

Chapter Outline

Chapter 29 Arthropods and Echinoderms

Section 1: Arthropods

KEY IDEAS

- > What are distinguishing features of arthropods?
- > How is molting an important feature of the arthropod life cycle?
- > What are the four main types of arthropods?

ARTHROPOD CHARACTERISTICS

- > What are distinguishing features of arthropods?
- > Arthropods are characterized by having a segmented body, jointed appendages, and a hard external skeleton.
 - Segmented Body
 - Arthropods have three distinct body segments—the head, the thorax (mid-body region), and the abdomen.
 - In some arthropods, such as crabs, the head is fused with the thorax, which forms the *cephalothorax*.
 - Jointed appendages
 - An appendage is a structure that extends from the arthropod's body wall.
 - Unlike the parapodia and setae of annelids, arthropod appendages have joints that bend.
 - The name *Arthropoda* means “joint footed.”
 - Exoskeleton
 - The rigid outer layer of the arthropod body is called an *exoskeleton*, which is composed primarily of the carbohydrate *chitin*.
 - The exoskeleton provides protection against predators and helps prevent water loss.
 - An exoskeleton does not grow; arthropods shed their exoskeleton periodically and form a new, larger one.
 - Respiration and Circulation
 - Many land arthropods breathe through a network of fine tubes. Each tube is called a *trachea*. Other land arthropods breathe through *book lungs*. Most aquatic arthropods breathe through *gills*.
 - The circulatory system of arthropods is open, which means that blood is not always contained within vessels.

Arthropods and Echinoderms *continued*

- Feeding, Digestion, and Excretion
 - Different arthropod groups have varied mouthparts and other appendages that are involved in obtaining food.
 - The intestinal tract extends from the mouth to the anus and contains structures that are specialized for storage, mechanical and chemical digestion, nutrient absorption, and elimination of digestive wastes.
 - The arthropod excretory system is composed of structures called *Malpighian tubules*.
- Compound Eyes
 - Many arthropods have compound eyes, which are composed of thousands of individual visual units.
 - The brain receives input from these units and then composes the image of an object.
 - The compound eye is exceptionally good at detecting movement, which is why sneaking up on a fly is difficult.

ARTHROPOD LIFE CYCLE

- > How is molting an important feature of the arthropod life cycle?
- > Molting allows the arthropod's body to grow larger.
 - Most arthropods reproduce only sexually, though some can produce offspring from unfertilized eggs.
 - Eggs are usually laid outside the female's body, and the immature animals that hatch from the eggs generally receive no parental care.
 - Molting
 - The tough exoskeleton protects arthropods but does not grow, so an arthropod must periodically shed their exoskeleton and grow a new one.
 - The process of shedding and discarding the exoskeleton is called *molting*.
 - This process allows arthropods to grow a larger body.
 - Most arthropods molt several times before they reach their adult stage.

Arthropods and Echinoderms *continued*

GROUPS OF ARTHROPODS

- > What are the four main types of arthropods?
- > The four main arthropods groups (subphyla) are Hexapoda (insects), Myriapoda (millipedes and centipedes), Crustacea (lobsters and shrimps), and Chelicerata (spiders, scorpions, mites, ticks, and horseshoe crabs).
 - Living arthropods are traditionally divided into two groups—arthropods that have jaws and arthropods that have fangs or pincers.
 - Members of the subphylum Chelicerata have fangs or pincers.
 - Members of the other subphyla have jaws.
 - The total number of arthropods exceeds the number of all other animal species combined.
 - This is mainly due to the enormous evolutionary success of arthropods.
 - Arthropods' exoskeleton provides adaptation to life on land; arthropods are small, and they show a wide range of specialization in food sources and habitats.

Arthropods and Echinoderms *continued***Section 2: Arachnids and Crustaceans****KEY IDEAS**

- > What adaptations have evolved in arachnids?
- > What adaptation has evolved in crustaceans?

ARACHNIDS AND THEIR RELATIVES

- > What adaptations have evolved in arachnids?
- > The chelicerates are arthropods that have appendages called *cheliceræ*, which are specialized for feeding.
 - The subphylum Chelicerata includes spiders, scorpions, mites, ticks, and horseshoe crabs.
 - Cheliceræ are the first pair of modified appendages and are modified into pincers or fangs. The second pair of appendages are *pedipalps*, which catch and handle prey.
 - Because arachnids do not have jaws, they can only consume liquid food.
 - The arachnid first injects its prey with powerful enzymes that turn the prey's tissues into liquid. Then the arachnid sucks the liquid food into its stomach.
 - While feared and disliked, arachnids play an important role in the environment. Many spiders are major predators of insect pests.
 - Spiders
 - The cheliceræ of spiders are modified into fangs. Poison glands that are located in the front part of the spider's body secrete a toxin through these fangs.
 - The toxin kills or paralyzes the prey, and then the spider eats the prey.
 - In the United States, two species of spiders that are poisonous to humans are the black widow and the brown recluse.
 - Most spiders have *spinnerets*, appendages at the end of the abdomen that secrete sticky strands of silk.
 - Scorpions, Mites, and Ticks
 - Scorpions have a long, segmented abdomen that ends in a venomous stinger that is used to stun prey.
 - The pedipalps of scorpions are large, grasping pincers, which are used not for defense but for seizing food and during sexual reproduction.
 - Mites are the largest group of arachnids. Their head, thorax, and abdomen are fused into a single, unsegmented body.
 - Most mites are not harmful, but some are plant and animal pests.
 - Blood-sucking ticks attach themselves to a host, often a human. Lyme disease is spread by bites from infected deer ticks.

Arthropods and Echinoderms *continued*

- Horseshoe Crabs
 - Horseshoe crabs are more closely related to spiders than to crabs.
 - Horseshoe crabs make up an ancient group of invertebrates that probably appeared on Earth about 400 million years ago.

CRUSTACEANS

- > What adaptation has evolved in crustaceans?
- > Many crustaceans have a cephalothorax and an abdomen. Like chelicerates, crustaceans have appendages on their abdomen. Unlike chelicerates, crustaceans have mandibles that are adapted for feeding and have two antennae. Crustaceans breathe by using gills.
 - Almost all crustaceans have a distinctive larval form called a *nauplius*.
 - Isopods are the only crustaceans that are truly terrestrial. Pill bugs are examples of isopods.
 - Some aquatic crustaceans are quite small.
 - Common examples include fairy shrimps, water fleas, and copepods.
 - Another small marine crustacean, commonly known as *krill*, is the chief food source for many marine species.
 - Some crustaceans are sessile, which means that they are permanently attached to something.
 - Barnacles are an example of a sessile crustacean.
 - Decapods
 - Decapods are large crustaceans such as shrimps, crayfish, crabs, and lobsters. They all have five pairs of legs.
 - Almost one-quarter of all crustacean species are decapods.
 - The head and thorax of decapods are fused into a cephalothorax, which is covered by a carapace that is especially thick on top.
 - Decapods can propel themselves through the water by forcefully flexing their abdomen.

Arthropods and Echinoderms *continued***Section 3: Insects****KEY IDEAS**

- > What are common insect characteristics?
- > How are insects adapted for flight?
- > How is insect development unique among arthropods?
- > What are the characteristics of social insects?
- > Which arthropods are known as myriapods?

INSECT CHARACTERISTICS

- > What are common insect characteristics?
- > Most insects share the same general body plan, specialized mouthparts for feeding, a unique life cycle, and the ability to fly.
 - In insects, the thorax is composed of three fused segments. Three pairs of jointed walking legs are attached to the thorax.
 - Most insects have specialized mouthparts for eating called *mandibles*.
 - The types of feeding among insects vary including sucking blood, chewing seeds or wood, and sucking nectar from flowers.

ADAPTATIONS FOR FLIGHT

- > How are insects adapted for flight?
- > Insects are adapted for flight by having a lightweight body, wings, and strong muscles to power flight.
 - Insects were the first animals to have wings.
 - Flight was a great evolutionary innovation. Flying insects were able to reach previously inaccessible food sources and to escape quickly from danger.
 - An insect's wings develop from saclike outgrowths of the body wall of the thorax. Most insects have two pairs of wings.

INSECT LIFE CYCLE

- > How is insect development unique among arthropods?
- > Insects have a unique life cycle compared with other arthropods. During development, a young insect undergoes metamorphosis.
 - Metamorphosis is a dramatic physical change, which can be complete or incomplete.

Arthropods and Echinoderms *continued*

- Almost all insect species undergo complete metamorphosis.
 - In complete metamorphosis, the wingless larva grows in size and passes through a number of molts that are characteristic for its species.
 - The four stages in a complete metamorphosis life cycle are the egg, the larva, the pupa, and the adult.
- A smaller number of insect species undergo incomplete metamorphosis.
 - During incomplete metamorphosis, the egg hatches into a juvenile, or nymph, that looks like a small, wingless adult.
 - After several molts, the nymph develops into a sexually mature adult.

SOCIAL INSECTS

- > What are the characteristics of social insects?
- > Social insects have elaborate social systems involving specialization of labor, parental care, and communication between individuals.
 - The role that an individual plays in a colony is called a *caste*.
 - Caste is determined by a combination of heredity, diet, hormones, and pheromones.
 - Social insects include honeybees and termites.
 - A honeybee hive contains a queen, workers, and drone males.
 - Termites have kings as well as queens. Workers gather the food, raise the young, and excavate tunnels.

CENTIPEDES AND MILLIPEDES

- > Which arthropods are known as myriapods?
- > Myriapods include centipedes and millipedes.
 - The name of the subphylum Myriapoda means “many footed.”
 - Myriapods are not considered insects, though they share certain characteristics.
 - Each myriapod has a head region that is followed by many similar segments.
 - Centipedes have one pair of legs per segment and millipedes usually have two pair of legs per segment.

Arthropods and Echinoderms *continued***Section 4: Echinoderms****KEY IDEAS**

- > What characteristics do echinoderms share?
- > What are the different classes of echinoderms?

ECHINODERM CHARACTERISTICS

- > What characteristics do echinoderms share?
- > All adult echinoderms have an internal skeleton, five-part radial symmetry, a water-vascular system, and the ability to breathe through their skin.
 - Echinoderms are recognized by the spines that project from their internal skeleton through their outer covering. *Echinoderm* means “spiny skinned.”
 - Endoskeleton
 - Echinoderms have a calcium-rich endoskeleton that is composed of individual plates called *ossicles*.
 - In most echinoderms, the plates of the endoskeleton bear spines that project outward through the skin.
 - Five-Part Radial Symmetry
 - All adult echinoderms have a five-part body plan with arms that radiate from a central point. However, the number of the arms can vary.
 - Echinoderms have no head or brain. The nervous system consists of a central ring of nerves called the *ring canal*, with branches extending into each of the arms.
 - Water-Vascular System
 - Echinoderms have a water-filled system of interconnected canals with thousands of tiny, hollow tube feet that make up a water-vascular system.
 - The tube feet are tiny legs that can be used to move, grip surfaces, or manipulate objects.
 - Gas exchange and waste excretion also takes place through the thin walls of the tube feet.
 - Circulation and Respiration
 - The body cavity, or coelom, functions as a simple circulatory and respiratory system. Particles and respiratory gases move freely throughout the large, fluid-filled coelom.
 - Many echinoderms have skin gills that aid respiration and waste removal. Skin gills are small, fingerlike projections that grow among the echinoderm’s spines.
 - These projections create a larger surface area through which respiratory gases can be exchanged.

Arthropods and Echinoderms *continued*

ECHINODERM DIVERSITY

- > What are the different classes of echinoderms?
- > The living classes of echinoderms include sea stars, brittle stars and basket stars, sea lilies and feather stars, sea urchins and sand dollars, and sea cucumbers.
 - Sea stars, commonly called *starfish*, are perhaps the most familiar echinoderms.
 - Brittle stars and basket stars are similar to sea stars, but their arms are narrower and may be branched.
 - Sea lilies and feather stars do not move around as most other echinoderms do.
 - Sea urchins and sand dollars lack arms.
 - Because of a sluglike shape and a lack of arms or spines, sea cucumbers look different from other echinoderms.