A. **Mollusks**—soft-bodied invertebrates with bilateral symmetry and usually one or two shells with organs in a fluid-filled cavity

1. Thin layer of tissue called the **mantle** covers the body organs and secretes shell.
2. Mantle cavity (between soft body and mantle) contains **gills**.
3. For most mollusks, an **open circulatory system** moves blood through vessels and into open spaces around body organs.
4. Well-developed head has a **mouth** and some sensory organs.
5. Underside is a muscular **foot** used to move.

B. Mollusks are **classified** into three common groups based on shell presence, shell type and foot type.

1. **Gastropods** usually have a single shell.
   a. Include **snails**, **conchs**, and garden slugs
   b. Use **radula** (a tongue-like organ with rows of teeth) to get food
   c. Some have foot glands that secret a layer of **mucus** for sliding
2. **Bivalves** have a hinged, two-part shell and include clams, oysters, and scallops.
3. **Cephalopods** are the most specialized and complex mollusks.
   a. Include squid, octopuses, cuttlefish, and chambered nautiluses
   b. Cephalopods have a well-developed head and many **tentacles** for capturing prey.
   c. A **closed circulatory system** moves blood through the body in a series of closed vessels.
   d. Cephalopods use **jet propulsion** to move at speeds of 6 m/s.
   e. Mollusk fossils date to more than **500** million years ago.

C. Among other uses, mollusks provide **food** for people and other animals as well as pearls and shells for jewelry and decorations.

**Discussion Question**

**What are the three common groups of mollusks?** Gastropods, bivalves, and cephalopods
Section 2  Segmented Worms

A. **Annelids**, segmented worms, have **setae** (bristlelike structures) to hold on to the soil and to move; they also have bilateral symmetry, a body cavity holding organs, and two body openings (mouth and anus).

B. **Earthworms** have more than 100 segments and move using their setae and two sets of muscles in the body wall.
   1. Earthworms ingest soil which moves to the **crop** for storage, then to the **gizzard** for grinding, then to the intestine; wastes exit the anus and help fertilize the soil.
   2. Earthworms have a **closed** circulatory system and exchange oxygen and carbon dioxide through skin covered with watery mucus.
   3. Earthworms have a small brain which is connected to nerves in each segment; they are **hermaphrodites** that must exchange sperm with another earthworm to reproduce.

C. **Marine worms**, or polychaetes, have segments with setae in bundles.
   1. Some polychaetes are **sessile**, and some build tubes around their bodies for protection.
   2. Some polychaetes such as the bristleworm are **free-swimming**.

D. **Leeches** are segmented worms without setae; they feed on blood from other animals.
   1. Leeches are used in medicine to prevent blood from **coagulating** and to heal surgical sites.
   2. Leeches release **chemicals** that are being studied as treatments for heart and circulatory diseases, strokes, arthritis, and glaucoma.

E. Segmented worms are valuable since they aerate the soil, produce medically useful chemicals, and provide food for many fish, invertebrates, and mammals.

F. Segmented worms probably evolved in the sea and may have had a common ancestor with mollusks.

**Discussion Question**

How do earthworms breathe? They exchange carbon dioxide and oxygen through their skin.
Section 3  Arthropods

A. Arthropods have jointed **appendages**, bilateral symmetry, segmented bodies, an **exoskeleton**, a body cavity, a digestive system with two openings, and a nervous system; most species have separate sexes.
   1. Some arthropods have many segments, while others have **fused** segments forming body regions.
   2. A hard, thick, outer covering called an **exoskeleton** covers, supports, and protects the arthropod; it is shed and replaced occasionally in a process called **molting**.

B. **Insects** have three body regions
   1. An insect’s head has a pair of **antennae**, eyes, and a mouth.
   2. The **thorax** has three pairs of legs; if the insect has wings, they are attached to the thorax.
   3. The abdomen contains reproductive structures and an open circulatory system; insects obtain air and release waste gases through openings called **spiracles**.
   4. **Metamorphosis** – series of body changes as insects become adults
      a. **Incomplete** metamorphosis stages – egg, nymph, adult
      b. **Complete** metamorphosis stages – egg, larva, pupa, adult
   5. Insects eat plants, blood of animals, nectar, decaying materials, wood, and clothes; mouth parts are diverse and adapted to **diet**.
   6. Insects are **successful** due to their exoskeletons, ability to fly, rapid reproductive cycles, and small sizes.

C. **Arachnids** such as spiders and ticks have two body regions (the cephalothorax and abdomen), four pairs of legs, and no antennae.
   1. **Scorpions** have a sharp, poison-filled stinger at the end of their abdomen.
   2. Spiders inject their prey with **enzymes** to digest it.
   3. **Mites** and **ticks** are generally parasites; ticks often carry diseases.

D. **Centipedes** and **millipedes** have long bodies with many segments, many legs, antennae, and simple eyes.
E. **Crustaceans** such as crabs, shrimp, and barnacles have one or two pairs of antennae and mandibles for crushing food.

F. Arthropods are a food source, aid agriculture, and are an important part of ecological communities in which humans live; some arthropods are pests that carry disease or damage property.

1. **Insecticides** can kill insects, but cause other environmental problems; biological methods for controlling insects are being developed.
2. Some arthropod fossils are more than 500 million years old; arthropods probably evolved from a segmented worm ancestor.

**Discussion Question**

What is an exoskeleton and what is its purpose? An exoskeleton is a hard, thick, outer covering that supports and protects an arthropod.
Section 4  Echinoderms

A. Echinoderms have a hard endoskeleton covered by a thin, bumpy or spiny epidermis; they are radially symmetrical, have a mouth, stomach, and intestines; they have no head or brain, but they do have a nerve ring around the mouth.

1. The water-vascular system allows echinoderms to move, exchange carbon dioxide and oxygen, capture food, and release wastes.

2. Echinoderms have a water-vascular system, a network of water-filled canals connected to thousands of tube feet.

B. About 6,000 species of echinoderms exist.

1. Sea stars have at least five arms arranged around a central point; they reproduce sexually and can regenerate a lost arm.

2. Brittle stars allow a predator to break off an arm, while the brittle star escapes; they quickly regenerate the lost parts.

3. Sea urchins and sand dollars are disk- or globe-shaped animals covered with spines.

4. Sea cucumbers are soft-bodied with a leathery covering.

C. Echinoderms help recycle materials and are used in research as possible medicine sources.

D. Echinoderms date back more than 400 million years and more closely resemble vertebrates than any other group of invertebrates.

Discussion Question

What physical feature is unique to echinoderms? The water-vascular system