

## LAB EXERCISE 6

# The Cell's Life Cycle

Cells in many parts of the human body divide to produce more cells of the same type. The hereditary information contained within the nucleus of a resting *parent* cell must first be **replicated** (copied), then evenly distributed between the two cells that result from division. The process of distributing genetic material is termed **mitosis**. Mitosis was named in the late nineteenth century by Walther Flemming, who noticed thread-like structures in cells during cell division (*mitos-* “threads,” *-osis* “condition of”).

The pinching in of the plasma membrane, and eventual split of the membrane and its contents into two *daughter cells*, is termed **cytokinesis**. Cytokinesis occurs about the same time (or just after) the last phases of mitosis.

*Life cycles* are circular patterns of organisms' life histories. For example, the life cycle of humans would list conception, development, adulthood, reproduction, then list conception, and so forth, again for the offspring. Likewise, individual body cells are formed, they reproduce, and their daughter cells continue the cycle of life. In this exercise, we will explore the major events of the human cell's life cycle.

### BEFORE YOU BEGIN

- Read the appropriate chapter in your textbook.
- Set your learning goals. When you finish this exercise, you should be able to:
  - list the major phases of a cell's life cycle
  - describe the principal events of mitosis
  - identify cell parts involved in mitosis
  - explain the importance of mitosis
  - define the term *cytokinesis*
- Prepare your materials:
  - chart or model: *animal mitosis series*
  - colored pencils or pens
  - microscope
  - prepared microslide: *whitefish blastula*
- Read the directions and safety tips for this exercise *carefully* before starting any procedure.

### A. INTRODUCTION TO THE CELL LIFE CYCLE

The process of mitosis can be described step by step to make it a little easier to picture. We will divide the whole life cycle into five phases: **interphase**, **prophase**, **metaphase**, **anaphase**, and **telophase**.

Note the major events of each life cycle phase listed in Figure 6-1. Try to identify the physical representation of those events in a chart or model of cells at various life cycle stages.

- 1 **Interphase** is not a phase of mitosis but is the period between cell divisions. It is not an inactive time, however, because the chromatin replicates during interphase (forming two sister **chromatids** joined at a **centromere**). In anticipation of division, additional cell fluid and organelles are formed during interphase. As Figure 6-1 shows, an initial growth phase ( $G_1$ ) is followed by the DNA replication or synthesis (S) phase, which is in turn followed by a second growth ( $G_2$ ) phase.
- 2 **Prophase** is the first phase of mitosis. During prophase, the nuclear membrane disappears, freeing the chromatin (which first shortens into tiny bodies called **chromosomes**). Also, centriole pairs move to opposite poles of the cell as **spindle fibers** begin to project from them. The spindle fibers extend toward the equator of the cell and may overlap with spindle fibers projecting from the opposite centriole pair. A spindle fiber may also attach to one side of a chromosome's centromere.



### HINT

The cell life cycle is a continuous process. The cell does not suddenly jump from one phase to another but gradually changes. Therefore cell models represent a snapshot of each phase at a point where it is most distinct from the phases before and after it.

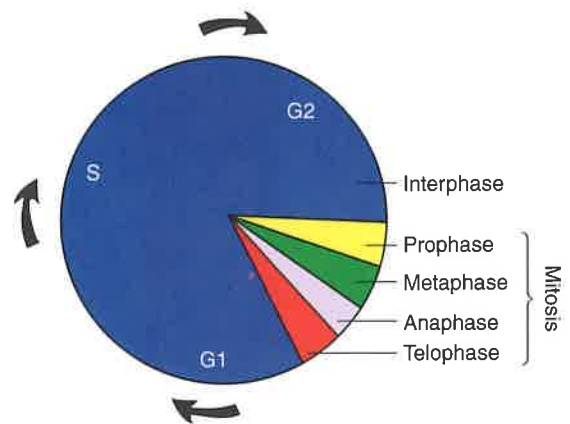


Figure 6-1 Cell life cycle and its major phases.

- 3 **Metaphase** is the period during which the chromosomes (each a pair of replicate chromatids joined at a centromere) line up along the cell's equator (imaginary center plane). Each chromosome now has a pair of spindle fibers attached to it, one from each centriole pair.
- 4 **Anaphase** is the phase during which the chromatids split at the centromere, each moving toward an opposite pole along the path of a spindle fiber. At the end of anaphase, each pole of the cell has a full group of 46 single chromosomes. The chromosomes on one side of the cell are replicates of the set of chromosomes on the other side.
- 5 **Telophase** is the time during which each side of the cell changes everything to the way it should be during interphase:
  - A nuclear membrane forms around each group of chromosomes
  - The chromosomes uncoil to form long chromatin strands
  - Remnants of the spindle fibers disintegrate
- 6 During anaphase of mitosis, the separate (but concurrent) process of *cytokinesis* begins. By the end of anaphase, cleavage, or pinching in, of the parent cell is evident. By the end of telophase, complete splitting of the parent cell into two similar daughter cells is complete. Each daughter cell has a nucleus and roughly half of the cytoplasm and organelles of the parent cell.
- 7 Review the major events of the cell life cycle by completing the coloring exercise *Cell Life Cycle* (Figure 6-2).

The length of time between divisions, and the time required for division to take place, vary considerably from cell to cell. Even the relative length of different phases varies among individual cells. Cell division can range from 20 minutes to several hours.

## B. MICROSCOPIC OBSERVATIONS

In this activity, you will observe cells of the *whitefish blastula* in a prepared slide as in Figures 6-3 and 6-4. The blastula is a developmental stage in the growth of many animals. The original cell

formed by the joining of the egg and sperm undergoes mitosis many times, at one stage forming a ball of cells called a *blastula*. The cells of the blastula are still undergoing rapid cell division, making it a specimen likely to have many cells at various stages of the cell life cycle.



### SAFETY FIRST!

Do not forget to check the microscope's power cord for frays and for proper placement. Take care that you don't crack a slide or lens by zooming in with coarse focus without looking from the side. Accidents do not happen when you are careful.

- 1 Obtain a prepared microscope slide (microslide) of whitefish blastula cross sections (c.s.).
- 2 Locate a group of cells using low-power magnification. There are usually several different cell groups from which to choose on each slide.
- 3 Switch to high power and try to locate individual cells in each of the five phases of the cell life cycle. You may need to occasionally switch slides to find all the phases.



### LANDMARK CHARACTERISTICS

Many prepared whitefish blastula specimens are stained so that the cytoplasm appears pinkish to brown-red (Figure 6-3). The DNA (chromatin, chromosomes) is stained black. Therefore look for fine, black formations when looking for the major events of mitosis. The plasma membranes and centrioles are so small that they will not appear distinctly in your specimen.

In a single microscopic field, you will see many cells, all at different points in the cell life cycle. There is no pattern to the way the cells in different phases are arranged (they are not laid out in order of mitotic phases, for instance). If you are fortunate, you may find at least one example of each phase in a single field.

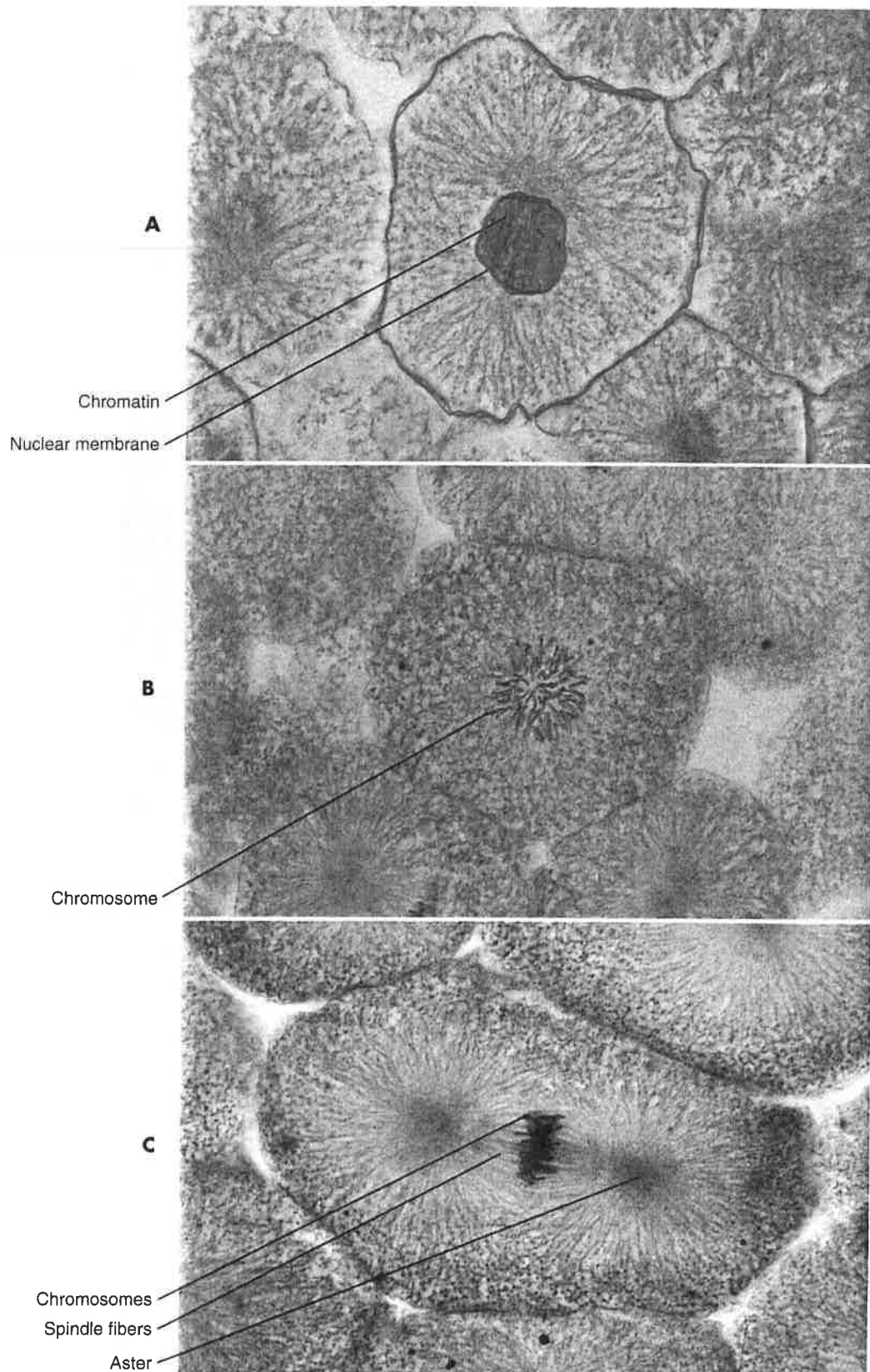


Figure 6-3 Micrographs of whitefish cells during the cell life cycle. A, Interphase. B, Prophase. C, Metaphase.

*Continued*

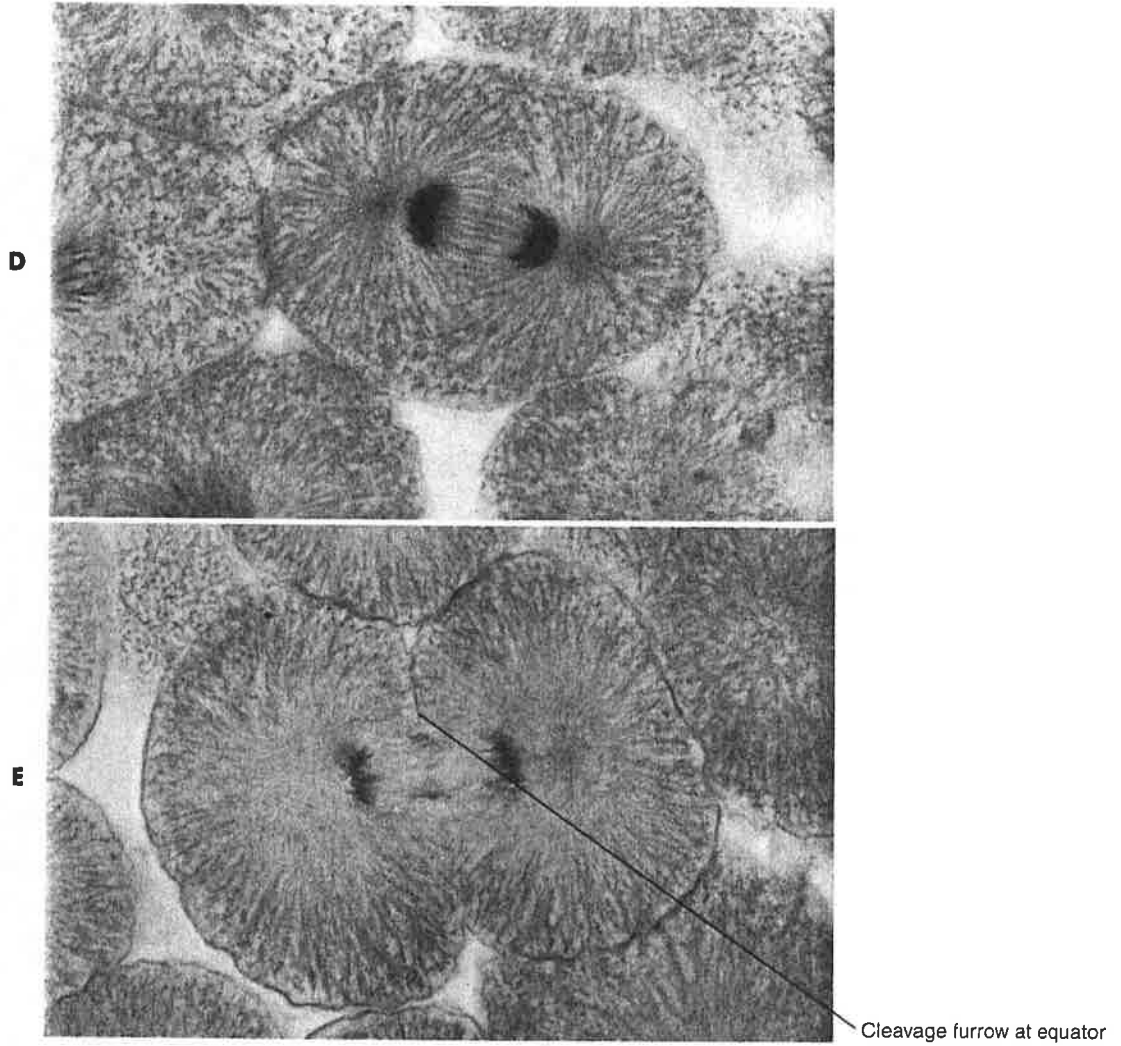


Figure 6-3, cont'd D, Anaphase. E, Telophase.

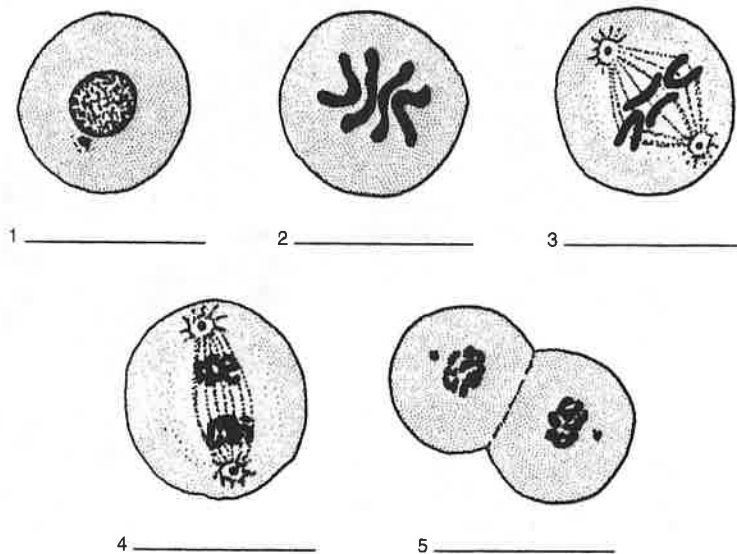


Figure 6-4 Examples of whitefish cells. Label each with the name of the appropriate phase on the lines provided and on the blanks in the Lab Report at the end of this exercise.

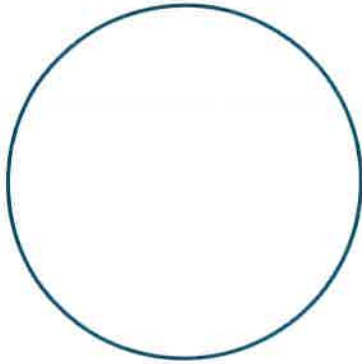
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## Lab Report

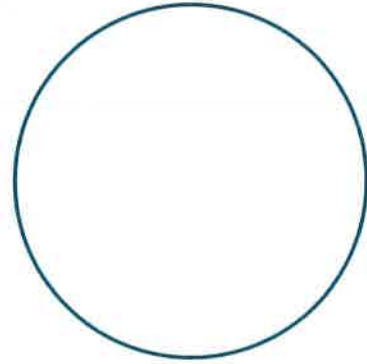
# The Cell's Life Cycle

Sketch your observations of particularly clear examples of mitotic phases in whitefish cells.



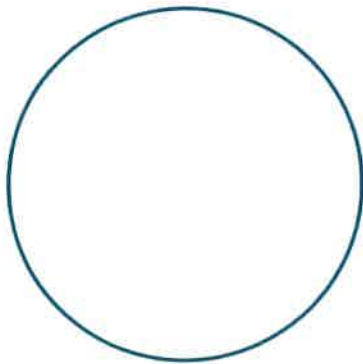
Specimen: *whitefish*, phase \_\_\_\_\_

Total Magnification: \_\_\_\_\_



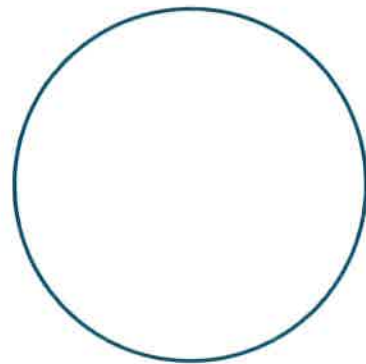
Specimen: *whitefish*, phase \_\_\_\_\_

Total Magnification: \_\_\_\_\_



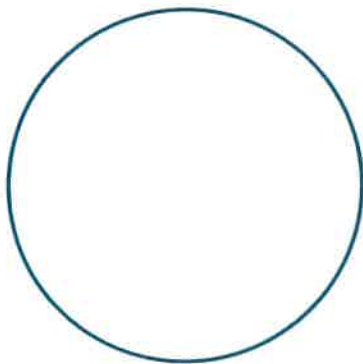
Specimen: *whitefish*, phase \_\_\_\_\_

Total Magnification: \_\_\_\_\_



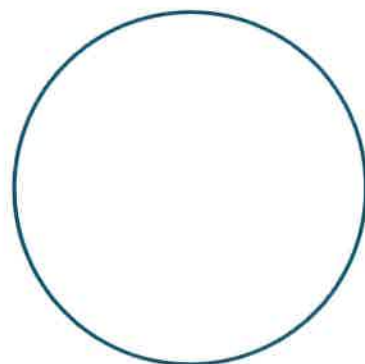
Specimen: *whitefish*, phase \_\_\_\_\_

Total Magnification: \_\_\_\_\_



Specimen: *whitefish*, phase \_\_\_\_\_

Total Magnification: \_\_\_\_\_



Specimen: *whitefish*, phase \_\_\_\_\_

Total Magnification: \_\_\_\_\_

**Fill-in** (write the name of the mitotic phase identified in each item)

1. The centrioles move toward opposite poles during   ?  .
2. During   ?   the nuclear membrane disintegrates.
3. The nuclear membrane reappears during   ?  .
4. The last phase of mitosis is   ?  .
5. During   ?   the chromosomes align at the cell's equator.
6. Cytokinesis usually begins during   ?   of mitosis.
7. The first phase of mitosis is   ?  .
8. During   ?   the chromatids separate and move toward opposite poles.
9. Spindle fibers appear during   ?  .
10. Mitosis ends with   ?  .

**Multiple Choice** (only one choice is correct)

1. The function of mitosis is
  - a. to distribute the cell's DNA equally between the daughters
  - b. to divide the cytoplasm equally between the daughter cells
  - c. to distribute the parent cell's organelles evenly
  - d. all of the above
  - e. none of the above
2. The chromosomes of daughter cells formed during mitosis
  - a. are double the number of those in the parent cell
  - b. are identical to the chromosomes of the other daughter
  - c. are half the number of those in the parent cell
  - d. b and c are correct
  - e. all are correct
3. Which of these cells is likely to have been formed using mitosis?
  - a. skin cell
  - b. sperm cell
  - c. egg cell
  - d. heart muscle cell
  - e. a and d are correct
4. A certain stain colors DNA violet. When stained, which of these should appear violet?
  - a. chromatin
  - b. chromosomes
  - c. chromatids
  - d. a and b are correct
  - e. all of the above
5. Two DNA molecules, joined at a centromere, have coiled to form tiny bodies. This connected pair of DNA molecules should properly be called
  - a. a centromere
  - b. a centriole
  - c. a chromosome
  - d. a chromatid
  - e. a chromatin strand

**Fill-in**

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_
5. \_\_\_\_\_
6. \_\_\_\_\_
7. \_\_\_\_\_
8. \_\_\_\_\_
9. \_\_\_\_\_
10. \_\_\_\_\_

**Multiple Choice**

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_
5. \_\_\_\_\_



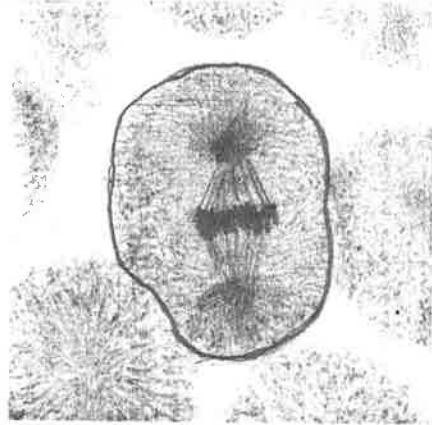
# Cell Division: Mitosis and Cytokinesis

6. What is the importance of mitotic cell division? \_\_\_\_\_

7. Identify the three phases of mitosis shown in the following photomicrographs, and select the events from the key choices that correctly identify each phase. Write the key letters on the appropriate answer line.

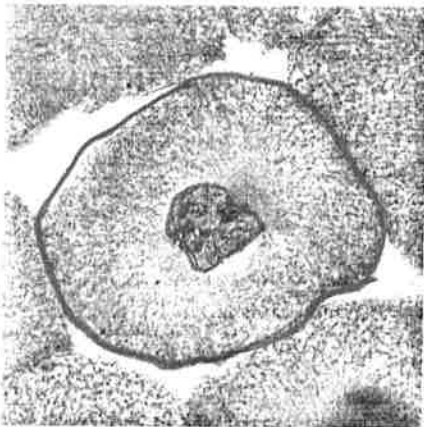
Key:

- a. Chromatin coils and condenses, forming chromosomes.
- b. The chromosomes (chromatids) are V-shaped.
- c. The nuclear membrane re-forms.
- d. Chromosomes stop moving toward the poles.
- e. Chromosomes line up in the center of the cell.
- f. The nuclear membrane fragments.
- g. The spindle forms.
- h. DNA synthesis occurs.
- i. Chromosomes first appear to be double.
- j. Chromosomes attach to the spindle fibers.
- k. The nuclear membrane(s) is absent.



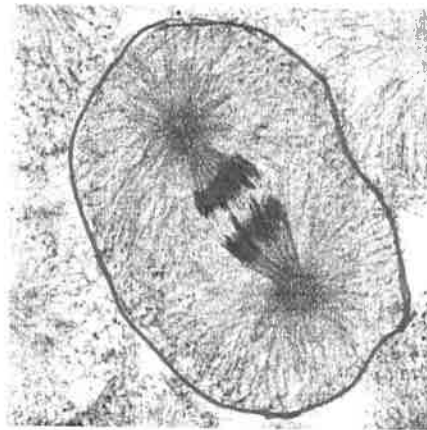
1. Phase: \_\_\_\_\_

Events: \_\_\_\_\_



2. Phase: \_\_\_\_\_

Events: \_\_\_\_\_



3. Phase: \_\_\_\_\_

Events: \_\_\_\_\_

**COLORING EXERCISE**

Use colored pens or pencils to shade in both the figure and the labels. Each red numeral in the figure corresponds to a blue numeral following the appropriate label.

**Cell Life Cycle**

- MITOSIS 1
- CYTOKINESIS 2
- INTERPHASE 3
- PROPHASE 4
- METAPHASE 5
- ANAPHASE 6
- TELOPHASE 7

- CELL MEMBRANE 8
- NUCLEAR MEMBRANE 9
- NUCLEOLUS 10
- CENTRIOLES 11
- CHROMATIN/CHROMOSOME 12
- CENTROMERE 13

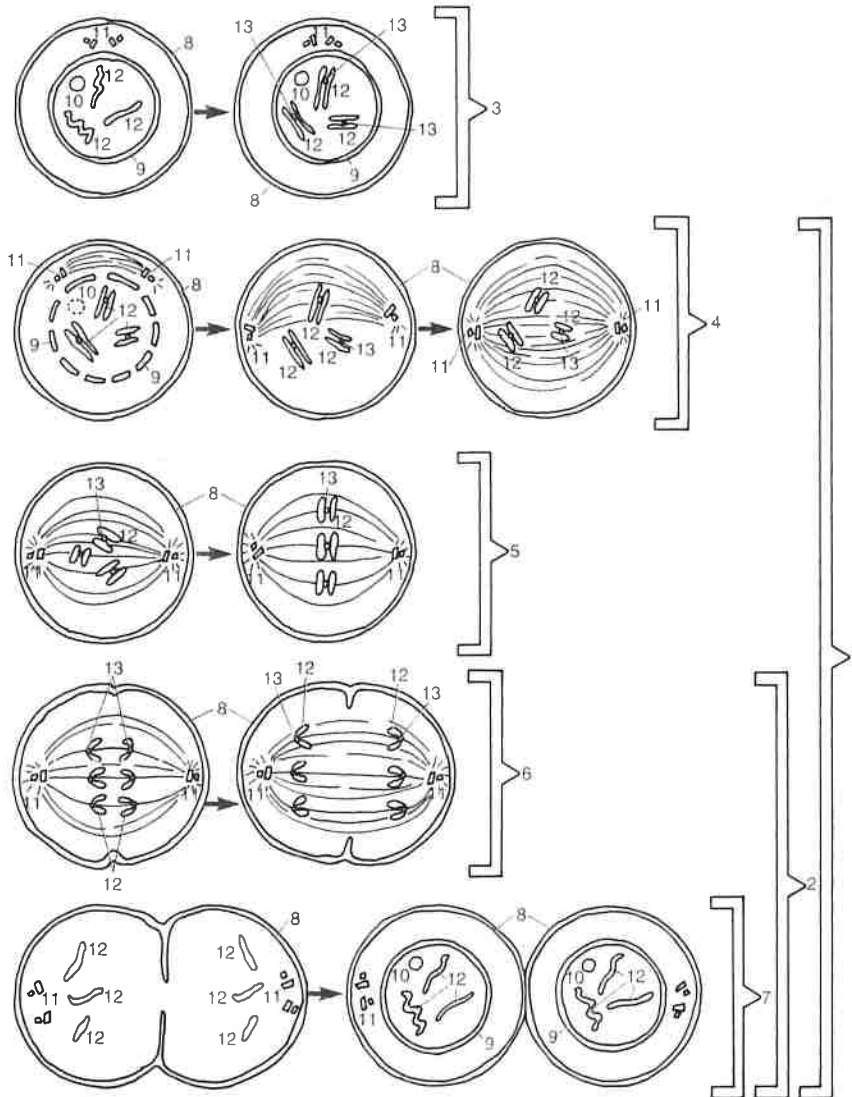


Figure 6-2