LESSON 27.1

Getting Started

Objectives

27.1.1 Describe the different ways animals get food.

27.1.2 Explain how digestion occurs in different animals.

27.1.3 Describe how mouthparts are adapted for an animal's diet.

Student Resources

Study Workbooks A and B, 27.1 Worksheets

Spanish Study Workbook, 27.1 Worksheets

Lab Manual B, 20.1 Data Analysis Worksheet, 20.1 Hands-On Activity Worksheet

BIOLOGY.com Lesson Overview • Lesson Notes • Activity: Visual Analogy, Assessment: Self-Test, Lesson Assessment

For corresponding lesson in the **Foundation Edition**, see pages 646–649.

Activate Prior Knowledge

Show students pictures of a wolf, a cow, and a fiddler crab, or write the names of these animals on the board. Ask students to try to classify each animal according to how it obtains food. Have students describe the differences in feeding among these animals using terms they learned in Chapter 3. *(wolf, carnivore; cow, herbivore; crab, detritivore)*

NATIONAL SCIENCE EDUCATION STANDARDS

UNIFYING CONCEPTS AND PROCESSES

I, V

CONTENT

C.1.b, C.4.b, C.4.c, C.5.d, C.6.b

INQUIRY

A.1.c, A.2.a

27.1 Feeding and Digestion

Key Questions

- ***How do animals obtain food?***
- ***How does digestion occur in animals?***
- ***How are mouthparts adapted for different diets?***

Vocabulary

intracellular digestion
extracellular digestion
gastrovascular cavity
digestive tract
rumen

Taking Notes

Outline Before you read, use the headings in this lesson to outline the ways animals obtain and digest food. As you read, add details to your outline.

THINK ABOUT IT From tiny insects that dine on our blood, to bison that feed on prairie grasses, to giant blue whales that feed on plankton, all animals are heterotrophs that obtain nutrients and energy from food. In fact, adaptations for different styles of feeding are a large part of what makes animals so interesting.

Obtaining Food

How do animals obtain food?

As the old saying goes, you are what you eat. For animals, we can rephrase that as "how you look and act depends on what and how you eat." The converse is also true: What and how you eat depends on how you look and act. To learn why that's true, we'll compare the various ways animals, such as those in **Figure 27–1,** obtain their food.

Filter Feeders Filter feeders strain their food from water. **Most filter feeders catch algae and small animals by using modified gills or other structures as nets that filter food items out of water.** Many invertebrate filter feeders are small or colonial organisms, like worms and sponges, that spend their adult lives in a single spot. Many vertebrate filter feeders such as whale sharks and blue whales, on the other hand, are huge, and feed while swimming.

Detritivores Detritus is made up of decaying bits of plant and animal material. **Detritivores feed on detritus, often obtaining extra nutrients from the bacteria, algae, and other microorganisms that grow on and around it.** From earthworms on land to a wide range of worms and crustaceans in aquatic habitats, detritivores are essential components of many ecosystems.

Carnivores **Carnivores eat other animals.** Mammalian carnivores, such as wolves, use teeth, claws, and speed or stealthy hunting tactics to bring down prey. You probably don't often think about carnivorous invertebrates, but many would be terrifying if they were larger. Some cnidarians paralyze prey with poison-tipped darts, while some spiders immobilize their victims with venomous fangs.

UbD Teach for Understanding

ENDURING UNDERSTANDING Animals have evolved diverse ways to carry out basic life processes and maintain homeostasis.

GUIDING QUESTION How do different animals obtain and digest food?

EVIDENCE OF UNDERSTANDING *After completing the lesson, assign the following assessment to show students understand the differences in how animals obtain food and digest food.* Ask each student to choose two different animals and sketch or attach a clipping of it to a piece of paper. Then, for each animal, students should make a list that identifies how the animal obtains food, how it processes food, and whether it has any specialized mouthparts for its diet. Call on volunteers to share their work with the class.

Herbivores **Herbivores eat plants or parts of plants in terrestrial and aquatic habitats.** Some herbivores, such as locusts and cattle, eat leaves, which is not an easy way to make a living! Leaves don't have much nutritional content, are difficult to digest, and can contain poisons or hard particles that wear down teeth. Other herbivores, including birds and many mammals, specialize in eating seeds or fruits, which, in contrast to leaves, are often filled with energy-rich compounds.

BUILD Vocabulary

WORD ORIGINS The word part *-vore* comes from the Latin verb *vorare,* which means "to devour."

Nutritional Symbionts Recall that a symbiosis is the dependency of one species on another. Symbionts are the organisms involved in a symbiosis. **Many animals rely upon symbiosis for their nutritional needs.**

▶ ***Parasitic Symbionts*** Parasites live within or on a host organism, where they feed on tissues or on blood and other body fluids. Some parasites are just nuisances, but many cause serious diseases in humans, livestock, and crop plants. Parasitic flatworms and roundworms afflict millions of people, particularly in the tropics.

▶ ***Mutualistic Symbionts*** In mutualistic relationships, both participants benefit. Reef-building corals depend on symbiotic algae that live within their tissues for most of their energy. Those algae capture solar energy, recycle nutrients, and help corals lay down their calcium carbonate skeletons. The algae, in turn, gain nutrition from the corals' wastes and protection from algae eaters. Also, animals that eat wood or plant leaves rely on microbial symbionts in their guts to digest cellulose.

FIGURE 27–1 Obtaining Food The orca, sea slug, barnacles, and cleaner shrimp obtain their food in different ways.

Quick Facts

WHALES AS FILTER FEEDERS

Biologists classify whales into two major groups, toothed whales and baleen whales. Baleen whales are filter feeders, and they get their name from the hundreds of thin plates, or baleen, that hang from their upper jaw. These plates, also called whalebone, are made of the same material as fingernails. Baleen whales include blue whales, which are the largest animals that have ever lived on Earth. They can grow to more than 30 meters long and can weigh close to 200 metric tons. Blue whales eat mostly krill, which are tiny, shrimplike animals that make up part of the ocean's plankton. To feed, a blue whale gulps in a huge amount of water and krill. Then, it closes its mouth and forces the water back out through the filter of hundreds of baleen. The baleen trap the krill inside the whale's mouth.

Teach

Build Study Skills

Explain that a good way to organize information such as the classification of animals by feeding style is to make a **Compare/Contrast Table.** Have pairs of students work together to make a table entitled Different Styles of Feeding. They can use these column heads: Feeding Style, Description, and Examples. Tell students they should record examples from the text, as well as examples mentioned in class discussion.

Study Wkbks A/B, Appendix S20, Compare/Contrast Table. **Transparencies,** GO3.

DIFFERENTIATED INSTRUCTION

ELL English Language Learners Pair English language learners with native speakers to work together on the table described above. In addition, have pairs work on the pronunciation of terms such as *herbivore, parasitic symbionts,* and *mutualistic symbionts.* Ask English language learners to add an extra column to their table for pronunciation guides and drawings to help them remember these terms.

L3 Advanced Students Ask students to use online sources to make lists and print images of animals that can be classified as filter feeders, detritivores, carnivores, herbivores, and nutritional symbionts. Then, have students make a poster about how these animals obtain food. Display the posters in the classroom.

Teach continued

Lead a Discussion

Use **Figure 27–2** and the section, **Processing Food,** to differentiate between intracellular and extracellular digestion and between a gastrovascular cavity and a digestive tract. Point out that the visual includes three parts: diagrams of a sponge, cnidarian, and bird. Have pairs of students make a **Concept Map** that categorizes the organisms and structures in the figure. Students should use these terms in the map: *intracellular digestion, extracellular digestion, sponge, cnidarian, bird, gastrovascular cavity, digestive tract.* Then, discuss the figure as a class.

Ask In a cnidarian, how is food digested? *(Some cells secrete enzymes and absorb digested food. Other cells surround food particles and digest them in vacuoles.)*

Ask In a bird's digestive tract, what are the two openings called? *(mouth and anus)*

Study Wkbks A/B, Appendix S21, Concept Map.
Transparencies, GO4.

DIFFERENTIATED INSTRUCTION

L1 **Special Needs** Use a simple model to help students understand the difference between a gastrovascular cavity and a digestive tract. First, have students feel a large sock, and explain that this is like a gastrovascular cavity with only one opening. Then, cut the toe off the sock and turn it halfway inside out. Have students again feel the sock. Explain that the sock's inner layer represents the digestive tract and the sock's outer layer represents the animal's outside body wall. Point out that the inside tube has two openings.

ELL **English Language Learners** Before students read, introduce them to the terms: *intracellular digestion, extracellular digestion,* and *gastrovascular cavity.* Explain that *intra-* means "within," *extra-* means "outside," and *gastro-* means "belly or stomach." Help students arrive at the meaning of each term by saying and discussing its prefix and then putting the whole term together. Encourage students to write definitions in their own words to help them remember the meanings.

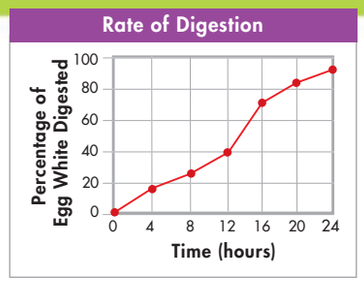
Analyzing Data

Protein Digestion

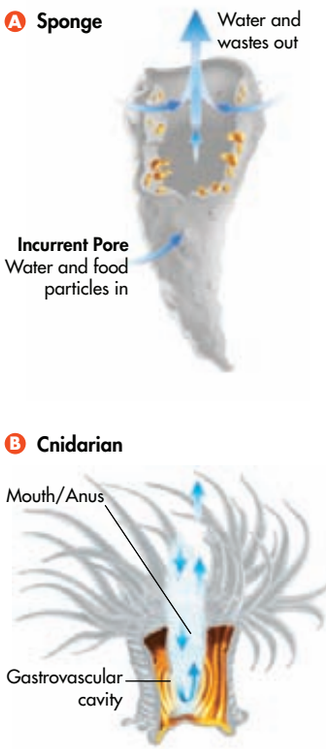
A scientist performed an experiment to determine the amount of time needed for a certain carnivorous animal to digest animal protein. He placed pieces of hard-boiled egg white (an animal protein) in a test tube containing hydrochloric acid, water, and the enzyme pepsin, which digests protein. The graph shows the rate at which the egg white was "digested" over a 24-hour period.

1. **Interpret Graphs** Describe the trend in the amount of protein digested over time.

2. **Analyze Data** About how many hours did it take for half of the protein to be digested?



3. **Draw Conclusions** How would you expect the rate of meat digestion to differ in an animal whose digestive tract had less of the enzyme pepsin?



Processing Food

How does digestion occur in animals?

Obtaining food is just the first step. Food must then be broken down, or digested, and absorbed to make energy and nutrients available to body tissues. **Some invertebrates break down food primarily by intracellular digestion, but many animals use extracellular digestion to break down food.** A variety of digestive systems are shown in **Figure 27–2.**

Intracellular Digestion Animals have evolved many ways of digesting and absorbing food. The simplest animals, such as sponges, digest food inside specialized cells that pass nutrients to other cells by diffusion. This digestive process is known as **intracellular digestion.**

Extracellular Digestion Most more-complex animals rely on extracellular digestion. **Extracellular digestion** is the process in which food is broken down outside cells in a digestive system and then absorbed.

▶ ***Gastrovascular Cavities*** Some animals have an interior body space whose tissues carry out digestive and circulatory functions. Some invertebrates, such as cnidarians, have a **gastrovascular cavity** with a single opening through which they both ingest food and expel wastes. Some cells lining the cavity secrete enzymes and absorb digested food. Other cells surround food particles and digest them in vacuoles. Nutrients are then transported to cells throughout the body.

▶ ***Digestive Tracts*** Many invertebrates and all vertebrates, such as birds, digest food in a tube called a **digestive tract,** which has two openings. Food moves in one direction, entering the body through the mouth. Wastes leave through the anus.

Analyzing Data

PURPOSE Students will interpret a graph about protein digestion and draw a conclusion that the enzyme pepsin aids in the digestion of protein.

PLANNING Have students review the type of food carnivores eat. Remind them to read the introductory paragraph carefully to help them find the information they need to draw a conclusion from the graph.

ANSWERS

1. Sample answer: Protein was digested at a rate of a little over 3 percent per hour for the first 12 hours. In the next 4 hours, the rate increased, and then dropped back down during the remaining 8 hours.

2. about 14 hours

3. Sample answer: Because pepsin digests protein and meat contains relatively high amounts of protein, the rate of meat digestion would be slower in an animal whose digestive tract had less of the enzyme pepsin.

One-way digestive tracts often have specialized structures, such as a stomach and intestines, that perform different tasks as food passes through them. You can think of a digestive tract as a kind of "disassembly line" that breaks down food one step at a time. In some animals, the mouth secretes digestive enzymes that start the chemical digestion of food. Then, mechanical digestion may occur as specialized mouthparts or a muscular organ called a gizzard breaks food into small pieces. Then, chemical digestion begins or continues in a stomach that secretes digestive enzymes. Chemical breakdown continues in the intestines, sometimes aided by secretions from other organs such as a liver or pancreas. Intestines also absorb the nutrients released by digestion.

▶ ***Solid Waste Disposal*** No matter how efficiently an animal breaks down food and extracts nutrients, some indigestible material will always be left. These solid wastes, or feces, are expelled either through the single digestive opening or through the anus.

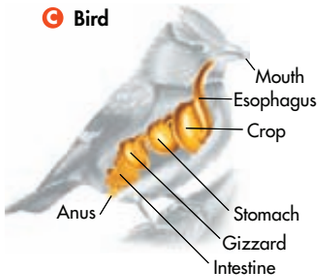


FIGURE 27–2 Digesting Food Animals have different digestive structures with different functions. A The sponge (previous page) has one digestive opening and uses intracellular digestion to process its food. B The cnidarian (previous page) processes its food by extracellular digestion in a gastrovascular cavity. C The bird has a one-way digestive tract with two openings.

Specializations for Different Diets

How are mouthparts adapted for different diets?

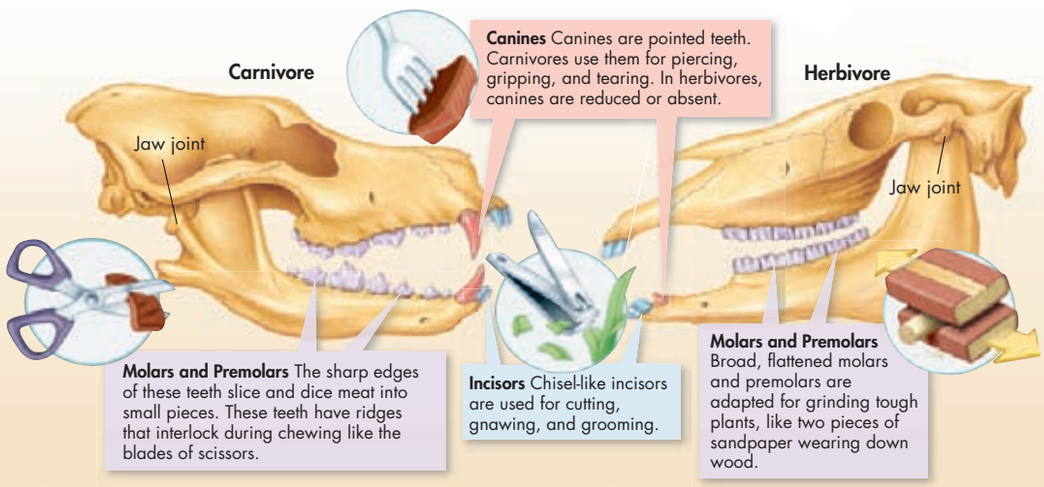
The mouthparts and digestive systems of animals have evolved many adaptations to the physical and chemical characteristics of different foods, as shown in **Figure 27–3.** As a window into these specializations, we'll examine adaptations to two food types that are very different physically and chemically: meat and plant leaves.

Specialized Mouthparts Carnivores and leaf-eating herbivores usually have very different mouthparts. These differences are typically related to the different physical characteristics of meat and plant leaves.

VISUAL ANALOGY

SPECIALIZED TEETH

FIGURE 27–3 Mouthparts The specialized jaws and teeth of animals are well adapted to their diets.



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Check for Understanding

USE VOCABULARY

List the lesson's vocabulary terms on the board. Ask students to create a **Concept Map** that includes each vocabulary term and identifies the relationships between the terms. *(Students' concept maps should show the following relationships: intracellular digestion and extracellular digestion are the two types of digestive processes in animals. To carry out extracellular digestion, animals have either a gastrovascular cavity or a digestive tract. A rumen is a structure in the digestive tract of some animals.)*

ADJUST INSTRUCTION

If students have trouble identifying the relationships among the terms, have them review the definitions in their text and re-examine the digestive systems shown in **Figure 27–2.**

VISUAL ANALOGY

As a class, discuss the different kinds of teeth animals have (premolars, molars, canines, incisors) and how these specialized mouthparts are adapted to an animal's diet. If you have any animals in the classroom—a snake, a lizard, gerbils, a terrarium with earthworms—have students observe their eating habits and make observations and drawings of the animals' mouthparts. Discuss how each animal is adapted for its special diet.

DIFFERENTIATED INSTRUCTION

L1 **Special Needs** To help students visualize how their teeth are adapted to eating plant foods, suggest that the next time they eat a fruit or vegetable they need to bite into, such as an apple or stalk of celery, they use a mirror to observe which teeth are used to bite and tear and which teeth are used to grind the food into a form that can be swallowed.

L1 **Struggling Students** Have students create a **Two-Column Table** that organizes the information in **Figure 27–3.** The left column should be labeled Carnivore Teeth, and the right column should be labeled Herbivore Teeth. In each column, students should include all the tooth types shown in the figure. Have students add definitions and sketches to their table that help them remember the shape and function of each kind of tooth.

Study Wkbks A/B, Appendix S31, Two-Column Table. **Transparencies,** GO16.

ELL Focus on ELL: Build Background

BEGINNING AND INTERMEDIATE SPEAKERS Have students collect images (drawings, Internet printouts, clippings) of the teeth of carnivores and herbivores and sort the animals into those two groups. Then, instruct students to label whichever teeth they can in English, using **Figure 27–3** as a model, while explaining their decisions either orally or in captions in their native language.

BIOLOGY.com Students can compare the structure and function of teeth in the **Visual Analogy: Specialized Teeth.**

Teach continued

Assess and Remediate

EVALUATE UNDERSTANDING

Read aloud each of the boldface Key Concepts in the lesson. For each, call on a volunteer to provide a supporting detail. Then, ask others in the class for additional supporting details. After students have provided support for a Key Concept, ask a volunteer to explain the importance of it in understanding feeding and digestion in animals. After reviewing all Key Concepts, have students complete the 27.1 Assessment.

REMEDIATION SUGGESTION

L1 **Struggling Students** If your students have trouble answering **Question 1a,** have them reread the subsection, **Nutritional Symbionts,** and use the Key Concept in the section to help them write a definition of the term in their own words.

BIOLOGY.com Students can check their understanding of lesson concepts with the **Self-Test** assessment. They can then take an online version of the **Lesson Assessment.**

FIGURE 27–4 Eating Plant Leaves
The teeth and jaws of herbivores, such as horses, are adapted for pulling, rasping, and grinding plant leaves.

▶ ***Eating Meat*** **Carnivores typically have sharp mouthparts or other structures that can capture food, hold it, and "slice and dice" it into small pieces.** Carnivorous mammals, such as wolves, have sharp teeth that grab, tear, and slice food like knives and scissors would. The jaw bones and muscles of carnivores are adapted for up and down movements that chop meat into small pieces.

▶ ***Eating Plant Leaves*** **Herbivores typically have mouthparts adapted to rasping or grinding.** To digest leaf tissues, herbivores usually need to tear plant cell walls and expose their contents. To do this, many herbivorous invertebrates, from mollusks to insects, have mouthparts that grind and pulverize leaf tissues. Herbivorous mammals, such as the horse in **Figure 27–4,** have front teeth and muscular lips adapted to grabbing and pulling leaves, and flattened molars that grind leaves to a pulp. The jaw bones and muscles of mammalian herbivores are also adapted for side-to-side "grinding" movements.

Specialized Digestive Tracts Carnivorous invertebrates and vertebrates typically have short digestive tracts that produce fast-acting, meat-digesting enzymes. These enzymes can digest most cell types found in animal tissues.

No animal produces digestive enzymes that can break down the cellulose in plant tissue, however. Some herbivores have very long intestines or specialized pouches in their digestive tracts that harbor microbial symbionts that digest cellulose. Cattle, for example, have a pouchlike extension of their esophagus called a **rumen** (plural: rumina), in which symbiotic bacteria digest cellulose. Animals with rumina, or ruminants, regurgitate food that has been partially digested in the rumen, chew it again, and reswallow it. This process is called "chewing the cud."

27.1 Assessment

Review Key Concepts

1. a. Review What types of food do herbivores eat? What are nutritional symbionts?

b. Relate Cause and Effect How might a coral be affected if all its symbiotic algae died?

2. a. Review What are two types of digestion animals use to break down and absorb food?

b. Compare and Contrast What is a major structural difference between gastrovascular cavities and digestive tracts?

3. a. Review Describe the adaptations of the mouthparts and digestive systems of leaf-eaters and meat-eaters.

b. Use Analogies Describe the relationship between a ruminant and its microbial symbionts in terms of "teamwork."

WRITE ABOUT SCIENCE

Summary

4. Describe the process of a cow's digestion of grass, from the cow's uprooting of the grass to its reswallowing of it. Use the terms *molar, rumen, symbiont,* and *cud.*

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Assessment Answers

1a. Herbivores eat plants or parts of plants. Nutritional symbionts are organisms that rely upon other animals for their nutritional needs.

1b. The coral would die.

2a. intracellular and extracellular

2b. A gastrovascular cavity has only one opening, while a digestive tract has two openings.

3a. Leaf-eaters typically have mouthparts adapted to pulling and rasping or grinding. Some leaf-eaters have very long intestines or rumina in their digestive tracts that harbor microbial symbionts that digest cellulose. Meat-eaters typically have sharp mouthparts to "slice and dice" food into small pieces. Meat-eaters typically have short digestive tracts that produce fast-acting, meat-digesting enzymes.

3b. Sample answer: The herbivore and the symbionts work together in digestion. The herbivore takes in the food, and the symbionts digest the cellulose. The herbivore provides the symbionts with a place to live, and the symbionts help the herbivore digest plant parts.

WRITE ABOUT SCIENCE

4. Answers will vary. All answers should describe the grinding of food by the molars, symbiont digestion of cellulose in a pouchlike extension of the stomach called the rumen, and "chewing the cud," a process that involves regurgitation, re-chewing, and swallowing again.