

## Section Summary

The cell cycle is an orderly sequence of events. Cells on the path to cell division proceed through a series of precisely timed and carefully regulated stages. In eukaryotes, the cell cycle consists of a long preparatory period, called interphase. Interphase is divided into  $G_1$ , S, and  $G_2$  phases. Mitosis consists of five stages: prophase, prometaphase, metaphase, anaphase, and telophase. Mitosis is usually accompanied by cytokinesis, during which the cytoplasmic components of the daughter cells are separated either by a cleavage furrow, animal cells or by cell plate formation, plant cells.

Each step of the cell cycle is monitored by internal controls called checkpoints. There are three major checkpoints in the cell cycle: one near the end of  $G_1$ , a second at the  $G_2$ –M transition, and the third during metaphase. Cancer is the result of unchecked cell division caused by a breakdown of the mechanisms regulating the cell cycle.

## Exercises

1. Which phase will come between prophase and metaphase?
  - a. Telophase
  - b. S phase
  - c. Anaphase
  - d. Prometaphase
2. Chromosomes are duplicated during what portion of the cell cycle?
  - a.  $G_1$  phase
  - b. S phase
  - c. prophase
  - d. prometaphase
3. Separation of the sister chromatids is a characteristic of which stage of mitosis?
  - a. prometaphase
  - b. metaphase
  - c. anaphase
  - d. telophase
4. Cancers can begin when a mutation occurs in the DNA
  - a. TRUE
  - b. FALSE
5. What is necessary for a cell to pass the  $G_2$  checkpoint?
  - a. the cell has reached a sufficient size
  - b. an adequate stockpile of nucleotides
  - c. accurate and complete DNA replication
  - d. proper attachment of mitotic spindle fibers to kinetochores
6. Describe the similarities and differences between the cytokinesis mechanisms found in animal cells versus those in plant cells.

## Answers

1. (d)
2. (b)
3. (c)
4. (a)
5. (c)
6. There are very few similarities between animal cell and plant cell cytokinesis. In animal cells, a ring of actin fibers is formed around the periphery of the cell at the former metaphase plate. The actin ring contracts inward, pulling the plasma membrane toward the center of the cell until the cell is pinched in two. In plant cells, a new cell wall must be formed between the daughter cells. Because of the rigid cell walls of the parent cell, contraction of the middle of the cell is not possible. Instead, a cell plate is formed in the center of the cell at the former metaphase plate. The cell plate is formed from Golgi vesicles that contain enzymes, proteins, and glucose. The vesicles fuse, and the enzymes build a new cell wall from the proteins and glucose. The cell plate grows toward, and eventually fuses with, the cell wall of the parent cell.

## Glossary

**anaphase:** the stage of mitosis during which sister chromatids are separated from each other

**cell cycle:** the ordered sequence of events that a cell passes through between one cell division and the next

**cell cycle checkpoints:** mechanisms that monitor the preparedness of a eukaryotic cell to advance through the various cell cycle stages

**cell plate:** a structure formed during plant-cell cytokinesis by Golgi vesicles fusing at the metaphase plate; will ultimately lead to the formation of a cell wall to separate the two daughter cells

**centrosomes:** microtubule-organizing centers that give rise to the mitotic spindle

**cleavage furrow:** a constriction formed by the actin ring during animal-cell cytokinesis that leads to cytoplasmic division

**cytokinesis:** the division of the cytoplasm following mitosis to form two daughter cells

**G<sub>0</sub> phase:** a cell-cycle phase distinct from the G<sub>1</sub> phase of interphase; a cell in G<sub>0</sub> is not preparing to divide

**G<sub>1</sub> phase:** (also called gap 1) a cell-cycle phase; the first phase of interphase centered on cell growth during mitosis

**G<sub>2</sub> phase:** (also called gap 2) a cell-cycle phase; third phase of interphase where the cell undergoes the final preparations for mitosis

**interphase:** the period of the cell cycle leading up to mitosis; includes G<sub>1</sub>, S, and G<sub>2</sub> phases; the interim between two consecutive cell divisions

**kinetochore:** a protein structure in the centromere of each sister chromatid that attracts and binds spindle microtubules during prometaphase

**metaphase plate:** the equatorial plane midway between two poles of a cell where the chromosomes align during metaphase

**metaphase:** the stage of mitosis during which chromosomes are lined up at the metaphase plate

**mitosis:** the period of the cell cycle at which the duplicated chromosomes are separated into identical nuclei; includes prophase, prometaphase, metaphase, anaphase, and telophase

**mitotic phase:** the period of the cell cycle when duplicated chromosomes are distributed into two nuclei, and the cytoplasmic contents are divided; includes mitosis and cytokinesis

**mitotic spindle:** the microtubule apparatus that orchestrates the movement of chromosomes during mitosis

**prometaphase:** the stage of mitosis during which mitotic spindle fibers attach to kinetochores

**prophase:** the stage of mitosis during which chromosomes condense and the mitotic spindle begins to form

**sexual reproduction:** requires the egg and sperm to come together to form a zygote

**sister chromatids:** two identical chromosomes attached to one another at a location called the centromere region

**S phase:** the second, or synthesis phase, of interphase during which DNA replication occurs

**telophase:** the stage of mitosis during which chromosomes arrive at opposite poles, decondense, and are surrounded by new nuclear envelopes