Chapter 28 Organizer

Refer to pages 4T-5T of the Teacher Guide for an explanation of the National Science Education Standards correlations.

Section	Objectives	Activities/Features
Section 28.1 **Characteristics of Arthropods** National Science Education Standards UCP.1-5; A.1, A.2; C.3, C.5, C.6 (1 session, 1/2 block)	1. **Relate** the structural and behavioral adaptations of arthropods to their ability to live in different habitats. 2. **Analyze** the adaptations that make arthropods an evolutionarily successful phylum.	**MiniLab 28-1:** Crayfish Characteristics, p. 763 **Problem-Solving Lab 28-1,** p. 766
Section 28.2 **Diversity of Arthropods** National Science Education Standards UCP.1-5; A.1, A.2; C.3, C.4, C.5, C.6; E.1, E.2; F.1, F.4, F.5, F.6; G.1 (2 sessions, 1 block)	3. **Compare and contrast** the similarities and differences among the major groups of arthropods. 4. **Explain** the adaptations of insects that contribute to their success.	**Inside Story:** A Spider, p. 769 **Inside Story:** A Grasshopper, p. 772 **MiniLab 28-2:** Comparing Patterns of Metamorphosis, p. 774 **Focus On** Insects, p. 776 **Design Your Own BioLab:** Will salt concentration affect brine shrimp hatching? p. 780 **Health Connection:** Terrible Ticks, p. 782

Need Materials? Contact Carolina Biological Supply Company at 1-800-334-5551 or at **http://www.carolina.com**

MATERIALS LIST

BioLab
p. 780 clear plastic trays, brine shrimp eggs, uniodized salt, balance, water, graduated cylinder, beakers, labels

MiniLabs
p. 763 preserved crayfish, forceps, pencil, paper
p. 774 life stage specimens of grasshopper, life stage specimens of moth, forceps, pencil, paper

Alternative Lab
p. 762 bess beatles, cloth towel, transparent tape, heavy thread, balance, pennies, plastic petri dish

Quick Demos
p. 762 arthropod specimens
p. 762 arthropod specimens, hand lenses
p. 768 crayfish, lobster, crab, spider
p. 773 raw meat, fly eggs, 2-L soda bottle
p. 773 butterfly chrysalis, terrarium

Key to Teaching Strategies

- L1 Level 1 activities should be appropriate for students with learning difficulties.
- L2 Level 2 activities should be within the ability range of all students.
- L3 Level 3 activities are designed for above-average students.
- ELL ELL activities should be within the ability range of English Language Learners.
- COOP LEARN Cooperative Learning activities are designed for small group work.
- P These strategies represent student products that can be placed into a best-work portfolio.
- These strategies are useful in a block scheduling format.

Arthropods

Teacher Classroom Resources

Section	Reproducible Masters	Transparencies
Section 28.1 **Characteristics of Arthropods**	**Reinforcement and Study Guide,** pp. 123-124 L2 **BioLab and MiniLab Worksheets,** p. 125 L2 **Content Mastery,** pp. 137-138, 140 L1	**Section Focus Transparency 69** L1 ELL **Basic Concepts Transparency 49** L2 ELL **Reteaching Skills Transparency 41** L1 ELL
Section 28.2 **Diversity of Arthropods**	**Reinforcement and Study Guide,** pp. 125-126 L2 **Concept Mapping,** p. 28 L3 ELL **Critical Thinking/Problem Solving,** p. 28 L3 **BioLab and MiniLab Worksheets,** pp. 126-128 L2 **Laboratory Manual,** pp. 199-204 L2 **Content Mastery,** pp. 137, 139-140 L1 **Inside Story Poster** ELL **Tech Prep Applications,** pp. 33-36 L2	**Section Focus Transparency 70** L1 ELL **Reteaching Skills Transparency 41** L1 ELL **Reteaching Skills Transparency 42** L1 ELL

Assessment Resources

Chapter Assessment, pp. 163-168
MindJogger Videoquizzes
Performance Assessment in the Biology Classroom
Alternate Assessment in the Science Classroom
Computer Test Bank
BDOL Interactive CD-ROM, Chapter 28 quiz

Additional Resources

Spanish Resources L1 ELL
English/Spanish Audiocassettes L1 ELL
Cooperative Learning in the Science Classroom COOP LEARN
Lesson Plans/Block Scheduling

NATIONAL GEOGRAPHIC Teacher's Corner

Products Available From Glencoe
To order the following products, call Glencoe at 1-800-334-7344:
CD-ROM
NGS PictureShow: Structure of Invertebrates
Transparency Set
NGS PicturePack: Structure of Invertebrates

Index to National Geographic Magazine
The following articles may be used for research relating to this chapter:
"The Changeless Horsheshoe Crab," by Anne Rudloe, Jr., April 1981.

GLENCOE TECHNOLOGY

The following multimedia resources are available from Glencoe.

Biology: The Dynamics of Life
CD-ROM ELL
Video: *Molting Crab*
Exploration: *Arthropods*
BioQuest: *Biodiversity Park*
Video: *Arthropods*
Exploration: *Classifying Beetles*
Video: *Web-Spinning Spider*
Video: *Gradual Metamorphosis*
Video: *Complete Metamorphosis*
Videodisc Program
Arthropods
Web-Spinning Spider
Gradual Metamorphosis
Complete Metamorphosis

Chapter 28

Getting Started Demo

Visual-Spatial Provide students with a live crayfish in a pan of water. Ask them to describe how the crayfish moves and to describe the structures of the crayfish that make this movement possible. *Students are likely to describe the legs of the crayfish and its finlike structures that enable movement in water.* L2

Theme Development

The theme of **evolution** is stressed as the huge diversity of adaptations that arthropods have evolved is discussed. The theme of **homeostasis** is brought out through discussions of the organs that enable arthropods to maintain homeostasis with their environment.

0:00 Out of Time?

If time does not permit teaching the entire chapter, use the BioDigest at the end of the unit as an overview.

Chapter

28 Arthropods

What You'll Learn

- You will distinguish among the adaptations that have made arthropods the most abundant and diverse animal phylum on Earth.
- You will compare and contrast different classes of arthropods.

Why It's Important

Arthropods are adapted to fill many important niches in every ecosystem in the world. Because arthropods occupy so many niches, they have an impact on all living things, including humans.

Getting Started

Identifying Arthropod Characteristics

Examine two arthropods your teacher has provided. *What are two characteristics that you think all arthropods share?*

interNET CONNECTION To find out more about arthropods, visit the Glencoe Science Web Site.
www.glencoe.com/sec/science

There are about 1 million known species of arthropods. How can we explain the enormous diversity of arthropods—a group that includes both spiders and lobsters?

Multiple Learning Styles

Look for the following logos for strategies that emphasize different learning modalities.

Kinesthetic Meeting Individual Needs, p. 765; Tech Prep, p. 771; Extension, p. 775; Enrichment, p. 777

Visual-Spatial Quick Demo, pp. 762, 773; Reteach, p. 765; Display, p. 770; Portfolio, p. 773; Project, p. 773

Interpersonal Activity, p. 775; Project, p. 776

Intrapersonal Meeting Individual Needs, p. 770

Linguistic Portfolio, p. 764; Enrichment, pp. 768, 773; Biology Journal, pp. 768, 769, 777, 778

Naturalist Biology Journal, p. 764; Check for Understanding, p. 775

Section

28.1 Characteristics of Arthropods

Two out of every three animals living on Earth today are arthropods. You can find arthropods deep in the ocean and on high mountaintops. They live in polar regions and in the tropics. Arthropods are adapted to living in air, on land, and in freshwater and saltwater environments. Arthropods range in size from the 0.3-mm-long spider mite to the giant Japanese spider crab, which measures 4 m across. This water flea, Daphnia, *lives in freshwater lakes and filters microscopic food from the water with its bristly legs.*

Daphnia

SECTION PREVIEW

Objectives

Relate the structural and behavioral adaptations of arthropods to their ability to live in different habitats.

Analyze the adaptations that make arthropods an evolutionarily successful phylum.

Vocabulary

appendage
molting
cephalothorax
tracheal tube
spiracle
book lung
pheromone
simple eye
compound eye
mandible
Malpighian tubule
parthenogenesis

What Is an Arthropod?

Arthropods pollinate many of the flowering plants on Earth. Some arthropods spread plant and animal diseases. Despite the enormous diversity of arthropods, they all share some common characteristics.

A typical arthropod is a segmented, coelomate invertebrate animal with bilateral symmetry, an exoskeleton, and jointed structures called appendages. An **appendage** (uh PEN dihj) is any structure, such as a leg or an antenna, that grows out of the body of an animal. In arthropods, appendages are adapted for a variety of purposes including sensing, walking, feeding, and mating. ***Figure 28.1*** shows some of these adaptations.

Figure 28.1
The development of jointed appendages was a major evolutionary step that led to the success of the arthropods.

A The powerful jointed legs of this crab are adapted for walking.

B Spiders hold their prey with jointed mouthparts while feeding.

C The antennae of a moth are adapted for the senses of touch and smell.

Assessment Planner

Portfolio Assessment
MiniLab, TWE, p. 763
Portfolio, TWE, pp. 764, 773
Assessment, TWE, pp. 765, 773

Performance Assessment
MiniLab, SE, pp. 763, 774
Biolab, SE, pp. 780-781
Alternative Lab, TWE, pp. 762-763
Assessment, TWE, p. 775

Knowledge Assessment
Section Assessment, SE, pp. 766, 775
Chapter Assessment, SE, pp. 783-785
MiniLab, TWE, p. 774

Skill Assessment
Assessment, TWE, p. 764
BioLab, TWE, pp. 780-781

Prepare

Key Concepts

Characteristics common to all arthropods are presented along with their specific adaptations to land, air, and water.

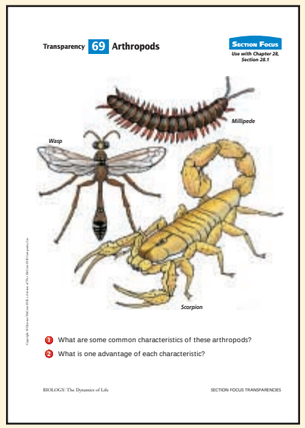
Planning

- Obtain pennies, heavy thread, and plastic petri dishes for the Alternative Lab.
- Purchase plastic arthropods for the Meeting Individual Needs.

1 Focus

Bellringer

Before presenting the lesson, display **Section Focus Transparency 69** on the overhead projector and have students answer the accompanying questions. L1 ELL



Resource Manager
Section Focus Transparency 69 and Master L1 ELL

2 Teach

Quick Demo

Provide students with live or preserved specimens of insects, crayfishes, spiders, and other arthropods. Ask students to compare and contrast their appendages.

Quick Demo

Visual-Spatial Ask students to examine a variety of preserved or live arthropods and draw sketches of their body segments. Provide binocular microscopes or hand lenses to aid in observation. Ask students to label their drawings with the terms *head, thorax, cephalothorax, and abdomen,* as appropriate. L2 ELL

GLENCOE TECHNOLOGY

CD-ROM
Biology: The Dynamics of Life
Video: *Molting Crab*
Disc 4

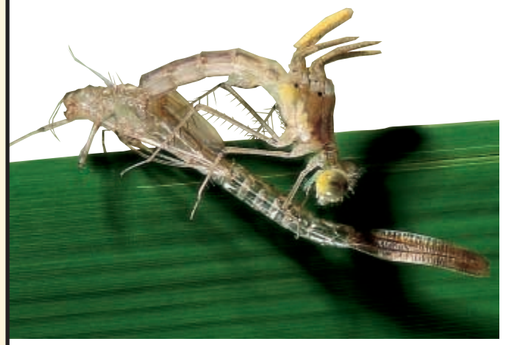


Figure 28.2
Arthropods molt several times during their development. The old exoskeleton is discarded after a new one is formed underneath.

Arthropods are the earliest known invertebrates to exhibit jointed appendages. Joints are advantageous because they allow more flexibility in animals that have hard, rigid exoskeletons. Joints also allow powerful movements of appendages, and enable an appendage to be used in many different ways. For example, the second pair of appendages in spiders is used for sensing and for mating. In scorpions, this pair of appendages is used for seizing prey.

Arthropod exoskeletons provide protection

The success of arthropods as a group can be attributed in part to the presence of an exoskeleton. The exoskeleton is a hard, thick, outer covering made of protein and chitin (KITE un). Chitin is also found in the cell walls of fungi and in many other animals. In some species, the exoskeleton is a continuous covering over most of the body. In other species, the exoskeleton is made of separate plates held together by hinges. The exoskeleton protects and supports internal tissues and provides places for attachment of muscles. In many species that live on land, the exoskeleton is covered by a waxy layer that provides additional protection against water loss. In many aquatic species, the exoskeletons also contain calcium.

Why arthropods must molt

Exoskeletons are an important adaptation for arthropods, but they also have their disadvantages. First, they are relatively heavy structures. Many terrestrial and flying arthropods are adapted to their habitats by having a thinner, lighter-weight exoskeleton, which offers less protection but allows the animal more freedom to fly and jump.

More importantly, though, exoskeletons cannot grow, so arthropods must shed them periodically. Shedding the old exoskeleton is called **molting.** Before an arthropod molts, a new, soft exoskeleton is formed from chitin-secreting cells beneath the old one. When molting occurs, the animal contracts muscles in the rear part of its body, forcing blood forward. The forward part of the body swells, causing the old exoskeleton to split open, as ***Figure 28.2*** shows. The animal then climbs out of its old exoskeleton. Before the new exoskeleton hardens, the animal swallows air or water to puff itself up in size. Thus, the new exoskeleton hardens in a larger size, allowing some room for the animal to continue to grow.

Most arthropods molt four to seven times in their lives, and during these periods, they are particularly vulnerable to predators. When the new exoskeleton is soft, arthropods cannot protect themselves or escape from danger because they move by bracing muscles against the rigid exoskeleton. Therefore, many species hide or remain motionless for a few hours or days until the new exoskeleton hardens.

WORD Origin

arthropod
From the Greek word *arthron*, meaning "joint," and *pod*, meaning "foot." Arthropods have jointed appendages, including legs and antennae.

cephalothorax
From the Greek words *kephalo*, meaning "head," and *thorax*, meaning "breastplate." The cephalothorax is the fused head and thorax of an arthropod.

Segmentation in arthropods

Most arthropods are segmented, but they do not have as many segments as you have seen in segmented worms. In most groups of arthropods, segments have become fused into three body sections—head, thorax, and abdomen. In other groups even these segments may be fused. Some arthropods show a head and a fused thorax and abdomen. In other groups, there is an abdomen and a fused head and thorax called a **cephalothorax** (sef uh luh THOR aks), as shown in ***Figure 28.3.***

Fusion of the body segments is related to movement and protection. Species such as beetles that have separate head and thorax regions are more flexible than those with fused regions. Many species such as shrimps and lobsters have a cephalothorax, which protects the animal but which limits movement. Take a closer look at the fused body segments of an arthropod called a crayfish in the *MiniLab* on this page.

Figure 28.3
You can see the different body segments in these arthropods.

A **A stag beetle shows fusion of body segments into a distinct head, thorax, and abdomen.**

B **In the camel-backed shrimp, the head and thorax are fused into a cephalothorax. The animal also has an abdomen.**

MiniLab 28-1 Comparing and Contrasting

Crayfish Characteristics
There are more species of arthropods than all of the other animal species combined. This phylum includes a variety of adaptations that are not found in other animal phyla.

Blue Crayfish

Procedure

1. Examine a preserved crayfish. **CAUTION:** ***Wear disposable latex gloves and use a forceps when handling preserved material.***
2. Prepare a data table with the following arthropod traits listed: body segmentation, jointed appendages, exoskeleton, sense organs, jaws.
3. Observe the crayfish. Fill in your data table, indicating which of the arthropod traits you observed.
4. Gently lift the edge of the body covering where the legs attach to the body. Look for feathery structures. These are gills and are part of the animal's respiratory system. **CAUTION:** ***Wash hands with soap and water after handling preserved materials.***

Analysis

1. Do crayfish have all of the traits listed above?
2. Make a hypothesis as to how crayfish locate food.

MiniLab 28-1

Purpose
Students will observe a crayfish as they are introduced to traits not seen in phyla studied previously.

Process Skills
compare and contrast, acquire information, classify, collect data, organize data

Teaching Strategies

- Living crayfish may be used in place of preserved specimens. Both preserved and living crayfish are available from biological supply houses.
- If living crayfish are used, caution students about being pinched by the animals' pincers.

Expected Results
All arthropod traits can be observed on the crayfish.

Analysis

1. Yes; all traits listed are the major traits that characterize Arthropoda.
2. Student answers may vary: visually through their eyes; detection of odor with antennae; detection of movement through antennae.

Assessment

Portfolio Ask students to write a short paragraph that describes the traits that differentiate the three major classes of arthropods from one another. Use the Performance Task Assessment List for Writing in Science from **PASC,** p.87. L2

Alternative Lab

Beetle Strength

Purpose
Students will observe and compare the pulling power of a beetle and a human.

Materials
bess beetles, cloth toweling (30 cm²), clear tape, heavy thread (30 cm long), balance, pennies, smooth tabletop, plastic petri dish

Procedure
Give students the following directions.

1. Obtain the mass of the petri dish and the mass of the penny.
2. Place a beetle on its back in the petri dish and obtain the mass of the beetle and the dish. Calculate the mass of the beetle.
3. Make a slipknot loop on one end of the thread and put the loop over the head and body of the beetle so that it acts as a harness. Tape the ends of the thread inside the rim of the petri dish. Make a hypothesis about how many pennies the beetle will be able to pull on the petri dish sled.
4. Secure the cloth to the tabletop with tape. When the beetle begins to pull or move the sled by walking, slowly add pennies to the petri dish, one at a time, until you find the maximum mass the beetle can pull. Do not prod the beetle.
5. Count and record the total number of pennies in the petri dish.
6. Record the relative pulling power of the insect by dividing the mass of the pennies by the mass of the beetle.

Expected Results
Students may find that beetles pull as many as 13 pennies.

Analysis

1. Did your data support your hypothesis? *Beetles pull about 13 pennies, more than most students will hypothesize. Some beetles pull more than 50 times their weight.*
2. Of what adaptive value is it for beetles to have such great pulling power? *They can push and pull parts of the dead logs in which they live.*

Assessment

Performance Have students calculate how many grams they could pull if they had the same strength as their beetle. They should multiply their weight in grams by the pulling power of the beetle. Use the Performance Task Assessment List for Using Math in Science in **PASC,** p. 29. L2

Assessment

Skill Ask students to make a table that compares gas exchange in all of the animals they have studied so far in this unit. Their tables should include the names of the animal phyla studied, the different groups within each phyla, and the method each group uses to exchange gases. They can include their tables in their portfolios. L2 P

GLENCOE TECHNOLOGY

CD-ROM
Biology: The Dynamics of Life
Exploration: *Arthropods*
Disc 4
BioQuest: *Biodiversity Park*
Disc 3, 4
Video: *Arthropods*
Disc 4

Resource Manager

BioLab and MiniLab Worksheets, p. 125 L2

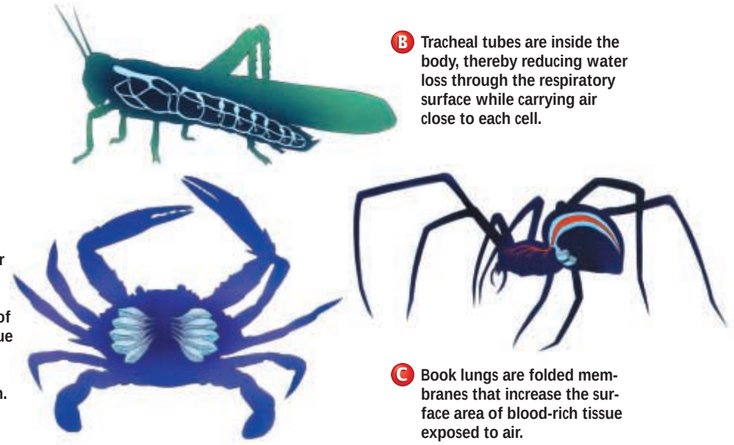


Figure 28.4
Arthropods have a wide variety of respiratory structures.

A Gills, with their large surface area, enable a large amount of blood-rich tissue to be exposed to water containing oxygen.

B Tracheal tubes are inside the body, thereby reducing water loss through the respiratory surface while carrying air close to each cell.

C Book lungs are folded membranes that increase the surface area of blood-rich tissue exposed to air.

Arthropods have efficient gas exchange

Arthropods are generally quick, active animals. They crawl, run, climb, dig, swim, and fly. In fact, some flies beat their wings 1000 times per second. As you would expect, arthropods have efficient respiratory structures that ensure rapid oxygen delivery to cells. This large oxygen demand is needed to sustain the high levels of metabolism required for rapid movements.

Three types of respiratory structures for taking oxygen into their bodies have evolved in arthropods: gills, tracheal tubes, and book lungs. In some arthropods, air diffuses right through the body wall. Aquatic arthropods exchange gases through gills, which extract oxygen from water and release carbon dioxide into the water. Land arthropods have either a system of tracheal tubes or book lungs. Most insects have **tracheal tubes** (TRAY kee ul), branching networks of hollow air passages that carry air throughout the body. Muscle activity helps pump the air through the tracheal tubes. Air enters and leaves the tracheal tubes through openings on the thorax and abdomen called **spiracles** (SPIHR ih kulz).

Most spiders and their relatives have **book lungs,** air-filled chambers that contain leaflike plates. The stacked plates of a book lung are arranged like pages of a book. All three types of respiration in arthropods are illustrated in ***Figure 28.4.***

Arthropods have acute senses

Quick movements that are the result of strong muscular contractions enable arthropods to respond to a variety of stimuli. Movement, sound, and chemicals can be detected with great sensitivity by antennae, stalklike structures that detect changes in the environment.

Antennae are also used for communication among animals. Have you ever watched as a group of ants carried home a small piece of food? The ants were able to work together as a group because they were communicating with each other by **pheromones** (FER uh mohnz), chemical odor signals given off by animals. Antennae sense the odors of pheromones, which signal animals to engage in a variety of behaviors. Some pheromones are used as scent trails, such as in the group-feeding behavior of ants, and many are important in the mating behavior of arthropods.

Accurate vision is also important to the active lives of arthropods. Most arthropods have one pair of large compound eyes and from three to eight simple eyes. A **simple eye** is a visual structure with only one lens that is used for detecting light. A **compound eye** is a visual structure with many lenses. Each lens registers light from a tiny portion of the field of view. The total image that is formed is made up of thousands of parts. The multiple lenses of a flying arthropod, such as the dragonfly shown in ***Figure 28.5,*** enable it to analyze a fast-changing landscape during flight. Compound eyes can detect the movements of prey, mates, or predators, and can also detect colors.

Arthropod nervous systems are well developed

Arthropods have well-developed nervous systems that process information coming in from the sense organs. The nervous system consists of a double ventral nerve cord, an anterior brain, and several ganglia. Arthropods have ganglia that have become fused. These ganglia act as control centers for the body section in which they are located.

Arthropods have other complex body systems

Arthropod blood is pumped by one or more hearts in an open circulatory system with vessels that carry blood away from the heart. The blood flows out of the vessels, bathes the tissues of the body, and returns to the heart through open body spaces.

Arthropods have a complete digestive system with a mouth, stomach, intestine, and anus, together with various glands that produce digestive enzymes. The mouthparts of most arthropod groups include a variety of jaws called **mandibles** (MAND uh bulz). Mouthparts are adapted for holding, chewing, sucking, or biting the various foods eaten by arthropods, illustrated in ***Figure 28.6.***

Most terrestrial arthropods excrete wastes through **Malpighian tubules** (mal PIGH ee un). In arthropods, the

Figure 28.5
The compound eyes of this dragonfly cover most of its head and consist of about 30 000 lenses. However, the images formed by compound eyes are unclear.

A Sand flies and other insects that feed by drawing blood have piercing blades or needle-like mouthparts.

B The rolled-up sucking tube of moths and butterflies can reach nectar at the bases of long, tubular flowers.

C The sponging tongue of the housefly has an opening between its two lobes through which food is lapped.

Figure 28.6
Mouthparts of arthropods exhibit tremendous variation among species.

3 Assess

Check for Understanding

Ask students to list the characteristics of arthropods. Have them describe each characteristic on their list. L1

Reteach

Visual-Spatial Ask students to make a table that summarizes the characteristics of arthropods. Students should include the following headings in their tables: Appendages, Exoskeleton, Segmentation, Gas exchange, Senses, Nervous system, Circulatory system, Digestive system, Mouthparts, Excretory system, Muscular system, Reproduction. L2

Extension

Ask students to collect and mount a variety of arthropods. Have them refer to a field guide to identify, classify, and label each specimen. L3

Assessment

Portfolio Have students imagine that their town is scheduling mosquito spraying several times during the summer. Ask them to write a letter to the mayor, to be included in their portfolios, which states their opposition or support of the spraying. They should support their views with library research. L2 P

4 Close

Demonstration

Present a slide show of a variety of arthropods. Review the characteristics of arthropods shown by each animal. Have students speculate about the likely habitat for each arthropod. L1

BIOLOGY JOURNAL

Arthropod Habitats

Naturalist Ask student groups to list in their journals all the arthropods they know. Ask them to identify each arthropod's habitat: land, water, or air. Ask them why arthropods are able to live in so many different kinds of habitats and why there are so many different kinds of arthropods. L2 COOP LEARN

Portfolio

Arthropod Respiration

Linguistic Provide students with live or preserved arthropods that have gills, tracheal tubes, and book lungs. Ask students to explain how these arthropods get oxygen and how this method illustrates adaptations of these animals to their environments. L2 P

MEETING INDIVIDUAL NEEDS

Visually Impaired

Kinesthetic For students who are visually impaired, purchase a variety of plastic arthropods from a toy store. Have visually impaired students handle each arthropod while a sighted student names the arthropod, the group to which it belongs, and the adaptations of that group of arthropods. L2

Resource Manager

Content Mastery, p. 139 L1
Reinforcement and Study Guide, pp. 123-124 L2

Problem-Solving Lab 28-1

Purpose

Students will use a protractor to measure angles on a circle graph. The number of degrees measured will correlate with the number of species in the major animal phyla.

Process Skills

analyze information, think critically, compare and contrast, interpret data, interpret scientific illustrations, make and use graphs

Teaching Strategies

- Review use of the protractor and how to read it.
- Student answers may not agree exactly with certain values provided in the text regarding species numbers.

Thinking Critically

1. 360 × 3000 = 1 080 000; 876 000; 81%
2. Insecta; 810 000; 75%; 92.5%
3. Coleoptera; 336 000; 38%
4. Arthropods are capable of living in almost any environment and/or biome; they can utilize many food sources; and they have a rapid life cycle and produce a large number of offspring.

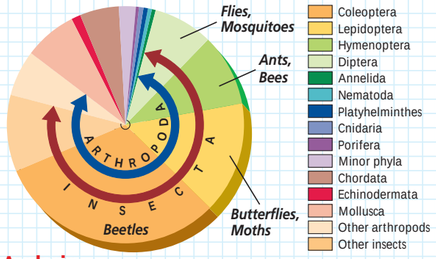
Assessment

Performance Ask students to research insect orders. Have them pick one order that has economic impact on our lives and prepare a brief oral report on how these insects affect us. Use the Performance Task Assessment List for Oral Presentation in **PASC,** p. 71. L2

Problem-Solving Lab 28-1 Using Numbers

How many are there? There are a lot of arthropod species on Earth. How do arthropods compare with other animals?

Numbers of Animal Species



Analysis

Look over the circle graph. Determine the number of species in each phylum or class by noting that each degree on the circle represents about 3000 species. Note: You will need a protractor.

Thinking Critically

1. About how many species of arthropods are known? What percentage of all animal species are arthropods?
2. Which class of arthropods makes up the larger category? How many species are in this class? What percentage of all arthropods is in this class? What percentage of all animal species is in this class?
3. Which order (Diptera, Hymenoptera) makes up the largest category? How many species are in this order? What percentage of all arthropods is in this order?
4. Formulate a hypothesis that explains why there are so many arthropod species.

tubules are all located in the abdomen rather than in each segment, as you have seen in segmented worms. Malpighian tubules are attached to and empty into the intestine.

Another well-developed system in arthropods is the muscular system. In a human limb, muscles are attached to the outer surfaces of internal bones. In an arthropod limb, the muscles are attached to the inner surface of the exoskeleton. An arthropod muscle is attached to the exoskeleton on both sides of the joint.

Arthropods reproduce sexually

Most arthropod species have separate males and females and reproduce sexually. Fertilization is usually internal in land species but is often external in aquatic species. A few species, such as barnacles, are hermaphrodites, animals with both male and female reproductive organs. Some species, including bees, ants, and wasps, exhibit **parthenogenesis** (par thuh noh JEN uh sus), a form of asexual reproduction in which a new individual develops from an unfertilized egg.

There are more arthropod species than all other animal species combined. Find out how many species of arthropods there are by reading the *Problem-Solving Lab* on this page.

Section Assessment

Understanding Main Ideas

1. Describe the pathway taken by the blood as it circulates through an arthropod's body.
2. Describe two features that are unique to arthropods.
3. What are the advantages and disadvantages of an exoskeleton?
4. Compare how spiders and crabs protect themselves.

Thinking Critically

5. What characteristics of arthropods might explain why they are the most successful animals in terms of population sizes and numbers of species?

Skill Review

6. **Comparing and Contrasting** Compare the adaptations for gas exchange in aquatic and land arthropods. For more help, refer to *Thinking Critically* in the **Skill Handbook.**

Section Assessment

1. Blood is pumped by one or more hearts through vessels. The blood flows out of the vessels, bathes the tissues of the body, and returns to the heart through open body spaces rather than through blood vessels.
2. jointed appendages, segmented bodies, exoskeletons
3. An exoskeleton is advantageous because it protects against water loss and injury. Disadvantages include its weight and inflexibility.
4. Crabs have a hard exoskeleton and pincers. Spiders have poisonous fangs.
5. jointed appendages, exoskeletons, efficient gas exchange, wings in some, acute senses
6. Aquatic arthropods exchange gases through gills, which extract O_2 from water and release CO_2 into the water. Land arthropods have either tracheal tubes or book lungs. Tracheal tubes carry air throughout the body. Book lungs are chambers with leaflike plates for gas exchange.

Section

28.2 Diversity of Arthropods

SECTION PREVIEW

Objectives

Compare and contrast the similarities and differences among the major groups of arthropods.

Explain the adaptations of insects that contribute to their success.

Vocabulary

chelicerae
pedipalp
spinneret
metamorphosis
larva
pupa
nymph

Female mosquitoes drink an average of 2.5 times their body weight in blood every day. Other arthropods feed on nectar, dead organic matter, oil, and just about every other substance you can imagine. The varied eating habits of arthropods reflect their huge diversity. The phylum Arthropoda includes these classes: Arachnida, spiders and their relatives; Crustacea, crabs and their relatives; Chilopoda, centipedes; Diplopoda, millipedes; Merostomata, horseshoe crabs; and Insecta, insects.

Female mosquito, *Aedes stimulans*

Arachnids

Do you remember the last time you saw a spider? Did you draw back with a quick, fearful breath, or did you move a little closer, curious to see what it would do next? Of the 30 000 species of spiders, only about a dozen are dangerous to humans. In North America, you need to watch out for only the two species illustrated in ***Figure 28.7***—the black widow and the brown recluse.

What is an arachnid?

Spiders, scorpions, mites, and ticks belong to the class Arachnida (uh RAK nu duh). Spiders are the largest group of arachnids. Spiders and other arachnids have only two

WORD Origin

arachnid
From the Greek word *arachne,* meaning "spider." Spiders, and their relatives the scorpions, ticks, and mites, are arachnids.

a

b

Figure 28.7
The black widow spider is shiny black with a red, hourglass-shaped spot on the underside of the abdomen (a). The brown recluse is brown to yellow and has a violin-shaped mark on its body (b). A bite from either spider will require prompt medical treatment.

GLENCOE TECHNOLOGY

VIDEODISC
Biology: The Dynamics of Life
Arthropods (Ch. 35)
Disc 1, Side 2, 52 sec.

Resource Manager

Critical Thinking/Problem Solving, p. 28 L3
Section Focus Transparency 70 and Master L1 ELL

Prepare

Key Concepts

Students will study the diversity and the structural and behavioral adaptations of arthropods. Spiders, ticks, mites, scorpions, crustaceans, centipedes, millipedes, and insects will all be examined.

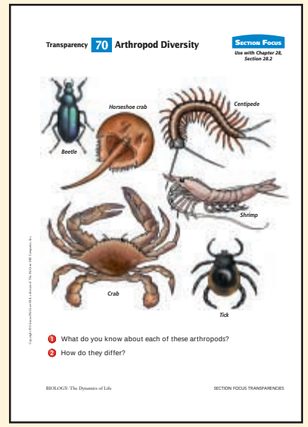
Planning

- For Quick Demos and Meeting Individual Needs, obtain a lobster, raw meat, and 2L soft drink bottles.
- Purchase mealworms for an Assessment.
- For the BioLab, obtain clear plastic trays, brine shrimp eggs, noniodized salt, and plastic bottles.

1 Focus

Bellringer

Before presenting the lesson, display **Section Focus Transparency 70** on the overhead projector and have students answer the accompanying questions. L1 ELL



2 Teach

Quick Demo

Display a crayfish and a lobster, or a crab and a spider. Ask students to compare the animals on display. *Students should recognize differences in the structure of legs and antennae.*

Discussion

Ask students to relate their experiences with spiders. Remind them that spiders are predators and are able to inject poison that can cause itching and swelling.

Enrichment

Linguistic Ask groups of students to report on the current medical research on venom from spiders. L3

Misconception

Many students think that pill bugs, also known as wood lice, are insects. Point out that pill bugs have all the characteristics of crustaceans even though they live on land. Students may also think that pill bugs and sow bugs are the same organism. Although they have a similar appearance and habitat, pill bugs and sow bugs are different species.

NATIONAL GEOGRAPHIC

VIDEODISC
GTV: Planetary Manager
Animal
Side 2

Magnification: 236×

Figure 28.8
Mites are distributed throughout the world and found in just about every habitat. House-dust mites feed on discarded skin cells that collect in dust on floors, in bedding, and on clothing. Some people are allergic to mite waste products.

body regions—the cephalothorax and the abdomen. Arachnids have six pairs of jointed appendages. The first pair of appendages, called **chelicerae** (kih LIHS uh ree), is located near the mouth. Chelicerae are often modified into pincers or fangs. Pincers are used to hold food, and fangs inject prey with poison. Spiders have no mandibles for chewing. Using a process of extracellular digestion, digestive enzymes from the spider's mouth liquefy the internal organs of the captured prey. The spider then sucks up the liquefied food.

The second pair of appendages, called the **pedipalps** (PED ih palpz), are adapted for handling food and for sensing. In male spiders, pedipalps are further modified to carry sperm during reproduction. The four remaining appendages in arachnids are modified as legs for locomotion. Arachnids have no antennae.

Most people know spiders for their ability to make elaborate webs. Although all spiders spin silk, not all make webs. Spider silk is secreted by silk glands in the abdomen. As silk is secreted, it is spun into thread by structures called **spinnerets,** located at the rear of the spider. How well can a spider see? Find out by reading the *Inside Story* on the next page.

Ticks, mites, and scorpions: Spider relatives

Spiders are not the only arthropods classified as arachnids. Ticks, mites, and scorpions are arachnids, too. Ticks and mites differ from spiders in that they have only one body section, as shown in ***Figure 28.8***. The head, thorax, and abdomen are completely fused. Ticks feed on blood from reptiles, birds, and mammals. They are small but capable of expanding up to 1 cm or more after a blood meal. Ticks also can spread diseases. You can find out more about ticks and disease in the *Health Connection* at the end of this chapter.

Mites are so small that they often are not visible to the naked human eye. However, you can certainly feel the bite of mites called chiggers if they get under your clothing while you are camping.

Scorpions are easily recognized by their many abdominal body segments and enlarged pincers. They have a long tail with a venomous stinger at the tip. Scorpions live in warm, dry climates and eat insects and spiders. They use the poison in their stingers to paralyze large prey organisms.

Crustaceans

Most crustaceans (krus TAY shuns) are aquatic and exchange gases as water flows over feathery gills. Crustaceans are the only arthropods that have two pairs of antennae for sensing. All crustaceans have mandibles for crushing food, and two compound eyes, which are usually located on movable stalks. Unlike the up-and-down movement of your jaws, crustacean mandibles open and close from side to side.

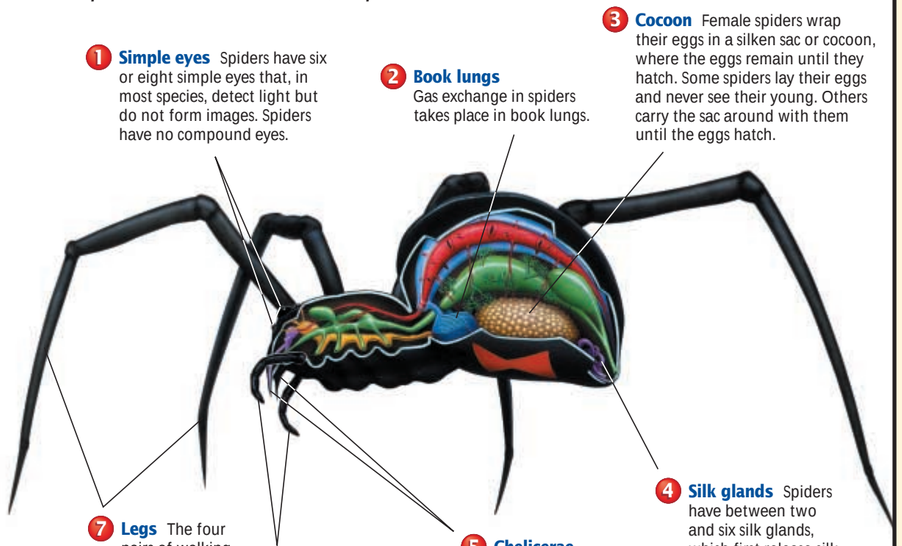
INSIDE STORY

A Spider

The garden spider weaves an intricate and beautiful web, dribbles sticky glue on the spiraling silk threads, and waits for insects to crash into them. Spiders are predatory animals, feeding almost exclusively on other arthropods. Many spiders build unique webs, which are effective in trapping flying insects.

Wandering spider with cocoon

Critical Thinking ***Explain how certain structures in spiders enable them to be effective predators.***



1 **Simple eyes** Spiders have six or eight simple eyes that, in most species, detect light but do not form images. Spiders have no compound eyes.

2 **Book lungs** Gas exchange in spiders takes place in book lungs.

3 **Cocoon** Female spiders wrap their eggs in a silken sac or cocoon, where the eggs remain until they hatch. Some spiders lay their eggs and never see their young. Others carry the sac around with them until the eggs hatch.

4 **Silk glands** Spiders have between two and six silk glands, which first release silk as a liquid. The silk then passes through as many as 100 small tubes before being spun into thread by the spinnerets.

5 **Chelicerae** Chelicerae are the two biting appendages of arachnids. In spiders, they are modified into fangs. Poison glands are located near the tips of the fangs.

6 **Pedipalps** A pair of pedipalps is used to hold and move food and also to function as sense organs. In males, pedipalps are bulbous and are used to carry sperm.

7 **Legs** The four pairs of walking legs are located on the cephalothorax of the spider.

INSIDE STORY

Purpose

Students learn about the structural and behavioral adaptations of spiders.

Teaching Strategies

- Explain to students that not all spiders spin webs. The tarantula is a fierce predator that stalks its prey and does not build webs. Such predators usually have thicker legs than web-building spiders.
- Have students create a table with these column heads: Head and Cephalothorax. Beneath each head, have them list the structures of a spider that connect to that body part. L2

Visual Learning

- As you point out each structure on the spider, have students use the caption to identify its function.

Critical Thinking

Fangs with poison glands enable spiders to paralyze and subdue their prey. Spiders build webs that snare prey.

GLENCOE TECHNOLOGY

CD-ROM
Biology: The Dynamics of Life
Video: *Web-Spinning Spider*
Disc 4

VIDEODISC
Biology: The Dynamics of Life
Web-Spinning Spider (Ch. 36)
Disc 1, Side 2, 36 sec.

BIOLOGY JOURNAL

Spider Poetry

Linguistic Ask students to write a limerick about a spider. Give them examples of limericks from anthologies of poetry and explain that a limerick is a humorous poem written in a special meter with five lines. Encourage them to include both humor and scientific accuracy in their limericks. L2

GLENCOE TECHNOLOGY

VIDEODISC
The Infinite Voyage: *Secrets from a Frozen World, Krill: The Vital Link of the Food Chain* (Ch. 2)
5 min. 30 sec.

BIOLOGY JOURNAL

Charlotte's Web

Linguistic Many students have read the book *Charlotte's Web* by E. B. White. Ask students to recall this story and list in their journals the scientific and factual information in the book. Have them make a second list of information that is not factual. Ask students to explain how this book portrays spiders. L2

Resource Manager

Reteaching Skills Transparency 41 and Master L1 ELL

Display

Visual-Spatial Ask groups of students to design an arthropod that would be adapted to either water, soil, dry sand, the inside of trees, or living on another arthropod. Ask them to make sketches that show how their arthropods feed, defend themselves, and are adapted to their habitats. Display their sketches on the bulletin board. L1 ELL

Misconception

Students may think that barnacles are mollusks because of their shell-like covering. Point out that they have all of the characteristics of crustaceans even though they look like mollusks.

Visual Learning

Figure 28.10 Ask students to use Figure 28.10 to distinguish the differences between millipedes and centipedes.

DESIGN YOUR OWN BioLab The BioLab at the end of the chapter can be used at this point in the lesson.

Figure 28.9
Adult barnacles are somewhat distinct in structure from other arthropods, but they have jointed limbs. Barnacles are filter feeders that trap food by extending feathery legs out of their shells.

Many crustaceans have five pairs of walking legs that are used for walking, for seizing prey, and for cleaning other appendages. The first pair of walking legs are often modified into strong claws for defense.

Crabs, lobsters, shrimps, crayfishes, barnacles, water fleas, and pill bugs are members of the class Crustacea, ***Figure 28.9.*** Some crustaceans have three body sections, and others have only two. Sow bugs and pill bugs, the only land crustaceans, must live where there is moisture, which aids in gas exchange. They are frequently found in damp areas around building foundations. You can observe crustaceans in the *BioLab* at the end of this chapter.

Centipedes and Millipedes

Centipedes, which belong to the class Chilopoda, and millipedes, members of the class Diplopoda, are shown in ***Figure 28.10.*** If you have ever turned over a rock on a damp forest floor, you may have seen the flattened bodies of centipedes wriggling along on their many tiny, jointed legs. Centipedes are carnivorous and eat soil arthropods, snails, slugs, and worms. The bite of a centipede is painful to humans. Like spiders, millipedes and centipedes have Malpighian tubules for excreting wastes. In contrast to spiders, centipedes and millipedes have tracheal tubes rather than book lungs for gas exchange.

A millipede eats mostly plants and dead material on damp forest floors. Millipedes do not bite, but they can spray obnoxious-smelling fluids from their defensive stink glands. You may have seen their cylindrical bodies walking with a slow, graceful motion.

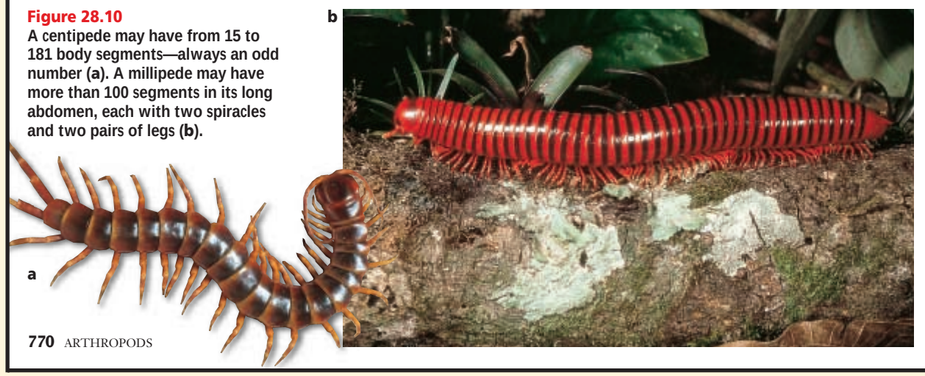


Figure 28.10
A centipede may have from 15 to 181 body segments—always an odd number (a). A millipede may have more than 100 segments in its long abdomen, each with two spiracles and two pairs of legs (b).

Horseshoe Crabs: Living Fossils

Horseshoe crabs, members of the class Merostomata, are considered to be living fossils because they have remained relatively unchanged since the Cambrian period, about 500 million years ago. They are similar to trilobites in that they are heavily protected by an extensive exoskeleton. Shown in ***Figure 28.11,*** horseshoe crabs forage on sandy or muddy ocean bottoms for seaweed, worms, and mollusks. These arthropods migrate to shallow water during mating season, and the females lay their eggs on land, buried in sand above the high water mark. Newly hatched horseshoe crabs look like trilobites.

Figure 28.11
Horseshoe crabs have a semicircular exoskeleton and a long, pointed tail. They have four pairs of walking legs, and five or six pairs of appendages that move water over their gills.

Insects

Have you ever launched an ambush on a fly with your rolled-up newspaper? You swat with great accuracy and speed, yet your prey is now firmly attached upside down on the kitchen ceiling. How does a fly do this?

The fly approaches the ceiling right-side up at a steep angle. Just before impact, it reaches up with its front legs. The forelegs grip the ceiling with tiny claws and sticky hairs, while the other legs swing up into position. The flight mechanism shuts off, and the fly is safely out of swatting distance. Adaptations that enable flies to land on ceilings are among the many that make insects the most successful arthropod group. How is the ability to fly an adaptive advantage to insects? Find out by reading the *Inside Story* on the next page.

Flies, grasshoppers, lice, butterflies, bees, and beetles are just a few members of the class Insecta, by far the largest group of arthropods. There are more species of insects than all other classes of animals combined. You can find out more about insects in the *Focus On Insects* at the end of this section.

Insect reproduction

Insects mate once, or at most only a few times, during their lifetimes. The eggs are fertilized internally, and, in some species, shells form around them. Most insects lay a large number of eggs, which increases the chances that some offspring will survive long enough to reproduce. Many female insects are equipped with an appendage that is modified for piercing through the surface of the ground or into wood. The female lays eggs in the hole.

Metamorphosis: Change in body shape and form

After eggs are laid, the insect embryo develops and the eggs hatch. In some wingless insects, such as springtails and silverfish, development is direct; the eggs hatch into miniature forms that look just like tiny adults. These insects go through

TechPrep

Kinesthetic Ask student groups to make an insect light trap by putting a flashlight in a box with a 5 cm hole. They should set up their trap for several hours after dark and then cover the opening with tape and put the box into the freezer for an hour. This will immobilize the insects. Then have them empty their boxes, examine the insects with a hand lens, and identify the insects with a field guide. Have them count the number of each kind of insect trapped. Ask them to predict the diet and habitat of each insect based on their structural adaptations. L2 ELL COOP LEARN

Glencoe Technology

CD-ROM
Biology: The Dynamics of Life
Video: *Gradual Metamorphosis* Disc 4
Video: *Complete Metamorphosis* Disc 4

VIDEODISC
Biology: The Dynamics of Life
Gradual Metamorphosis (Ch. 37) Disc 1, Side 2, 27 sec.
Complete Metamorphosis (Ch.38) Disc 1, Side 2, 57 sec.

Meeting Individual Needs

Gifted

Intrapersonal Provide students with a crayfish. Ask them to observe the behavior of the crayfish and then design an experiment that would test some aspect of crayfish behavior, such as response to stimuli, habitat, or food preferences. L3

Cultural Diversity

Charles Henry Turner

Have students report on the important contributions of African-American biologist Charles Henry Turner (1867–1923) to our modern understanding of insect behavior. Turner's research included many species of insects such as ants, bees, and cockroaches, and he often developed unique and interesting experimental techniques to study them. Turner was a very prolific scientist; between 1892 and 1923, he published 49 articles in the leading scientific journals of his time. L2

Resource Manager

Concept Mapping, p. 28 L3 ELL
Laboratory Manual, pp. 199-204 L2

INSIDE STORY

Purpose

Students will learn about the structural adaptations of grasshoppers.

Teaching Strategies

- Provide students with a live grasshopper in a large, clear container. Ask students to observe and describe its behavior. Have them examine the grasshopper under a stereoscopic microscope and make a labeled sketch of its external body parts. Students should relate each structure to how the grasshopper is adapted to its environment. L2
- Caution students that they are working with live animals and to treat them gently.

Visual Learning

- Make an overhead transparency of the grasshopper with the labels covered. Ask students to label the lines pointing to grasshopper organs. Ask them to identify how each organ contributes to survival of the grasshopper. L1 ELL

Critical Thinking

Grasshoppers have a complex nervous system consisting of a brain, a double ventral nerve cord, and several ganglia that act as control centers for other body sections.

Resource Manager

Reteaching Skills Transparency 41 and Master L1 ELL

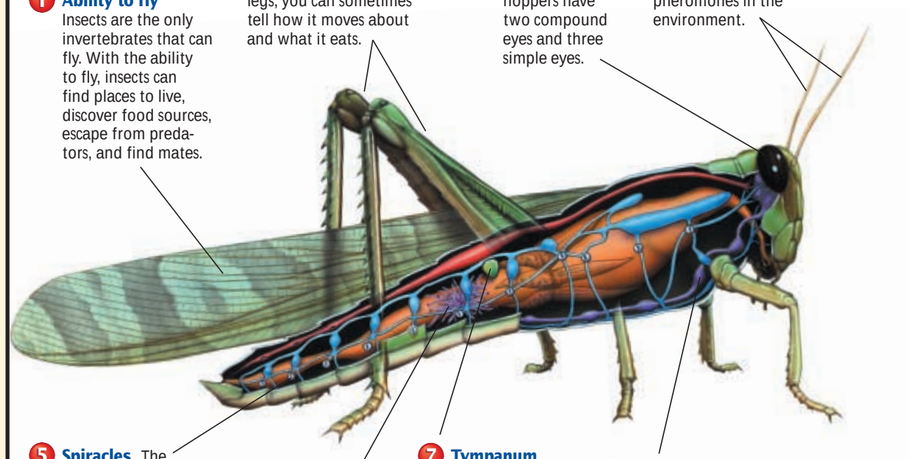
INSIDE STORY

A Grasshopper

Green grasshopper nymph

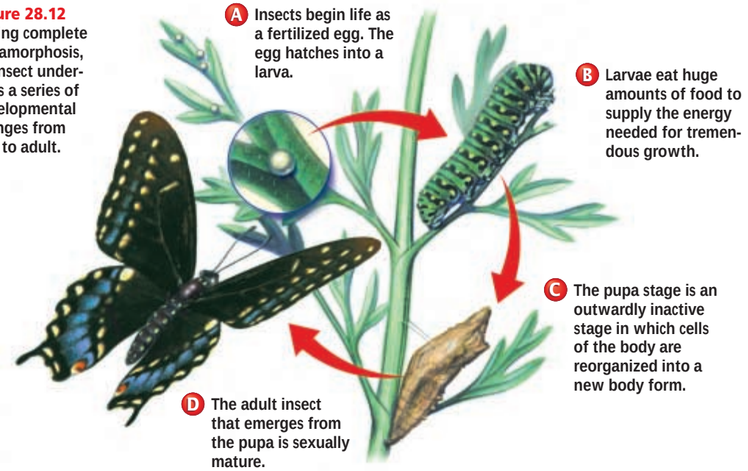
Grasshoppers make rasping sounds either by rubbing their wings together or by rubbing small projections on their legs across a scraper on their wings. Most calls are made by males. Some aggressive calls are made when other males are close. Other calls attract females, and still others serve as an alarm to warn nearby grasshoppers of a predator in the area.

Critical Thinking ***Do grasshoppers have a well-developed nervous system?***



1. **Ability to fly** Insects are the only invertebrates that can fly. With the ability to fly, insects can find places to live, discover food sources, escape from predators, and find mates.
2. **Legs** Insects have six legs. By looking at an insect's legs, you can sometimes tell how it moves about and what it eats.
3. **Eyes** Grasshoppers have two compound eyes and three simple eyes.
4. **Antennae** Insects have one pair of antennae, which is used to sense vibrations, food, and pheromones in the environment.
5. **Spiracles** The spiracles in the abdomen open into a series of tracheal tubes.
6. **Malpighian tubules** Excretion takes place in Malpighian tubules. In the grasshopper, wastes are in the form of dry crystals of uric acid. Producing dry waste helps insects conserve water.
7. **Tympanum** The structure insects use for hearing is a flat membrane called a tympanum.
8. **Nervous system** Grasshoppers, like other insects, have a complex nervous system that includes several ganglia that act as nerve control centers for the body sections in which they are located.

Figure 28.12 During complete metamorphosis, an insect undergoes a series of developmental changes from egg to adult.



A. Insects begin life as a fertilized egg. The egg hatches into a larva.
B. Larvae eat huge amounts of food to supply the energy needed for tremendous growth.
C. The pupa stage is an outwardly inactive stage in which cells of the body are reorganized into a new body form.
D. The adult insect that emerges from the pupa is sexually mature.

successive molts until the adult size is reached. Many other species of insects undergo a series of major changes in body structure as they develop. In some cases, the adult insect bears little resemblance to its juvenile stage. This series of changes, controlled by chemical substances in the animal, is called **metamorphosis** (met uh MOR fuh sus).

Insects that undergo metamorphosis usually go through four stages on their way to adulthood: egg, larva, pupa, and adult. The **larva** is the free-living, wormlike stage of an insect, often called a caterpillar. As the larva eats and grows, it molts several times.

The **pupa** (PYEW puh) stage of insects is a period of reorganization in which the tissues and organs of the larva are broken down and replaced by adult tissues. Usually the insect does not move or feed during the pupa stage. After a period of time, a fully formed adult emerges from the pupa.

The series of changes that occur as an insect goes through the egg, larva, pupa, and adult stages is known as complete metamorphosis. In winged insects that undergo complete metamorphosis, the wings do not appear until the adult stage. More than 90 percent of insects undergo complete metamorphosis. The complete metamorphosis of a butterfly is illustrated in ***Figure 28.12.*** Other insects that undergo complete metamorphosis include ants, beetles, flies, and wasps.

Complete metamorphosis is an advantage for arthropods because larvae do not compete with adults for the same food. For example, butterfly larvae (caterpillars) feed on leaves, but adult butterflies feed on nectar from flowers.

Incomplete metamorphosis has three stages

Many insect species, as well as other arthropods, undergo a gradual or incomplete metamorphosis, in which the insect goes through only three stages of development: egg, nymph, and adult, as shown in

Quick Demo

Make a terrarium by using a 2L soft drink bottle. Inside, place a small piece of raw meat that has been exposed to flies. Seal the terrarium. Have students observe and describe the larval stage of development of the flies that grow in the terrarium.

Enrichment

Linguistic Have each student prepare a report on the life cycle of the arthropod of their choice. L2

Quick Demo

Visual-Spatial Obtain a butterfly chrysalis from a biological supply company. Place it in a glass terrarium. Have students observe the chrysalis daily and make notes on any changes they see. L1 ELL

Assessment

Portfolio Ask students to observe and record the development of a colony of mealworms as they develop from larvae to adults. Direct students to focus their attention on evidence suggesting molting has occurred. Students' notes should be placed in their portfolios. L2

GLENCOE TECHNOLOGY

VIDEODISC
The Infinite Voyage:
Insects: The Ruling Class
Insects and Their Behavior (Ch. 1) 7 min.
Caterpillars: Altering Appearances (Ch. 5) 5 min.

Internet Address Book

internet CONNECTION Note Internet addresses that you find useful in the space below for quick reference.

Portfolio

Mosquito Farming

Visual-Spatial Have students raise mosquitoes in a bucket of pond water covered with window screening. Have students observe and record in their portfolios mosquito metamorphosis by observing the eggs, larvae, pupae, and adults with hand lenses. L2 ELL P

PROJECT

Arthropod Origins

Visual-Spatial Ask students to create a bulletin board display of arthropod origins. Instruct them to have one section of the bulletin board represent mollusk and annelid ancestors. Ask them to point out similarities and differences between these ancestors and present-day arthropods. L2

MiniLab 28-2

Purpose
Students will compare and contrast patterns of metamorphosis.

Process Skills
compare and contrast, acquire information, collect data, hypothesize, observe and infer

Safety Precautions
Remind students to use tongs, forceps, and/or latex gloves when handling specimens.

Teaching Strategies
- You will have to mark the different stages of each life cycle so students can identify them.
- Legs may be a good indicator of the stage being capable of movement. Mouthparts may provide evidence of feeding.

Expected Results
See data table below.

Analysis
1. A grasshopper has incomplete metamorphosis. The moth has complete metamorphosis.
2. The stages that were able to move are the only stages in which feeding occurs.
3. The nymph stage looks like a small adult, but it lacks wings and is sexually immature.

Assessment
Knowledge Show students photos of different insects undergoing metamorphosis. Ask them to determine if the animal shown exhibits complete or incomplete metamorphosis. Use the Performance Task Assessment List for Making Observations and Inferences in **PASC,** p. 17. L2

MiniLab 28-2 Comparing and Contrasting

Comparing Patterns of Metamorphosis Insects undergo a series of developmental changes called metamorphosis. But not all insects follow the same pattern of metamorphosis.

Procedure
1. Copy the data table.
2. Examine the three life stages of a grasshopper. Complete the information called for in your data table. **CAUTION:** ***Wear disposable latex gloves and use forceps to handle preserved insects.***
3. Examine the four life stages of a moth. Complete the information called for in your data table.

Data Table

Insect	Grasshopper			Moth			
Stage	egg	nymph	adult	egg	larva	pupa	adult
Locomotion Method							
Feeding Method							
Able to Reproduce							

Analysis
1. What are the differences between the stages of metamorphosis of a grasshopper and those of a moth?
2. Correlate the ability to move with ability to feed.
3. Compare a nymph stage with an adult stage.

Figure 28.13. A **nymph,** which hatches from an egg, has the same general appearance as the adult but is smaller. Nymphs may lack certain appendages, or have appendages not seen in adults, and they cannot reproduce. As the nymph eats and grows, it molts several times. With each molt, it comes to resemble the adult more and more. Wings begin to form, and an internal reproductive system develops. Gradually, the nymph becomes an adult. Grasshoppers and cockroaches are insects that undergo incomplete metamorphosis. You can compare the two types of metamorphosis in the *MiniLab* on this page.

Origins of Arthropods

Arthropods have been enormously successful in establishing themselves over the entire surface of Earth. Their ability to exploit just about every habitat is unequaled in the animal kingdom. The success of arthropods can be attributed in part to their varied life cycles, high reproductive output, and structural adaptations such as small size, a hard exoskeleton, and jointed appendages.

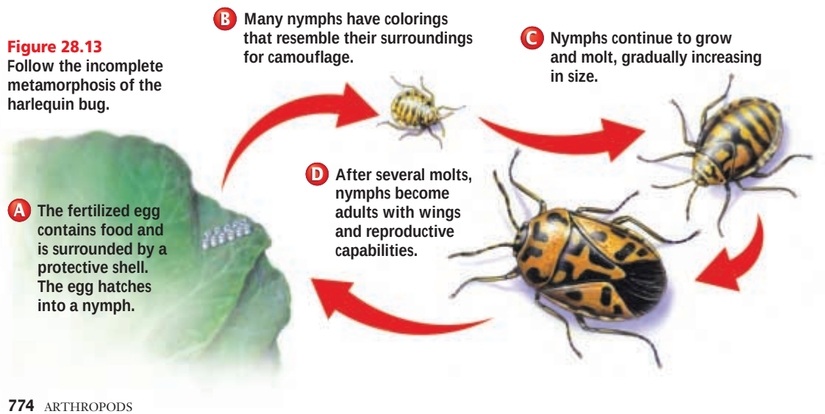


Figure 28.13 Follow the incomplete metamorphosis of the harlequin bug.

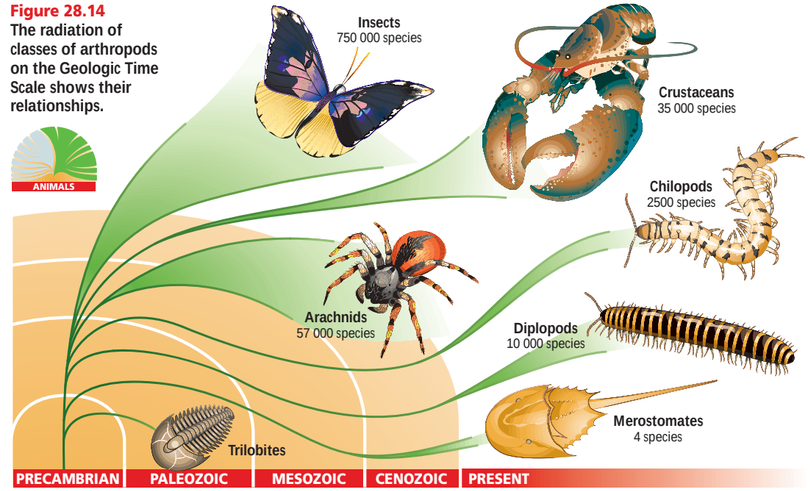


Figure 28.14 The radiation of classes of arthropods on the Geologic Time Scale shows their relationships.

Arthropods most likely evolved from an ancestor of the annelids. As arthropods evolved, body segments fused and became adapted for certain functions such as locomotion, feeding, and sensing the environment. Segments in arthropods are more complex than in annelids, and arthropods have more developed nerve tissue and sensory organs such as eyes.

The exoskeleton of arthropods provides protection for their soft bodies. Muscles in arthropods are arranged in bands associated with particular segments and portions of appendages. The circular muscles of annelids do not exist in arthropods. Because arthropods have many hard parts, much is known about their evolutionary history. The trilobites shown in ***Figure 28.14*** were once an important group of ancient arthropods, but they have been extinct for 250 million years.

Section Assessment

Understanding Main Ideas
1. How are centipedes different from millipedes?
2. How are insects different from spiders?
3. Describe three sensory adaptations of insects.
4. Compare the stages of complete and incomplete metamorphosis.

Thinking Critically
5. Why might complete metamorphosis have greater adaptive value for an insect than incomplete metamorphosis?

Skill Review
6. **Recognizing Cause and Effect** Some plants produce substances that prevent insect larvae from forming pupae. How might this chemical production be a disadvantage to the plant? For more help, refer to *Thinking Critically* in the **Skill Handbook.**

3 Assess

Check for Understanding

Naturalist Give students a list of traits for an arthropod. Have them determine which arthropod class the traits describe. L2

Reteach

Have students make a chart on arthropod classes. Have them include an illustration in each column that shows the number of body sections, antennae positions, and numbers of legs. L1

Extension

Kinesthetic Have students use modeling clay and pipe cleaners to make models of centipedes and millipedes. L1 ELL

Assessment
Performance Have students develop a plan for constructing an insect exhibit for a zoo. They should choose insects, make a diagram of their exhibit, and explain how the insects must be cared for. L2

4 Close

Activity

Interpersonal Divide the class into two groups. Play the "Who am I?" game. A member of one group will call out clues, while a member of the second group guesses the class of the arthropod. A correct answer will earn the team one point. L2 COOP LEARN

Data Table

Insect	Grasshopper			Moth			
Stage	egg	nymph	adult	egg	larva	pupa	adult
Locomotion Method	no	yes	yes	no	yes	no	yes
Feeding Method	no	yes	yes	no	yes	no	yes
Able to Reproduce	no	no	yes	no	no	no	yes

Resource Manager

Content Mastery, pp. 137, 139-140 L1
Reinforcement and Study Guide, pp. 125-126 L2
Reteaching Skills Transparency 42 and Master L1 ELL
Basic Concepts Transparency 49 and Master L2 ELL
BioLab and MiniLab Worksheets, p. 126 L2

Section Assessment

1. Centipedes have only one pair of legs per body segment, eat meat, and bite. Millipedes have two pairs of legs per body segment, eat plants and dead material, and do not bite.
2. Spiders have two body regions, six pairs of appendages, book lungs, simple eyes, and spin silk. Insects generally have three body regions, three pairs of legs, one pair of antennae, spiracles, and compound eyes.
3. Insects have compound eyes, antennae, tympanums, and sensitive hairs over parts of the body.
4. Complete metamorphosis has four stages: egg, larva, pupa, and adult. Incomplete metamorphosis has three stages: egg, nymph, and adult.
5. Complete metamorphosis is an advantage because the larvae do not compete with adults for food.
6. Although the larval stage is most destructive to plants, many plants require the adult insects for pollination.

Focus On

Insects

Purpose

Students will learn characteristics of insects and features of major groups of insects.

Background

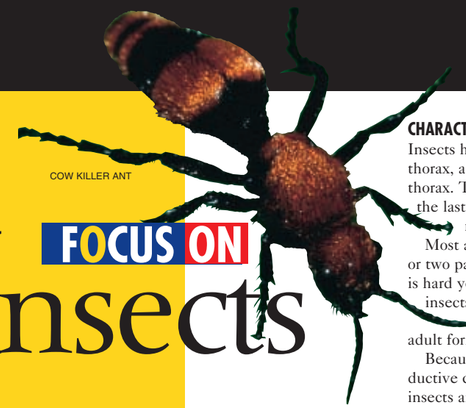
Insects are essential to life, yet many are harmful. Their diversity in form makes insects not only successful, but also the largest animal group.

Teaching Strategies

- Obtain a praying mantis egg case and have students make observations of hatching and development. Emphasize the adaptations that make the mantis an effective predator. L1 ELL
- Ask students to examine the mouthparts of preserved ants. Then have them design and conduct an experiment to determine food preferences of live ants. L2

Visual Learning

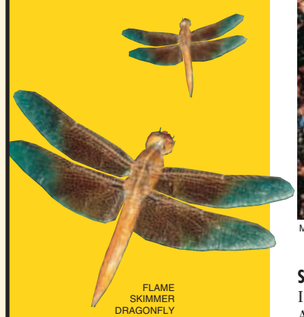
Ask students to discuss their most positive and most negative experiences with insects. Ask if they have seen any insects similar to ones in the photos in this Focus On. Have them explain how the insects were similar to and different from the photos. L1



COW KILLER ANT

FOCUS ON Insects

Without insects, life as we know it would be impossible. Two-thirds of all flowering plants depend on insects to pollinate them. Insects also digest and degrade carrion, animal wastes, and plant matter. Their actions help fungi, bacteria, and other decomposers recycle nutrients and enrich the soil on which plants and all terrestrial organisms depend.



FLAME SKIMMER DRAGONFLY

CHARACTERISTICS

Insects have three body divisions—head, thorax, abdomen—and six legs attached to the thorax. The abdomen has multiple segments, the last ones often possessing external reproductive organs.

Most adult insects have wings, usually one or two pairs. An insect's skin, or integument, is hard yet flexible, and waterproof. Many insects must molt in order to grow larger before metamorphosing into adult forms.

Because of their ability to fly, a rapid reproductive cycle, and a tough, external skeleton, insects are both resilient and successful.

MONARCH BUTTERFLIES

HONEYBEE

SIZE AND DIVERSITY

Insects are members of the phylum Arthropoda and the class Insecta.
The most diverse class in the animal kingdom, Insecta is also the largest—it contains more species than all other animal groups combined.

COMPOUND EYES OF GIANT RUDDER FLY

SENSE ORGANS

Insects gather information about their environment using a variety of sense organs that detect light, odors, sound, vibrations, temperature, and even humidity. Most adult insects have compound eyes, as well as two or three simple eyes on top of their heads. The compound eye of a large dragonfly contains a honeycomb of 28 000 lenses. The image from each lens is sent to the brain and somehow combined into a composite image, but we don't know exactly what such insects see. Some insects navigate by using sound waves or following odor trails. Katydids and crickets have "ears" on their front legs; houseflies have taste receptors on their feet.

KATYDID

ARCTIC WOOLLY BEAR CATERPILLAR

VERSATILITY

Some insects, such as the Arctic woolly bear caterpillar, can survive 10 months a year in subzero temperatures. Others, such as the monarch butterfly, migrate thousands of miles to warmer regions. Honeybees conserve heat in freezing temperatures by clumping into a ball that hums and churns all winter. Although some insects are plant pests, many others prey on their plant-munching relatives, and in so doing aid humans in the fight to control crop damage.

MOUTHPARTS

Insects get food by biting, lapping, and sucking. Some insects, such as grasshoppers and ants, have mouthparts for biting and chewing, with large mandibles for tearing into plant tissue or seizing prey. The powerful mandibles of bulldog ants, for example, are hinged at the sides of the head and bite inward–with great force–from side to side. Butterflies and honeybees have mouthparts shaped for lapping up nectar. Aphids and cicadas can pierce plant stems and then plant juices can be sucked like soda through a straw.

BLUE MORPHO BUTTERFLY

BULLDOG ANT

PROJECT

Insect Scavenger Hunt

Interpersonal Ask a group of students to prepare a class scavenger hunt for insects and signs of insects. The scavenger hunt should require that classmates observe various insect behaviors such as movement and sound production, plus physical features of the insect and its habitat. Make sure the questions require that students actually observe the insect. For example: Describe two insect sounds that you hear outside. What insects are making these sounds? L2 COOP LEARN

BIOLOGY JOURNAL

Flea Collar Safety

Linguistic Ask students to contact a local veterinarian and report in their journals about the safety of flea collars for pets. Students should ask about the insecticides used, how the flea collar works, why the flea collars are not dangerous to the health of the pet, and alternatives to flea collars. L2

Internet Address Book

internet CONNECTION Note Internet addresses that you find useful in the space below for quick reference.

_____

_____

_____

_____

Enrichment

Kinesthetic Obtain preserved specimens of a variety of moths and butterflies and have students use a dissecting needle to unroll and measure the length of each proboscis. Have them hypothesize how proboscis length correlates with the type of flower each insect visits to sip nectar. L2

NATIONAL GEOGRAPHIC

VIDEODISC
STV: Rain Forest
Forest Floor
Leaf-Cutting Ants
Unit 2, Side 1, 2 min. 30 sec.
Insects by Night and Day
Unit 2, Side 1, 1 min. 2 sec.

Teaching Strategies

- Ask if any students ever caught and kept an insect in a jar. Ask why they did this and what they learned.
- Ask students to research the discovery of DDT and the factors that led to the banning of its use in the United States. L3
- Have students work in groups and imagine that they are a team of inventors with backgrounds in entomology. They have been given unlimited funding to design the ultimate device for insect control. Students should use their creative imaginations as well as scientific knowledge to make a model of their bug catcher and explain its function to the class. L2 COOP LEARN

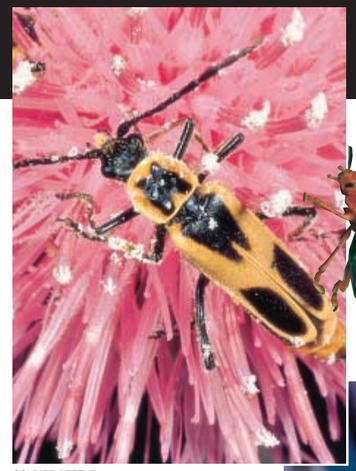
GLENCOE TECHNOLOGY

VIDEODISC
The Infinite Voyage:
Insects: The Ruling Class
The Rothschild Legacy: Study of Fleas and the Bubonic Plague (Ch. 2), 6 min. 30 sec.

Classifying Social Insects: Ants (Ch. 3), 6 min. 30 sec.

Classifying Social Insects: Bees (Ch. 4), 5 min. 30 sec.

American Burying Beetles: An Endangered Insect (Ch. 7) 7 min. 30 sec.



SOLDIER BEETLE

A SUPERLATIVE CRITTER

Some beetles can chew through lead or zinc or timber—not to mention whole fields of cotton. A leaf beetle in the Kalahari Desert produces a toxin powerful enough to fell an antelope. The American burying beetle can lift 200 times its weight. Among Earth's most recognizable beetles, fireflies light up summer evenings, and ladybugs control garden pests.

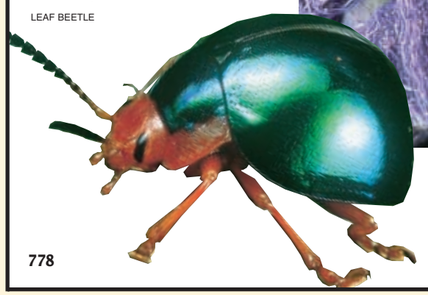
HARMFUL VERSUS HELPFUL

Some beetles damage crops and spread disease. Spotted cucumber beetles, for example, devour leaves and flowers of cucumbers, melons, and squashes. They can also spread bacterial diseases to the plants they attack.

Many other beetles, such as ladybugs (also known as ladybirds), should be welcome visitors anywhere. Gardeners, farmers, and fruit-growers release thousands of ladybugs into gardens, fields, and orchards as a first line of defense against insect pests, especially aphids. The bright red-orange of ladybug beetles is an unmistakable warning to potential predators that the beetles are extremely distasteful.

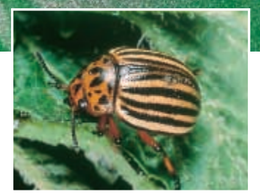
LADYBUG BEETLES

LEAF BEETLE



SPOTTED CUCUMBER BEETLE

WEEVIL BEETLE



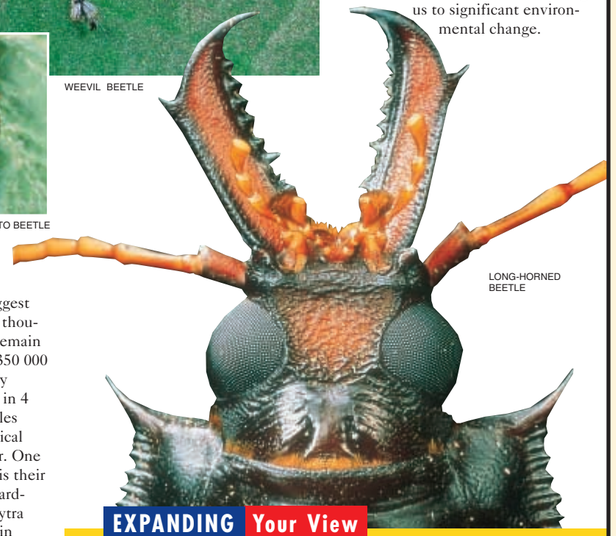
COLORADO POTATO BEETLE

BODY ARMOR

Many scientists consider beetles to be evolution's biggest success story and think that thousands of additional species remain undiscovered. Beetles—all 350 000 described species—presently account for approximately 1 in 4 known animal species. Beetles thrive in deserts, under tropical forest canopies, and in water. One key to beetles' adaptability is their "shell"—actually a pair of hardened wings called elytra. Elytra permit some beetles to live in deserts by sealing in moisture and other species to breathe underwater by trapping air. Many beetles are remarkably resistant to pesticides.

A SPECIAL NICHE

The Mesozoic era is often identified as the age of dinosaurs. But the truly colossal event during this period in Earth's history was the proliferation of flowering plants. Primary pollinators of the era, beetles most likely fueled this explosion of color and fragrance. Beetles fill critical ecological niches as scavengers and as harvesters of caterpillars and other pests, which, left untended, would devour thousands of acres of crops and forest trees each year. When a beetle species faces extinction—as nine species in the United States currently do—scientists see it as an early warning system alerting us to significant environmental change.



LONG-HORNED BEETLE

EXPANDING Your View

1. **THINKING CRITICALLY** What are the advantages and disadvantages of an exoskeleton?
2. **JOURNAL WRITING** Research social behavior in insects and write a short essay to present to the class.

Biology Journal

Linguistic Have students contact their local agricultural extension service to ask about integrated pest management efforts in their area. Then have students write an advertisement for a gardening magazine to sell insects used for natural pest control. L2

Portfolio

Insect Population

Ask students to do an insect population study by sampling one species of insect in a small area and then estimating the total number over a larger area. They should measure an area 1 m^2 and collect one type of insect, such as beetles. Then, knowing the size of the area, they can calculate how many insects of that type there are. Have students release the insects as soon as their calculations are complete. Challenge students to relate the number of insects counted to the insect's niche. Have students predict how a sudden change in insect population number would impact the ecology of the area. L3 P COOP LEARN

Enrichment

Ask students to design and conduct an experiment to determine the ideal temperature for hatching and developing flour beetle eggs. L2

Answers to Expanding Your View

1. Advantages of exoskeletons: protection, waterproofing. Disadvantages: heavy, can't grow very large, must molt to grow
2. Students might present information on the social structure of bees in a hive or an ant colony.

GLENCOE TECHNOLOGY

CD-ROM
Biology: The Dynamics of Life
Exploration: *Classifying Beetles*
Disc 3

DESIGN YOUR OWN BioLab

Time Allotment

One class period for set up, then 10 minutes per day for 3 days

Process Skills

collect data, identify and control variables, design an experiment, draw a conclusion, experiment, hypothesize, interpret data, observe and infer, organize data

Safety Precautions

Remind students to wear goggles to protect their eyes.

Preparation

- Purchase brine shrimp eggs from a pet store or biological supply house.
- Plan the experiment so that it starts on a Monday.
- Plastic trays are available from the meat or produce department in most grocery stores.
- Review the procedure for preparation of 1, 2, and 4% salt solutions.
- Use noniodized table salt (kosher or sea salt). Check to make sure that iodine has not been added.

Possible Hypotheses

Students may hypothesize that hatching will not occur in any salt solution. Students may hypothesize that hatching will occur only in salt concentrations higher than 10% but lower than 20%.

DESIGN YOUR OWN BioLab

Will salt concentration affect brine shrimp hatching?

Brine shrimp (Artemia salina) *belong to the class Crustacea. They are excellent experimental animals because their eggs hatch into visible swimming larvae within a very short time. Using the name as a clue, where might these animals normally be found?*

Preparation

Problem

How can you determine the optimum salt concentration for the hatching of brine shrimp eggs?

Hypothesis

Decide on one hypothesis that you will test. Your hypothesis might be that increased salt concentrations result in an increase in the number of eggs hatched.

Objectives

In this BioLab, you will:

- **Analyze** how salt concentration may affect brine shrimp hatching.
- **Interpret** your experimental findings.

Possible Materials

beakers or plastic bottles
labels or marking pencil
graduated cylinder
brine shrimp eggs
clear plastic trays
salt (noniodized)
balance
water

Safety Precautions

Wear protective eye goggles when preparing solutions.

Skill Handbook

Use the **Skill Handbook** if you need additional help with this lab.

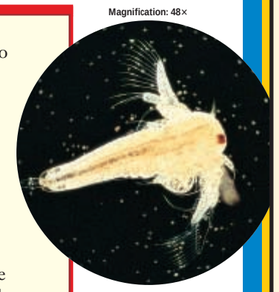
Plan the Experiment

1. Decide on a way to test your group's hypothesis. Keep the available materials in mind as you plan your procedure. Be sure to include a control. For example, you might place brine shrimp eggs in two trays —one with the salt concentration of the water brine shrimp normally inhabit, and one with a different salt concentration.
2. Decide how long you will make observations and how you will judge the extent of egg hatching.
3. Decide on the number of different salt water concentrations to use and what these concentrations will be. Review the steps needed to prepare solutions of different concentrations.

Check the Plan

Discuss the following points with other group members to decide on the final procedure for your experiment.

1. What is your one independent variable? Your dependent variable?
2. What will be your control?
3. How much water will you add to each tray and how will you measure the same number of eggs to be used in each tray?
4. Will it be necessary to control variables such as light and temperature?
5. What data will you collect and how will it be recorded?
6. ***Make sure your teacher has approved your experimental plan before you proceed further.***
7. Carry out your experiment.



Brine shrimp hatchling

Analyze and Conclude

1. **Interpreting Data** Using specific numbers from your data, explain how salt concentration affects brine shrimp hatching.
2. **Drawing a Conclusion** Was your hypothesis supported? Explain.
3. **Identifying and Controlling Variables** What were the independent and dependent variables? What were some of the variables that had to be controlled?
4. **Hypothesizing** Formulate a hypothesis that explains why high salt concentrations may be harmful to brine shrimp hatching.
5. **Classifying** Classify brine shrimp. Identify their kingdom, phylum, class, order, family, genus, and species.

Going Further

Project Design an experiment that you could perform to investigate the role that temperature plays in brine shrimp hatching. If you have all of the materials you will need, you may want to carry out the experiment.

interNET CONNECTION To find out more about brine shrimp and other crustaceans, visit the Glencoe Science Web Site. **www.glencoe.com/sec/science**

Plan the Experiment

Teaching Strategies

- Have students work in small groups of 3 or 4 students.
- At the conclusion of the experiment, pool student data so students can see the results when a range of different salt concentrations were tested.
- Judging the amount or degree of hatching may be a problem. Brine shrimp hatchlings cannot be seen by the naked eye. Observing trays under a binocular microscope will allow students to make a qualitative assessment of the amount of hatching.

Possible Procedures

- Students may prepare only 2 or 3 different salt concentrations. Make sure that the control dish contains only water and no salt.
- Students will have to determine some method for controlling the same number of eggs used in each experimental tray. Counting eggs is difficult because of their small size. One suggestion is to touch the flat end of a toothpick to the eggs and transfer that same amount to each dish.
- Binocular microscopes may be used to observe the presence of hatched larvae.
- Keep all trays at a temperature close to 21°C.

Data and Observations

Ideal salt concentrations for hatching will be in the 1-4% range. No salt present or concentrations higher than 4% will result in no or few larvae hatching.

DESIGN YOUR OWN BioLab

Analyze and Conclude

1. Students answers may vary; maximum hatching will occur at 1-4% salt concentration.
2. Student answers will vary depending upon their original hypothesis.
3. The independent variable was the salt concentration. The dependent variable was the number of eggs hatched. Other variables that had to be controlled were the temperature of the water, amount of water used, and number of eggs used.
4. Too high a salt concentration may result in water loss from the egg or larva, leading to dessication.
5. animal, Arthropoda, Crustacea, Anostraca, *Artemia salina*

Assessment

Skill Have students design an experiment that would determine how much time brine shrimp larvae spend in this stage. Use the Performance Task Assessment List for Designing an Experiment in **PASC,** p. 23.

Going Further

Have students carry out an experiment to determine if brine shrimp larvae respond in a similar manner to different colors of light. L2

Resource Manager

BioLab and MiniLab Worksheets, pp. 127-128 L2

Health Connection

Purpose

Students will learn about Lyme disease, the bacterium that causes it, and the ticks that transmit it.

Teaching Strategies

- Be sure students understand that ticks do not cause Lyme disease; they carry the bacterium that causes the disease from animal host to human and animal hosts.
- After students have read the feature, ask if they know how a tick should be removed. Placing several drops of vegetable oil on the tick will cause it to withdraw its head because it can no longer obtain enough oxygen. Then the tick can be removed easily.
- Ask students to report about two other diseases transmitted by ticks: Rocky Mountain spotted fever and Colorado tick fever. L3

Connection to Biology

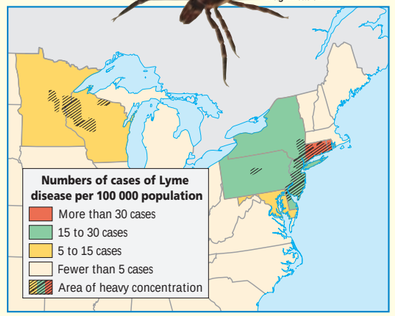
Because deer are primary carriers of *Borrelia burgdorferi*, an increase in the deer population probably means an increase in infected ticks. This would likely translate into an increase in the incidence of Lyme disease.

Health Connection

Terrible Ticks

Magnification: 7×

Every American city, it seems, has its claim to fame. Chicago is recognized for its outstanding architecture. New York has long been thought of as the cultural center of the United States. Los Angeles is home to television production and to the nation's legendary movie industry. One American city, however, would probably just as soon forget its claim to fame. Lyme, Connecticut, will forever be associated with Lyme disease, a crippling bacterial malaise that was first identified in this town in 1975.



Lyme disease manifests itself in humans in three distinct stages. First, a circular, bull's-eye rash appears. The rash is generally accompanied by chills, fever, and aching joints. These symptoms may resemble symptoms that result from an infection with an influenza virus. This is the mildest form of the disease. If left untreated, Lyme disease progresses to a second stage. The joint pains become more severe and may be joined by neurological symptoms, such as memory disturbances and vision impairment. Stage three is the most severe form of the disease. Crippling arthritis, facial paralysis, heart abnormalities, and memory loss may result.

Tick transmission

The cause of this debilitating disease is *Borrelia burgdorferi*, a corkscrew-shaped bacterium that is transmitted to humans through the bite of ticks. The bacterium infects mostly deer and white-footed mice. Ticks pick up the bacteria by sucking the blood from these animals. When the same ticks bite humans, the bacteria are passed on, and the result is Lyme disease.

Where Lyme disease strikes

Most cases of Lyme disease are reported in the Northeast, Mid-Atlantic, and North Central regions, as seen on the map. Lyme disease is also on the rise in many other areas.

Prevention and treatment

Ticks live in weedy areas, low shrubs, and tall grasses. If you are entering this type of habitat, it is advisable to wear light colored clothing to easily detect darker ticks, and to tuck pants legs into socks. In addition, insect repellents containing the chemical DEET can be applied to clothing (but not to skin). Careful examination of the body for ticks is also important.

Like most bacteria, *Borrelia burgdorferi* responds to antibiotics. Early treatment with antibiotics usually prevents the disease from progressing to its second or third stages. A new vaccine has been developed that is effective in 90 percent of adults exposed to Lyme disease, but this vaccine has not yet been proven to be safe for those under age 18.

Connection to Biology

Since the turn of the century, the deer population in the United States has been increasing steadily. How might this increase affect the incidence of Lyme disease? Why?

internet CONNECTION To find out more about ticks and Lyme disease, visit the Glencoe Science Web Site.
www.glencoe.com/sec/science

Internet Address Book

internet CONNECTION Note Internet addresses that you find useful in the space below for quick reference.

Chapter 28 Assessment

Summary

Section 28.1 Characteristics of Arthropods

Main Ideas

- Arthropods have jointed appendages, exoskeletons, varied life cycles, and body systems adapted to life on land, water, or air.
- Arthropods are members of the most successful animal phylum in terms of diversity. This can be attributed in part to their structural and behavioral adaptations.

Vocabulary

appendage (p. 761)
book lung (p. 764)
cephalothorax (p. 763)
compound eye (p. 765)
mandible (p. 765)
Malpighian tubule (p. 765)
molting (p. 762)
parthenogenesis (p. 766)
pheromone (p. 764)
simple eye (p. 765)
spiracle (p. 764)
tracheal tube (p. 764)

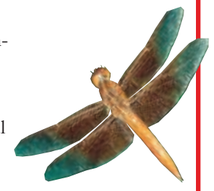
Section 28.2 The Diversity of Arthropods

Main Ideas

- Spiders have two body regions with four pairs of walking legs. They spin silk. Ticks and mites have one body section. Scorpions have many abdominal segments, enlarged pincers, and a stinger at the end of the tail.
- Most crustaceans are aquatic and exchange gases in their gills. They include crabs, lobsters, shrimps, crayfishes, barnacles, and water fleas.
- Centipedes are carnivores with flattened, wormlike bodies. Millipedes are herbivores with cylindrical, wormlike bodies.
- Insects are the most successful arthropod class in terms of diversity. They have many structural and behavioral adaptations that allow them to exploit all habitats.

Vocabulary

chelicerae (p. 768)
larva (p.773)
metamorphosis (p. 773)
nymph (p. 774)
pedipalp (p. 768)
pupa (p. 773)
spinneret (p. 768)



Understanding Main Ideas

1. Crustaceans are different from other arthropods because they have two _____ used for sensing.
   a. jointed appendages **c.** pedipalps
   b. pairs of antennae **d.** walking legs
2. Of the following, which are NOT appendages used by arthropods to obtain and eat food?
   a. chelicerae **c.** mandibles
   b. pedipalps **d.** spiracles
3. Jointed appendages allow for greater _____ and more powerful movements.
   a. mobility **c.** flexibility
   b. molting **d.** camouflage
4. _____ are arthropods with only one body section.
   a. Spiders **c.** Scorpions
   b. Ticks and mites **d.** Crustaceans
5. _____ are used by arthropods for gas exchange.
   a. Pedipalps **c.** Chelicerae
   b. Spiracles **d.** Spinnerets

GLENCOE TECHNOLOGY

VIDEOTAPE
MindJogger Videoquizzes
Chapter 28: *Arthropods*
Have students work in groups as they play the videoquiz game to review key chapter concepts.

Resource Manager

Chapter Assessment, pp. 163-168
MindJogger Videoquizzes
Computer Test Bank
BDOL Interactive CD-ROM, Chapter 28 quiz

Chapter 28 Assessment

Main Ideas

Summary statements can be used by students to review the major concepts of the chapter.

Using the Vocabulary

To reinforce chapter vocabulary, use the Content Mastery Booklet and the activities in the Interactive Tutor for Biology: The Dynamics of Life on the Glencoe Science Web Site.
www.glencoe.com/sec/science

THE PRINCETON REVIEW ***All Chapter Assessment questions and answers have been validated for accuracy and suitability by The Princeton Review.***

Understanding Main Ideas

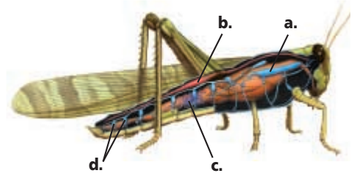
1. b
2. d
3. c
4. b
5. b

6. c
7. d
8. b
9. d
10. a
11. insect
12. exoskeleton
13. blood circulation
14. cephalothorax
15. Tracheal tubes
16. crustaceans
17. segmented bodies
18. Malpighian tubules
19. egg, nymph
20. oxygen, carbon dioxide

Applying Main Ideas

21. An insect larva may eat crop plants, but an adult may pollinate the flowers.
22. They cannot move around to find mates. Having both male and female sex organs in the same animal means that every individual is a potential mate.
23. Exoskeletons in arthropods that swim can be heavier as the water will help support their weight. Arthropods that fly have lightweight exoskeletons. Arthropods that move on land have exoskeletons that are medium in weight.
24. Wings enable some arthropods to easily escape predators, find food sources inaccessible to terrestrial arthropods, and move easily to other areas to find mates and nesting areas.
25. The eyes would give the rigid crustacean a greater field of view.

6. What arthropod has many abdominal segments, enlarged pincers, and a stinger at the end of its tail?
   a. a spider **c.** a scorpion
   b. a tick **d.** a crab
7. Arthropods are so successful because of their _____.
   a. larvae **c.** antennae
   b. book lungs **d.** adaptations
8. Name an arthropod that is a carnivore and has a flattened, wormlike body.
   a. millipede **c.** crustacean
   b. centipede **d.** insect
9. Of the following, which is NOT an appendage of an arthropod?
   a. chelicerae **c.** pedipalps
   b. antennae **d.** cephalothorax
10. Arthropods with two body regions and four pairs of walking legs are called _____.
    a. spiders **c.** scorpions
    b. ticks and mites **d.** crustaceans
11. The most diverse group of arthropods is the _____ class.
12. Molting occurs when an arthropod sheds its old _____ and grows a new one.
13. The structure labeled b in the diagram below is used for what purpose by the grasshopper?

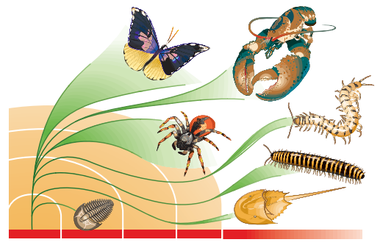


Test-Taking Tip

Stock Up on Supplies

Be sure to supply yourself with the test-taking essentials: number two pencils, pens, erasers, a ruler, and a pencil sharpener. If the room doesn't have a pencil sharpener, a broken pencil can be upsetting.

14. Spiders have a fused head and thorax region called a _____.
15. _____ are the hollow passages that carry air through the body of an arthropod.
16. Study the diagram below. The group most closely related to insects is the _____.



17. Evolutionary biologists have hypothesized that arthropods may have evolved from annelids because both have _____.
18. A butterfly excretes wastes through _____.
19. List in the correct order the stages of incomplete metamorphosis: _____, _____, adult.
20. When water passes over gills, _____ and _____ are exchanged.

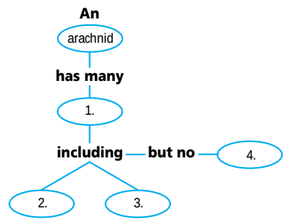
Applying Main Ideas

21. Many insects are pests to humans when they are larvae but are beneficial when they are adults. Explain.
22. Why is it an adaptive advantage for barnacles to be hermaphrodites?
23. Relate differences in exoskeleton structure to the various modes of arthropod locomotion.
24. In what ways have wings been an adaptive advantage to the success of insects?
25. Of what advantage might movable, stalked eyes be to a crustacean that has a cephalothorax?

Thinking Critically

26. **Interpreting Scientific Illustrations** Identify each of the arthropods at right as an arachnid, crustacean, or insect. What are their distinguishing features?

27. **Recognizing Cause and Effect** What is the advantage to a plant of producing a chemical that is an effective insect repellent?
28. **Recognizing Cause and Effect** What might be the effect on plant and animal life if all insects were suddenly to die?
29. **Observing and Inferring** Evidence shows that deer, mice, and even household pets may harbor the bacteria that cause Lyme disease. How could pets become infected with these bacteria?
30. **Concept Mapping** Complete the concept map by using the following vocabulary terms: appendages, mandibles, chelicerae, pedipalps.

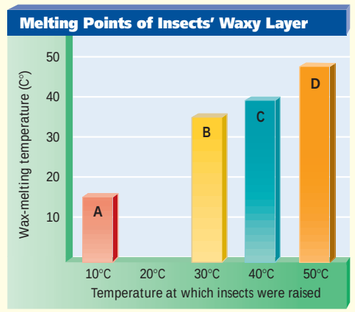


CD-ROM

For additional review, use the assessment options for this chapter found on the ***Biology: The Dynamics of Life Interactive CD-ROM*** and on the Glencoe Science Web Site.
www.glencoe.com/sec/science

Assessing Knowledge & Skills

The melting points of the waxy layers on certain insect exoskeletons are shown in the graph below. These melting points reflect the environments in which the insects were raised. Insects raised in warmer environments have wax that melts at higher temperatures than insects raised in cooler environments.



Interpreting Data

Study the graph and answer the following questions.

1. What is the melting point of the wax on insects in group B?
   a. 15°C **c.** 35°C
   b. 50°C **d.** 40°C
2. What is the melting point of the wax on insects in group C?
   a. 15°C **c.** 35°C
   b. 50°C **d.** 40°C
3. Which insects were raised at the lowest temperature?
   a. A **b.** B **c.** C **d.** D
4. **Making a Graph** Make a graph of these data: insect exoskeletons found by a stream melt at 15°C; in a forested area at 20°C; in a grassy meadow at 40°C; and on roadside soil at 50°C.

Thinking Critically

26. An insect has six legs and a pair of antennae. An arachnid has eight legs and no antennae. A crustacean has five pairs of walking legs and stalked eyes.
27. The plant will not be eaten by insects.
28. Many plants that depend upon insects for pollination would be unable to reproduce, so there would be fewer plants. Plant- and insect-eating organisms would have to find new food sources or die.
29. Pets can pick up ticks when they are outdoors in an area inhabited by ticks.
30. 1. Appendages; 2. Pedipalps; 3. Chelicerae; 4. Mandibles

Assessing Knowledge & Skills

1. c
2. d
3. a
4. **Melting Temperatures of Insects' Waxy Layers**