

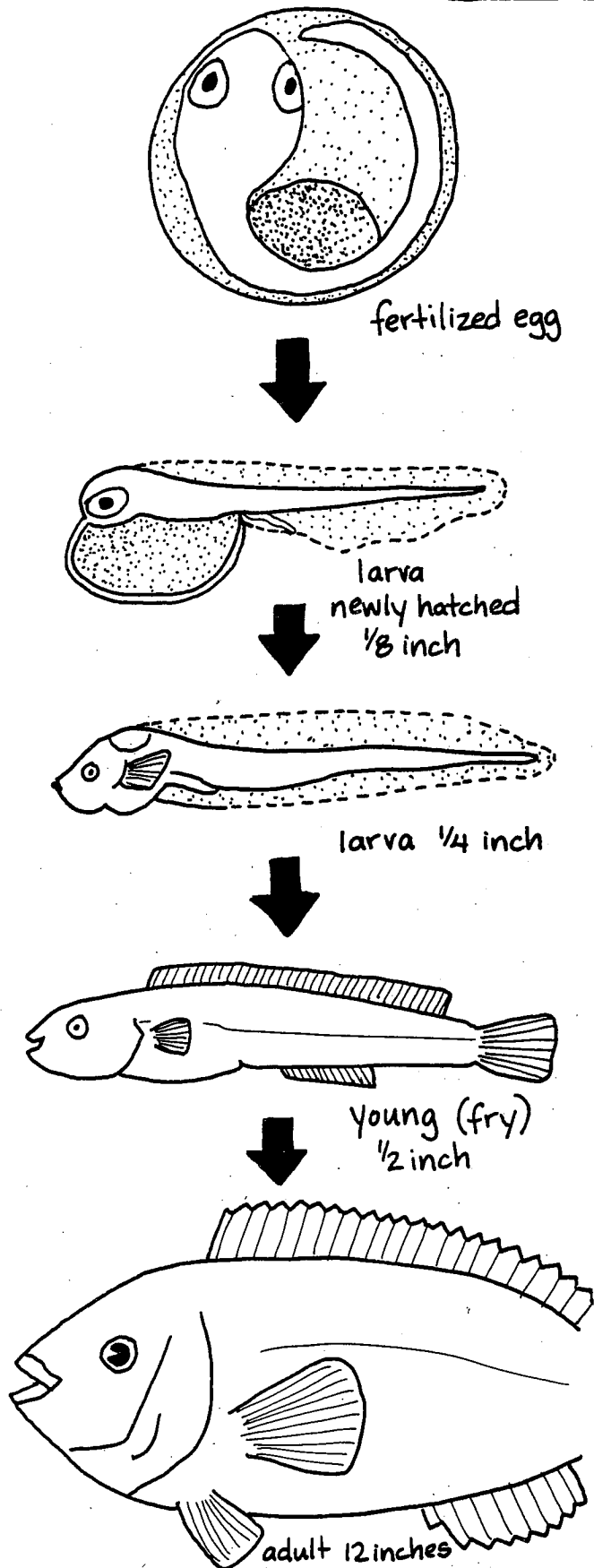
14 Fish

Fish are aquatic, cold-blooded vertebrates that breathe with gills and have fins instead of limbs. Nearly half of the 40,000 known species of vertebrates are fish. Ninety percent of these fish species belong to the class Osteichthyes, the bony fish. Most of the other 10 percent belong to the class Chondrichthyes, the cartilaginous fish. Bony fish have a skeleton made of bone; cartilaginous fishes have a skeleton made of cartilage. Sharks, rays, and skates are cartilaginous fish, whereas almost all other fish, such as cod, tuna, and salmon, are bony fish.

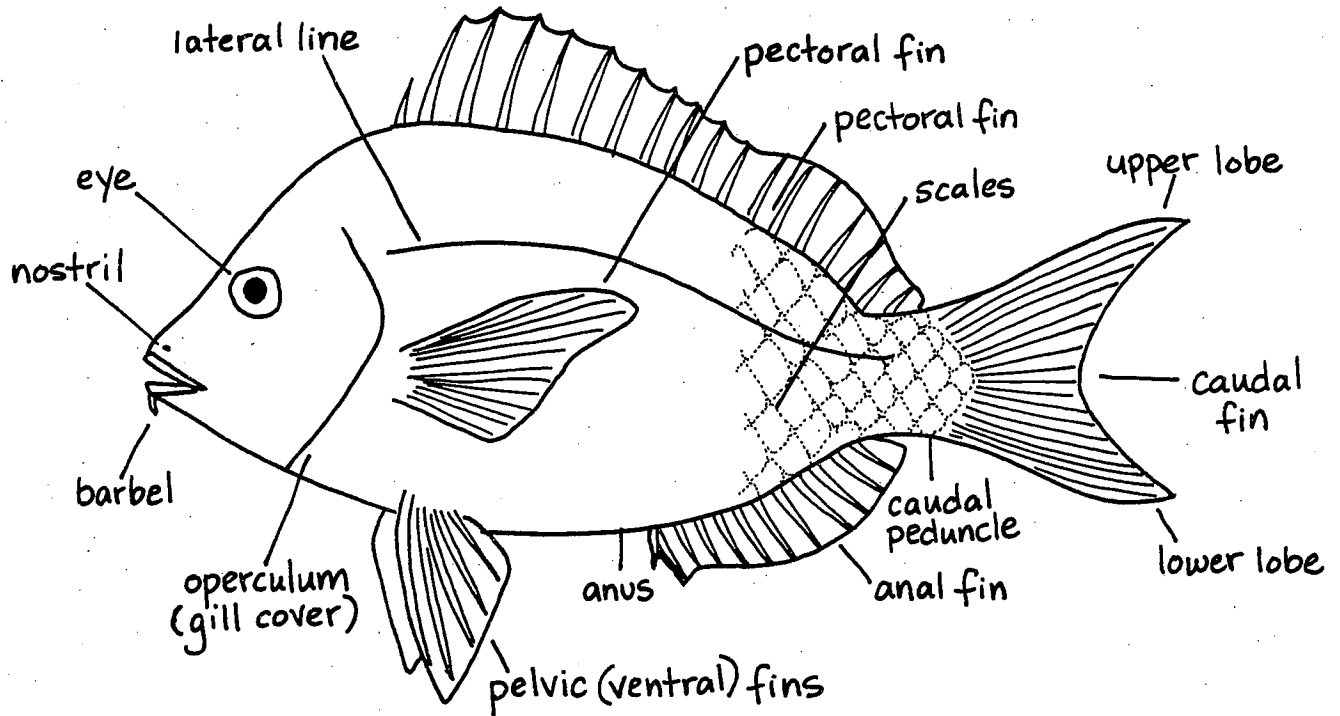
Fish differ greatly in breeding habits. Most fish species reproduce through external fertilization. Some fish merely swim next to each other while releasing eggs and sperm into the water. In this case, with egg and sperm randomly discharged into the water, there is a good chance that many eggs will never be fertilized. To compensate for this, the female produces thousands, even millions, of eggs, thus ensuring that sperm cannot help but bump into some of them. A few species, especially the sharks, display internal fertilization. Male sharks actually place sperm into the reproductive tract of the female.

Although some fish attach their fertilized eggs to the bottom and others build nests, most species of bony fish start life as tiny planktonic eggs, adrift in the sea. The eggs float (some contain a drop of oil to increase their buoyancy) and disperse from the breeding ground.

Larvae develop inside the eggs, nourished by the yolk. Depending on the species, they hatch out days or weeks later. Fish larvae have large eyes, a short trunk, a long tail, and a transparent fin extending from head to tail. Between their head and anus is a glob of yolk that sustains the young fish until its muscles and jaws are well enough developed so it can fend for itself. When the yolk is depleted, the larvae feed on plankton. Eventually the fish larvae develop into fry (young fish), and then into adults. Some fish mature in weeks, while others take years to reach sexual maturity. Naturally, only a small percentage of fish larvae live to adulthood.



The External Bony Fish



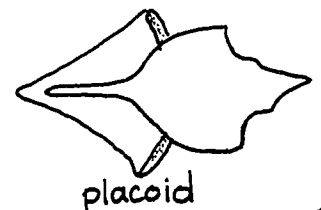
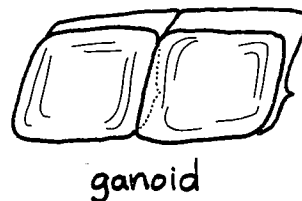
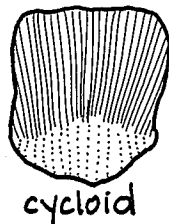
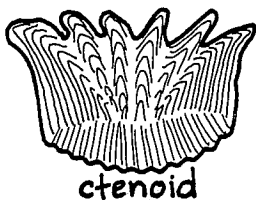
Fins give fish mobility, stability, and maneuverability. There are two types of fins: paired and unpaired (median). The dorsal and anal fins are unpaired. They act as keels and prevent the fish from rolling. The caudal, or tail, fin is also unpaired. It helps propel and maneuver the fish. Pelvic and pectoral fins are paired. By extending both pectoral fins, a fish can brake. When one pectoral is extended at a time, a fish steers. Pelvic fins help keep the fish horizontal in the water. Spiny or soft rays in the fins keep the fins upright.

The skin of most fish is covered with scales, which grow from pockets in the skin and begin to develop early in a fish's life. Growth of a fish is marked in annual rings on each scale. Scales vary in size and shape. Ctenoid scales are rough, with a comb-like edge; cycloid scales are smooth. Primitive fish often have heavy ganoid scales; sharks have placoid scales. Mucus over

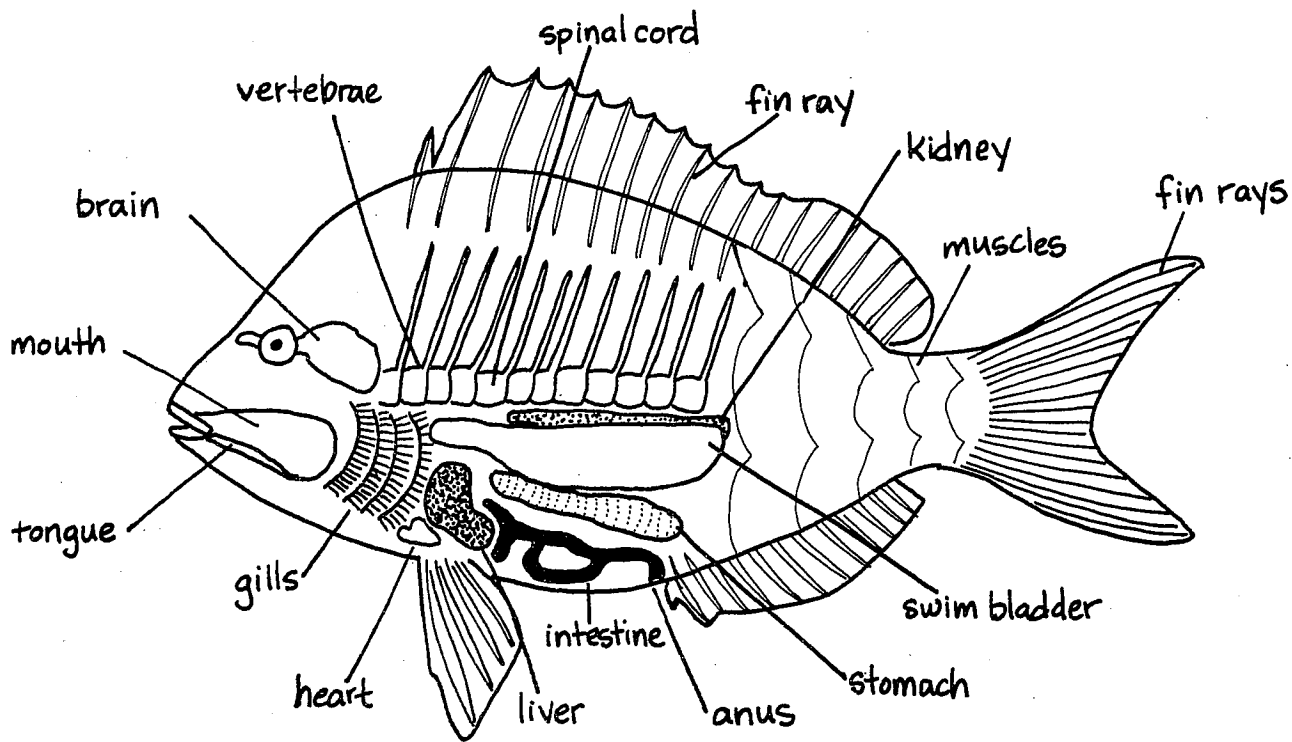
the skin and scales protects the fish from disease.

The color of fish is due to a combination of chromatophores (pigment cells) and iridocytes (reflective cells). These cells can contract or expand to alter the color of the fish. Many fish exhibit countershading: dark on top, where the sun hits, and light underneath, which is usually shaded. This helps them to blend in with the sky (when the fish is viewed from below) and the sea bottom (when viewed from above).

Other external anatomical features include the mouth, which may contain teeth; the barbel, used in tasting and feeling; the nostrils, and the bony gill cover, also called the operculum. The lateral line is made up of sensory cells that detect disturbances in the water. Some fish have a faint lateral line, while others have none at all.



The Internal Bony Fish



Bony fish have a skeleton of bone. Cartilaginous fish (sharks, rays, and skates) have a skeleton of cartilage. The skeleton of bony fish is similar to that of other vertebrates. The vertebral column starts from the skull and ends where the tail begins. Fish bones are strong, yet light weight. As with other creatures, the skeleton is a site of muscle attachment.

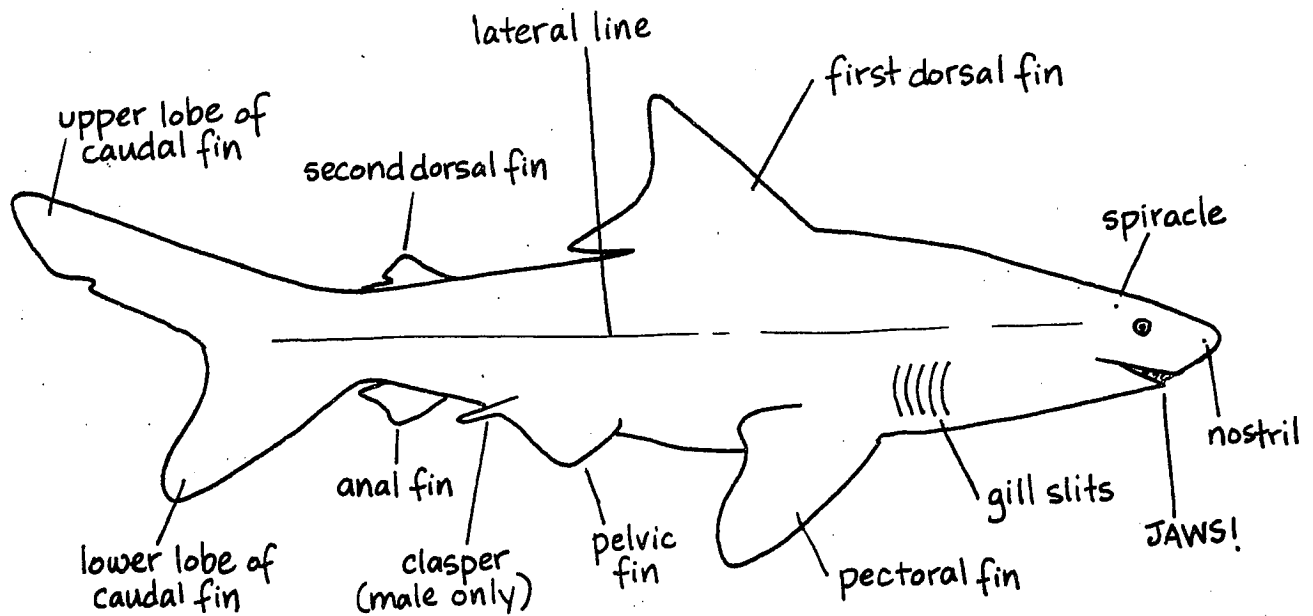
Fish swim by flexing their streamlined bodies. Waves of contractions travel down successive muscle segments along the fish. These waves push the water backward, causing the fish to move forward. Fins assist in braking, steering and maneuvering. Each fin is moved by its own set of muscles.

Most fish have a swim bladder. This is a gas-filled sac that the fish inflates or deflates in order to maintain *neutral buoyancy* in the water. When a fish is neutrally buoyant, it neither sinks to the bottom nor floats to the surface, but is able to "hang" in the water. Gas for the swim bladder is manufactured in a gland. Some fish have a swim bladder with an

opening. To deflate the bladder, gas is expelled through the opening and exits through the mouth and gills. Fish with closed bladders expel excess gas into their blood. Sharks, skates, rays, clingfish, and flatfish are examples of fish that do not have swim bladders.

By breathing, organisms take in oxygen, which is used in bodily reactions that release the energy needed to live and grow. Fish breathe by taking water in through their mouth. As they close their mouth, water is forced over their gills and out the operculum. Fish gills are made of fine filaments attached to a flexible skeletal arch. Blood circulates through these fine filaments, and hemoglobin in the blood absorbs the dissolved oxygen in the water. Water exiting through a fish's gills contains 80 percent less oxygen than when it entered through the mouth. Some fish have gill rakers (screen-like structures) across their gills. The gill rakers filter out food and debris from the water as it passes over the gills.

The External Shark



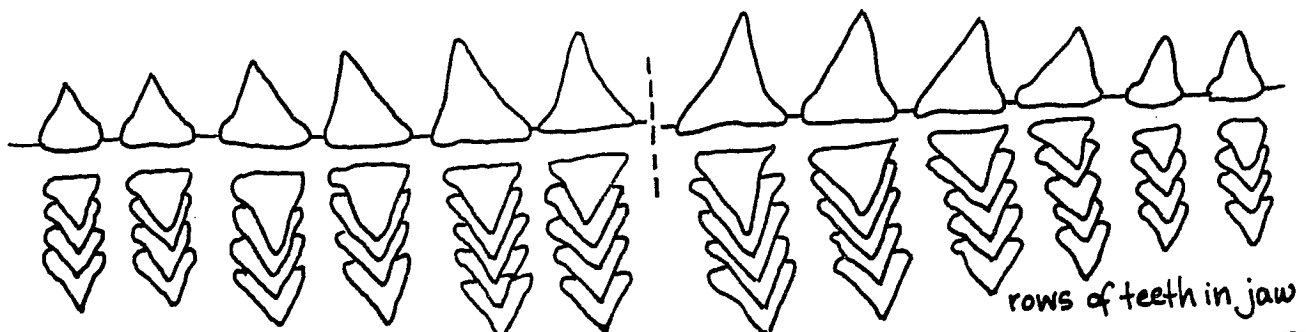
Approximately 300 out of the 20,000 species of fish are sharks. Sharks, along with rays and skates, have a skeleton made of cartilage, not bone. Bony fish and sharks differ in many ways. Instead of having a bony flap over the gills, sharks' gills open to the outside through slits. Most sharks have five slits to a side; other have up to seven. The spiracle is a vestigial gill slit.

Sharks are covered with tiny placoid scales, often called dermal denticles. These scales, formed like small teeth, grow out of the shark's skin. Many of the denticles point in the same direction—toward the tail. If a shark is rubbed from tail to head, the skin feels like sandpaper.

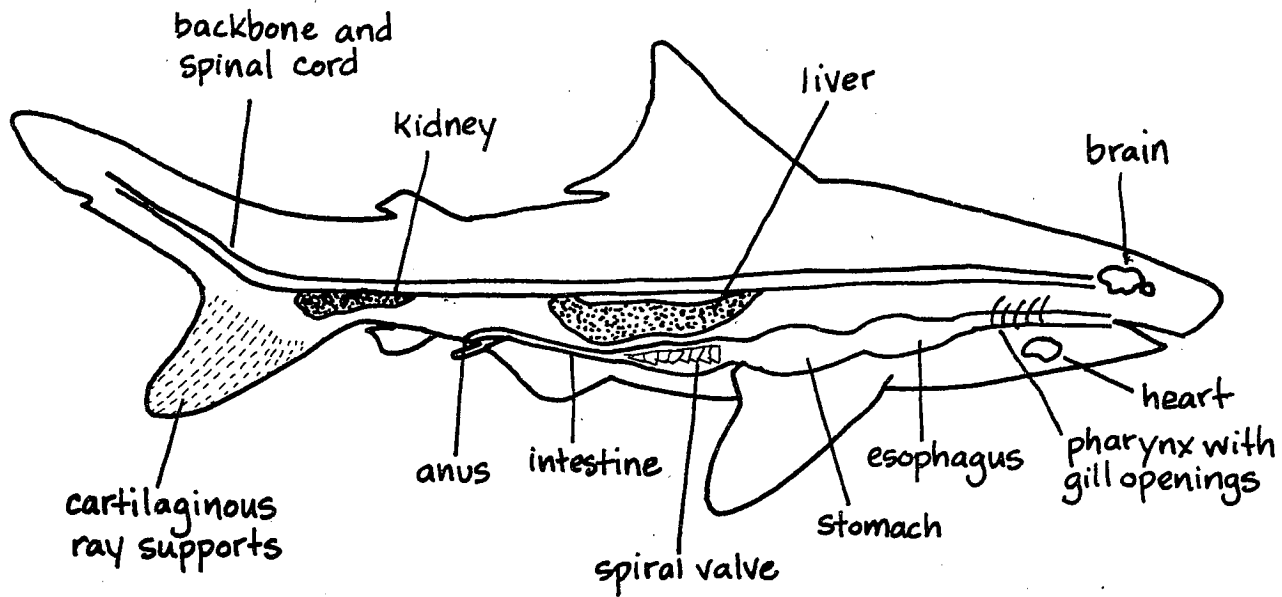
The teeth of a shark are specialized dermal denticles loosely embedded in tissue over the

jaw. Three to fifteen sets of replacement teeth are neatly arranged on the inside of the jaw. They point downward and only turn up in a conveyor belt system as they reach the outer edge of the mouth. Sharks continually shed their teeth, always growing new ones in reserve.

Most sharks are torpedo-shaped and very streamlined. Their powerful tail propels them through the water. The upper lobe of the caudal fin is usually larger than the lower lobe. Strong-swimming sharks, such as the Mako and Great white, have a crescent shaped tail and a very small second dorsal fin. All fins are supported internally by rays of cartilage. In male sharks, a clasper device used in reproduction extends from the pelvic fins.



The Internal Shark



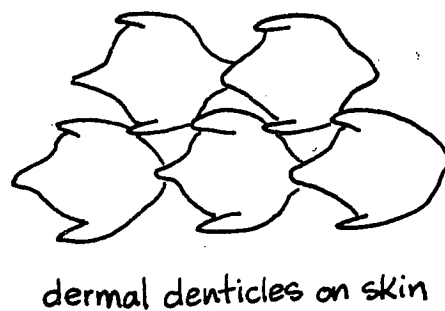
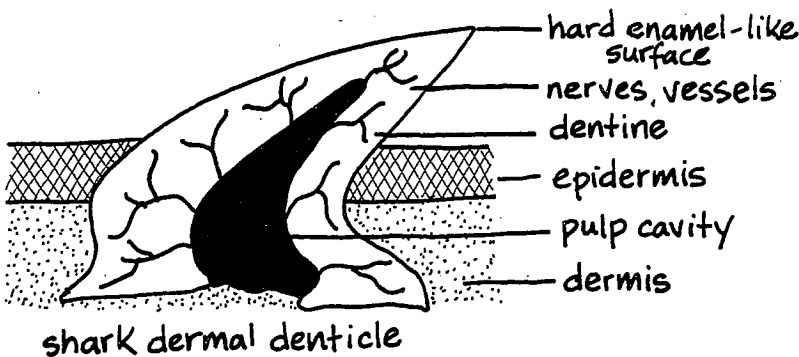
A shark has no bones. Its skull and vertebrae are made of cartilage. Cartilage is relatively flexible, but the backbone may be calcified for extra rigidity. Unlike the tail of bony fish, which starts where the backbone ends, a shark's backbone extends well into the tail, making the tail very powerful. There is no rib cage to protect a shark's internal organs, so despite their tough exterior, sharks can't tolerate much abuse, especially out of the water. They are held together only by skin and muscle.

Sharks have no swim bladder. Instead, they use their liver, which can be more than 15 percent of their body weight, to control buoyancy. In addition to producing bile, a shark's liver serves as a fat and oil reserve. The oil helps keep the shark from sinking to the bottom. Unlike bony fish, which can change the size of their swim bladder, a shark cannot readily change the size or buoyancy of its liver.

Water enters a shark through the mouth, passes over the gills, where oxygen is extracted,

and then leaves the body through the gill slits. Many sharks must keep swimming to keep breathing. They are not able to pump water over their gills, and therefore cannot hang motionless in the water without becoming short of breath. Some sharks, especially those that live inshore, have muscles around their gills, enabling them to rest and breathe at the same time.

During copulation, a male shark inserts his clasper (on the pelvic fin) into the female. Sperm passes from the male along a groove in the clasper and into the female. Some species of sharks lay eggs in leathery cases, and the babies hatch in the water months later. Others retain the fertilized eggs in their bodies, and baby sharks emerge live from the female after hatching inside her. A few species actually have a placental attachment to the developing embryos. No sharks care for their babies after hatching.



Shark Senses and Feeding Behavior

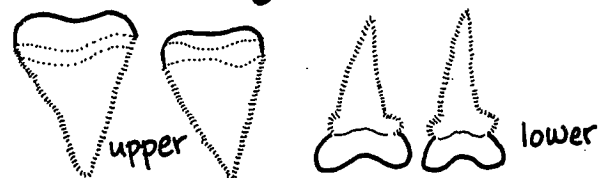
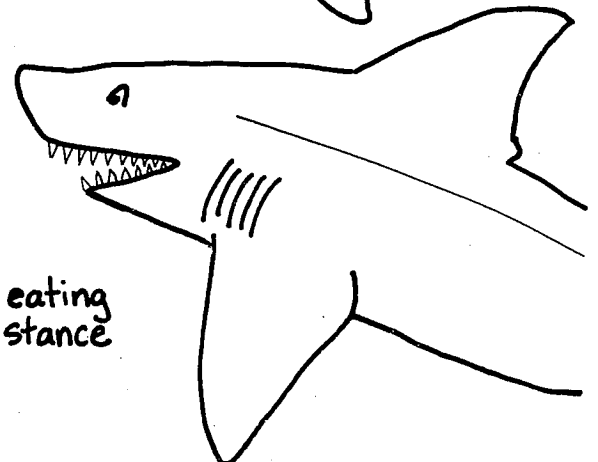
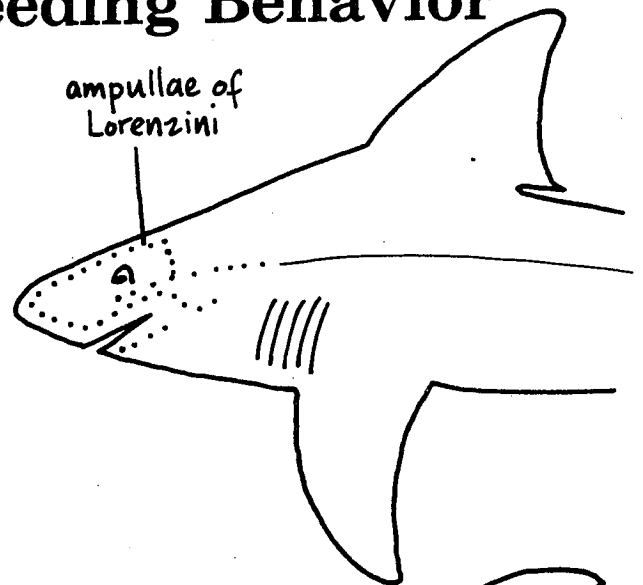
Sharks are scavengers and carnivores. Although it seems most sharks are attracted to thrashing movements and blood (especially of fish), we are not yet able to predict a shark's behavior or food choice. Some sharks eat almost anything, edible or not: tin cans, raincoats, bottles, etc. Others have more specific diets. Nurse sharks prefer crustaceans and mollusks. Basking and Whale sharks eat only plankton.

No matter what they eat, sharks rely on their senses to find food. Their eyes are usually small but well adapted for vision, even in dim light. Color vision may be limited. Sharks have an acute sense of smell and can detect minute quantities of some substances, especially blood, in the water. Their internal ear and lateral line both detect impulses in the water, such as the thrashings of sick fish. Sac-like pores in the head, the ampullae of Lorenzini, are sensitive to electric impulses, especially the electrical signals created by the muscular movements of thrashing animals. All these senses make sharks efficient, astute predators.

Because a shark's mouth is located on the underside, it had been thought that a shark had to roll over to bite and grab its prey. That is not the case. A shark's jaws are very flexible and loosely set in the mouth. When a shark grabs its prey, it lifts its snout and thrusts out its jaws, without having to get above or to the side of the prey.

Each species of shark has its own type of teeth. Differences in tooth structure reflect differences in their function and in the shark's diet. The relatively flat teeth of Nurse sharks crush mollusk shells. Bladelike, triangular teeth of Great white sharks cut flesh from large prey.

With the variety of items sharks eat, it's no wonder people are occasionally bitten. But shark attacks are very rare. Most occur when a person provokes a shark or if the person is bleeding profusely in the water, such as after an air or sea disaster.



teeth of Great white shark



upper

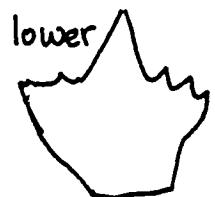


lower

teeth of Spiny dogfish



upper



lower

teeth of Nurse shark