

# 27 Study Guide

## Big idea Structure and Function

The circulatory system transports nutrients from the digestive system and oxygen from the respiratory system to body cells. It then transports cellular waste to the excretory system and carbon dioxide to the respiratory system.

### 27.1 Feeding and Digestion

Most filter feeders catch algae and small animals by using modified gills or other structures as nets that filter food items out of water. Detritivores feed on detritus. Carnivores eat other animals. Herbivores eat plants or parts of plants. Nutritional symbionts rely upon symbiosis.

Some invertebrates break down food primarily through intracellular digestion, but many animals use extracellular digestion.

Carnivores typically have sharp mouthparts or other structures that capture food, hold it, and cut it into small pieces. Herbivores typically have mouthparts adapted to rasping or grinding.

intracellular digestion (784) digestive tract (784)  
extracellular digestion (784) rumen (786)  
gastrovascular cavity (784)

### 27.2 Respiration

Respiratory structures provide a large surface area of moist, selectively permeable membrane and maintain a difference in the concentrations of oxygen and carbon dioxide on either side of the respiratory membrane, promoting diffusion.

Many aquatic invertebrates and most aquatic chordates other than reptiles and mammals exchange gases through gills. Aquatic reptiles and aquatic mammals, such as whales, breathe with lungs and must hold their breath underwater.

Respiratory structures in terrestrial invertebrates include skin, mantle cavities, book lungs and tracheal tubes. Terrestrial vertebrates breathe with lungs.

gill (788) lung (788) alveolus (790)

### 27.3 Circulation

In an open circulatory system, blood is only partially contained within blood vessels. In a closed circulatory system, blood circulates entirely within blood vessels.

Most vertebrates with gills have a single-loop circulatory system with a single pump that forces blood around the body in one direction. Most vertebrates that use lungs for respiration have a double-loop, two-pump circulatory system.

heart (791) atrium (792)  
open circulatory system (791) ventricle (792)  
closed circulatory system (792)

### 27.4 Excretion

Animals either eliminate ammonia from the body quickly or convert it into other nitrogenous compounds that are less toxic.

Aquatic animals allow ammonia to diffuse out of their bodies into surrounding water.

Some terrestrial invertebrates, including annelids and mollusks, produce urine in nephridia. Other terrestrial invertebrates, such as insects and arachnids, convert ammonia into uric acid. Mammals and land amphibians convert ammonia into urea. Most reptiles and birds convert ammonia into uric acid.

excretion (794) nephridium (797)  
kidney (795) Malpighian tubule (797)

#### Think Visually

Fill in the table below showing different types of animals and their differing respiratory structures.

Animal Type	Aquatic Invertebrates	2	Land Invertebrates	4
Respiratory Structures	1	Reptiles and mammals—lungs; Others—gills	3	Lungs

## Study Online

### BIOLOGY.com REVIEW AND ASSESSMENT RESOURCES

**Editable Worksheets** Pages of Study Workbooks A and B, Lab Manuals A and B, and the Assessment Resources Book are available online. These documents can be easily edited using a word-processing program.

**Lesson Overview** Have students reread the Lesson Overviews to help them study chapter concepts.

**Vocabulary Review** The *Flash Cards* and *Match It* provide an interactive way to review chapter vocabulary.

**Chapter Assessment** Have students take an online version of the Chapter 27 Assessment.

**Standardized Test Prep** Students can take an online version of the Standardized Test Prep. You will receive their scores along with ideas for remediation.

**Diagnostic and Benchmark Tests** Use these tests to monitor your students' progress and supply remediation.

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Chapter 27

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Match It

Chapter Assessment

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## Ubd Performance Tasks

**SUMMATIVE TASK** Have students work in pairs to prepare an illustrated pamphlet about one kind of animal. Students can focus on any invertebrate or vertebrate. The pamphlet should describe what structures and processes the animal uses to obtain essential materials and eliminate wastes. It should also include information about how the animal obtains food, how food is digested, what kind of respiratory and circulatory systems the animal has, and how it manages nitrogenous wastes.

**TRANSFER TASK** Have students work in small groups to create an animal that doesn't exist but might have existed if animals had evolved differently. Remind students that their animal should be well adapted to its environment. Each group should prepare a "field report" about its animal, with descriptions and sketches, as if members of the group were researchers who had just discovered a new organism. The report should include information on its methods of feeding, digestion, respiration, circulation, and excretion.

## Answers

### THINK VISUALLY

1. Body covering; gills
2. Aquatic Vertebrates
3. Skin; mantle cavities; book lungs; tracheal tubes
4. Land Vertebrates

## Lesson 27.1

## UNDERSTAND KEY CONCEPTS

1. a      2. c      3. b
4. In intracellular digestion, food is digested inside specialized cells that pass nutrients to other cells by diffusion. In extracellular digestion, food is broken down outside cells in a digestive system and then absorbed into cells.
5. Canine teeth, prominent in carnivorous mammals, are pointed teeth used for piercing, gripping, and tearing. In herbivorous mammals, canines are reduced or absent. Molars in herbivorous mammals are broad, flattened teeth adapted for grinding. Molars in carnivorous mammals have sharp edges for slicing and dicing meat.
6. Many vertebrate filter feeders feed while swimming.

## THINK CRITICALLY

7. It practices extracellular digestion, because a digestive tract breaks down food into nutrients that cells can absorb.
8. Sample answer: Do birds that require more energy eat more foods with higher energy content than birds that require less energy do?

## Lesson 27.2

## UNDERSTAND KEY CONCEPTS

9. b      10. d      11. a
12. Sample answer: Spiders respire using organs called book lungs, which are made of parallel, sheetlike layers of thin tissues that contain blood vessels. Most insects have a system of tracheal tubes that extend throughout the body. Air enters and leaves the system through openings in the body surface called spiracles.
13. lungs
14. They breathe with lungs. Lungs cannot exchange gases in water, so these animals must hold their breath underwater.

## THINK CRITICALLY

15. Earthworms can respire across their skins as long as the skin stays moist. If they remained above ground, the skin would dry out and the earthworms could not respire.
16. The mucus keeps the surface of the cavity moist; probably so that gases may diffuse more efficiently across the membrane.

## 27 Assessment

## 27.1 Feeding and Digestion

## Understand Key Concepts

- An animal that relies primarily on intracellular digestion is the
  - sponge.
  - clam.
  - dragonfly.
  - earthworm.
- Animals that obtain food by ingesting decaying bits of plant and animal material are called
  - herbivores.
  - carnivores.
  - detritivores.
  - filter feeders.
- Algae that live in the bodies of reef-building corals are
  - parasitic symbionts.
  - mutualistic symbionts.
  - occupants that have no effect on the coral animals.
  - consumed as food by the coral animals.
- Compare the processes of intracellular and extracellular digestion.
- Describe the differences between the canine and molar teeth of herbivorous and carnivorous mammals.
- How do vertebrate filter feeders obtain food?

## Think Critically

7. **Classify** You are observing an animal that has a digestive tract. Does this animal practice intracellular digestion or extracellular digestion? Explain your answer.
8. **Pose Questions** Hummingbirds eat high-energy foods, such as nectar. Many ducks eat foods that contain less energy, such as plant leaves. What are some research questions you could investigate to discover more about the diet of a bird species and its energy needs?

## 27.2 Respiration

## Understand Key Concepts

9. Most terrestrial insects breathe using a network of structures called
  - gills.
  - tracheal tubes.
  - book gills.
  - book lungs.

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10. In order for the exchange of oxygen and carbon dioxide to take place, an animal's respiratory surfaces must be kept
  - cold.
  - dry.
  - hot.
  - moist.
11. Most fishes exchange gases by pumping water from their mouths
  - over their gills.
  - through the lungs.
  - over their atria.
  - through their esophagus.
12. Describe two types of respiratory structures found in terrestrial invertebrates.
13. What respiratory structures do all terrestrial vertebrates possess?
14. With what respiratory structures do aquatic reptiles and aquatic mammals breathe? What inconvenience does this cause when they are underwater?

## Think Critically

15. **Predict** During heavy rains, earthworms often emerge from their burrows. What might happen to an earthworm if it did not return to its burrow when the ground dried out?
16. **Infer** Land snails have a respiratory structure called a mantle cavity, which is covered with mucus. What might the purpose of the mucus be?

## 27.3 Circulation

## Understand Key Concepts

17. Most arthropods have
  - no circulatory system.
  - an open circulatory system.
  - a closed circulatory system.
  - skin gills.
18. In a closed circulatory system, blood
  - comes in direct contact with tissues.
  - remains within blood vessels.
  - empties into sinuses.
  - does not transport oxygen.

## Lesson 27.3

## UNDERSTAND KEY CONCEPTS

17. b      18. b      19. c
20. Sample answer: The gills are where gas exchange takes place, which is the function of the respiratory system. Inside the gill membranes is a network of tiny, thin-walled blood vessels called capillaries, which are part of the circulatory system. Blood that flows through the capillaries brings carbon dioxide to the gills and carries oxygen from the gills to the body's cells. This process

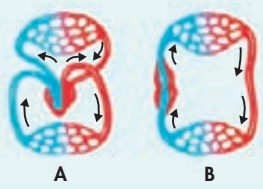
supplies the body with the oxygen it needs and removes the carbon dioxide.

21. A mammal has a closed circulatory system that has double-loop circulation and a four-chambered heart.
22. In single-loop circulation, a single pump forces blood around the body in one direction. In double-loop circulation, a pump powered by one side of the heart forces oxygen-poor blood from the heart to the lungs. After the blood picks up oxygen, it returns to the heart, and the other side of the heart pumps the blood through the second circulatory loop to the rest of the body.

19. Most chordates that have gills for respiration have a(n)
- double-loop circulatory system.
  - accessory lung.
  - single-loop circulatory system.
  - four-chambered heart.
20. In the gills of aquatic animals, how do the respiratory and circulatory systems interact?
21. Describe the circulatory system of a mammal as open or closed, and state the number of loops and the number of heart chambers.
22. Compare single-loop circulation and double-loop circulation.

**Think Critically**

23. **Interpret Graphics** The diagrams below represent two kinds of circulatory systems.



- Which diagram illustrates a heart with blood containing carbon dioxide but little oxygen?
  - Which diagram shows a circulatory system with a four-chambered heart?
24. **Apply Concepts** How do a fish's respiratory and circulatory systems work together to maintain homeostasis in the body as a whole?

**27.4 Excretion**

**Understand Key Concepts**

25. The composition of and levels of body fluids in mammals are controlled by the
- lungs.
  - kidneys.
  - intestine.
  - heart.
26. The elimination of metabolic wastes from the body is called
- excretion.
  - circulation.
  - respiration.
  - digestion.
27. Why do most animals convert ammonia into urea or uric acid?

**solve the CHAPTER MYSTERY**



**(NEAR) DEATH BY SALT WATER**

Luckily, the pick-up the group arranged arrived earlier than planned. They rushed the sick man to a hospital, where he was diagnosed with severe dehydration and given water and intravenous fluids. If he had gone much longer without treatment, doctors told his friends, he would have died. What had happened? Why didn't his friends suffer the same problems?

As sailors have known for centuries, humans can't drink seawater for any length of time. But why *can't* we drink seawater?

Because seawater is saltier than human blood and body fluids, drinking it loads the body with excess salt. Human kidneys cannot produce urine with salt concentrations high enough to get rid of that salt efficiently. So the kidneys are forced to excrete more water in urine than the amount of salt water consumed. This lowers body water content to the point that blood literally becomes thicker and harder to push through fine capillary networks. Cells and tissues begin to dehydrate, and fatal kidney failure can result.

- Compare and Contrast** While the group member who drank seawater became seriously ill, the other group members experienced some water stress as well. What was going on in their circulatory and excretory systems, and why was it not as serious?
- Propose a Solution** If you were marooned on an island that had no fresh water, what would be your plan for getting some?
- Connect to the Big idea** Although humans can't drink salt water, and can't exist without fresh water, many marine birds and reptiles can do either or both. Using the Web, research the different strategies other animals use to regulate salt content and water balance.

**CHAPTER MYSTERY**

After students have read through the Chapter Mystery, discuss the importance to terrestrial vertebrates of having an adequate supply of fresh water for drinking.

**Ask** How does water cross kidney membranes? (*Kidneys pump ions from salt across their membranes to create osmotic gradients. Water then follows those ions passively.*)

Point out that if the kidneys pumped too many ions from salt across their membranes, too much water would follow, depriving the body of the water it needs to function well. That is a reason why kidneys cannot excrete excess salt.

**Ask** How do saltwater fishes solve the problems of losing water to their salty environment and gaining salt from it? (*They produce very small amounts of concentrated urine, and they actively pump salt out across their gills.*)

Emphasize that humans are adapted to land, not to seawater, and do not have the adaptations to conserve water and pump out salt that saltwater fishes have.

**CHAPTER MYSTERY ANSWERS**

- Sample answer: Although the other group members took in some water by drinking the coconut "milk," they probably didn't get enough water to keep their circulatory and excretory systems functioning normally. The lack of fresh water caused some water stress in these group members.
- Sample answer: You could collect condensation underneath smooth surfaces at night, collect rainwater if it were available, and eat juicy plants.
- Big idea** Have students use Internet search engines to find out about the strategies marine reptiles and marine birds use to regulate water balance. They should find, for example, that some reptiles get their water mostly or solely from food. Students should also learn that some marine birds and reptiles have salt glands that secrete a salty solution from their body. These and other adaptations allow birds and reptiles to live in extreme environments where there is little fresh water or mostly salt water available.



To explore how bears have adapted to survive in extreme environments, have students watch the short video **Bearly Asleep**.

**THINK CRITICALLY**

23. a. B, b. A
24. The fish's respiratory system takes in oxygen from the water that passes over the gills. The oxygen diffuses into the blood through capillaries in the gills, and the circulatory system carries the oxygen to body cells. The waste product, carbon dioxide, is removed from the body as the circulatory system carries the gas to the gills, where it passes from the body. By bringing in oxygen and getting rid of carbon dioxide, the two systems help maintain a fish's homeostasis.



## Lesson 27.4

### UNDERSTAND KEY CONCEPTS

25. b      26. a
27. Ammonia is poisonous, and urea and uric acid are nitrogenous compounds that are less toxic than ammonia.
28. In freshwater fishes, the kidneys produce lots of watery urine, because their bodies contain a higher concentration of salt than the water they live in, and they take in excess water by osmosis. In saltwater fishes, the kidneys produce very little concentrated urine, because their bodies contain a lower concentration of salt than the water they live in, and they take in excess salt and lose water by osmosis.

### THINK CRITICALLY

29. Small aquatic animals are able to rid their bodies of ammonia quickly, allowing it to diffuse into the water.
30. Terrestrial animals must remove wastes while conserving water.

## Connecting Concepts

### USE SCIENCE GRAPHICS

31. Caffeine causes a rise in the heart rate.
32. Sample answer: The heart rate may further increase, but after rising sharply with the third drop, the rate seems to be leveling off. Therefore, the rate would probably not increase much more with five or more drops.

### WRITE ABOUT SCIENCE

33. Sample answer: Fishes have a single-loop circulation system with a two-chambered heart. The one atrium receives blood from the body, and the one ventricle pumps blood out of the heart to the gills and then to the rest of the body. Mammals have a double-loop circulation system with a four-chambered heart. One side of the heart forces oxygen-poor blood from the heart to the lungs. After the blood picks up oxygen and returns to the heart, the other side of the heart forces the blood through the second circulatory loop to the rest of the body.
34. **Big idea** Sample answer: A digestive tract allows animals to take in food whenever it is available and, at the same time, continue digesting a previous meal. An animal with a gastrovascular cavity, which has only one opening, must digest food and expel wastes before more food can be taken in.

28. What is the difference in kidney function of freshwater fishes and saltwater fishes?

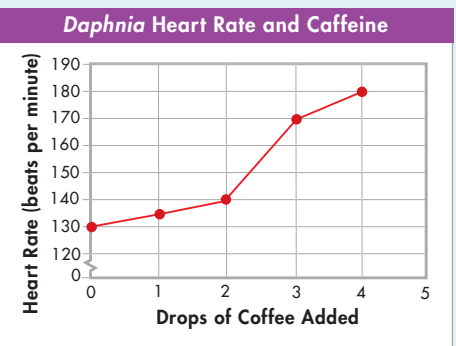
### Think Critically

29. **Infer** The excretory systems of terrestrial invertebrates, such as earthworms, convert ammonia to less toxic substances. Explain why this change is unnecessary in small aquatic invertebrates, such as planarians.
30. **Apply Concepts** Of all the nitrogenous wastes eliminated by animals, uric acid requires the least water to excrete. Why is the production of uric acid an advantage to animals that live on land?

## Connecting Concepts

### Use Science Graphics

A student conducts an experiment to measure the effect of caffeine on the heart rate of a small pond-water crustacean called *Daphnia*. The heart of this animal is visible through its transparent shell. With the help of a dissecting microscope, the student counts the heartbeats per minute before and after adding increasing amounts of coffee to the water surrounding the animal. Each data point in the graph at the top right represents the mean of five trials. Use the graph to answer questions 31 and 32.



31. **Interpret Graphs** Describe the effect of caffeine on the heart rate of *Daphnia*.
32. **Predict** What would be your prediction of the effect of five or more drops of coffee on the heart rate of *Daphnia*?

### Write About Science

33. **Explanation** Write a paragraph in which you compare and contrast the structures and functions of the heart of a fish and the heart of a mammal.
34. **Assess the Big idea** Explain why a digestive tract is a more efficient structure for taking in and processing the food eaten by a large animal than a gastrovascular cavity would be.

## Analyzing Data

A researcher conducted an experiment to see how air temperature affects the speed at which a snake can hunt for food. The experimenter placed the snake a fixed distance away from a piece of food and recorded the air temperature. Then, she recorded the time it took for the snake to reach the food. She repeated the experiment four times. Each time, the experimenter changed the air temperature. The data are shown to the right.

35. **Interpret Tables** At what temperature did the snake reach the food the fastest?
36. **Analyze Data** How did the time to reach the food change as the temperature increased?

37. **Draw Conclusions** What conclusion about snake hunting and temperature can you draw from the data?

The Effect of Temperature on Snake Hunting Speed	
Temperature (°C)	Time (seconds)
4	51
10	50
15	43
21	37
27	35

## Analyzing Data

**PURPOSE** Students will analyze data to understand how air temperature affects a snake's ability to hunt for food.

**PLANNING** Discuss body temperature regulation in reptiles with your students. Point out the difference between ectotherms and endotherms.

### ANSWERS

35. 27°C
36. The time decreased as the temperature increased.
37. Sample answer: Snake hunting is affected by temperature—the higher the temperature, the faster a snake can move.

# Standardized Test Prep

## Multiple Choice

- Animals that live on an animal and feed on its body tissues are called
  - parasites.
  - carnivores.
  - herbivores.
  - detritivores.
- Examining the teeth of an animal can give information about whether it
  - practices intracellular or extracellular digestion.
  - is a filter feeder or a detritivore.
  - is a nutritional symbiont.
  - is a herbivore or a carnivore.
- Movement of oxygen and carbon dioxide across a respiratory surface requires
  - that the respiratory surface be moist.
  - active transport by the cells of the respiratory surface.
  - alveoli.
  - an equal concentration of both gases on both sides of the membrane.
- In an open circulatory system, blood
  - is confined to blood vessels at all times.
  - circulates around body tissues.
  - exchanges gases with lung alveoli.
  - is not required for exchanging gases with body cells.
- In chordates with four-chambered hearts, there is
  - only one loop in the circulatory system.
  - mixing of oxygen-rich and oxygen-poor blood.
  - partial partition of the ventricle.
  - no mixing of oxygen-rich and oxygen-poor blood.
- Most reptiles excrete wastes in the form of
  - urea.
  - ammonia.
  - uric acid.
  - toxins.
- What is a function of the excretory system?
  - to supply cells with oxygen and nutrients
  - to rid the body of metabolic wastes
  - to exchange oxygen and carbon dioxide with the environment
  - to break down food

## Questions 8–9

A biology student is investigating the relationship between cricket chirping and air temperature. She catches a cricket and places it in a jar. She leaves the jar outside, and each day she counts the number of chirps during a 15-second period. At the same time, she records the outside temperature near the cricket. Her data for a 5-day period are shown below.

Temperature and Cricket Chirping		
Day	Number of Chirps in 15 Seconds	Outside Temperature (°C)
Monday	31	23
Tuesday	20	16
Wednesday	12	11
Thursday	29	21
Friday	25	19

- At which of the following temperatures would a cricket be most likely to chirp 9 times in 15 seconds?
  - 10°C
  - 18°C
  - 0°C
  - 25°C
- What can the student conclude from this experiment?
  - Crickets cannot chirp more than 31 times in 15 seconds.
  - The number of times a cricket chirps decreases when the temperature decreases.
  - The number of times a cricket chirps increases when the temperature decreases.
  - There is no relationship between the number of times a cricket chirps and temperature.

## Open-Ended Response

- Which types of vertebrates have double-loop circulation and which types have single-loop circulation?

## If You Have Trouble With . . .

Question	1	2	3	4	5	6	7	8	9	10
See Lesson	27.1	27.1	27.2	27.3	27.3	27.4	27.4	27.3	27.3	27.3

Animal Systems I **805**

## Answers

- A
- D
- A
- B
- D
- C
- B
- A
- B
- Most vertebrates that use lungs for respiration have double-loop circulation. These include mammals, reptiles, birds, and adult amphibians. Most vertebrates with gills have single-loop circulation. This includes fishes.

## Test-Taking Tip

### USE TIME WISELY

Tell students that when they are taking a long time to answer a question on a test, they should consider moving on to the next question and coming back to the harder question later. When answering other questions, they may remember the information needed to answer the skipped question.