Name _____ **Period** _____

Chapter 6: A Tour of the Cell

In introductory biology, you probably learned all the cell parts and what they do. In AP Biology, change your focus to understanding the importance of specialized organelles, how they function in normal cells, and what may occur if their function is disrupted. EK 4.A.2 and 2.B.3 provide specific content you must know about cell organelles. Surface-to-volume ratio is an important concept (EK 2.A.3), as it determines the ability of a cell to exchange materials with the environment. Be able to calculate this, and understand its significance.

Concept 6.1 Biologists use microscopes and the tools of biochemistry to study cells

1. The study of cells has been limited by their small size, and so they were not seen and described until 1665, when Robert Hooke first looked at dead cells from the bark of an oak tree. His contemporary, Antoni van Leeuwenhoek, crafted lenses and opened a new world with the improvements in optical aids. *Magnification* and *resolving power* limit what can be seen. Explain the difference.

2. The development of electron microscopes has further opened our window on the cell and its organelles. What is considered a major disadvantage of the electron microscope?

3. Study the electron micrographs in your text. Describe the different types of images obtained from:

   scanning electron microscopy (SEM)

   transmission electron microscopy (TEM)

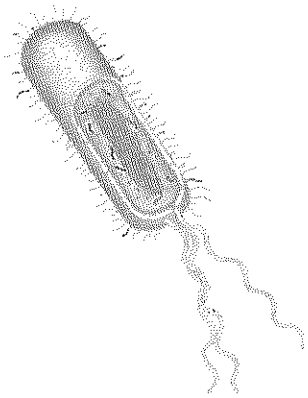
4. In *cell fractionation*, whole cells are broken up in a blender, and this slurry is centrifuged several times. Each time, smaller and smaller cell parts are isolated. This will isolate different organelles and allow study of their biochemical activities. Which organelles are the smallest ones isolated in this procedure?

Concept 6.2 Eukaryotic cells have internal membranes that compartmentalize their functions

5. Which two domains consist of prokaryotic cells?

6. A major difference between prokaryotic and eukaryotic cells is the location of their DNA. Describe this difference.

7. On the figure of a prokaryotic cell, label each of these features and give its function or description.



cell wall

plasma membrane

bacterial chromosome

nucleoid

ribosomes

flagella

8. Why are cells so small? Explain the relationship of surface area to volume.

9. Exchange of materials across the plasma membrane requires a high surface-to-volume ratio. How do the *microvilli* of intestinal cells facilitate this?

10. Image an elongated cell (such as a nerve cell) that measures 125 × 1 × 1 arbitrary units (cell A). Predict how the surface-to-volume ratio would compare with a cell that is 5 × 5 × 5 (cell B) and then calculate the ratio for both cells. (Calculations will be found at the end of this chapter.)

11. Spend some time with the calculations of surface area and volume on page 98 and 99 of Campbell Biology 10e. The AP course includes several objectives (LOs 2.6–2.9) that require this skill and an understanding of the concept. The Scientific Skills Exercise would be good practice!

Concept 6.3 The eukaryotic cell's genetic instructions are housed in the nucleus and carried out by the ribosomes

12. Describe the *nuclear envelope*. How many layers does it consist of? What connects the layers? How do molecules such as mRNA pass through the envelope?

13. What are the *nuclear lamina* and *nuclear matrix*? What function do they perform?

14. Found within the nucleus are the *chromosomes*. They are made of *chromatin*. What are the two components of chromatin? When do the thin chromatin fibers condense to become distinct chromosomes?

15. When are the *nucleoli* visible? What are assembled here?

16. What is the function of *ribosomes*? What are their two components?

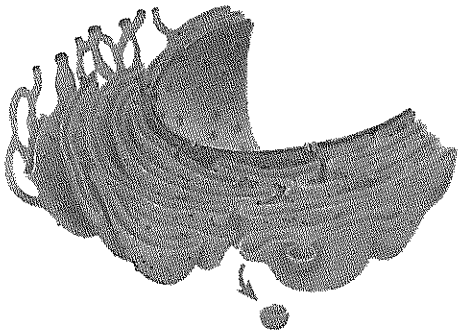
17. Ribosomes in any type of organism are all the same, but we distinguish between two types of ribosomes based on where they are found and the destination of the protein product made. Complete this chart to demonstrate this concept.

Type of Ribosome	Location	Product
Free ribosomes		
Bound ribosomes		

Concept 6.4 The endomembrane system regulates protein traffic and performs metabolic functions in the cell

18. List all the structures of the *endomembrane system.*

19. The *endoplasmic reticulum (ER)* makes up more than half the total membrane system in many eukaryotic cells. Use this sketch to explain the *lumen, transport vesicles,* and the difference between *smooth* and *rough ER.*



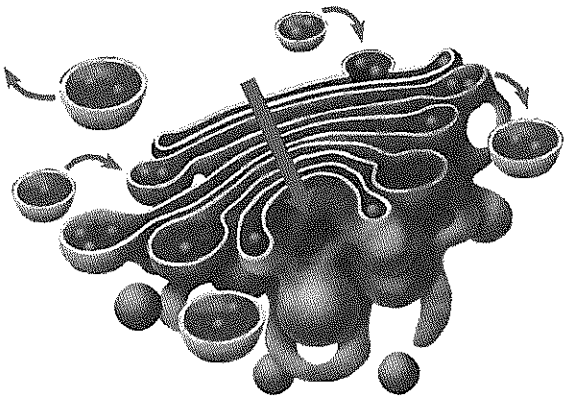
20. List and describe three major functions of the smooth ER.

21. Why does alcohol abuse increase tolerance to other drugs such as barbiturates?

22. The rough ER is studded with ribosomes. As proteins are synthesized, they are threaded into the lumen of the rough ER. Some of these proteins have carbohydrates attached to them in the ER to form *glycoproteins*. What does the ER then do with these secretory proteins?

23. Besides packaging secretory proteins into transport vesicles, what is another major function of the rough ER?

24. The transport vesicles formed from the rough ER fuse with the Golgi apparatus. Use this sketch to label the *cisterna* of the Golgi apparatus, and its *cis* and *trans* faces. Describe what happens to a transport vesicle and its contents when it arrives at the Golgi.



25. What is a *lysosome*? What does it contain? What is the pH range inside a lysosome?

26. One function of lysosomes is intracellular digestion of particles engulfed by *phagocytosis*. Describe this process of digestion. Which human cells carry out phagocytosis?

27. A second function of lysosomes is to recycle cellular components in a process called *autophagy*. Describe this process.

28. Explain what occurs in lysosomes to cause Tay-Sachs disease.

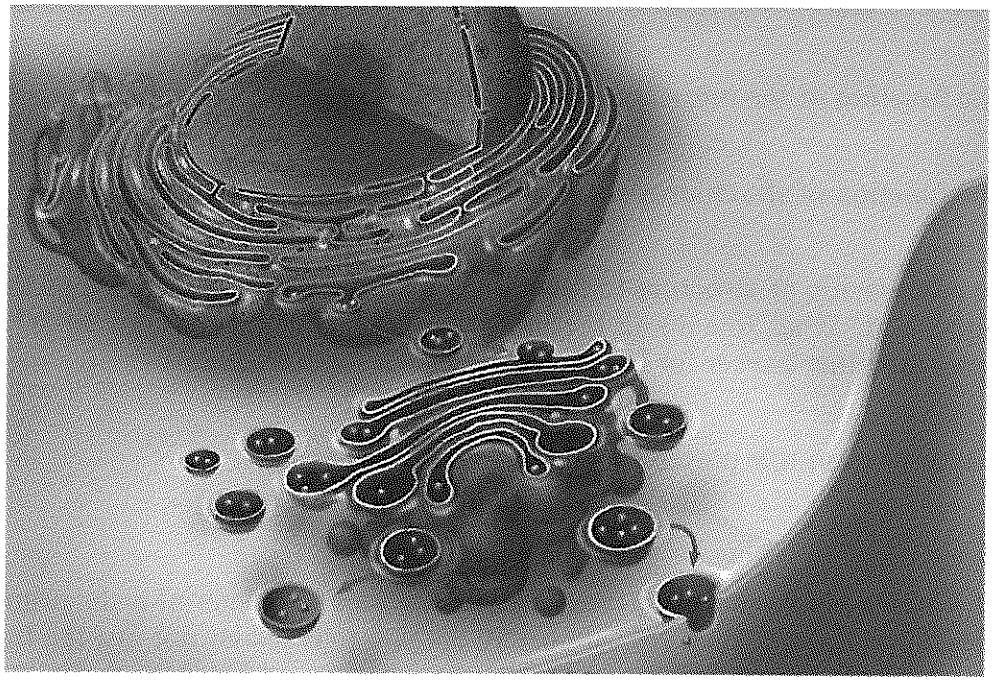
29. There are many types of vacuoles. Briefly describe each type of vacuole below.

food vacuoles

contractile vacuoles

central vacuoles in plants

30. Label and use this figure to explain how the elements of the endomembrane system function together to secrete a protein and to digest a cellular component.



Concept 6.5 Mitochondria and chloroplasts change energy from one form to another

31. What is the *endosymbiont theory*? Summarize three lines of evidence that support the model of endosymbiosis.

32. Mitochondria and chloroplasts are not considered part of the endomembrane system, although they are enclosed by membranes. Sketch a mitochondrion here and label its *outer membrane*, *inner membrane*, *inner membrane space*, *cristae*, *matrix*, and *ribosomes*.

33. Now sketch a chloroplast and label its *outer membrane*, *inner membrane*, *inner membrane space*, *thylakoids*, *granum*, and *stroma*. Notice that the mitochondrion has two membrane compartments, whereas the chloroplast has three compartments.

34. What is the function of the mitochondria?

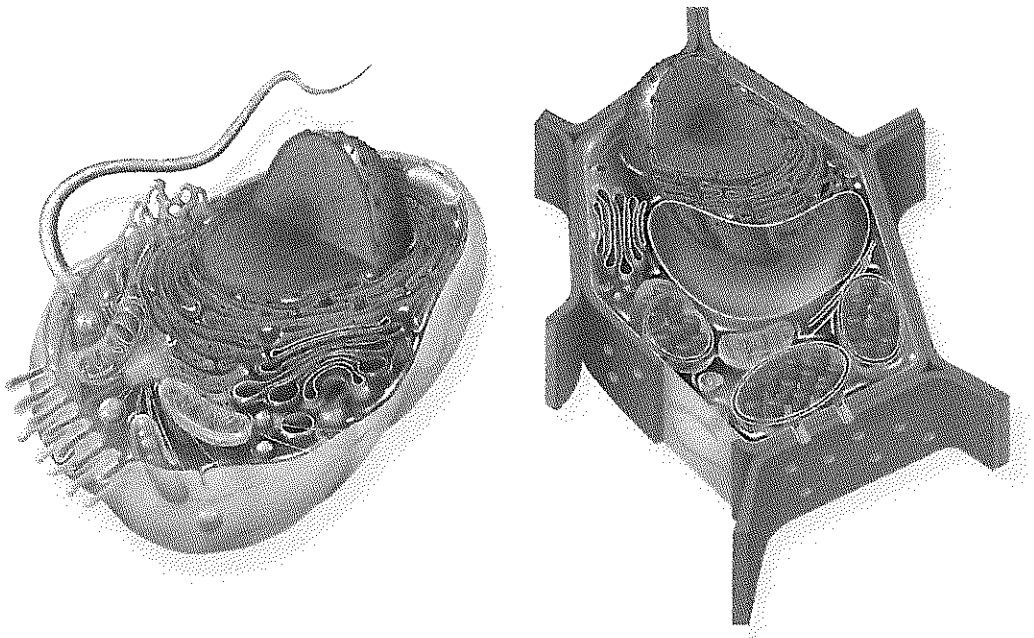
35. What is the function of the chloroplasts?

36. Recall the relationship of structure to function. Why is the inner membrane of the mitochondria highly folded? What role do all the individual thylakoid membranes serve? (Notice that you will have the same answer for both questions.)

37. Explain the important role played by *peroxisomes*.

SUMMARY

On the 2013 AP Biology Exam, one essay question asked students to determine the primary function of a cell type, based on its organelles. It is important for you to consider not just the function of an organelle, but *in what cell types* specialized organelles might be found (or absent). On these diagrams of plant and animal cells, label *each* organelle, give a brief statement of its function, and cite a tissue where cells might have many of these organelles. For example: Chloroplasts capture light energy and can be found in green leaves. Cilia move materials across the surface of a cell, and can be found in epithelial cells lining the trachea.



Concept 6.6 The cytoskeleton is a network of fibers that organizes structures and activities in the cell

38. What is the *cytoskeleton*?

39. There are three main types of fibers that make up the cytoskeleton. Name them.

40. What are three functions of the cytoskeleton?

41. *Microtubules* are hollow rods made of a globular protein called tubulin. Each tubulin protein is a dimer made of two subunits. These are easily assembled and disassembled. Describe several functions of microtubules.

42. Animal cells have a *centrosome* that contains a pair of *centrioles*. Plant cells do not have centrioles. What is believed to be the role of centrioles?

43. *Compare* and *contrast* cilia and flagella. For both, select a human cell that has this feature, and describe the role for that cell.

44. How do motor proteins called *dyneins* cause movement of cilia? What is the role of ATP in this movement?

45. *Microfilaments* are solid, and they are built from a double chain of *actin*. Study Figure 6.26 in your text, and explain three examples of movements that involve microfilaments.

46. What are the motor proteins that move the microfilaments?

47. *Intermediate filaments* are bigger than microfilaments but smaller than microtubules. They are more permanent fixtures of cells. Give two functions of intermediate filaments.

Concept 6.7 Extracellular components and connections between cells help coordinate cellular activities

48. What are three functions of the *cell wall*?

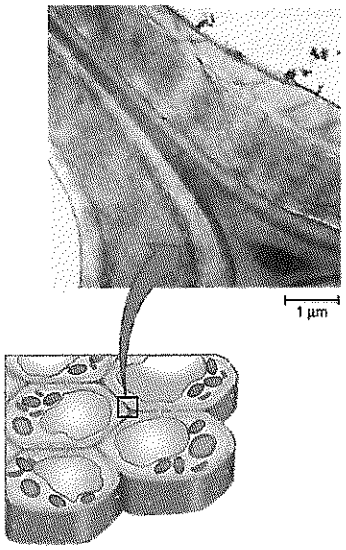
49. What is the composition of the cell wall?

50. What is the relatively thin and flexible wall secreted first by a plant cell?

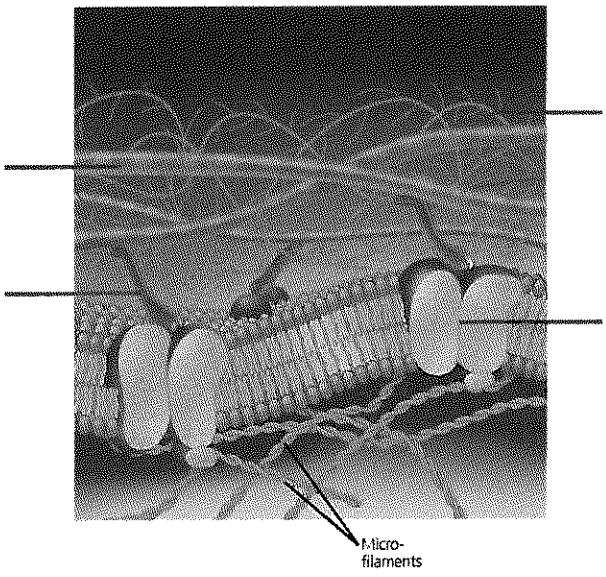
51. What is the *middle lamella*? Where is it found? What material is it made of?

52. Explain the deposition of a *secondary cell wall.*

53. On the sketch, label the *primary cell wall, secondary cell wall, middle lamella, cytosol, plasma membrane, central vacuole,* and *plasmodesmata.*

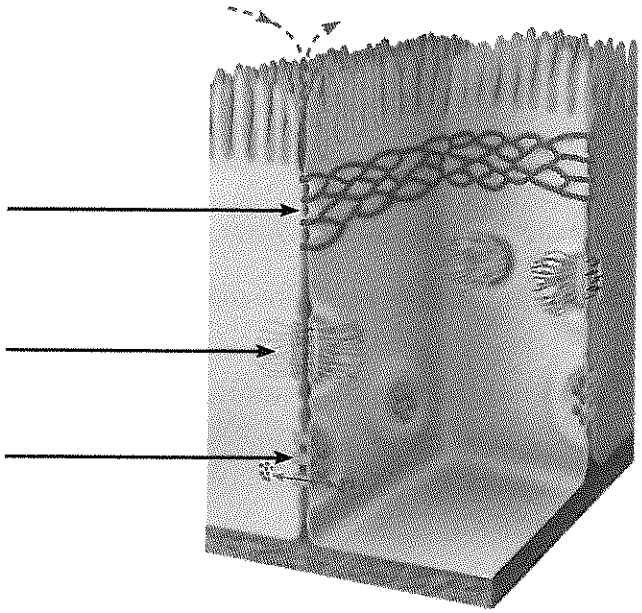


54. Animal cells do not have cell walls, but they do have an extracellular matrix (ECM). On this figure, label the elements indicated by the arrows, and give the role of each. Also label the extracellular fluid and cytoplasm.



55. What are the intercellular junctions between plant cells? What can pass through them?

56. Animal cells do not have *plasmodesmata*. This figure shows the three types of intercellular junctions seen in animal cells. Label each type and summarize its role.



There is an excellent chart on page 122 of your text that summarizes Concepts 6.3–6.5. Be sure to study it, and answer the three questions there.

Test Your Understanding Answers

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

1. _____ 2. _____ 3. _____ 4. _____ 5. _____ 6. _____

7. _____

Solution to question 10:

Cell A: SA = (125 × 1) × 4 + (1 × 1) × 2 = 502 units^2; Volume = 125 × 1 × 1 = 125 units^3 ; S-to-V = 502/125 = 4.02
Cell B: SA = 5 × 5 × 6 = 150 units^2; Volume = 5 × 5 × 5 =125 units^3; S-to-V = 150/125 = 1.2
Note that both cells have the same volume, but the elongated cell A has a higher S-to-V and therefore is better able to exchange materials with the environment.

Name _____ **Period** _____

Chapter 7: Membrane Structure and Function

Transport of materials across the membrane is an essential cell function, so you will need to understand the component molecules and their functions. There is considerable vocabulary associated with the movement of materials and concentrations on either side of the membrane, which you will need to accurately describe transport. Big Idea 2 has several specific LOs on membranes and transport, which you should have mastered when you complete this chapter.

Concept 7.1 Cellular membranes are fluid mosaics of lipids and proteins

1. Phospholipids are *amphipathic.* Explain what this means.

2. The currently accepted model of the plasma membrane is the *fluid mosaic model.* Describe this model.

3. What is meant by *membrane fluidity*?

4. Describe how each of the following can affect membrane fluidity:

   a. decreasing temperature

   b. phospholipids with unsaturated hydrocarbon chains

   c. cholesterol

   d. increasing the number of saturated hydrocarbon tails

5. Membrane proteins are the *mosaic* part of the model. Describe each of the two main categories:

   integral proteins

   peripheral proteins

6. Study Figure 7.7 in your text. Use it to briefly describe the following major functions of membrane proteins.

Function	Description
Transport	
Enzymatic activity	
Signal transduction	
Cell-cell recognition	
Intercellular joining	
Attachment to cytoskeleton and ECM	

7. Membrane carbohydrates are important in cell-cell recognition. What are two examples of this?

8. Distinguish between *glycolipids* and *glycoproteins.*

9. Label the following components of an animal cell membrane on the figure. Note the role of each component.

glycolipid

glycoprotein

integral protein

peripheral protein

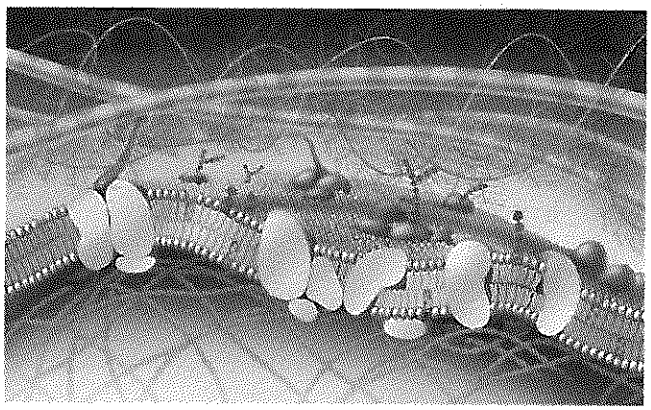
cholesterol

phospholipid

ECM fibers

cytoskeleton microfilaments

integrins (go back to Chapter 6, Figure 6.28)



Concept 7.2 Membrane structure results in selective permeability

10. Distinguish between *channel proteins* and *carrier proteins.*

11. Are transport proteins specific? Cite an example that supports your response.

12. Peter Agre received the Nobel Prize in 2003 for the discovery of *aquaporins*. What are they?

13. Consider the following materials that must cross the membrane. For each, tell how it is moved across.

Material	Method of Transport
CO_2	
Glucose	
H^+	
O_2	
H_2O	

Concept 7.3 Passive transport is diffusion of a substance across a membrane with no energy investment

14. Define the following terms:

diffusion

concentration gradient

passive transport

osmosis

isotonic

hypertonic

hypotonic

turgid

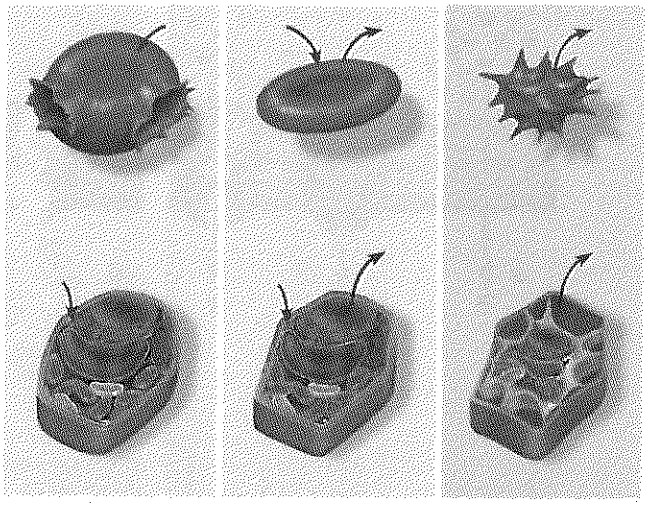
flaccid

plasmolysis

15. Use as many words as possible from the previous list to describe why a carrot left on the counter overnight becomes limp. Underline or highlight each word you use.

16. What is *facilitated diffusion*? Is it active or passive? Cite two examples.

17. In the following figure, label the *hypotonic solution*, *isotonic solution*, and *hypertonic solution*. What is indicated by the *blue arrows*? Label them. Which cell is *lysed*? *Turgid*? *Flaccid*? *Plasmolyzed*? Apply all these labels.



18. Why does the red blood cell burst when placed in a hypotonic solution, but not the plant cell?

Concept 7.4 Active transport uses energy to move solutes against their gradients

19. Describe *active transport*. What type of transport proteins are involved, and what is the role of ATP in the process?

20. The *sodium-potassium pump* is an important system for you to know. Use the following diagram to understand how it works. Use these terms to label the figures, and briefly summarize what is occurring in each step: *extracellular fluid*, *cytoplasm*, Na^+, K^+, *ATP*, *ADP*, *P*, and *transport protein*.

SUMMARY: SODIUM-POTASSIUM PUMP

1.

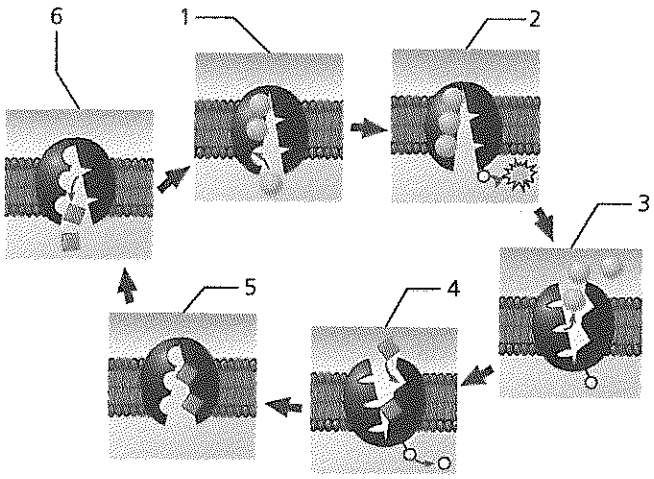
2.

3.

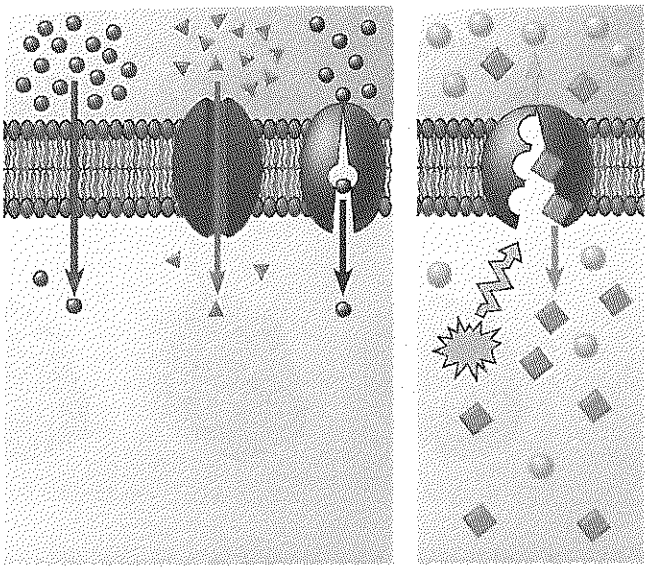
4.

5.

6.



21. On the following diagram, add these labels: *facilitated diffusion with a carrier protein, facilitated diffusion with a channel protein, active transport with a carrier protein,* and *simple diffusion.* For each type of transport, give an example of a material that is moved in this manner.



Examples

22. What is *membrane potential*? Which side of the membrane is positive?

23. What are the two forces that drive the diffusion of ions across the membrane? What is the combination of these forces called?

24. What is *cotransport*? Explain how understanding it is used in our treatment of diarrhea.

Concept 7.5 Bulk transport across the plasma membrane occurs by exocytosis and endocytosis

25. Define each of the following, and give a specific cellular example:

exocytosis

endocytosis

receptor-mediated endocytosis

phagocytosis

pinocytosis

26. What is a *ligand*? What do ligands have to do with receptor-mediated endocytosis?

27. Are the processes you described in question 26 active or passive transport? Explain your response.

Test Your Understanding Answers

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

1. _____ 2. _____ 3. _____ 4. _____ 5. _____

Reproduce the diagram for question 6, and draw arrows as instructed.

6b. _____ 6d. _____ 6e. _____

Name _____ **Period** _____

Chapter 8: An Introduction to Metabolism

This chapter on energy transfer and enzyme action is fundamental to your understanding of numerous topics discussed later in the course. AP Biology Big Idea 2 deals with energy transfer, and EK 4.B.1 includes how enzymes function and are regulated. Your careful study of this chapter will help you in both important areas.

Concept 8.1 An organism's metabolism transforms matter and energy, subject to the laws of thermodynamics

The totality of an organism's chemical reactions is called *metabolism*. As a whole, metabolism manages the material and energy resources of the cell in intersecting pathways.

1. There are two types of reactions in metabolic pathways: *anabolic* and *catabolic*.
   a. Which reactions release energy?
   b. Which reactions consume energy?
   c. Which reactions build up larger molecules?
   d. Which reactions break down molecules?
   e. Which reactions are considered "uphill"?
   f. What type of reaction is photosynthesis?
   g. What type of reaction is cellular respiration?
   h. Which reactions require enzymes to catalyze reactions?

2. *Energy* is the capacity to cause change, do work, or move matter against opposing forces. It exists in various forms. Contrast *kinetic energy* with *potential energy*.

3. Which type of energy does water behind a dam have? A mole of glucose?

4. According to the first law of thermodynamics, what can and cannot happen to energy?