form.

10. The processes that take place during the M phase of the cell cycle lead to new cells that are referred to as daughter cells. A single mother cell (a) has passed through the G1, S, and G2 phases and enters cell division to produce two daughter cells (b.) Each of the two new cells will now enter interphase and the cycle will be repeated.

Name _____

ONE summary sentence of each paragraph.
1.
2.
3.
4.
5.
6.
7.
8.
9.
10.
Overall Summary

Questions

1. What are the two major periods of the cell cycle and what happenes in each?

a.

b.

2. What are the stages of Mitosis?

3. What is the end result of mitosis?

4. WHY is this important for a multicellular organism?

Mitosis

1. During the cell division phase of the cell cycle, the cell undergoes. Mitosis and then cytokinises . mitosis is the process in which the duplicated chromosomal pairs separate and, in cytokinesis the cell splits to form two new cells. This plate will explore the process of mitosis.

2. As you may remember, the DNA in the nucleus of the cell replicated during the S Phase of the cell cycle, but is not distinguished as distinct chromosomes during the first phase of mitosis, Interphase. The nucleus (B) contains the DNA in a diffused mass called chromatin. The nucleolus © is seen clearly in the Interphase cell, and the nuclear membrane (D) encloses the nucleus. Color the cytoplasm a light color

3. Two submicroscopic bodies (also duplicated prior to mitosis) that participate in mitosis are the centrosomes. Each of the centrosomes contains two cylindrical structures that are arranged at right angles to each other, called centrioles (E),which are involved in the organization of microtubules during cell division.

4. Prophase is the longest phase of mitosis. It begins when the chromatin of the cell nucleus condenses to form distinct chromosomes is composed of two identical, stands, known as chromatids (G1). Notice that in early prophase the centrioles (E)a re surrounded by a series of microtubules that radiate outward; these are called asters.

5. In late prophase the centrioles (E) have moved to opposite poles of the cell and the asters (F) are still available. Spindle fibers (H) can be seen extending between the centrioles and should be traced with a light color such as yellow. Spindle Fibers are composed of microtubules and associated proteins. Notice that the chromatids (G1) have continued to compact, becoming shorter and thicker. The nuclear membrane begins to break apart and disappear as the cell proceeds through late prophase.

6. The next phase of mitosis is the metaphase. Here the chromatid pairs align themselves along the equator of the cell, at an area the called the metaphase or equitorial plate. The chromatids (G,) are linked near the middle of the chromosome at a development called the kinetochore (I). There is one kinetochore located on each sister chromatid, and their compositions are unknown. At this stage from centrioles. The remainder of the cytoplasm (A) should be colored in a light color.

7. In anaphase, the DNA at the kinetochore (I) has duplicated, and the chromatids have separated. Each chromatid is now a chromosome (G2). Four chromosomes are seen moving to the bottom of the diagram, and four to the top of the diagram. The chromosomes resemble "V's" because the spindle fivers lead them by their centrioles. An equal number of chromosomes move to the opposite poles of the cell. In a human cell, for example, forty-six chromosomes move to one pole and forty-six chromosomes move to the opposite pole.

8. As the dividing cell enters telophase, you can see that the chromosomes (G2) arrive at opposite ends of the cell, where they become thinner and less distinct. The spindle fibers (H) begin to break down in this phase, the nuclear membrane (D) begins to form around the chromosomal material, and the nucleolus (C) reappears.

9. As telophase comes to an end, the cytoplasm (A) is divided between the two new daughter cells. At the center of the cell in animal cells a cleavage furrow (J) begins to form as the membrane pinches in from both sides. The appearance of the cleavage furrow signals the end of telophase and the beginning of cytokinesis. The furrow pushes inward from opposite sides of the cell until two cells are created. These cells are referred to as the daughter cells.

Name _____

ONE summary sentence of each paragraph.
1.
2.
3.
4.
5.
6.
7.
8.
9.
Overall Summary

Questions

1. **What is mitosis?**

2. **How are Prophase & Metaphase different?**

3. **What happens in Telophase?**

4. **What is the end result of mitosis?**

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ARE THERE MORE DIVIDING CELLS OR RESTING CELLS IN A ROOT TIP

A plant grows in length at the tip of a stem and root. In the stem and root tip there is a small group of cells that divide many times; however, not all cells in these parts may be dividing. A dividing cell may be next to several resting cells and a resting cell can be surrounded by several dividing cells.

Cells in mitosis are different from resting cells. Some parts of a cell are seen best only when a cell is dividing. These parts seem to disappear after a cell had divided.

Keywords: Define the following keywords:

Dividing cell _____

Resting cell _____

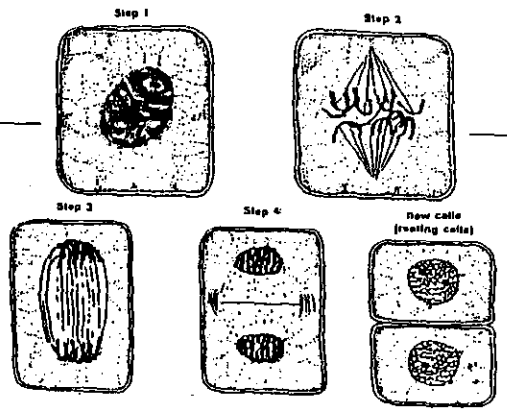
Root tip _____

Table 1

Steps of Mitosis	Number of Cells Seen
Prophase	
Metaphase	
Anaphase	
Telophase	
Interphase Resting Cells	
Total Cells Seen	

Figure 1

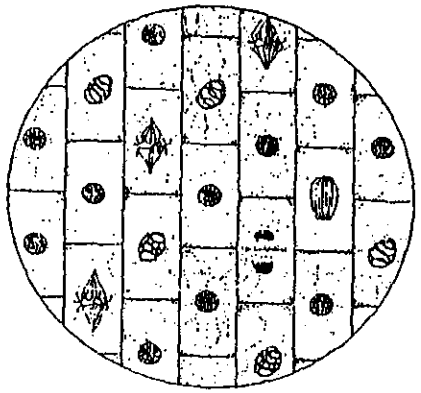
YOUR Drawings



11. A biology student was looking at an onion root tip through the microscope and made a drawing of the cells she saw. Record on the chart how many cells you think she saw that were either resting cells or dividing cells.

Table 2 Cells seen by the student.

Steps of Mitosis	Number of Cells Seen
Prophase	
Metaphase	
Anaphase	
Telophase	
Interphase Resting Cells	
Total Cells Seen	



Questions

1. What part is seen in the resting cells that is missing in cells that are dividing?

2. What parts are seen in dividing cells that are not visible in the resting cells?

3. Why do you think new cells are sometimes called resting cells?

4. Which cells did you see more of in the onion root, dividing cells or resting cells?

5. Which step of mitosis was most common in the onion root?

6. Which step of mitosis was least common in the onion root?

7. Suppose you examined another root tip and saw that half of the cells were dividing. Would this root be growing faster or slower than the one you examined in this exercise? Explain your response.

Lesson 8 DNA and Cell Division

Key Words

cell cycle:	process by which a cell grows, prepares for division, and divides to form two daughter cells
interphase:	part of the cell cycle during which a cell grows and copies its chromosomes
chromosomes:	cell structures made of DNA and proteins that contain hereditary information
mitosis:	part of the cell cycle during which a parent cell distributes its chromosomes to two daughter cells

KEY IDEAS

The cell cycle is the continuous process by which cells grow, prepare for division, and divide into two daughter cells. The daughter cells inherit chromosomes from the parent cell. The process of distributing chromosomes during cell division is called mitosis.

If you look at a picture of yourself as a toddler, you'll find that your body has changed dramatically since then. Your height and weight increased as you got older. Did you ever wonder why this happened? You grow partly because the number of cells that make up your body increases.

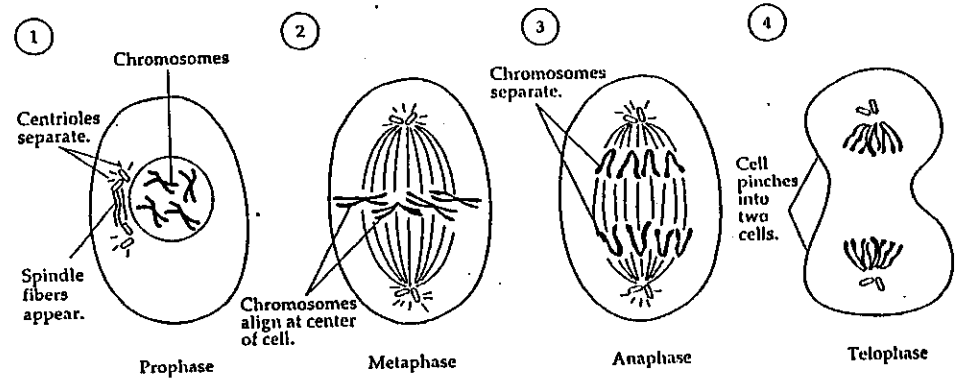
The Cell Cycle. Even as you read these words, the cells in your body are growing. Materials that flow into the cell cause it to increase in size. As a cell gets larger, substances have more difficulty moving through it. Yet, to function properly, the cell must be able to transport materials throughout itself. Every cell has a size limit, or a point at which it can no longer transport materials throughout itself. When the cell reaches this limit, it divides, forming two new cells. The term cell cycle (sehl SY-kuhl) is used to describe the continuous process by which cells grow, prepare for division, and divide into new cells called daughter cells.

Interphase. The stage of the cell cycle during which the cell grows and copies its chromosomes is called interphase (IHN-tuhr-fayz). This is the longest stage of the cell cycle. It is an active time before cell division.

Near the end of interphase, the cell makes a copy of its chromosomes. For example, a cell that contains 12 chromosomes before interphase would contain 24 chromosomes after interphase. Chromosomes (KROH-muh-sohmz) are large, threadlike structures located in the cell nucleus. Chromosomes contain hereditary information that is passed on to new cells. This hereditary information is carried on DNA molecules found inside each chromosome.

Mitosis. When a cell divides, it passes on copies of its DNA to its offspring through mitosis. Mitosis (my-TOH-sihs) is the process of the cell cycle in which chromosomes are distributed to two daughter cells. There are four stages of mitosis. Fig. 8-1 shows these stages in animal cells.

Fig. 8-1



Prophase: Organelles called centrioles help to separate the duplicated chromosomes. Two pairs of centrioles are found outside the nucleus in the cytoplasm. The centriole pairs move apart. As they separate, fine threads of protein called spindle fibers form between the centriole pairs. By the end of prophase, the centriole pairs are at opposite ends of the cell. The nuclear membrane disappears. The spindle fibers align between the centriole pairs.

Metaphase: In the second stage of mitosis, the chromosome pairs line up across the center of the cell. Each chromosome pair is attached to a spindle fiber.

Anaphase: During the third stage of mitosis, each chromosome pair separates to form two single chromosomes. The spindle fibers pull one chromosome from each pair to opposite ends of the cell. This forms two sets of single chromosomes.

Telophase: In the last stage of mitosis, a nuclear membrane forms around each set of chromosomes. The spindle fibers disappear. Mitosis ends when the cell membrane begins to pinch the cell in two. This causes the cytoplasm to divide, forming two identical daughter cells.

☑ 1. How do spindle fibers help distribute chromosomes to daughter cells?

_____

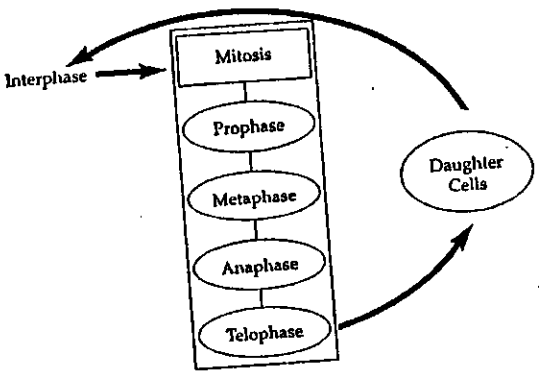
_____

Name _____

TAKE ANOTHER LOOK

Fig. 8-2 summarizes the cell cycle.

Fig. 8-2



Check Your Understanding

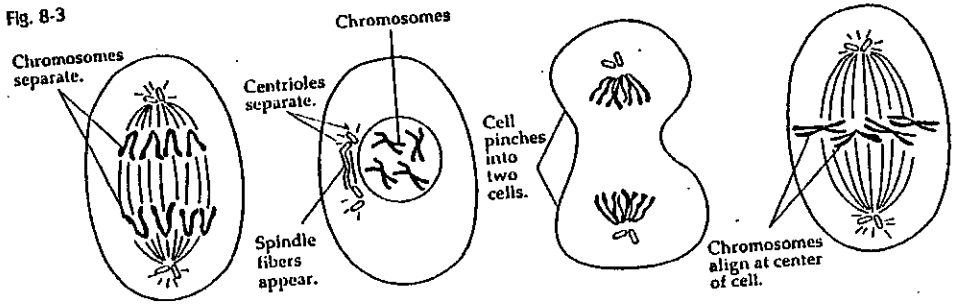
Write a sentence explaining the connection between each pair of words.

2. chromosomes, interphase _____

3. cell cycle, mitosis _____

4. Fig. 8-3 shows each of the four stages of mitosis. On each line, write the name of the stage shown. Then write the letters in the correct order of their occurrence.

Fig. 8-3



(a) _____ (b) _____ (c) _____ (d) _____

(e) Correct order of occurrence: _____

5. What is the cell cycle? _____

6. What causes cells to divide? _____

7. How is hereditary information passed from a parent cell to daughter cells? _____

8. What are the four stages of mitosis? _____

9. What is interphase? _____

10. If a parent cell contains eight chromosomes, how many chromosomes are present after interphase? Why?

014

Chapter 8: Cellular Transport and the Cell Cycle
8.2 Cell Growth and Reproduction
(pgs. 209-216)

Cell Size Limitations/Reproduction

Main Idea

Supporting Detail			

Chromosomes:
Chromatin:
Word Origin: chromosome

The Cell Cycle/Interphase

Main Idea

Supporting Detail			

Cell Cycle:
Interphase:
Mitosis:

The Phases of Mitosis

Main Idea

Supporting Detail			

Name _____

Prophase:

Sister Chromatids:

Centromere:

Centrioles:

Spindle Fibers:

Metaphase:

Anaphase:

Telophase:

Cytokinesis:

Tissue:

Organs:

Organ System:

Section Assessment 1-5

1. Describe how a cells surface area to volume ratio limits its size.

2. Why is it necessary for a cells chromosomes to be distributed to its daughter cells in such a precise manner?

3. How is the division in the cytoplasm different in plants and in animals?

4. In multicellular organisms, describe two cellular specializations that result from mitosis.

5. At one time, interphase was referred to as the resting place of the cell cycle. Why do you think this description is no longer used.

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Chapter 8: Cellular Transport and the Cell Cycle
8.3 Control of the Cell Cycle

Pages: 217-219

Normal Control of the Cell Cycle

Main Idea

Cancer:

Gene:

Cancer: A Mistake in the Cell Cycle

Main Idea

Supporting Detail			

Name _____

Section Assessment 1-5

1. Do all cells complete the cell cycle in the same amount of time?

2. Describe how genes control the cell cycle.

3. How can disruption of the cell cycle result in cancer?

4. How does cancer except normal cell functioning.

5. What evidence shows that the environment influences the occurrences of cancer?

VIDEO: DNA and Cancer