KEY CONCEPT

Arthropods have exoskeletons and joints.

Sunshine State STANDARDS
SC.F.1.3.1: The student understands that living things are composed of major systems that function in reproduction, growth, maintenance, and regulation.
SC.F.2.3.3: The student knows that generally organisms in a population live long enough to reproduce because they have survival characteristics.
SC.G.1.3.3: The student understands that the classification of living things is based on a given set of criteria and is a tool for understanding biodiversity and interrelationships.

BEFORE, you learned
• Mollusks are invertebrates with soft bodies, some have shells
• Echinoderms have spiny skeletons
• Different species adapt to the same environment in different ways

NOW, you will learn
• About different groups of arthropods
• About exoskeletons in arthropods
• About metamorphosis in arthropods

EXPLORE Arthropods

What are some characteristics of arthropods?

PROCEDURE
1) Observe the pillbugs in their container. Draw a sketch of a pillbug.
2) Gently remove the pillbugs from their container and place them in the open end of the box. Observe and make notes on their behavior for several minutes.
3) Return the pillbugs to their container.

WHAT DO YOU THINK?
• Describe some of the characteristics you noticed about pillbugs.
• Are pillbugs radially or bilaterally symmetrical?

MATERIALS
• clear container
• shoebox with half of cover removed
• pillbugs
• hand lens

Most invertebrates are arthropods.

There are more species of arthropods than there are any other type of invertebrate. In fact, of all the animal species classified by scientists, over three-quarters are arthropods. An arthropod is an invertebrate that has a segmented body covered with a hard outer skeleton. Arthropods can have many pairs of legs and other parts that extend from their body. Insects are arthropods, as are crustaceans such as the shrimp and arachnids such as the spider.

Fossil evidence shows that arthropods first appeared on land about 420 million years ago, around the same time as plants. Arthropods are active animals that feed on all types of food. Many arthropods live in water, but most live on land.
Exoskeletons and Jointed Parts

One adaptation that gives arthropods the ability to live in many different environments is the exoskeleton. An **exoskeleton** is a strong outer covering, made of a material called chitin. The exoskeleton completely covers the body of an arthropod. In a sense, an exoskeleton is like a suit of armor that protects the animal’s soft body. For arthropods living on land, the exoskeleton keeps cells, tissues, and organs from drying out.

Check Your Reading What are two functions of an exoskeleton?

A suit of armor is not much good unless you can move around in it. The arthropod’s exoskeleton has joints, places where the exoskeleton is thin and flexible. There are joints along the different segments of the animal’s body. An arthropod body typically has three sections: a head at one end, a thorax in the middle, and an abdomen at the other end. Legs are jointed, as are other parts attached to the body, such as antennae and claws. Muscles attach to the exoskeleton around the joints, enabling the arthropod to move.

The exoskeleton is like a suit of armor in one other way. It doesn’t grow. An arthropod must shed its exoskeleton as it grows. This process is called **molting**. For an arthropod, the times when it molts are dangerous because its soft body is exposed to predators.

Complex Body Systems

Arthropods have well-developed body systems. They have a nervous system with a brain and many different sensory organs. Their digestive system includes a stomach and intestines. Arthropods have an open circulatory system, which means the heart moves blood into the body directly. There are no blood vessels. Arthropods reproduce sexually. An arthropod has either a male or a female reproductive system.
Three Major Groups of Arthropods

Scientists have named at least ten groups of arthropods, but most arthropod species belong to one of three groups: insects, crustaceans, or arachnids.

**Insects**
- Includes beetles, bees, wasps, ants, butterflies, moths, and grasshoppers
- 3 pairs of legs, 3 body segments, 1 pair of antennae
- Most live on land

**Crustaceans**
- Includes shrimp, crabs, lobsters, barnacles, and pill bugs
- Number of body segments and pairs of legs varies, 2 pairs of antennae
- Most live in water; some live on land

**Arachnids**
- Includes spiders, ticks, mites, and scorpions
- 4 pairs of legs, 2 body segments, no antennae
- Most live on land

What body features can you see that are shared by all of these arthropods?
Insects are six-legged arthropods.

Scientists have so far identified over 700,000 insect species. Insects are arthropods that as adults have three body segments, a pair of antennae, and six legs attached to the middle segment, the thorax. Insect species have adapted to all sorts of environments and live on every continent. Most insects live on land. These insects obtain oxygen through spiracles, small openings in their exoskeleton.

What are two characteristics all adult insects share?

Insects show great diversity in appearance. Many species have adaptations in color and shape that allow them to blend into their environments. For example, a stick insect is the same color and shape as a twig. Insect bodies also have different adaptations. Many insects have compound eyes and antennae, which are sensory organs. Many insects fly, having one or two pairs of wings.

Many insects are herbivores. And many insect species have mouth parts adapted for feeding on specific plants. A butterfly, for example, has a tubelike mouth that can reach into a flower to get nectar. Insects that feed on flowers often help the plants reproduce because the insects carry pollen from flower to flower. Other insects harm the plants they feed on. A grasshopper has jawlike mouth parts that crush parts of a plant. Many plants have defensive adaptations, such as poisons in leaves and stems, to keep insects from eating them.

Some insects, for example, ants, termites, and some bees, are social insects. They must live in groups in order to survive. Members of the group work together to gather food, maintain the nest, and care for the offspring. Often with social insects, just one female, called a queen, produces and lays eggs.
All insects can reproduce sexually. Females lay eggs, often a large number of eggs. The queen honey bee can lay over a million eggs in her lifetime. Many insect eggs have a hard outer covering. This adaptation protects the egg from drying out and can allow hatching to be delayed until conditions are right.

During their life cycle, insects undergo a process in which their appearance and body systems may change dramatically. This process is called metamorphosis. There are three stages to a complete metamorphosis. The first stage is the larva, which spends its time eating. The second stage is the pupa. During this stage, the insect body develops within a protective casing. The final stage is the adult, which is capable of going on to produce a new generation.

Not all insects go through complete metamorphosis. Some insects, such as grasshoppers, have a simple metamorphosis. When a young grasshopper hatches from an egg, its form is similar to an adult’s, just smaller. A grasshopper grows and molts several times before reaching adult size.
You have probably seen many insects in their larval form. A caterpillar is a larva; so is an inchworm. Often the larval form of an insect lives very differently from its adult form. A mosquito, for example, begins its life in the water. The larva swims about, feeding on algae. The pupa forms at the water’s surface. The developing mosquito is encased in a protective covering. The adult form of the mosquito, the flying insect, leaves the water. The female is a parasite that feeds off the blood of other animals.

**Crustaceans live in water and on land.**

Most crustaceans live in the water. Several of these, including the Atlantic lobster and the Dungeness crab, are used by people as a source of food. Crustaceans are important to the ocean food web. Tiny crustaceans such as krill and copepods are a food source for many other animals, including other invertebrates, fish, and whales. Some species of crustaceans live in freshwater and a few, such as pill bugs, live on land.

Crustaceans have three or more pairs of legs and two pairs of sensory antennae. Many of the larger, water-living crustaceans, such as crabs, have gills. Most crustaceans, like other arthropods, have a circulatory system that includes a heart but no blood vessels. Crustaceans reproduce sexually. Their young hatch from eggs.

The eating habits of crustaceans vary. Lobsters and shrimp eat plants and small animals. Many crustaceans are scavengers, feeding off the remains of other organisms. Some, such as barnacles, are filter feeders. The larval form of a barnacle is free swimming. However, as an adult this arthropod attaches itself to a rock or another hard surface, such as a mollusk’s shell or the hull of a ship. It uses its tentacles to capture food from the surrounding water.
Arachnids are eight-legged arthropods.

Spiders, mites, ticks, and scorpions belong to a group called the arachnids. Like all arthropods, arachnids have an exoskeleton, jointed limbs, and segmented bodies. But the bodies of arachnids have some characteristics that distinguish them from other arthropods. Arachnids always have four pairs of legs and only two body segments. Arachnids do not have antennae.

Some arachnids, including ticks and chigger mites, are parasites. Other arachnids, such as spiders and scorpions, are predators. Recall that predators get their food by capturing and consuming other animals. Predatory arachnids kill their prey by stinging them, biting them, or injecting them with venom.

The spiders are the largest group of arachnids. Many spiders have a unique adaptation for capturing their prey. They produce an extremely strong material, called silk, inside their bodies and use the silk to make webs for capturing food. The spider spins strands of silk out from tubes called spinnerets at the rear of its abdomen. It weaves the strands into a nearly invisible web. The web serves as a net for catching insects and other small organisms that the spider eats. This adaptation allows web-building spiders to wait for their prey to come to them. Other invertebrates, such as silkworms, produce silk, but they do not weave webs.

Some arachnids obtain oxygen through spiracles, as insects do. However, certain species of spiders have a unique type of respiratory organ referred to as book lungs. Book lungs are like moist pockets with folds. They are located inside the animal’s abdomen.
Millipedes and centipedes are arthropods.

At first glance, the members of two other arthropod groups look similar. Both centipedes and millipedes have long, segmented bodies and many legs. However, animals from these groups differ in their body features and their behavior.

Millipedes are arthropods with two pairs of walking legs on each body segment. Millipedes move rather slowly and eat decaying leaves and plant matter. When disturbed, many millipedes emit a foul odor that can be harmful to predators.

Centipedes can move more quickly. They have one pair of walking legs per body segment. They have antennae and jawlike mouthparts. Many centipedes also have pincers on their rearmost segment. Centipedes are predators. They can use their jaws and pincers to paralyze prey and protect themselves from predators.