Section 26.3

SB4f. Relate animal adaptations, including behaviors, to the ability to survive stressful environmental conditions. **SB5d.** Relate natural selection to changes in organisms. **Also covers: SCSh4b, SB3b, SB5b**

Objectives

- **Identify** characteristics of insects.
- **Analyze** how structure determines function in insects.
- **Compare and contrast** complete and incomplete metamorphosis.

Review Vocabulary

pollen: a fine powder produced by certain plants when they reproduce

New Vocabulary

metamorphosis
pupa
nymph
caste

Insects and Their Relatives

MAIN Idea Insects have structural and functional adaptations that have enabled them to become the most abundant and diverse group of arthropods.

Real-World Reading Link Think about a time you were stung by a bee, admired a bright butterfly flitting from flower to flower, or heard the chirp of a cricket. It seems like insects are everywhere, and they affect your life in many ways.

Diversity of Insects

Scientists estimate that there are as many as 30 million insect species, which is more species than all other animals combined. Recall that arthropods make up about three-fourths of all named animal species. About 80 percent of arthropods are insects. They are the most abundant and widespread of all terrestrial animals. You can find insects in soil, in forests and deserts, on mountaintops, and even in polar regions.

Insects live in many habitats because of their ability to fly and their ability to adapt. Their small size enables them to be moved easily by wind or water. Diversity of insects also is enhanced by the hard exoskeleton that protects them and keeps them from drying out in deserts and other dry areas. In addition, the reproductive capacity of insects ensures that they are successful in any areas they inhabit. Insects produce a large number of eggs, most of the eggs hatch, and the offspring have short life cycles, all of which can lead to huge insect populations.

External Features

Insects have three body areas—the head, thorax, and abdomen, shown in **Figure 26.15.** Head structures include antennae, compound eyes, simple eyes, and mouthparts. Insects have three pairs of legs and generally two pairs of wings on the thorax. Some only have one pair of wings, and others do not have wings at all.

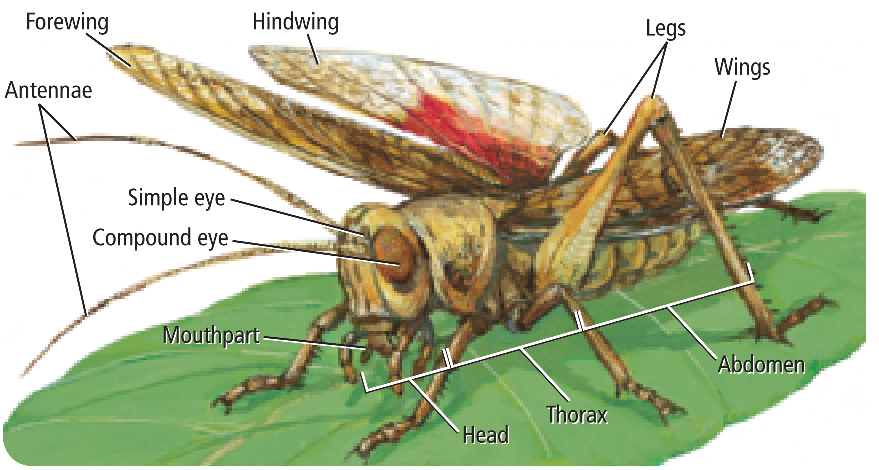


Figure 26.15 The head, thorax, and abdomen regions of this cricket are characteristic of insects.
Compare *How do the body regions of insects differ from those of crustaceans?*

Concepts In Motion

Interactive Figure To see an animation of the basic anatomy of a grasshopper, visit biologygmh.com.

Insect Adaptations

Structural adaptations to legs, mouthparts, wings, and sense organs have led to increased diversity in insects. These adaptations enable insects to utilize all kinds of food and to live in many different types of environments. Taking advantage of a variety of food sources, insects might be parasites, predators, or plant-sap suckers.

Legs Insect legs are adapted to a variety of functions. Beetles have walking legs with claws that enable them to dig in soil or crawl under bark. Flies have walking legs with sticky pads on the ends that enable them to walk upside down. Honeybee legs have adaptations for collecting pollen, while the hind legs of grasshoppers and crickets are adapted to jumping. Water striders have legs adapted to skimming over the surface of water. On its footpads, a water strider has water-repellent hairs that do not break the surface tension of the water. As it skates over the water, this insect propels itself with its back legs and steers with its front legs, like a rear-wheel-drive car.

Mouthparts Insects' mouthparts are adapted to the food they eat, as shown in **Table 26.2.** Butterflies and moths have a long tube through which they draw nectar from flowers in a motion similar to sipping through a straw. Different types of flies, such as houseflies and fruit flies, have sponging and lapping mouthparts that take up liquids. Some insects, such as leafhoppers and mosquitoes, have piercing mouthparts for feeding on plant juices or prey. Insects such as beetles and ants cut animal skin or plant tissue with their mandibles to reach the nutrients inside.

Concepts in Motion

Interactive Table To explore more about insect mouthparts, visit biologygmh.com.

Table 26.2 Insect Mouthparts

Type of mouthpart	Siphoning	Sponging	Piercing/Sucking	Chewing
Example				
Function	Feeding tube is uncoiled and extended to suck liquids into the mouth.	Fleshy end of mouthpart acts like a sponge to mop up food.	A thin, needlelike tube pierces the skin or plant wall to suck liquids into the mouth.	Mandible pierces or cuts animal or plant tissue, and other mouthparts bring food to the mouth.
Insects with adaptation	Butterflies, moths	Houseflies, fruit flies	Mosquitoes, leafhoppers, stink bugs, fleas	Grasshoppers, beetles, ants, bees, earwigs

Wings Insects are the only invertebrates that can fly. Unlike bird and mammal wings that are modified limbs, insect wings are outgrowths of the body wall. Wings are formed of a thin double membrane of chitin, which is the same material that makes up the exoskeleton, and they have rigid veins that give them strength. Wings can be thin, as in flies, or thick, as in beetles. The wings of butterflies and moths are covered with fine scales, as shown in **Figure 26.16.** Investigate how butterflies might use their wing scales to attract mates in **Data Analysis Lab 26.1.** Flying requires complex movements of the wings. Forward thrust, upward lift, balance, and steering are all important. Most insects rotate their wings in a figure-eight pattern, as shown in **Figure 26.16.**

Reading Check **Compare** How are wings like an exoskeleton?

Sense organs Along with leg, mouthpart, and wing adaptations, insects have a variety of adaptations in their sense organs. Recall how arthropods use their antennae and eyes to sense their environment. Insects also have hairlike structures that are sensitive to touch, pressure, vibration, and odor. In addition to visually detecting motion, a fly detects changes in airflow using the hundreds of hairs that cover its body. It's no wonder that a fly often is long gone before the flyswatter can strike.

Some insects detect airborne sounds with their tympanic organs, while others can detect vibrations coming from the ground. These sensory cells often are located on the legs.

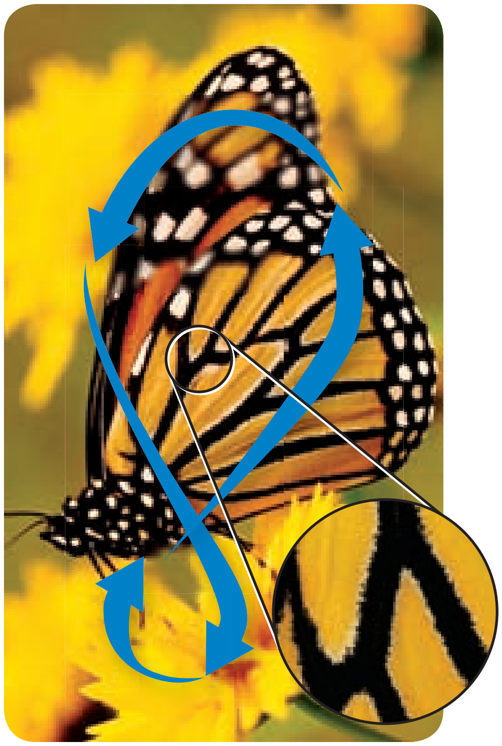


Figure 26.16 Butterfly wings are covered with fine scales. Notice how the up-and-down strokes of insect wings make a figure-eight pattern.

DATA ANALYSIS LAB 26.1

Based on Real Data*

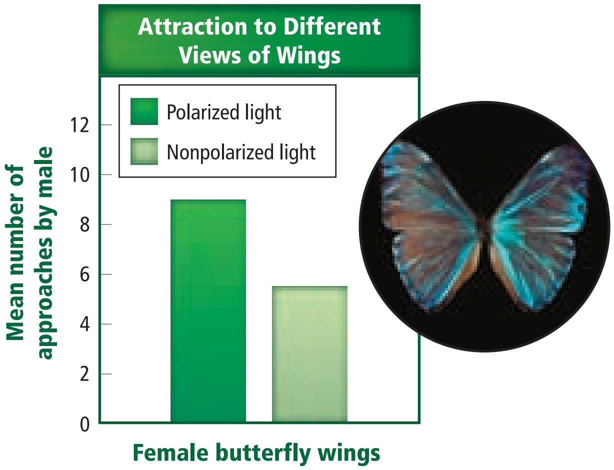
Interpret the Graph

Do butterflies use polarized light for mate attraction? Light waves with electric fields vibrating in the same direction are said to be polarized. Scientists hypothesized that the iridescent wing scales in some butterflies, such as the one shown at right, create polarized light to attract certain males to females. The graph shows the response of males to polarized light versus nonpolarized light from female iridescent butterfly wings.

Think Critically

1. **Interpret the Graph** To which view of wings does the male butterfly respond more often?
2. **Infer** Researchers have noted that forest-dwelling butterflies tend to have iridescent wings, while meadow-dwelling butterflies do not. What might explain this difference?

Data and Observations



*Data obtained from: Sweeney, A., et al. 2003. Insect communication: polarized light as a butterfly mating signal. *Nature* 423: 31-32.

Most insects have keen chemical senses. Chemical receptors, or chemoreceptors, for taste and smell are located on mouthparts, antennae, or legs. Some insects, such as moths, can detect odors several kilometers away. Chemical signals in the form of pheromones enable insects to communicate with one another to attract mates or to gather members in large colonies to migrate or survive periods of cold weather.

VOCABULARY

WORD ORIGIN

Metamorphosis
from the Greek word *metamorphoun,* meaning *to transform.*

Metamorphosis Insects that do not care for their young lay many more eggs than insects that do care for their young. Most insects lay their eggs in a specific habitat where the young can survive. For example, a monarch butterfly lays its eggs on milkweed plants, which the young feed on after they hatch. After hatching, most insects undergo **metamorphosis,** a series of major changes from a larval form to an adult form.

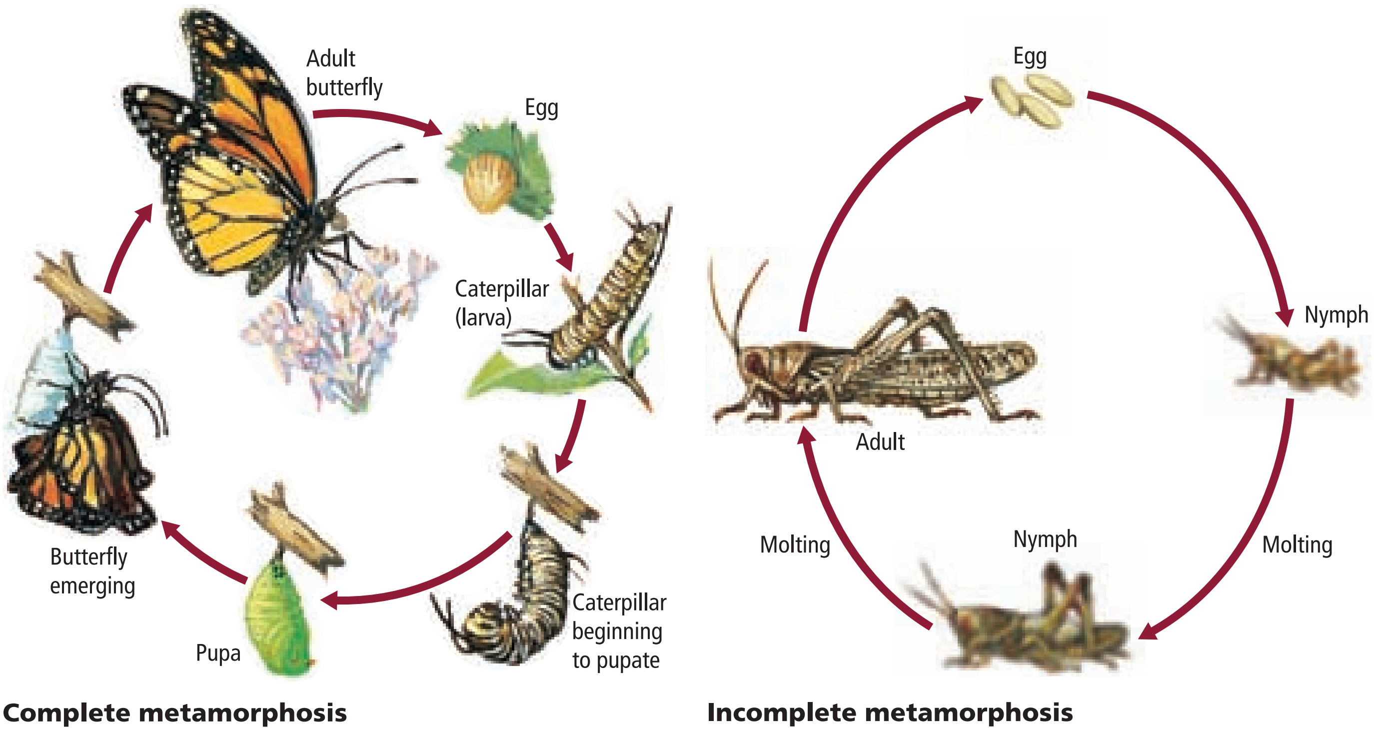
Complete metamorphosis Most insects develop through the four stages of complete metamorphosis—egg, larva, pupa, and adult. As shown in **Figure 26.17,** when the egg of a butterfly hatches, the worm-like larva that appears commonly is called a caterpillar. At this stage, the larva usually has chewing mouthparts and behaves like a feeding machine. The larva molts several times as it grows. A **pupa** (PYEW puh) is a nonfeeding stage of metamorphosis in which the animal changes from the larval form into the adult form. The adult stage of metamorphosis generally is specialized for dispersal and reproduction. If adults feed, they generally do not use the same food source as the larvae, which eliminates competition for the same food and increases chances for survival if food is scarce.

Incomplete metamorphosis Insects that undergo incomplete metamorphosis, as shown in **Figure 26.17,** hatch from eggs as **nymphs** (NIHMFS)—the immature form of insects that look like small adults without fully developed wings. After several molts, young nymphs become winged adults.

Figure 26.17 Insects that undergo complete metamorphosis have a resting stage called a pupa. This stage is absent in insects that undergo incomplete metamorphosis.

Concepts in Motion

Interactive Figure To see an animation of the stages in the complete metamorphosis of a butterfly, visit biologygmh.com.



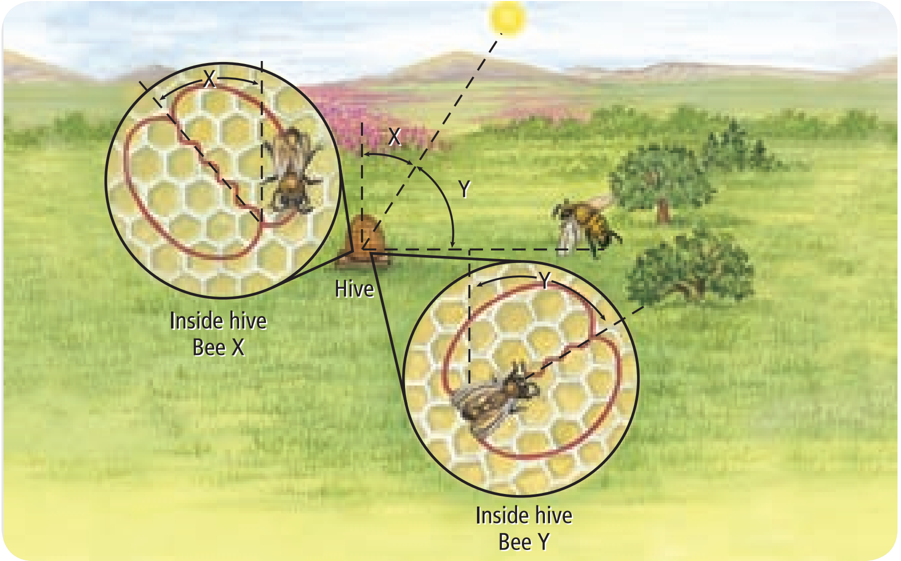


Figure 26.18 The straight run of the honeybee's figure-eight waggle dance indicates the direction of the food in relation to the angle of the Sun.

Interperet ***Where has Bee X found food?***

Concepts In Motion

Interactive Figure To see an animation of how honeybees use movement to communicate, visit biologygmh.com.

Insect societies The players on a basketball team work together to win the game. Insects such as honeybees, ants, and termites organize into social groups and cooperate in activities necessary for their survival. Honeybees have a complex society, with as many as 70,000 bees in one hive. There are three castes in a hive. A **caste** is a group of individuals within a society that perform specific tasks. Workers are females that do not reproduce. They gather nectar and pollen, build the honeycomb, manufacture honey, care for young, and guard the hive. Drones are the reproductive males. The queen is the only reproductive female.

Communication methods Honeybees have evolved an efficient system of communication, using bodily movements to indicate the location of food sources. One of the movements by which honeybees communicate is called the waggle dance. This dance is performed when a bee returns to the hive from a faraway food source. First, the returning bee makes a circle with a diameter about three times the bee's length. The bee then moves in a straight line while waggling its abdomen from side to side. The orientation of the line indicates the direction to the food source. Finally, the bee makes another circle in the opposite direction from the first circle. It traces this figure-eight pattern many times. The duration of the dance indicates the distance to the food source.

Connection to Math The most significant part of the waggle dance is the straight line because it tells the other bees where the food is in relation to the hive. The direction of the line relative to the vertical indicates the direction of the food relative to the Sun, as shown in **Figure 26.18.** If food is located 70 degrees to the right of the Sun, the straight line of the dance will be 70 degrees to the right of vertical.

Round dances also convey information about food sources and are used only if the food is close to the hive. In a round dance, the bee traces a clockwise circle followed by a counterclockwise circle and repeats this dance many times. The dance does not indicate distance or direction.

Ants also have evolved various societal behaviors for living in colonies. Females that do not reproduce gather food, care for young, and protect the colony from predators. Like honeybees, the males die after mating with the queen, whose sole function is to lay eggs.

CAREERS IN BIOLOGY

Entomologist Scientists who study insects are entomologists. They might study insect life cycles and behaviors, research insect pests and how to control them, or work with beneficial insects like honeybees. A beekeeper cares for bee colonies that are used for crop pollination and honey production. For more information on biology careers, visit biologygmh.com.

■ **Figure 26.19** Not only are insects important in pollinating flowers, some are important in feeding on harmful insects. This ladybird beetle feeds on plant pests.
Explain ***how insects maintain stability in ecosystems.***

Insects and humans It might be difficult to think of insects as beneficial when a mosquito buzzes around your head or when a bee stings you, but insects are an integral part of all ecosystems on Earth. Most insect species are not harmful to humans. Insects pollinate most flowering plants, including almost ten billion dollars' worth of food crops in the United States. They produce honey and silk used by humans and serve as food for many birds, fishes, and other animals. Insect predators, such as praying mantids and ladybird beetles, feed on plant pests such as aphids and mites, as shown in **Figure 26.19.**

Insects also can be harmful to humans. Lice and bloodsucking flies are human parasites. Fleas can carry plague, houseflies can carry typhoid fever, and mosquitoes can carry malaria, yellow fever, and filariasis. Weevils, cockroaches, ants, and termites cause much property destruction. Grasshoppers, corn borers, and boll weevils destroy agricultural crops. Bark beetles, spruce budworms, and gypsy moths can destroy whole portions of forests.

How is all this insect damage kept in check? In the past, chemicals were used indiscriminately to control insects. However, the overuse of chemicals disrupted food chains, reduced numbers of beneficial insects, and insects developed resistance to the insecticides. Use of biological controls has become increasingly important. Integrated pest management, a technique used by many farmers today, offers long-term control of pests. This strategy employs resistant plant varieties, crop rotation, and critical timing of planting and other agricultural practices along with small amounts of chemicals at critical times to control insect pests.

Centipedes and Millipedes

The centipedes of class Chilopoda and the millipedes of class Diplopoda are close relatives of insects. Centipedes move quickly and live in moist places under logs, bark, and stones. They have long, segmented bodies, and each segment has one pair of jointed legs. The first pair of appendages is modified to form poison claws, which a centipede uses to kill prey. Most species of centipedes are not harmful to humans.

Millipedes have two pairs of appendages on their abdominal segments and one pair on their thorax segments. Millipedes are herbivorous and live, as centipedes do, in moist places under logs or stones. Unlike centipedes, they do not wriggle quickly, but walk with a slow, graceful motion. Millipedes do not have poison claws and feed primarily on damp and decaying vegetation. Compare the centipede and millipede in **Figure 26.20.**

■ **Figure 26.20** Centipedes have one pair of appendages on each segment and poison claws on the first segment. Millipedes have two pairs of appendages on each abdominal segment, while the thorax has one pair of appendages on each segment.

Centipede

Millipede

(l)DK Limited/CORBIS, (r)Diane Nelson/Visuals Unlimited

Trilobite fossil

Color-Enhanced SEM Magnification: 750×

Tardigrade

Figure 26.21 Extinct trilobites are considered to be some of the first arthropods. They were abundant in Cambrian times. Tardigrades, belonging to a phylum that might be related to annelids and arthropods, are called water bears and can live in areas that are alternately wet and dry.

Evolution of Arthropods

The relationships of tardigrades, trilobites, and arthropods have been under close scrutiny as new evidence is discovered. Fossil records show that trilobites, abundant in the mid-Cambrian but now extinct, were early arthropods. Trilobites, like the one shown in **Figure 26.21,** were oval, flattened, and divided into three body sections like some modern arthropods. The large number of identical segments of these ancestral arthropods evolved to more specialized appendages and fewer segments in modern arthropods.

Tardigrades also are related to arthropods, but they appear to be related less closely to arthropods than trilobites are. The tardigrade shown in **Figure 26.21** illustrates why these tiny animals are known commonly as water bears. The largest are 1.5 mm long with four pairs of stubby legs. They feed on algae, decaying matter, nematodes, and other soil animals. They inhabit freshwater, marine, and land habitats. During temperature extremes and drought, tardigrades can survive for years in a completely dry state with reduced metabolism until favorable conditions return.

Section 26.3 Assessment

Section Summary

- Insects make up approximately 80 percent of all arthropod species.
- A variety of adaptations have enabled insects to live in almost all habitats on Earth.
- Insect mouthparts reflect their diets.
- Most insects undergo metamorphosis.
- In some insects, social structure, including individual specializations, is necessary for the survival of the colony.

Understand Main Ideas

1. MAIN Idea **Evaluate** three adaptations of insects in terms of the role they played in enabling insects to become so diverse and abundant.
2. **Identify** features common to all insects.
3. **List** adaptations of the mouthparts of insects that feed on three different food sources and explain each one.
4. **Identify** one reason most insects undergo complete metamorphosis.

Think Scientifically

5. *Design an Experiment* Different species of firefly beetles flash their light in different sequences of short and long flashes. Design an experiment that would explain why fireflies flash their lights.
6. MATH in Biology There are approximately 1.75 million named animal species. About three-fourths of all known animal species are arthropods, and 80 percent of arthropods are insects. Approximately how many named species are insects?

In the Field

Career: Forensic Entomologist

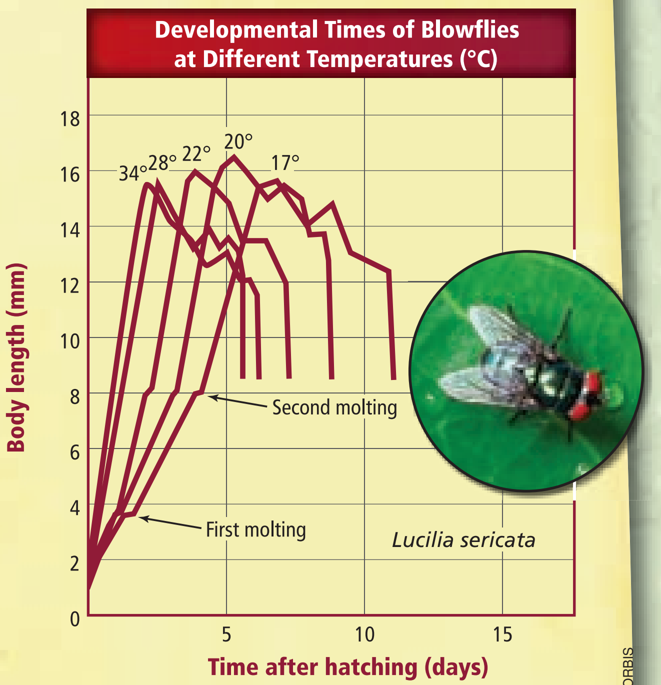
Insect Evidence

Insects often are the first to arrive at a crime scene. Blowflies can arrive within minutes. Over time, other insects arrive. As the insects feed, grow, and lay eggs, they follow predictable developmental cycles. For forensic entomologists—scientists who apply their knowledge of insects to help solve crimes—these cycles reveal information about the time and location of death.

Time of death Forensic entomologists use two methods to determine time of death. The first method is used when the victim has been dead for at least one month. While blowflies and houseflies arrive almost immediately, other species arrive later in the decomposition process. Some species arrive to feed on other insects already at the scene. The succession of insects provides information about the time that passed since death occurred.

When death has occurred within a few weeks, a second method used involves the developmental cycle of blowflies. Within a couple of days, the blowflies lay eggs. The next stages of development are determined in part by temperature, as shown in the graph. Based on the stage of insect development and area temperatures, entomologists can determine a range of days in which the first insects laid eggs in the body, establishing a time of death.

Location of death Insects help determine if a body was relocated after death. If insects found on the body are not native to the habitat where the body is found, investigators can assume that the body was moved. The species that are present also provide clues about the area where death took place.



Clive Druett/Papilio/CORBIS

Limitations In many locations, forensic entomology is less useful in winter, when insects are less active and less abundant. In addition, insects might be prevented from invading a body if it is frozen, buried deeply, or wrapped tightly. In many cases, however, insects can give crucial testimony about the details of a crime.

MATH in Biology

Study the graph to solve this problem: Blowfly larvae with a body length of about 6 mm are found on a corpse with a temperature of 22°C. How much time has passed since death? For more information about careers in biology, visit biologygmh.com.

BIOLAB

INTERNET: WHERE ARE MICROARTHROPODS FOUND?

Background: **Microarthropods range from 0.1 to 5 mm in size—barely visible to human eyes. Dozens of microarthropod species can be unearthed in one shovelful of soil. Discover these hidden animals during this investigation.**

Question: *What types of microarthropods can be found in your local environment?*

Materials

soil sample
clear funnel
ring stand
gooseneck lamp
wire mesh
beaker
95% ethanol
plastic collection vials
magnifying lens
arthropod field guide
metric ruler

Safety Precautions

Procedure

1. Read and complete the lab safety form.
2. Obtain a sample of leaf litter and soil from your teacher.
3. Create a data table to record your observations.
4. Place the funnel in the ring stand.
5. Cut the mesh screen in a circle so it rests inside the funnel.
6. Pour ethanol into the beaker until the beaker is two-thirds full. Set the beaker under the funnel.
7. Remove your soil sample from the bag and place it carefully on the mesh screen in the funnel.
8. Place the lamp at least 10 cm above the sample. Switch on the light and leave it on for several hours. The heat from the lamp dries the soil. This forces the microarthropods downward until they fall through the screen and into the alcohol.
9. Use a magnifying lens to observe the physical characteristics of the microarthropods you collected.
10. **Cleanup and Disposal** Be certain to properly dispose of the alcohol and specimens you collected by following your teacher's instructions.

Analyze and Conclude

1. **Classify** Place the microarthropods you collected into the three major groups of arthropods. Place unidentified specimens into a separate group.
2. **Graph** Use the data you collected to graph the abundances of each type of arthropod.
3. **Describe** Write a description of the physical characteristics of the microarthropod specimens that you could not classify into any of the three major groups.
4. **Hypothesize** How do microarthropods help create a healthy soil ecosystem?
5. **Error Analysis** Check your findings against those for the microarthropods collected by other classmates. Did you classify the microarthropods into the same group? If not, explain why.

SHARE YOUR DATA

Report Use a field guide or dichotomous key to identify the microarthropods you collected. Visit Biolabs at biologygmh.com and post your findings in the table provided for this activity. Write a report comparing your findings to those of students in another area of the country.

CHAPTER 26

Study Guide

STUDY TO GO Download quizzes, key terms, and flash cards from biologygmh.com.

FOLDABLES **Create** a scenario in which a species of terrestrial arthropod has been transferred from its native habitat to a nonnative habitat. Describe the possible short-term and long-term effects on the arthropod and on the habitat.

Vocabulary	Key Concepts
Section 26.1 Arthropod Characteristics	
• abdomen (p. 763) • appendage (p. 764) • book lung (p. 767) • cephalothorax (p. 763) • Malpighian tubule (p. 767) • mandible (p. 765) • molting (p. 764) • pheromone (p. 768) • spiracle (p. 767) • thorax (p. 763) • tracheal tube (p. 767)	MAIN Idea Arthropods have segmented bodies and tough exoskeletons with jointed appendages. • Arthropods can be identified by three main structural features. • Arthropods have adaptations that make them the most successful animals on Earth. • Arthropod mouthparts are adapted to a wide variety of food materials. • In order to grow, arthropods must molt. • Arthropods have organ system modifications that have enabled them to live in all types of habitats and to increase in variety and numbers.
Section 26.2 Arthropod Diversity	
• chelicera (p. 771) • cheliped (p. 771) • pedipalp (p. 772) • spinneret (p. 772) • swimmeret (p. 771)	MAIN Idea Arthropods are classified based on the structure of their segments, types of appendages, and mouthparts. • Arthropods are divided into three major groups. • Crustaceans have modified appendages for getting food, walking, and swimming. • The first two pairs of arachnid appendages are modified as mouthparts, as reproductive structures, or as pincers. • Spiders are carnivores that either hunt prey or trap it in webs that they spin out of silk. • Horseshoe crabs are ancient arthropods that have remained unchanged for more than 200 million years.
Section 26.3 Insects and Their Relatives	
• caste (p. 779) • metamorphosis (p. 778) • nymph (p. 778) • pupa (p. 778)	MAIN Idea Insects have structural and functional adaptations that have enabled them to become the most abundant and diverse group of arthropods. • Insects make up approximately 80 percent of all arthropod species. • A variety of adaptations have enabled insects to live in almost all habitats on Earth. • Insect mouthparts reflect their diets. • Most insects undergo metamorphosis. • In some insects, social structure, including specializations, is necessary for the survival of the colony.

Vocabulary PuzzleMaker biologygmh.com

CHAPTER 26 Assessment

Section 26.1

Vocabulary Review

An analogy is a relationship between two pairs of words and can be written in the following manner: A is to B as C is to D. *Complete each analogy by providing the missing vocabulary term from the Study Guide page.*

1. Spiracles are to breathing as __________ are to excreting wastes.
2. Compound eye is to sense organ as mandible is to __________.
3. Head is to thorax as __________ is to abdomen.

Understand Key Concepts

Use the diagram below to answer questions 4 and 5.

4. Which labeled structure helps terrestrial arthropods maintain water balance?
   A. 1
   B. 2
   C. 3
   D. 4
5. Which labeled structure would an arthropod use to sense odors in its environment?
   A. 1
   B. 2
   C. 3
   D. 4
6. Which group of words has one that does not belong?
   A. exoskeleton, chitin, molting, growth
   B. mandible, antennae, appendage, leg
   C. cephalothorax, thorax, head, abdomen
   D. simple eye, compound eye, tympanum, thorax
7. The relationship between muscle size and exoskeleton thickness limits which in an arthropod?
   A. diet
   B. habitat
   C. motion
   D. size

Constructed Response

8. **Open Ended** Make a table that lists arthropod structures, their functions, and an analogy of what each structure is like in a world of human-made devices. For example, a particular bird's bill that pulls insects out of bark might be compared to tweezers that can pull a sliver out of skin. Use the following structures in your table: antennae, exoskeleton, mandibles, tracheal tubes, and tympanum.
9. **Open Ended** Katydids are members of the grasshopper family. Most katydids are green, but occasionally both pink and yellow katydids appear. Make a hypothesis to explain why pink and yellow katydids sometimes appear.

Think Critically

Use the diagram below to answer question 10.

10. **CAREERS IN BIOLOGY** Arborists, people who specialize in caring for trees, sometimes spray horticultural oils on fruit trees to control aphids, the plant pest shown in the diagram. Based on your knowledge of insect anatomy, analyze why oils are an effective treatment to control plant pests.
11. **Infer** Some species of flowers produce heat that attracts certain beetles to live inside the bloom. Infer how the plant and the beetle both benefit from this relationship.

Section 26.2

Vocabulary Review

For each set of vocabulary terms, explain the relationship that exists.

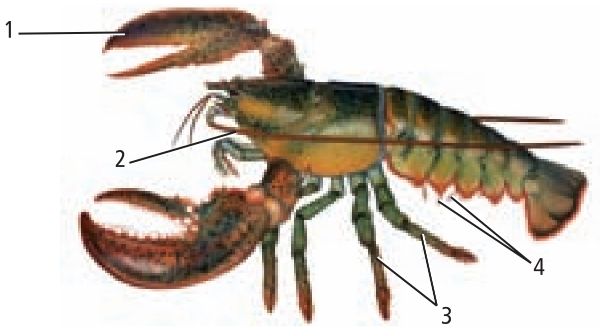
12. cheliped, swimmeret

13. chelicera, pedipalp

14. cheliped, chelicera

Understand Key Concepts

Use the diagram below to answer question 15.



15. Which structure would a lobster use to catch and crush food?
A. 1 **C.** 3
B. 2 **D.** 4

16. Which is not a characteristic of arachnids?
A. chelicerae **C.** spinnerets
B. pedipalps **D.** antennae

17. An animal you found on the forest soil has two body sections, no antennae, and large pincers as the second pair of appendages. What type of animal is it?
A. tick **C.** spider
B. scorpion **D.** lobster

18. In spiders, the spinnerets are involved in which activity?
A. defense **C.** circulation
B. getting rid of waste **D.** spinning silk

19. Which is not a characteristic of mites?
A. one oval-shaped body section
B. carry lyme disease bacteria
C. less than 1 mm long
D. animal parasite

Constructed Response

20. Short Answer Compare the body forms of aquatic crustaceans to those of terrestrial arachnids, showing how each is adapted to its environment.

21. Open Ended What would happen if crustaceans could not molt?

Think Critically

22. Formulate Models Draw and describe a model of a spider that would be adapted to conditions in a hot, dry attic with only crawling insects as a food source.

23. Interpret Scientific Illustrations Based on the lobster diagram in **Figure 26.10** and your knowledge of crustaceans, what adaptations enable a lobster to survive in its aquatic enviroment?

Section 26.3

Vocabulary Review

For each set of vocabulary terms, choose the one term that does not belong and explain why it does not belong.

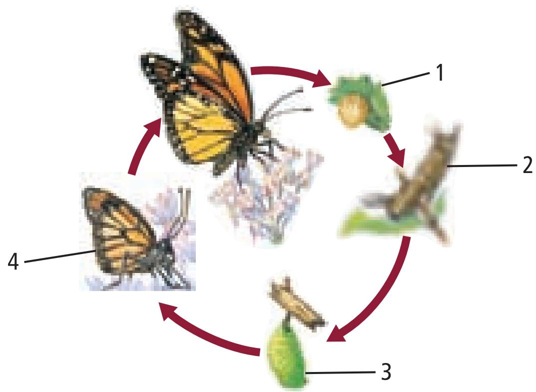
24. incomplete metamorphosis, pupa, larva, adult

25. complete metamorphosis, nymph, adult, molt

26. pupa, larva, nymph, caste, adult

Understand Key Concepts

Use the diagram below to answer question 27.



27. Which stage does not belong in the diagram of complete metamorphosis?
A. 1 **C.** 3
B. 2 **D.** 4

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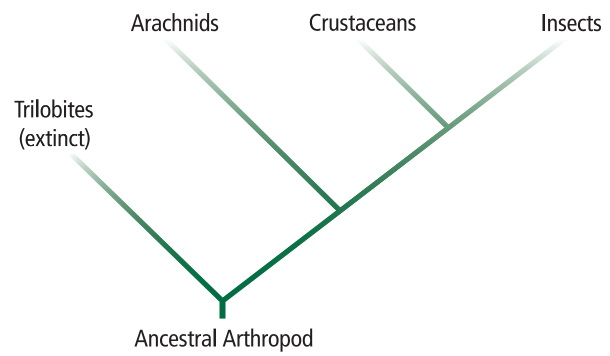
28. If the food is 40 degrees to the right of the Sun, what will be the angle of the straight line of the figure-eight waggle dance?
    A. 60 degrees to the right of vertical
    B. 40 degrees to the right of vertical
    C. 60 degrees to the right of horizontal
    D. 40 degrees to the right of horizontal

29. If a farm field has an infestation of insects, which method would the farmer use to manage it for the long-term?
    A. genetic engineering
    B. insecticides
    C. integrated pest management
    D. pesticide resistance

Constructed Response

Use the diagram below to answer questions 30 and 31.



30. **Open Ended** Based on this interpretation of the phylogeny of arthropods, which group developed the earliest? Which group developed most recently?

31. **Open Ended** Examine the cladogram and sequence the order of appearance, from oldest to most modern, of the following features in the evolution of insects: chelicerae, mandibles, body divided into two regions, segmentation. Explain your reasoning.

Think Critically

32. **Hypothesize** A certain species of beetle looks very much like an ant. Make a hypothesis about the advantage to the beetle of looking like a particular ant.

33. **Design an experiment** that would answer this question: Why do crickets chirp?

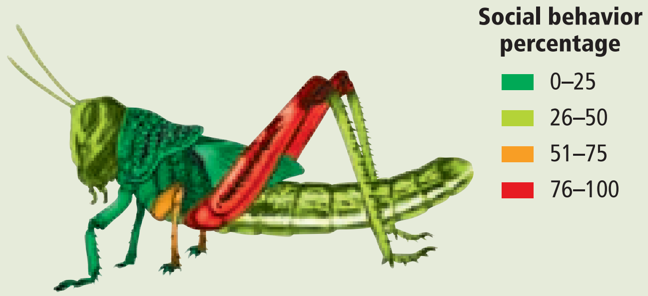
Additional Assessment

34. WRITING in Biology Malaria is spread by mosquitos and is one of the world's worst diseases in terms of numbers of people affected and the difficulties in treating and preventing it. Research and write an essay on how scientists are using fungi to prevent this disease.

Document-Based Questions

Desert locusts have two distinct phases in their lives: the solitary insect that stays in one area and the social phase in which locusts band together in swarms of billions and move kilometers in search of food. Biologists found that exposing individual insects to jostling by small paper balls induced swarming. Examine the locust below. Each color indicates the percentage of social behavior induced by touching the locust on various parts of the body.

Data obtained from: Enserink, M. 2004. Can the war on locusts be won? *Science* 306 (5703): 1880–1882.



35. What percentage of social behavior resulted from touching the insect's thorax?

36. What part of the insect's body is the most sensitive for generating social activity when touched?

37. Draw a conclusion about what physical trigger causes locusts to swarm.

Cumulative Review

38. Compare alternation of generations in plants and alternation of generations in jellyfishes. **(Chapter 24)**

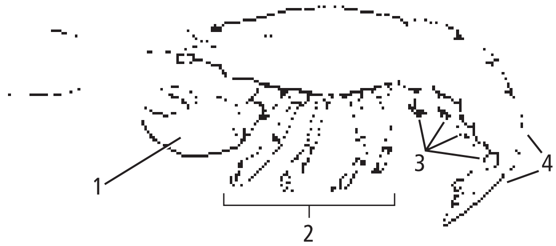
Standards Practice for the EOCT

Cumulative

Multiple Choice

1. Which common function do both the endoskeletons and exoskeletons of animals perform?
   A. growing along with the animal
   B. preventing water loss
   C. supporting the body
   D. providing protection from predators

Use the diagram below to answer questions 2 and 3.



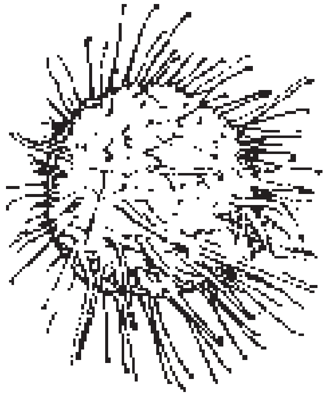
2. In which group does this animal belong?
   A. copepods
   B. crustaceans
   C. insects
   D. spiders

3. Which part of the body does this animal use for reproduction?
   A. 1
   B. 2
   C. 3
   D. 4

4. How are the organisms in Kingdom Protista different from animals?
   A. Some are multicellular.
   B. Some are prokaryotes.
   C. Some have cell walls.
   D. Some have tissues.

5. Which kind of asexual reproduction is possible in flatworms?
   A. budding
   B. fertilization
   C. parthenogenesis
   D. regeneration

Use the drawing below to answer question 6.



6. Which is the method of seed dispersal for this seed?
   A. animals
   B. gravity
   C. water
   D. wind

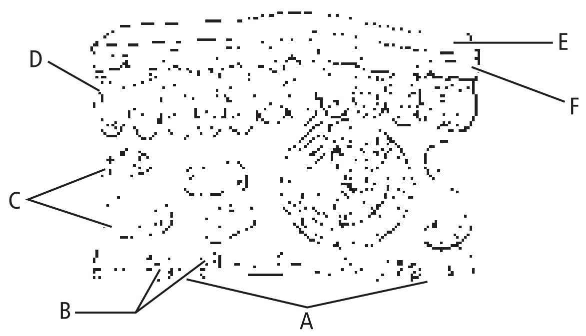
7. Which process is related to sexual reproduction in animals?
   A. budding
   B. fertilization
   C. fragmentation
   D. parthogenesis

8. Which is the role of an earthworm's clitellum in reproduction?
   A. It breaks off, allowing fragmentation to occur.
   B. It indicates whether or not an earthworm is hermaphroditic.
   C. It leaves the earthworm's body and forms a cocoon for developing earthworms.
   D. It produces sperm and eggs.

9. Which is used to classify protists?
   A. feeding
   B. habitat
   C. structure
   D. reproduction

Short Answer

Use the diagram below to answer question 10.



10. Identify the labeled parts of this leaf and state a function for each part.

11. Which characteristics differentiate arthropods from other invertebrates?

12. Describe embryonic development from a zygote to a gastrula. Provide the name of each stage, and explain how it is unique.

13. What characteristics do all mollusks share?

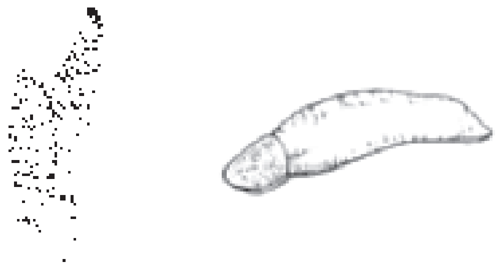
14. Compare and contrast how blood circulates through an insect with the circulation of blood in another kind of animal.

15. Explain the theory of endosymbiosis as it applies to protists. Assess the possible connection between certain organelles in eukaryotic protists and the structures of prokaryotic organisms.

16. Assess the importance of algae to all living things.

Extended Response

Use the illustrations below to answer question 17.



17. The figures above show spores and seeds from different kinds of plants. Explain why one of these structures would have an advantage and would be more likely to be naturally selected.

18. Evaluate the advantages and disadvantages of an exoskeleton.

Essay Question

The world's coral reefs and associated ecosystems are threatened by an increasing array of pollution, habitat destruction, invasive species, disease, bleaching, and global climate change. The rapid decline of these complex and biologically diverse marine ecosystems has significant social, economic, and environmental impacts in the U.S. and around the world. The U.S. Coral Reef Task Force identified two basic themes for national action:

- understand coral reef ecosystems and the processes that determine their health and viability
- reduce the adverse impacts of human activities on coral reefs and associated ecosystems

Using the information in the paragraph above, answer the following question in essay format.

19. What steps do you think the U.S. should take to preserve coral reef ecosystems?

If You Missed Question . . .	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Review Section . . .	24.1	26.2	26.2	24.1	25.1	23.3	24.1	25.4	19.1	22.2	26.1	24.1	25.3	26.1	19.1	19.3	21.3	26.1	24.3
Georgia Standards	B4f	B3b	B3b	B3b	B2e	B4e	B1a	B1a	B3b	B3a	B3b	B3b	B5d	B3b	B1a	B4b	B5d	B4f	B4d

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