Chapter 12: The Cell Cycle

12.1 Explain how mitosis results in genetically identical cells, using the terms chromosome, chromatid, and chromatin.

12.2 Describe the events of interphase and the M phase.

12.3 Identify three checkpoints that control the cell cycle and explain how they operate.

This chapter will be essential to your understanding of how heritable information is passed unchanged from one cell to its descendants and provides for the continuity of life. Multicellular organisms grow and cells are renewed in this process of cell division.

Study Tip: Figure 12.1 in your text summarizes how one cell passes on its genetic information to identical daughter cells in three distinct phases called the cell cycle. As you work through this chapter, you will add details to each process. Summarize each phase.

Interphase

Mitosis

Cytokinesis

Concept 12.1 Most cell division results in genetically identical daughter cells

LO 12.1: Explain how mitosis results in genetically identical cells, using the terms chromosome, chromatid, and chromatin.

1. What are the three key roles of cell division? Refer to Figure 12.2 in your text. State each function and give an example.

Function	Example

2. What is the meaning of *genome*?

3. What is *chromatin*?

4. How many chromosomes are in a human *somatic cell*? Name two types of somatic cells in your body.

5. What is a *gamete*? Name the two types of gametes.

6. How many chromosomes are present in a human gamete?

7. How many DNA molecules are in each of your somatic cells? Think carefully!

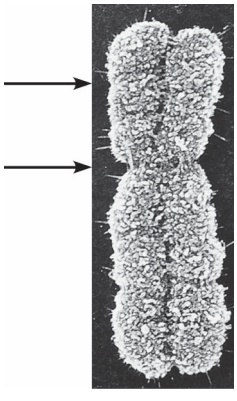
8. You are going to have to learn the difference between several similar-sounding terms. The following sketch that looks like an X represents a *duplicated chromosome* that has two *sister chromatids*. The narrow "waist" represents the location of the *centromere*. The centromere is a region of DNA, a part of the chromosome where one sister chromatid will attach to the other sister chromatid. A single chromosome has one centromere; duplicated chromosomes therefore have two centromeres, adhering to each other in this region. Students often get all these terms confused, so take time now to label the indicated areas of the figure and then define each of the terms below.

chromosome

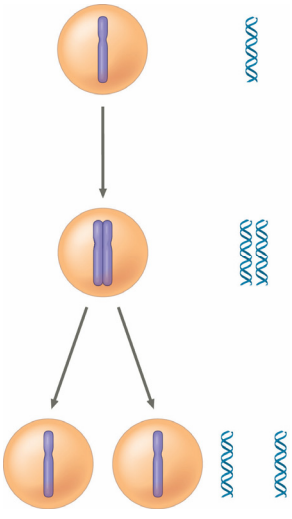
chromatid

centromere

chromatin



9. Study Figure 12.5 in your text. Label the following figure and summarize what occurs at the DNA level in each stage. The top figure shows one chromosome. The middle figure shows a duplicated chromosome with two sister chromatids. It is still considered one chromosome. When the sister chromatids have separated in the bottom figure, they are now considered individual chromosomes. Run through this again! Top picture, one chromosome. Middle picture, one duplicated chromosome (with two sister chromatids). Bottom picture, two chromosomes.



10. What is *mitosis*? How is it different from *cytokinesis*?

11. What occurs in *meiosis*? Where does it occur in humans?

12. A chicken has 78 chromosomes in its somatic cells.

    a. How many chromosomes did the chicken inherit from each parent?

    b. How many chromosomes are in each of the chicken's gametes?

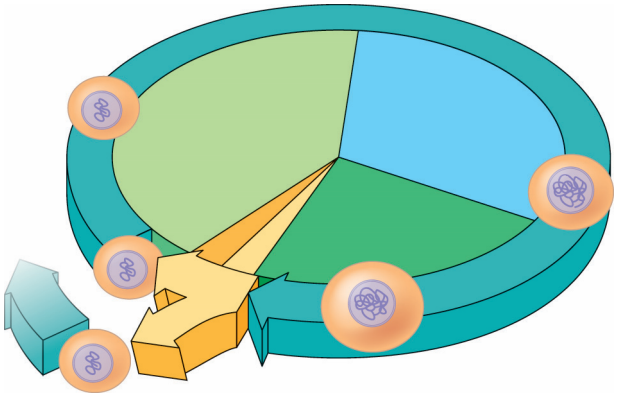
    c. How many chromosomes will be in each somatic cell of the chicken's offspring?

Concept 12.2 The mitotic phase alternates with interphase in the cell cycle

LO 12.2: Describe the events of interphase and the M phase.

13. What is considered to be the *cell cycle*?

14. Label each of the parts of the cell cycle listed below and give a brief explanation of what happens in each phase.



G_1

S

G_2

M

15. During which parts of the cell cycle does the cell grow?

16. Which part of the cell cycle is longest in duration?

17. What are the components of the *mitotic spindle*? What is the source of these components? (p. 240)

Refer to Figure 12.7 in your text. This two-page spread contains essential information about the events of mitosis in an animal cell. Note that this figure begins with events following the S phase, so the chromosomes are duplicated at this stage. The questions that follow will take you through this figure step-by-step.

18. Many of the events of mitosis depend on the *mitotic spindle.* In animal cells, the assembly of spindle microtubules starts at the *centrosome*. What is another name for the centrosome?

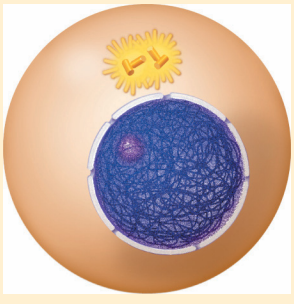
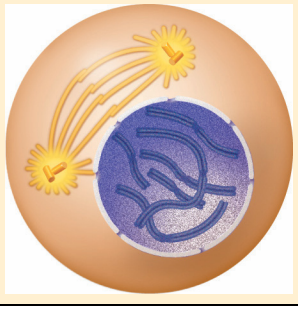
19. What is the function of the centrosomes?

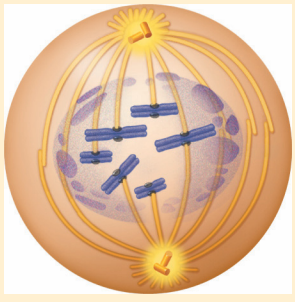
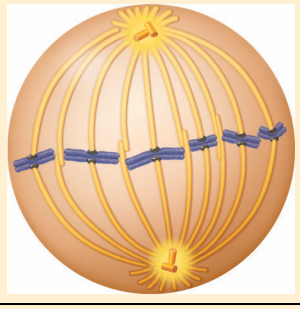
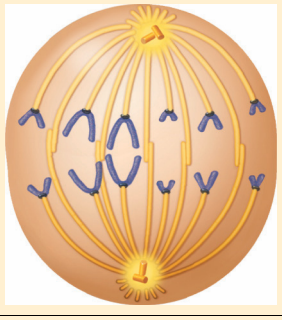
20. Sketch and label a centrosome with two *centrioles*.

21. Describe what happens to the centrosome during prophase.

22. What is a *kinetochore*? Read your text carefully, and then make a labeled sketch that shows a duplicated chromosome with two kinetochores and some attached spindle fibers. Figure 12.8 in your text will help.

23. Use Figure 12.7 in your text to help you complete this chart. Label each phase by name; then label the smaller structures. Finally, make two or three summary statements that indicate important features to note about the phase.

	Phase	Important Features of Phase
		
		

	Phase	Important Features of Phase
		
		
		
		

24. Explain the difference between *kinetochore* and *nonkinetochore* microtubules. What is the function of each?

25. Using Inquiry Figure 12.9 in your text, explain how evidence was gathered to justify the claim that microtubules depolymerize from the kinetochore end during anaphase.

26. Describe *cytokinesis* in an animal cell. Make a labeled sketch that shows the *cleavage furrow*.

27. Describe cytokinesis in a plant cell. Make a labeled sketch that shows the *cell plate*.

28. How is the cell plate formed? What is the source of the material for the cell plate?

29. Prokaryote reproduction does not involve mitosis, but instead occurs by *binary fission*. This process involves an *origin of replication*. Describe binary fission.

Concept 12.3 The eukaryotic cell cycle is regulated by a molecular control system

LO 12.3: Identify three checkpoints that control the cell cycle and explain how they operate.

30. What controls the cell cycle? Study Inquiry Figure 12.14 in your text to help you answer this question.

31. What is a cell cycle *checkpoint*?

32. Summarize what happens at each checkpoint. You may add to this chart as you study this section.

Checkpoint	What Happens? How Is It Controlled?
G_1	
G_2	
M	

33. What is the function of a *protein kinase*? (Recall that we discussed protein kinases in Chapter 11 also. Regardless of their location, their function is always the same.)

34. Kinases drive the cell cycle, but they must be activated by attachment of what molecules?

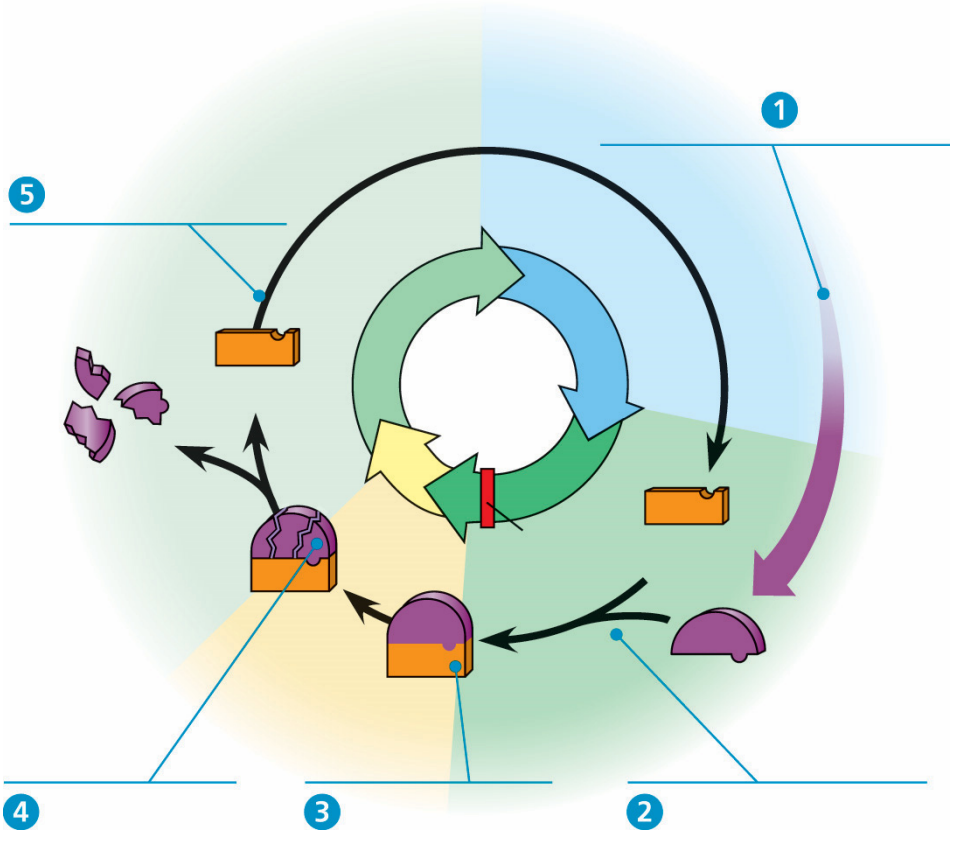
35. The activity of *cyclin-dependent kinases (Cdks)* rises and falls. Why?

36. What does *MPF* trigger? What are some specific activities that it triggers?

37. What is the *G_0 phase*? Describe this phase. What cell types remain in this phase throughout their life spans?

38. What happens if all the chromosome kinetochores are not attached to spindle fibers? When this occurs, which checkpoint is not passed?

39. Bring together the molecular mechanisms that help regulate the cell cycle by first labeling the figure below, then explain at each number what is occurring in the cell at that point.



40. What are *growth factors?* How does *platelet-derived growth factor (PDGF)* stimulate fibroblast division?

41. Cancer cells exhibit different behaviors than normal cells. Here are two normal behaviors they no longer show. Explain each behavior and tell how its loss affects normal cell behavior.

density-dependent inhibition

anchorage dependence

42. Cancer cells also show loss of cell cycle controls and may divide without being checked. The story of HeLa cells is worth noting. What is their source? How old are they? Note that, unlike normal cells, HeLa cells are immortal!

43. What is *transformation?* What is *metastasis*?

44. Distinguish between a *benign tumor* and a *malignant tumor*.

45. List two specific cancer treatments and explain how each treatment works.

Test Your Understanding, p. 251

Now you should be ready to test your knowledge. Place your answers here:

1. ____ 2. ____ 3. ____ 4. ____ 5. ____ 6. ____ 7. ____

8. ____