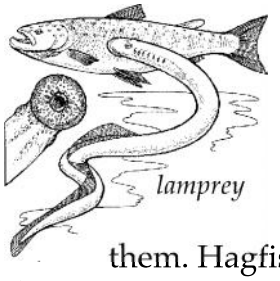
Introduction: Fish—Cold-Blooded Swimmers

In earlier units you read about small and microscopic marine animals called *zooplankton*. These organisms, you'll remember, were carried by the oceans' currents. Fish, on the other hand, are nekton, or marine animals that swim independently of the ocean waters' force.

Fish can be defined as cold-blooded vertebrates that live in water, use fins to swim, and breathe through gills. There are three classes of fish. Two of these classes—the **Agnatha**, or jawless fish, and the **cartilaginous** *fish*—have skeletons of **cartilage**. The third class of fish—the *bony fish*—has a skeleton of bone. These three classes of fish differ in their body covering, the types of fins they possess, and their methods of maintaining **buoyancy**, or remaining afloat. As you can imagine, as life forms inhabiting water, fish need a mechanism to remain buoyant and free to move around in search of food and habitat.

Agnatha: The Jawless Lamprey and Hagfish



Agnathans existed as far back as 550 million years ago. And, when compared to other fish, there is something quite *ancient* about them. They do not have a lower jaw. Instead they have a sucker-like mouth with large teeth and a rasp-like tongue. The **lamprey** scrapes a hole in its prey and then sucks the body juices from them. Hagfish also scrape a hole in the side of fish but then enter their prey and feed from the inside. Both fish have a flexible cartilage skeleton and small fins on an elongated snake-like body. They travel by attaching themselves to other more mobile fish. Many lampreys and hagfish make the Great Lakes their home.

Cartilaginous Fish: Sharks and Rays

Sharks and rays are examples of fish that have skeletons of cartilage rather than of bone. And, like all members of *Chondrichthyes*, a class of vertebrate fish made up of cartilaginous fish, they have small toothlike **scales** called **denticles** which cover their skin. All the points on the denticles face towards the tail. If you stroked a shark from head to tail, the skin would feel smooth. However, if you stroked the shark in the opposite direction—from tail to head—the skin would feel rough. (Shark skin was once used as sandpaper!) Some cartilaginous fish bear live young; others lay eggs. Unlike bony fish that have an air-filled **swim bladder** to keep them afloat,

the shark and ray must keep swimming to avoid sinking. Many possess large oily livers to help maintain their buoyancy.

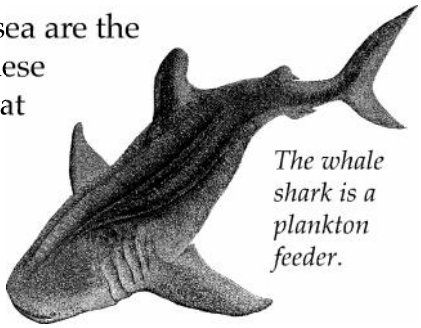
Sharks: *Mostly* Peaceful, Longtime Inhabitants of the Sea

Sharks have been swimming the seas for over 450 million years! During the last 300 million years they have changed very little. Most of us think of danger and sharp teeth chomping off body limbs when we think of sharks. But shark attacks are not as common as the media might lead us to believe. Fewer than 100 people a year are attacked by sharks, and very few of those attacks result in death. Consider that more people are hit by lightning in the United States than are attacked by sharks. Still, the media continues to mark them as a constant and overwhelming threat to beach-goers.

In fact, of the 350 known species of sharks, only 35 have shown themselves to be dangerous to humans. Of these, the hammerhead, mako, and tiger are among the best known. The most feared shark, however, is the great white shark, partly because of its representation as a creature of terror in the movie *Jaws*. The great white shark does deserve respect: It can grow to 25 feet in length and is one of the fastest swimming of all sharks. It tends to live in colder waters near large prey such as seals.

Many shark attacks on humans may be cases of mistaken identity. A swimmer on the surface of the water may look to a shark like a wounded marine animal. Other shark attacks may be the result of humans invading or disturbing sharks' territories.

Except for whales, the largest animals in the sea are the docile whale shark and the basking shark. These giant creatures are gentle plankton feeders that can grow to 40 feet and longer. Divers have been known to touch them and even on rare occasions to hitch a ride on them. Sharks range in size from these massive creatures to the six-inch cigar shark.



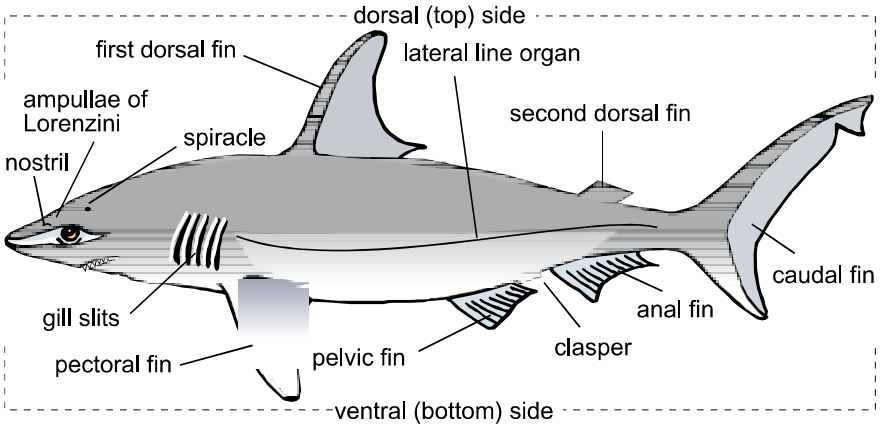
The whale shark is a plankton feeder.

The Structure of Sharks: Fins and Gills

Most sharks share a basic body structure that is characterized by their fins, which they use to push or propel themselves through water. On the top side, or *dorsum*, sharks may have several fins. Looking from head to tail, we first see a **dorsal** fin. (It is this fin that moviemakers show above water

to indicate dangerous sharks swimming about.) Next, on some sharks we see a second dorsal fin, smaller than the first and nearer the shark's tail. Their tail fin is called the **caudal** fin.

Sharks may also have fins on their **ventral**, or stomach, side. The large front fins on the side of sharks are the **pectoral** fins. The pectoral fins provide the lift which glides the shark through the water and also prevents the shark from sinking. Next are a pair of pelvic fins, located



structure of a shark

under sharks and near their tail. On the edge of their pelvic fins, males have a long extension, called a *clasper,* which they use in mating. The last pair of fins—present in only some sharks—are the anal fins, located near the tail.

Sharks, like other fish, breathe through gills located on the sides of their body. The gills of bony fish are concealed or covered by a fleshy flap. Unlike bony fish, sharks and rays have visible or exposed **gill slits**. Because most sharks cannot force water over their gills to breathe, they must keep swimming or rely on currents to move water over the gills.

Cartilaginous fish, like sharks, also have a pair of breathing holes called *spiracles*. The spiracles are located on their dorsal side behind each eye.

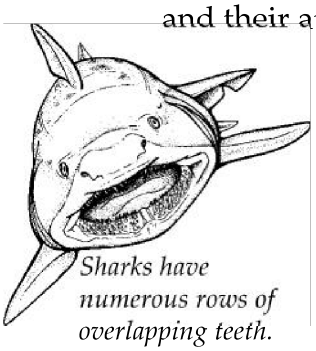
Sharks: Built for the Hunt

Sharks' bodies have many features that make them ideal for hunting and killing prey. Their many sense organs aid them in locating potential prey. Sharks *feel* vibrations in the surrounding water through special receptor cells located along both sides of their bodies. The receptor cells make up the **lateral line** organ. The lateral line organ picks up vibration (weak and

strong) as the energy from the vibration travels through the water. When the vibration hits the lateral line of the shark, the shark feels a change in pressure along its body. The feeling the shark experiences from the vibration is similar to when someone pokes you in the back and continues to poke you. This feeling is irritating to the shark so the shark goes to investigate the source of the vibration.

Sharks also have a pair of nostrils they use for detecting smells in the water. A shark's sense of smell is so sharp that a shark can detect a small amount of blood nearly a half a kilometer away. Marine biologists studying shark behavior have determined that the size of the shark's brain is responsible for its keen sense of smell. Nearly two-thirds of the shark's brain is utilized in detecting smells in the water. Other sensory cells that a shark uses to assist in locating prey are the **ampullae of Lorenzini**. These tiny cells are located in the snout of the shark. The ampullae of Lorenzini detect electric fields generated by the muscles of fish and other animals in the water. The presence of these cells explains the bizarre behavior of sharks attacking metal boat propellers and of consuming discarded metal cans and automobile license plates.

As sharks near their prey, they cover their eyes with a protective eyelid. Without vision, sharks then rely on their ability to detect the electrical fields produced by fish, other marine life, and objects. This lack of vision and their attraction to electrical fields may explain why sharks have attacked metal objects or boat motors when closing in on their prey. Once sharks begin their attack, their jaws and teeth do not permit many prey to escape. Their jaws are hinged, allowing them to disjoint during feeding. This feature permits sharks to chew large animal parts and whole animals. Sharks have numerous rows of overlapping razor-sharp teeth that are quickly regrown when they are broken off or worn down.



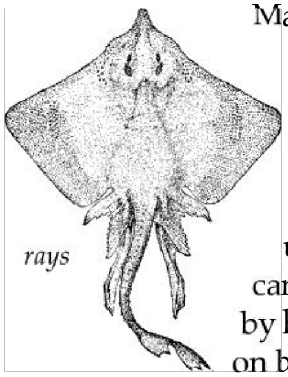
Sharks have numerous rows of overlapping teeth.

This description of the ocean's ultimate hunter should encourage us to be prepared for sharks when we swim in the sea. So what should swimmers do if they see a shark while in the water?

- Do not panic or try to drive the shark away by splashing or yelling.
- Remain calm and move slowly towards the surface or the shore.

Rays: Bottom Dwellers in the Ocean

Rays are close relatives of the shark: They also have skeletons of cartilage and denticles. Unlike sharks, however, rays have enlarged pectoral fins that resemble broad wings. Some rays may grow to 20 feet or more from one fin tip to the other. Rays flap these fins to propel themselves through the water or to bury themselves in the seafloor's sediments.


rays

Many rays, such as the southern stingray and the skate, live close to shore. They are hard to see because they bury themselves in the sand, and their coloring blends in with the sediments. Other rays such as the eagle ray or the manta ray live in deeper waters and feed on plankton schools. A ray's mouth is on its underside, and their *teeth* are broad, flat plates of cartilage used to grind up shellfish. They can even be fed by hand without danger of getting bit. Rays feed mainly on benthic animals including worms and clams.

A few rays can be dangerous. The stingray has a sharp, poisonous barb near the bottom of its tail, which it can drive into its enemy. This barb may stick in the skin and cause an infection. To avoid being stung, drag your feet as you walk along the bottom—this action scares them away. If you are stung by a stingray, do not try and remove the spine yourself. Remain calm, apply a cold compress to the site, and seek medical attention quickly.

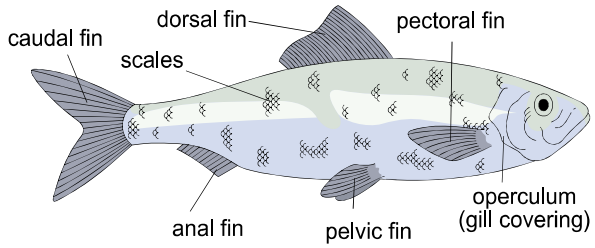
Bony Fish: The Ocean's Most Numerous Fish

Osteichthyes, the class of bony fish in the ocean, far outnumber sharks, rays, lampreys, and hagfish combined. They are found in every habitat of the ocean. And although they may swim long distances, they tend to remain and swim in a small range of depths. Fish are very well suited to their specific environments. For example, fish living near plants or narrow channels may be compressed from side to side so they can move safely around dangerous limbs or narrow passages. Fish that live on or near the sea bottom may be compressed from top to bottom, enabling them to rest on the marine floor. Most fish produce a large number of eggs during **spawning**, though only a small percentage survive to reach maturity.

Structure and Features of the Bony Fish

Unlike land animals, the bony fish's skeleton does not have to support much weight. Instead, the body of bony fish is entirely suited for moving

through water and staying afloat. Attached to their skeleton of bone are muscles, which fish contract and expand to move their fins and propel themselves through water. Their fins can be folded back against their body or fully extended to help them move and steer through water. Their ability to swim smoothly and with little effort is enhanced by their streamlined shape.



structure of bony fish

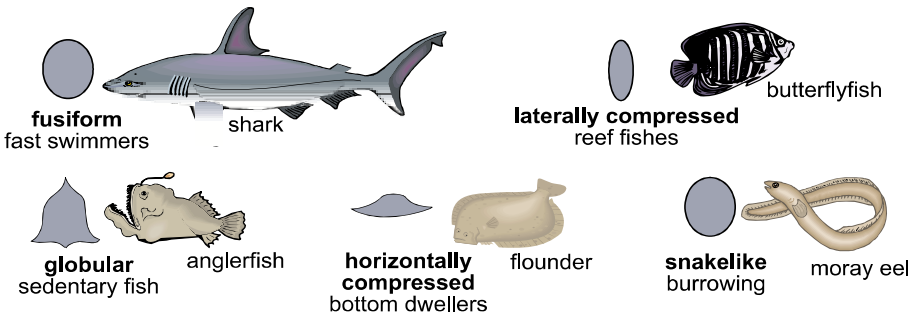
Overlapping plates called *scales* cover and protect fish's bodies. Fish feel slimy to the touch because their scales are covered with a coating of mucus. This coating serves as a defensive barrier that keeps bacteria and diseases from entering the fish's body through its scales. The coating also helps the fish move easily through the water. The slimy coating reduces the drag and friction, allowing the fish to glide through the water. You can determine the age of some fish by the number of rings on their scales. A single band on a scale may represent one year's growth.

Fish obtain oxygen from the water through their gills. The gills are covered by a flap of tissue called the **operculum**. If you have observed fish in an aquarium, you may have noticed the movement of the operculum as the fish breathed.

Fish are always on the move. Bony fish have an organ called a *swim bladder* that allows them to periodically float in the water. The swim bladder assists the fish in maintaining its buoyancy. *Buoyancy* is the ability to float or rise in a liquid medium such as water. The swim bladder is a gas filled organ (similar to a balloon) that fish use to rise, sink, or maintain their position in the water.

Although bony fish have the general structure and features described above, they come in all shapes and sizes. Open water, or *pelagic*, fish are much faster swimmers and cover a wider area than the bottom dwelling species such as the flounder. Pelagic fish have a body shape that is **fusiform**, or *streamlined*. A fusiform body shape produces little resistance to movement through the water. The fastest swimming speeds are reached when a fish uses its *caudal fin*. The shape and the height of the caudal fin affect speed. Tuna and sharks are examples of fish which are fast pelagic swimmers. These fish have a greater fin height than do slower fish.

Fish that live in seagrass or on coral reefs have a *laterally compressed* body that helps them to swim more efficiently through the seagrass or coral heads. The butterflyfish and angelfish are fish that have laterally compressed bodies. Bottom dwelling fish, like the flounder, have a *horizontally compressed* or flattened body. These fish swim horizontally instead of vertically and are poor swimmers. The toadfish and anglerfish are also bottom dwelling fish but have *globular* or rounded bodies and pectoral fins that are enlarged to help support their body on the seafloor. These fish are commonly called "ambush hunters" because they wait patiently on the seafloor and ambush their prey. *Burrowing* fish and fish



fish shapes

that live in between rocks have long, snake-like bodies and usually have reduced (or lack) pelvic and pectoral fins. A moray eel is a fish that exhibits a snake-like body.

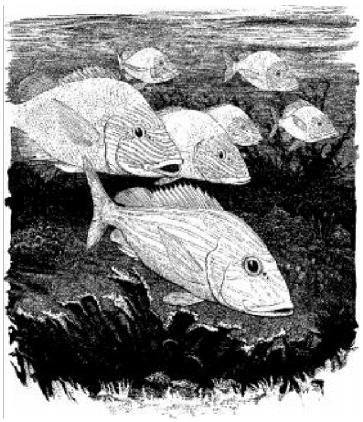
Fish use color for species recognition and concealment. Fish that live in the open ocean have body coloration known as **countershading**. In countershading, the fish's dorsal side (top) is dark and the ventral side (bottom) of the fish is light. How does this type of coloration help camouflage oceanic fish?

Coral reef fish exhibit a different coloration from oceanic fish. Reef fish have markings on their bodies that typically exhibit a banded pattern. The coloration pattern is called **disruptive coloration**. The banded patterns usually run vertically along the fish's body. This helps to break up the pattern of the fish's body. Predators have a harder time locating reef fish that display disruptive coloration.

Fish Schools: Survival in Numbers

About half of the species of fish live in **schools**. *Schools* describe large numbers of the same kinds of fish traveling and feeding together. Fish live in schools in freshwater streams and lakes, as well as oceans. Types of fish

that form schools can be as small as minnows or as large as tuna. The numbers of fish in a school range from about a dozen to thousands. Regardless of the size of the schools, they are made up of fish of nearly the same size and age.



Fish live in schools to increase their chances for survival.

Fish live in schools to increase their chances for survival. Fish in a school become quickly aware of an attack from a predator and, consequently, increase their chance that at least some will survive. In addition, swimming in schools may be easier for fish than swimming alone (as flying together is easier for birds than flying alone). Fish release a slippery film that make them glide through the water more easily; swimming in a school permits fish to use the film released from surrounding fish. Fish also create little currents for each other, thereby reducing drag (similar to a *draft* created by a big truck on the highway). By properly spacing themselves, fish swim more efficiently. Gathering into schools also provides fish with suitable mates to help insure reproduction.

Summary

Fish are cold-blooded vertebrates that live in the water and breathe with gills. Two classes of fish—*Agnatha* (lampreys and hagfish) and *cartilaginous* (sharks and rays)—have backbones made of *cartilage*. The third class of fish—the bony fish—is the most numerous by far, and has a skeleton made of bone. Most fish have scales and fins and well developed body systems. Special *buoyancy* systems and *swim bladders* equip them for locomotion in the water.

Sharks are some of the largest marine animals, growing up to 40 feet in length. They are particularly well built for hunting and killing. Their sense organs are designed to detect potential prey, and their overlapping razor-sharp teeth penetrate and kill prey easily. Although feared, sharks do not often kill humans. Rays are bottom dwellers that feed on benthic animals. Some rays are equipped with poisonous barbs.

Bony fish are well adapted to their specific environment. They may be shaped quite differently to swim easily and safely through their own particular surroundings. Many bony fish swim in *schools* for protection and reproduction benefits.