

4

CELL STRUCTURE AND FUNCTION

CHAPTER REVIEW

All organisms are composed of cells. Cells are the smallest units displaying the properties of life. Cells normally are measured in micrometers because they are so small. Their small size ensures a sufficient amount of plasma membrane to serve the **cytoplasm**.

The two major kinds of cells are **prokaryotic** and **eukaryotic**. They differ by the organization of chromosomal DNA and the presence of **organelles** in the cytoplasm. Prokaryotic cells are divided into two domains, **Archaea** and **Bacteria**. These cells lack a membrane-bounded nucleus and other membranous organelles.

Organisms with eukaryotic cells are members of the domain **Eukarya**. The **nucleus** of eukaryotic cells (plant and animal) is defined by a nuclear envelope, which separates the nucleoplasm from the cytoplasm. The chromosomal material exists as **chromatin** until the cell divides. The **nucleolus** in the nucleus contains ribosomal RNA and the proteins of ribosomal subunits.

The eukaryotic cell contains a variety of structures in the cytoplasm. **Ribosomes** are the site of protein syn-

thesis. They may exist freely or be attached to the **endoplasmic reticulum**. The **endomembrane system** consists of the nuclear envelope, the endoplasmic reticulum, the Golgi apparatus, and vesicles. The **endoplasmic reticulum** provides channels that transport substances through the cell. Substances are processed and packaged by the **Golgi apparatus**. **Lysosomes** contain enzymes that promote the breakdown of cell substances. Vesicles transport molecules from one part of the system to another.

Some organelles are specialized to handle energy in the cell. **Chloroplasts** are the site of photosynthesis, whereas the **mitochondria** are regions involved in cellular respiration. These organelles may be remnants of prokaryotes that inhabited eukaryotic cells over evolutionary time.

The **cytoskeleton** contains microtubules, intermediate filaments, and actin filaments. They maintain cell shape and assist movement of cell parts.

STUDY EXERCISES

Study the text section by section as you answer the questions that follow.

4.1 CELLULAR LEVEL OF ORGANIZATION (PP. 58–59)

- All organisms are composed of cells, which arise from preexisting cells.
- A microscope is usually needed to see a cell because most cells are small.

1. Check the two statements that are tenets of the cell theory.
 - a. All organisms are made up of cells.
 - b. Cork cells are living.
 - c. Multicellular organisms are living.
 - d. Cells come only from preexisting cells.
2. Label each of the following statements with B or T as describing the bright-field light microscope (B) or the transmission electron microscope (T):
 - a. focusing by glass lenses
 - b. focusing by magnetic lenses
 - c. image viewed from photographic film or fluorescent screen
 - d. image viewed through the microscope
3. Name several other microscopes or microscopy techniques available to study cells today. _____

Cell Size (p. 59)

- Surface-area-to-volume relationships explain why cells are so small.

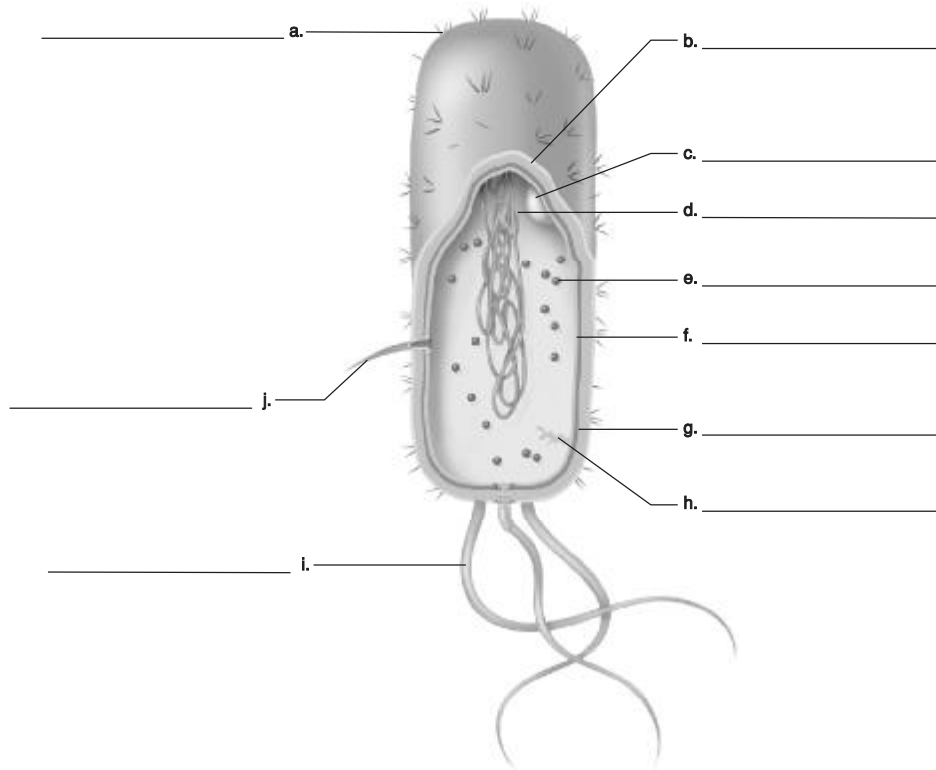
4. As the volume of a cell ^{a.} _____, the proportionate amount of cell surface area ^{b.} _____.
5. A large cell requires more ^{a.} _____ and produces more ^{b.} _____ than a small cell. Materials are exchanged at the cell's ^{c.} _____. Because the surface area of a large cell actually ^{d.} _____, cell size stays ^{e.} _____.

4.2 PROKARYOTIC CELLS (PP. 62–63)

- Prokaryotic cells do not have a membrane-bounded nucleus or other organelles of eukaryotic cells.

6. Label this diagram of a prokaryotic cell, using the following alphabetized list of terms.

- | | | |
|------------|------------------|-----------------|
| cell wall | inclusion bodies | pilus |
| fimbriae | mesosome | plasma membrane |
| flagellum | nucleoid | ribosomes |
| glycocalyx | | |



For questions 7–12, match each of the following prokaryotic cell parts to its description:

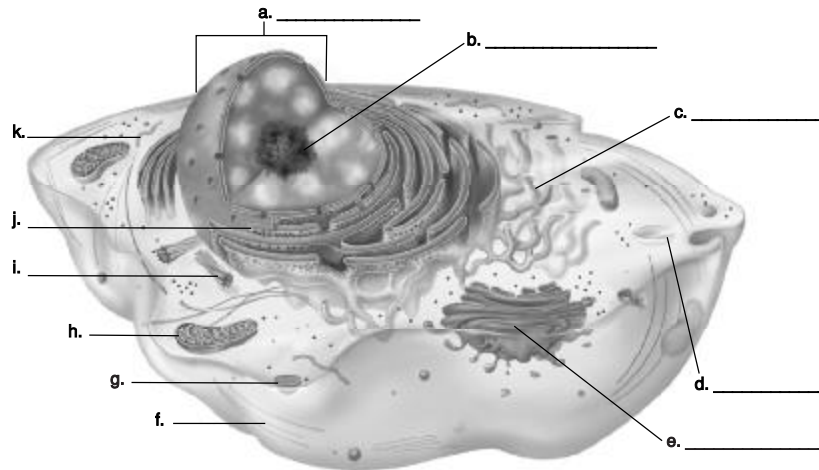
- | | |
|-------------------|---|
| ___ 7. cell wall | a. sites of protein synthesis |
| ___ 8. flagellum | b. gel-like coating outside the cell wall |
| ___ 9. glycocalyx | c. location of bacterial chromosomes |
| ___ 10. nucleoid | d. structure that provides support; shapes cell |
| ___ 11. pilus | e. rotating filament that pushes the cell forward |
| ___ 12. ribosomes | f. hollow appendage that transfers DNA to other cells |

4.3 EUKARYOTIC CELLS (PP. 64–79)

- Organelles are membrane-bounded compartments specialized to carry out specific functions.

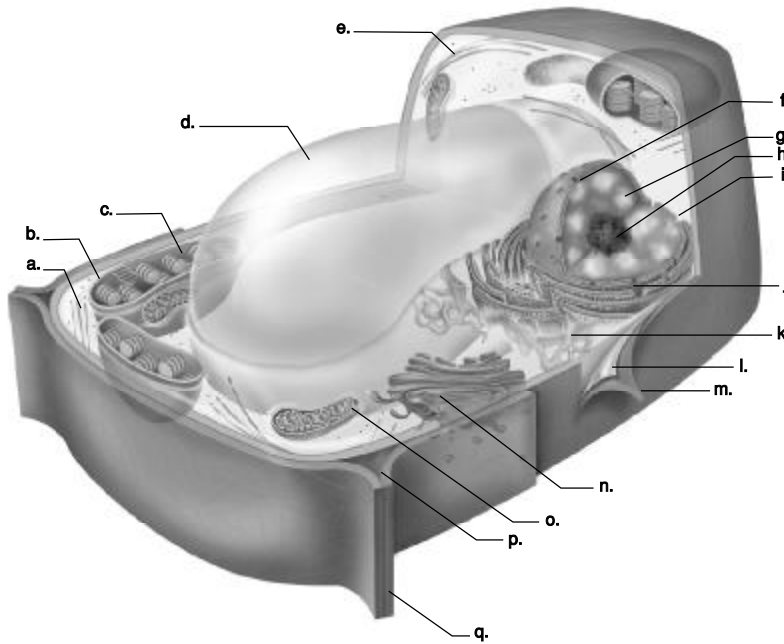
13. Label this diagram of an animal cell using the following alphabetized list of terms.

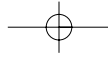
- centriole
- Golgi apparatus
- lysosome
- microtubule
- mitochondrion
- nucleolus
- nucleus
- ribosome
- rough ER
- smooth ER
- vacuole



14. Label this diagram of a plant cell using the following alphabetized list of terms.

- actin filament
- cell wall
- central vacuole
- chloroplast
- chromatin
- Golgi apparatus
- intracellular space
- microtubule
- middle lamella
- mitochondrion
- nuclear envelope
- nuclear pore
- nucleolus
- plasma membrane
- ribosome
- rough ER
- smooth ER





15. Complete this table by writing *yes* (the structure is present) or *no* (it is not present) on the lines provided.

Cell Part	Prokaryotic	Eukaryotic (animal)
plasma membrane		
cell wall		
nuclear envelope		
mitochondria		
endoplasmic reticulum		
ribosomes		
centrioles		

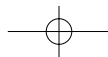
16. Place the following terms in the appropriate column to compare plant and animal cell structures (some terms are used in both columns).

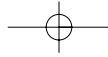
cell wall centrioles chloroplasts large central vacuole mitochondria
 plasma membrane small vacuoles

Animal	Plant

17. Which eukaryotic organelles could have evolved from independent prokaryotes that took up residence in early eukaryotic cells?

- a. ____ ribosomes
- b. ____ mitochondria
- c. ____ centrioles
- d. ____ chloroplasts





The Nucleus and Ribosomes (pp. 68–69)

• Eukaryotic cells have a membrane-bounded nucleus that contains DNA within chromosomes.

18. The nucleus is enclosed by the ^{a.} _____, which contains ^{b.} _____ that open into the cytoplasm. At the time of cell division, chromatin ^{c.} _____ to form chromosomes. Chromatin has a region called the ^{d.} _____, where ^{e.} _____ is produced.

The Endomembrane System (pp. 70–72)

19. Explain how these organelles work together.

a. ribosomes and endoplasmic reticulum _____

b. endoplasmic reticulum and Golgi apparatus _____

c. lysosomes and vesicles _____

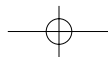
Energy-Related Organelles (pp. 74–75)

• Chloroplasts use solar energy to produce organic molecules that are broken down, releasing energy in mitochondria.

For questions 20–25, match each of the following endomembrane system organelles to its description:

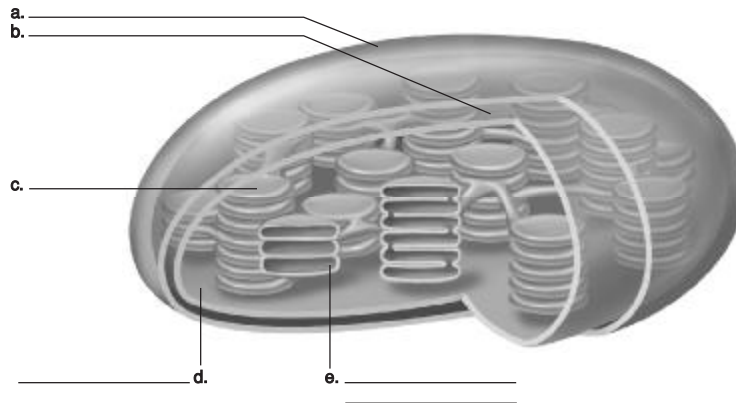
- | | |
|----------------------------|--|
| ___ 20. rough ER | a. contain digestive enzymes |
| ___ 21. smooth ER | b. sorts lipids and proteins and packages them in vesicles |
| ___ 22. lysosomes | c. fuse with plasma membrane to move substances outside cell |
| ___ 23. transport vesicles | d. synthesizes proteins and packages them |
| ___ 24. Golgi apparatus | e. synthesizes lipids |
| ___ 25. secretory vesicles | f. shuttle proteins and lipids to various locations |

26. Chloroplasts use ^{a.} _____ energy to synthesize ^{b.} _____, which are broken down by ^{c.} _____ to produce ^{d.} _____ molecules. Photosynthesis occurs in ^{e.} _____.



27. Label this diagram of a chloroplast using the following alphabetized list of terms.

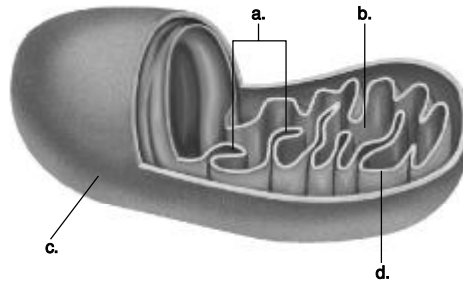
- granum
- inner membrane
- outer membrane
- stroma
- thylakoid space



28. Using words, what is the overall equation for photosynthesis? _____

29. Label this diagram of a mitochondrion using the following alphabetized list of terms.

- cristae
- inner membrane
- matrix
- outer membrane



30. Using words, what is the overall equation for cellular respiration? _____

The Cytoskeleton (pp. 76–79)

- The cytoskeleton, a complex network of interconnected filaments and tubules, gives the cell its shape and accounts for the movement of the cell and its organelles.

31. Match the definitions to these terms:

- actin filament intermediate filament microtubule
- a. _____ small cylinder made of the protein tubulin
- b. _____ long, extremely thin fiber that often interacts with myosin
- c. _____ fibrous polypeptide that varies according to the tissue

32. Microtubules, like actin filaments and intermediate filaments, are able to assemble and ^{a.} _____. Microtubules radiate out from the centrosome, the main ^{b.} _____ center in a cell. In animal cells, this center contains two ^{c.} _____, which have a 9 + 0 pattern of microtubules. Centrosomes have long been associated with the formation of the ^{d.} _____ during cell division. Centrioles are believed to give rise to ^{e.} _____, which organize cilia and flagella. Cilia and flagella have a(n) ^{f.} _____ pattern of microtubules.

CHAPTER TEST

OBJECTIVE QUESTIONS

Do not refer to the text when taking this test. In questions 1–8, match each cell part with these descriptions:

- a. regulates passage of substances into the cell
 b. processing and transport channel
 c. contains enzymes for digestion
 d. site of protein synthesis
 e. location of the nucleolus
 f. site of cellular respiration
 g. found in plants, not animals
 h. maintains cell shape
- ___ 1. chloroplast
 ___ 2. cytoskeleton
 ___ 3. endoplasmic reticulum
 ___ 4. lysosome
 ___ 5. mitochondrion
 ___ 6. nucleus
 ___ 7. plasma membrane
 ___ 8. ribosome
- ___ 9. Cells are normally measured in
 a. centimeters.
 b. meters.
 c. micrometers.
 d. millimeters.
- ___ 10. The minimum distance between two objects before they are seen as one object is known as
 a. illumination.
 b. magnification.
 c. resolution.
 d. transmission.
- ___ 11. Select the structure found in eukaryotic cells but not in prokaryotic cells.
 a. plasma membrane
 b. cell wall
 c. mitochondrion
 d. ribosome
- ___ 12. Select the incorrect association.
 a. glycocalyx—coating
 b. cell wall—provides support
 c. flagellum—movement
 d. mesosome—movement
- ___ 13. The structure that surrounds the cytoplasm in a bacterial cell is the
 a. cell wall.
 b. nucleoid.
 c. plasma membrane.
 d. ribosome.
- ___ 14. How are mitochondria and chloroplasts similar to bacteria?
 a. They are bounded by a single membrane.
 b. They have a limited amount of genetic material.
 c. They lack ribosomes.
 d. They are larger than normal cells.
- ___ 15. Which of the following structures is part of the cell's endomembrane system?
 a. chloroplast
 b. endoplasmic reticulum
 c. mitochondrion
 d. nucleolus
- ___ 16. Plant cells
 a. have a cell wall but not a plasma membrane.
 b. have chloroplasts but no mitochondria.
 c. do not have any centrioles and yet divide.
 d. have a large central vacuole but do not have endoplasmic reticulum.
- ___ 17. Which of these does NOT contain nucleic acid?
 a. chromosomes
 b. ribosomes
 c. chromatin
 d. centrioles
 e. genes
- ___ 18. How are mitochondria like chloroplasts?
 a. They have the same structure.
 b. They both absorb the energy of the sun.
 c. They both are concerned with energy.
 d. They are both in animal cells.
- ___ 19. Which of the following cell structures within the cytoplasm is connected to the nuclear envelope?
 a. nucleolus
 b. chromatin
 c. endoplasmic reticulum
 d. vacuoles
 e. lysosomes
- ___ 20. Which organelle is used to produce steroid hormones and to detoxify drugs?
 a. lysosomes
 b. Golgi apparatus
 c. mitochondria
 d. rough endoplasmic reticulum
 e. smooth endoplasmic reticulum

CRITICAL THINKING QUESTIONS

Answer in complete sentences.

21. What would be the effect on a cell if it were suddenly to lose its mitochondria?
22. How would the destruction of the Golgi apparatus affect a cell?

Test Results: _____ number correct ÷ 22 = _____ × 100 = _____ %

EXPLORING THE INTERNET

The Online Learning Center at www.mhhe.com/maderbiology8 has additional study material and practice quizzes that can help you master the content of this chapter. You can also find links to websites exploring additional topics in biology. Access to the Online Learning Center is free for those who have purchased a new textbook.

ANSWER KEY

STUDY EXERCISES

1. a, d 2. a. B b. T c. T d. B 3. scanning electron microscopy, phase contrast microscopy, video-enhanced contrast microscopy, confocal microscopy 4. a. increases b. decreases 5. a. nutrients b. wastes c. surface d. decreases proportionately e. small 6. a. fimbriae b. glycocalyx c. inclusion bodies d. nucleoid e. ribosomes f. plasma membrane g. cell wall h. mesosome i. flagellum j. pilus 7. d 8. e 9. b 10. c 11. f 12. a 13. a. nucleus b. nucleolus c. smooth ER d. vacuole e. Golgi apparatus f. microtubule g. lysosome h. mitochondrion i. centriole j. rough ER k. polyribosome 14. a. actin filament b. ribosome c. chloroplast d. central vacuole e. microtubule f. nuclear pore g. chromatin h. nucleolus i. nuclear envelope j. rough ER k. smooth ER l. plasma membrane m. cell wall n. Golgi apparatus o. mitochondrion p. intracellular space q. middle lamella

15.

Prokaryotic	Eukaryotic (animal)
yes	yes
yes	no
no	yes
no	yes
no	yes
yes	yes
no	yes

16.

Animal	Plant
centrioles	cell wall
mitochondria	mitochondria
small vacuoles only	large central vacuole
plasma membrane	plasma membrane
	chloroplasts

17. b, d 18. a. nuclear envelope b. nuclear pores
 c. condenses d. nucleolus e. rRNA 19. a. Proteins are
 made at the ribosomes located on the endoplasmic retic-
 ulum. b. Products made at the endoplasmic reticulum
 are sent to the Golgi apparatus for final processing, pack-
 aging. c. Vesicles may contain a substance that can be
 digested after fusion with lysosomes. 20. d
 21. e 22. a 23. f 24. b 25. c 26. a. solar b. car-
 bohydrates c. mitochondria d. ATP/energy e. chloro-
 oplasts 27. a. outer membrane b. inner membrane
 c. granum d. stroma e. thylakoid space 28. solar en-
 ergy + carbon dioxide + water → carbohydrate + oxygen
 29. a. cristae b. matrix c. outer membrane d. inner mem-
 brane 30. carbohydrate + oxygen → carbon dioxide +
 water + energy 31. a. microtubule b. actin filament
 c. intermediate filament 32. a. disassemble b. micro-
 tubule organizing body c. centrioles d. spindle e. basal
 bodies f. 9 + 2

CHAPTER TEST

1. g 2. h 3. b 4. c 5. f 6. e 7. a 8. d 9. c
 10. c 11. c 12. d 13. c 14. b 15. b 16. c
 17. d 18. c 19. c 20. e 21. The cell would be un-
 able to extract energy from carbohydrates. The ATP har-
 vested by this process would be unavailable for cell
 functions. Therefore, the cell would die. 22. The smooth
 ER packages substances in vesicles. A large portion of
 these go to the Golgi apparatus for further processing. These
 vesicles would most likely accumulate in the cell to the
 point that the cell would be unable to function properly.