

**Chapter 30 Nonvertebrate Chordates, Fishes, and Amphibians****Summary****30–1 The Chordates**

A chordate is an animal that has a hollow nerve cord, a notochord, pharyngeal pouches, and a tail. These characteristics need not be present during the entire life cycle of a chordate animal.

The hollow nerve cord runs along the back of the body. Nerves branch from it and connect to organs and muscles.

The notochord is a rod that runs just below the nerve cord. It gives support.

Pharyngeal pouches are paired structures in the throat. In some chordates, they develop into gills.

Most chordates are vertebrates. Vertebrates have a backbone made of segments called vertebrae. The backbone replaces the notochord. The backbone gives support and protects the spinal cord. It also gives the muscles a place to attach.

Two groups of chordates do not have backbones. Tunicates are filter feeders that live in the ocean. Adult tunicates have neither a notochord nor a tail. Larval tunicates have the chordate characteristics.

The other group of chordates without a backbone is the lancelet. Lancelets are small, fishlike animals. Adult lancelets have all four chordate characteristics. They also have a definite head region.

**30–2 Fishes**

Fishes are animals with backbones that live in water. They usually have paired fins, scales, and gills.

Fishes were the first vertebrates to evolve. The evolution of jaws and paired fins were the most important development in fish evolution. Jaws improved defense and expanded food choices. Paired fins gave more control of body movement.

Fishes have various modes of feeding. Fishes are herbivores, carnivores, parasites, filter feeders, and detritus feeders. One fish may even have several different modes of feeding, depending on the food available.

Most fishes breathe with gills. Gills have many tiny blood vessels. This provides a large surface area for oxygen and carbon to be exchanged. Most fishes breathe by pulling water through the mouth and pumping it over the gills and out through openings in the sides of the pharynx.

Fishes have a closed circulatory system that pumps blood in a single loop—from the heart to the gills, from the gills to the body, and back to the heart. The heart is made up of four parts: the sinus venosus, atrium, ventricle, and bulbus arteriosus. The ventricle is the actual pumping portion of the heart. The atrium is a one-way compartment for blood that is going to enter the ventricle.

Most fishes get rid of wastes as ammonia. Some wastes pass through the gills into the water. Other wastes are removed from the blood by the kidneys. Kidneys also help fishes control the amount of water in their bodies.

Fishes have well-developed nervous systems. The brain has several parts. The olfactory bulbs and cerebrum are involved with the sense of smell. The optic lobes process information from the eyes. The cerebellum coordinates body movements. Most fishes have a lateral line system that senses currents and vibrations in the water.

Most fishes move by contracting muscles on either side of the backbone. Fins propel the fish forward and help it steer. Many fishes have a gas-filled swim bladder that keeps them from sinking.

Fishes reproduce in a number of ways. Their eggs are fertilized either externally or internally, depending on the species. Some lay eggs. They are called oviparous. In ovoviviparous fishes, the eggs develop inside the female. The embryos are fed by an attached yolk sac. In viviparous fishes, the embryos get their food from the mother's body, not from an egg.

Lampreys and hagfishes are jawless fishes. Their bodies are supported by a notochord. They do not have true teeth or jaws. They are parasites and scavengers.

The cartilaginous fishes (class Chondrichthyes) include sharks, rays, and skates. All members of this group of fishes have a skeleton made of cartilage. Most also have toothlike scales covering their skin.

Body fishes (class Osteichthyes) have skeletons made of bone. Almost all bony fishes belong to the group known as the ray-finned fishes. Their fins have thin, bony spines that are joined together by a thin layer of skin.

### 30–3 Amphibians

Amphibians have some—but not all—of the adaptations necessary to live on land. As larvae, they live in water. As adults, they live on land. Adult amphibians breathe with lungs and have moist skin that has mucus glands. They do not have scales and claws.

Early amphibians had several adaptations that helped them live on land. Leg bones became stronger to hold weight and allow movement. Lungs and moist skin allowed them to get oxygen from air. The breastbone supported and protected internal organs.

Amphibian larvae are filter feeders or herbivores. They have long, coiled intestines. This helps them break down plant material. Adults have a much shorter intestine because they are carnivores.

In most larvae, gas exchange occurs through the skin as well as lungs. Lungs usually replace gills when an amphibian becomes an adult. However, some gas exchange occurs through the skin and the lining of the mouth.

In adult amphibians, the circulatory system forms a double loop. The first loop carries oxygen-poor blood from the heart to the lungs. It returns oxygen-rich blood to the heart from the lungs. The second loop carries oxygen-rich blood from the heart to the body and returns to the heart with oxygen-poor blood. The amphibian heart has three separate chambers: left atrium, right atrium, and ventricle.

Kidneys remove wastes from blood. Urine passes to the cloaca. From there, it either passes directly to the outside or is stored in a small bladder.

Amphibian eggs do not have shells. The female usually lays eggs in water. The male fertilizes them externally. The eggs hatch into larvae, which are often called tadpoles. Tadpoles gradually change into adults that live on land.

Amphibians have well-developed nervous systems and sense organs. Frogs have keen vision to spot and respond to moving insects. Tympanic membranes, or eardrums, receive sound vibrations.

The amphibian groups are salamanders (order Urodela), frogs and toads (order Anura), and caecilians (order Apoda). Salamanders have long bodies, legs, and tails. Frogs and toads do not have tails and can jump. Caecilians do not have legs.