

FIGURE 2–35



*Sea squirt.*⁷³

as vertebrates, have a backbone. A small animal group called hemichordates (phylum Hemichordata), or acorn worms, are considered an evolutionary link between invertebrates and vertebrates. Hemichordates share basic developmental characteristics with both echinoderms and chordates.

Chordates, including humans, have four major characteristics that they all share at some point in their lives. Specifically, they have a single hollow nerve cord that runs along the dorsal length of the body; pharyngeal gill slits—small openings along the anterior part of the gut; a flexible rod called a notochord, which is used for support and lies between the nerve cord and the gut; and a post-anal tail (a tail that extends beyond the anus).

Tunicates (subphylum Urochordata), the first subphylum of invertebrate chordates, are all marine. The most common tunicates are sea squirts, which have a sac-like body and are often attached to a hard surface. Sea squirts are filter feeders and use an incurrent siphon to bring water and food particles in and use an excurrent siphon to expel water. Pelagic tunicates called salps have transparent barrel-shaped bodies that float in the water column. Some colonial salps can reach several meters in length.

Cephalochordates (subphylum Cephalochordata), or lancelets, are an invertebrate chordate group with only a few known species. The body of a lancelet is elongated and compressed like a fish. Lancelets live on soft bottoms and are filter feeders, using their gill slits to capture food particles. These organisms are considered the invertebrate that is most closely related

FIGURE 2–36



*Lancelet.*⁷⁴

to vertebrate animals.

VERTEBRATES

Vertebrates have a vertebral column or spine, which we call a backbone. The vertebrae protect the nerve cord, or spinal cord, which terminates in a brain that is protected by a skull. Vertebrates are bilaterally symmetrical with clear anterior, posterior, dorsal, and ventral regions.

Vertebrates originated in the ocean approximately 500 million years ago, and their ancestral forms were fish-like. Approximately 350 million years ago, vertebrates from the ocean came onto land. The earliest land vertebrates came from a lineage called tetrapods, meaning “four-footed.” Tetrapods evolved from a group of marine fishes that had lungs. Amphibians, or land vertebrates that need water or moist environments to survive, were the first land tetrapods. Reptiles, or air-breathing vertebrates that have scales or bony plates as protective covering, evolved from amphibians. Birds and mammals evolved from different groups of extinct reptiles. More recently, many reptiles, birds, and mammals, returned to the ocean.

Fishes were the first vertebrates on Earth, appearing about 500 million years ago, and likely evolved from an invertebrate chordate relative similar to lancelets. Fishes are diverse and incredibly abundant in the ocean. In fact, fishes are the most successful and abundant vertebrates on Earth. Fishes range from being tiny in size to weighing more than forty-five tons and are an important source of food in marine