PART ONE

Fish

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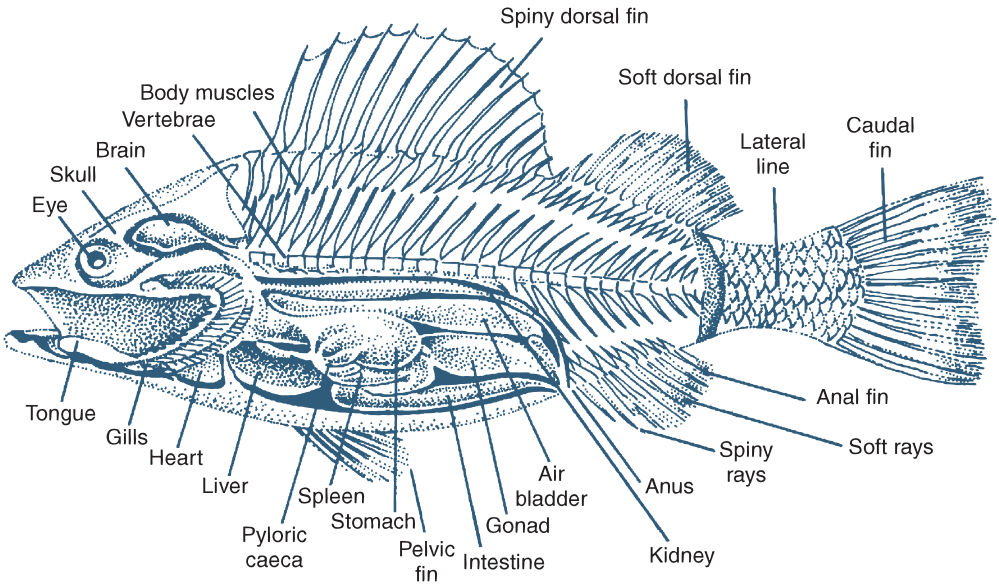
Anatomy and Physiology

The term "fish" is applied to a class of animals that, according to various scientific estimates, includes between 21,000 and 25,000 extremely diverse species.

Fish can be roughly defined (and there are a few exceptions) as cold-blooded creatures that have backbones, live in water, and have gills. The gills enable fish to "breathe" underwater, without drawing oxygen from the atmosphere. This is the primary difference between fish and all other vertebrates. Although such vertebrates as whales and turtles live in water, they cannot breathe underwater. No other vertebrate but the fish is able to live without breathing air. One family of fish, the lungfish, is able to breathe air when mature, and actually loses its functional gills.

Scientifically, fish are divided into four groups, or families: the hagfish, the lampreys, cartilaginous fish, and bony fish. The hagfish and lampreys lack jaws, and as such they are known as jawless fish; there are 32 species of hagfish and forty species of lamprey. The cartilaginous fish and the bony fish have jaws. The bony fish are by far the most common, making up over 95 percent of the world's fish species. Cartilaginous fish, including sharks, rays, and skates, are the second largest group, numbering some 700 species. Various



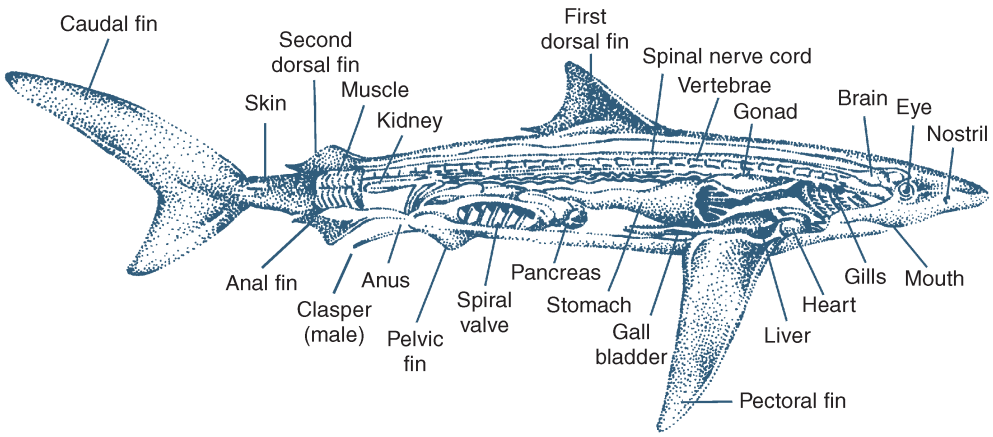
Anatomy of a Perch

species of cartilaginous and bony fish are the object of angling attention and thus the focus of this section.

Body

The body of a fish is particularly adapted to aquatic life. It is equipped with fins for the purpose of locomotion. Scales and mucus protect the body and keep it streamlined. The skeleton features a long backbone that can produce the side-to-side movements needed for forward propulsion in water. Since water is eight hundred times denser than air, fish must be extremely strong to move in their environment. They respond to this condition by being mostly muscle. Thus muscles make up 40 to 65 percent of a fish's body weight.

Many fish have air or gas bladders (sometimes called swim bladders) that allow them to float at a desired depth. They also have gills, their underwater breathing apparatus, located in the head. Most fish have only one gill cover, although some, like sharks, have gill slits, some as many as seven. The gills are the most fragile part of the fish; anglers should avoid touching the gills on fish that they plan on releasing.



Anatomy of a Shark

The limbs of fish come in the form of fins, membranes that extend from the body and are supported by spines or rays. Because the number of rays is usually constant within a species, a ray count is often used by scientists to determine the species of a fish. Each of the fins on a fish has a distinct name.

Moving from the head toward the tail, the first fins are the pectoral fins. They are used for balance and maneuvering in many species, and in a few for propulsion. Farther down the underside of the fish are the pelvic fins, located beneath the belly and used for balance. On the back is the dorsal fin. Some fish have more than one dorsal fin; in this case the dorsal fins are numbered, with the fin closest to the head called the first dorsal fin, and so on. Behind the dorsal fin there is occasionally a smaller, fleshy fin called the adipose fin. Behind the pelvic fins and the anus on the underside is the anal fin. The last fin, usually called the tail, is known scientifically as the caudal fin. It is the most important fin for locomotion: By moving it from side to side, a fish is able to gather forward momentum.

The scales of a fish form the main protection for the body. They are kept for the fish's entire life; as a fish grows, the scales get larger rather than regenerating.

Scales are divided into several types. The majority of fish have ctenoid or cycloid scales. Ctenoid scales are serrated on one edge and feel rough when rubbed the wrong way (such as on largemouth bass). Cycloid scales are entirely smooth, like the scales of trout. A minority of fish have other types of scales: Sharks have more primitive placoid scales, which are spiny; sturgeon have ganoid scales, which form armored ridges along parts of the body. Some species, like catfish, have no scales at all.

Scales can be used to determine the age of a fish. A scale will develop rings showing annual growth, much like the rings of a tree.

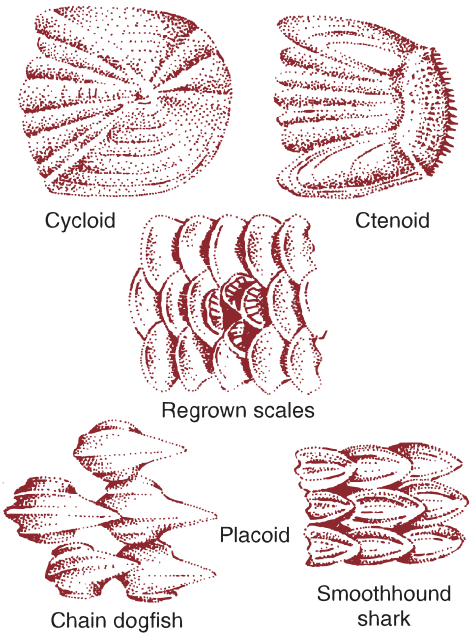
Many fish also have a covering of mucus that helps streamline their body and prevent infections. This covering will rub off onto a person's hands; it is the slimy substance that you can feel on your hands after holding a fish. Since the loss of mucus is detrimental to the fish, it is better to wet your hands before handling a fish that will be released, in order to minimize the amount of mucus removed. Also be careful not to harm a fish by holding it too tightly.

The skeletal and muscular systems of fish work together to maximize swimming power, the serially repeated vertebrae and muscle structure creating the shimmering, undulating movements that allow a fish to swim quickly. This structure is evident in a filleted fish, where the muscles show themselves in their interlocking pattern. The highly muscular nature of fish is the reason why they make such good eating, and why they are such a high-yield food source.

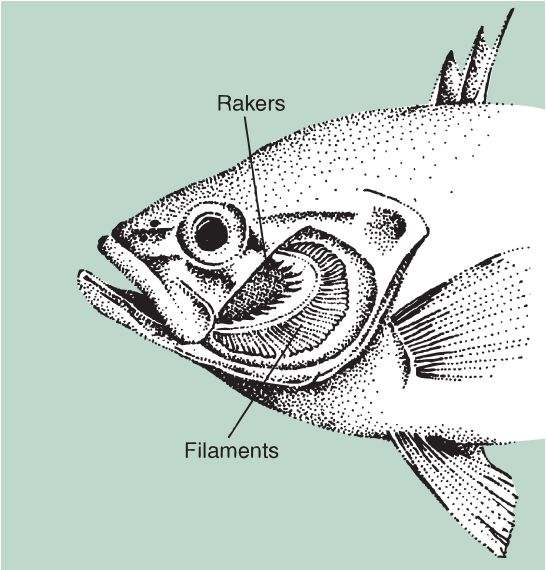
Bony fish have developed an organ called an air bladder, which acts as a kind of flotation device. A fish's body is naturally a bit denser than water, but the air bladder, filled with gas, increases the fish's ability to float. Fish can change the depth at which they float by varying the amount of gas in their air bladder, allowing them to float at any depth they desire without expending any effort. Fish that do not have air bladders, such as sharks, must continually move in order to prevent themselves from sinking.

Like virtually all animals, fish need oxygen to survive. However, a fish can get all the oxygen it needs from water by use of its gills. Water entering through the mouth is forced over the gills, which extract oxygen. In order to breathe, fish must

Scale Types



Cycloid scales have smooth rear margins, whereas ctenoid scales have comblike margins; placoid scales, found on sharks, are toothlike. Scales generally are layered, overlapping in rows like roof tiles.



This cutaway view shows the first gill arch of a sunfish. The rakers, which strain the water, are on the left; the filaments, which transfer dissolved oxygen to the blood, are on the right.

constantly have water passing over their gills. To accomplish this, some fish must either move continually or live in water with a strong current.

Although most fish are referred to as cold-blooded creatures, this is not entirely true. Some species are called warm-blooded, yet they cannot sustain a constant body temperature as humans do. Instead, the body temperature of a fish approximates that of its surrounding medium—water. Certain types of fish, such as tuna, by their constant vigorous propulsion through the water, sustain high muscular flexion that creates heat associated with rapid metabolism. Through built-in heat conservation measures, the fish is capable of maintaining a warmer body temperature than the medium that upholds it; for example, a bluefin tuna's fighting qualities are not impaired when it suddenly dives from surface waters where it was hooked down to the colder depths.

Shape

Fish shapes have also evolved to suit the needs of their aquatic life. These body shapes fall into general categories. Some fish are narrow, with bodies that are taller than they are thin, like sunfish, largemouth bass, or angelfish. Some are flat, with bodies that are shorter than they are wide, like flounder. Some are torpedo-shaped, like tuna or mackerel. Some are tubular and snakelike, such as eels.

A fish's shape tends to be related to its habits and habitats. Narrow-bodied fish are extremely agile, and tend to live in reefs or densely weeded ponds where the ability to maneuver between rocks or plants is essential. Flatfish tend to live on the bottom, where their low profiles prevent recognition. Torpedo-shaped fish are built for speed and are found either in open water or in strong currents where less streamlined fish would be swept away. Tubular fish often live in small crevices and areas that are inaccessible to other animals, rather than in wide-open ocean waters.

Color

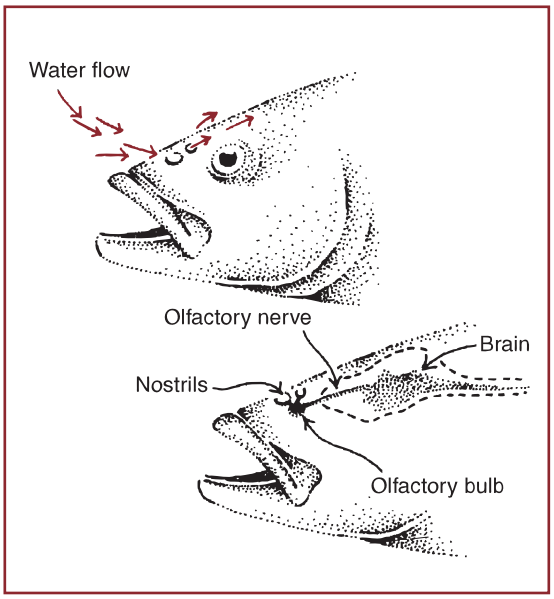
The amazing variety of colors that fish display clearly demonstrates the importance of color in the fish world. Most fish are colored for purposes of camouflage. When viewed from above, they tend to be dark in order to blend in with the dark bottom of the water. When viewed from below, they look light in order to blend in with the sky (this is called countershading).

Fish have developed a huge variety of colors and markings that allow them to escape detection in their environments. Color is also used for mating purposes. Certain fish have special breeding colors, usually brighter than normal. Many reef fish have brilliant colors year-round, which help to differentiate between the many species that live on the reefs.

Senses

An angler should understand the way a fish's senses work. Knowing what a fish is sensitive to helps an angler approach the fish without scaring it. Although some fish rely more on certain senses than on others, there are statements about senses that apply to all fish.

Fish hear very well. Sound travels five times faster in water than in air, and fish are quite sensitive to loud noises (which is why you should not tap on the glass of a fish tank). Fish can be scared off by the noise from people banging around in a boat, loud talking, and motors. Although fish do not have external ears, they do have internal ones.



Smell receptors are located in the nostrils, and water (carrying odors) is drawn into sacs that are lined with the organs of smell. Olfactory nerves connect the nostrils and brain.

Set in the bones of the skull, these hear very well. The role of sound in the lives of fish is not entirely understood, but many species are known to be noisy; fish have been recorded grunting, croaking, grinding teeth, and vibrating their muscles.

A fish's sense of smell is often very good, but the importance of this sense varies widely among species and may be subordinate to other senses, especially vision. With olfactory nerves in their nostrils, fish can detect odors in water just as terrestrial animals can detect odors in air. Some fish use their sense of smell to locate food, detect danger, and perhaps also to find their way to spawning areas.

There is evidence that a salmon's keen sense of smell contributes to its ability to return to its birthplace. Certainly a salmon's olfactory sense is incredibly acute: Salmon can detect one part per billion of odorous material in water. They may refuse to use fish ladders if the water contains the smell of human hands or bear paws. Salmon will panic if placed in a swimming pool with one drop of bear-scented water.

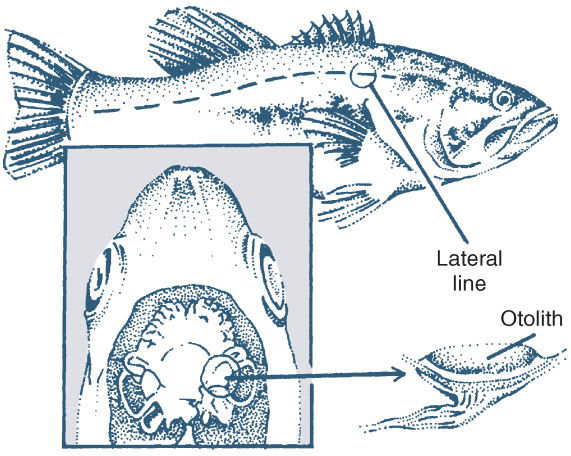
With the apparent importance of smell to many fish, removing human scents from fishing tackle is something that anglers should consider, although this practice is disputable and its usefulness varies widely with species. While the practice is considered vital by some anglers, others view it as irrelevant.

Sight varies in importance for fish. Most fish are nearsighted; although they can see well for short distances, their vision gets blurry past three feet or so. Some fish are exceptions to this rule; brown trout, for instance, have excellent vision. An important fact to realize about most fish is that they can see almost 360 degrees; their only blind spot is a small patch directly behind them.

Fish can also see color. In laboratory experiments, largemouth bass and trout have been able to identify red, green, blue, and yellow. Some fish have demonstrated preferences for certain colors, and red has long been considered a foremost attraction, although this is subject to a host of variables as well as disagreements among anglers.

The sense of taste does not seem to be as important to fish as other senses; taste buds are not as well developed, although there are exceptions, especially among bottom-scrounging fish. Some species, like catfish, use taste to find food and utilize this sense much more than other species of fish. Catfish even have taste buds on their barbels, and certain species have them on the underside of their body.

Many fish have an additional sensory organ called the lateral line. Visible along the length of the body, the lateral line is used to detect low-frequency vibrations. It acts like both a hearing and a touch organ, and is used to determine the



Hearing is accomplished primarily through nerves in the lateral line but also through sound waves detected by the otolith.

directions of currents, the proximity of objects, and even water temperature. The lateral line is sensitive to water vibrations and helps fish escape predators, locate prey, and stay in schools.

Reproduction

Fish reproduce in many different ways. Most lay eggs, but some bear live young; most eggs are fertilized after they are released from the female's body, but some are fertilized inside the body. Since almost all gamefish are egg layers (sharks being the main exception), their reproductive habits are the most important to the angler.

Mating, called spawning in egg-laying fish, usually occurs once a year. Each species has its own spawning habits, which greatly influence its behavior. Some fish do not eat when they are in a spawning mode; others are voracious prior to spawning. Some migrate; some build visible nests, and others have no nests; some move to deep water, and some move to shallow water.

Once fish choose a site for spawning, or the time is right, they begin to mate. Sometimes the mating is an elaborate ritual; sometimes it merely amounts to the female scattering the eggs and the male fertilizing them. After the eggs are fertilized, some fish guard and care for the eggs, and some do not. The eggs hatch fairly quickly, at times in as little as twenty-four hours, although the time is influenced by such factors as water temperature, turbidity, sunlight, salinity, and current.

The young fish just out of the eggs are called fry. Fry are usually so much smaller than their parents that they are not recognizably similar. They live on microorganisms in the water until they are ready for larger food. In certain species, each spawning pair can produce thousands of fry, but only a few grow to adulthood. Most fall victim to predation; fry are eaten by many predators, including other fish and, in some species, their own parents.

Certain types of fish spawn in habitats other than their normal ones. Some fish that live in the ocean spawn in rivers, and some that live in rivers spawn in the sea. Fish that live in the ocean yet spawn in freshwater are called anadromous, the most prominent example being salmon. Fish that live in freshwater and spawn in the sea are called catadromous, most notably eels.

Food and Feeding

Fish have evolved to fill almost every ecological niche. Many are strictly herbivores, eating only plant life. Many are purely plankton eaters. Most are carnivorous (in the sense of eating the flesh of other fish as well as crustaceans, mollusks, and insects) or at least piscivorous (eating fish), and some—like the great white shark and the piranha—are among the most feared predators in the world by humans, although their danger to people is oversensationalized.

Almost all species that are considered gamefish are predators because their eating habits and aggressive behavior lead them to strike bait or lures that essentially mimic some form of natural food. Many predaceous fish eat other fish, but they also eat insects, worms and other invertebrates, and other vertebrates. Some fish will eat almost anything that can fit in their mouths and is alive. Some are scavengers and will consume dead fish or parts of fish. Many fish fill only specific niches and have very specific diets. As a result, it is important for anglers to know the natural food of any particular gamefish.

Growth and Size

Growth in fish is affected by many factors; especially important are heredity, length of growing season, and food supply. Although each species can be expected to reach a predetermined size, the length of time required to reach this size is extremely variable. The growing season is the time during the year when a fish will actively feed and grow. Generally, fish living in northern latitudes and colder waters have a shorter growing season than those living in southern latitudes and warmer waters. If all other growing factors remain the same, the fish with the longer growing season will reach a greater size over a given time period.

Additionally, a fish that has optimum food and space conditions will grow more rapidly than one that must compete more heavily for food and space. This in part explains why fish of the same species in the same latitude and growing seasons,

but in different bodies of water, may have different rates of growth.

Obviously fish range widely in size. On the bantam side of the spectrum are tiny Philippine gobies less than half an inch long, the smallest of all animals with backbones. At the behemoth end of the spectrum are giant plankton-eating whale sharks 65 to 70 feet long and weighing as much as 25 tons. Such highly prized game species as bluefin tuna, swordfish, and certain sharks and marlin reach weights of more than 1,000 pounds, with some shark and marlin specimens weighing considerably more. The white sturgeon, one of the largest of freshwater fish, formerly reached weights of well over 1,000 pounds in the Columbia and Fraser rivers.

Fish size is of special interest to anglers, many of whom aspire to match their skills against the larger specimens of various game species. Competitive events often place a premium on large individual catches, and other rewards, both material and intangible, accrue to those who have caught fish deemed to be of large, if not trophy, caliber.

Records for freshwater and saltwater fish caught on rod and reel are maintained by the International Game Fish Association based upon specific standards and on weight. In some cases, fish are known to grow much larger than sport-caught records indicate, but record rod-and-reel catches greatly exceed the average size of most species.

A fish does not have to be gigantic to provide fun, however. In this regard, tackle plays an important role. Anglers, using ultralight tackle in ponds and lakes, find it challenging to catch quarter-pound bluegills, rarely if ever hooking one that approaches a pound in weight, let alone the species top record of 4 pounds 12 ounces. Indeed, line-class record categories were long ago established for each species to recognize the angler's fishing skill by virtue of a notable catch for a particular weight of tackle.

Size is a relative issue both in terms of a fish's fighting ability and in its desirability as a catch. Although most larger fish are more difficult to subdue than smaller ones, that is not always the case. Size is also not necessarily comparable between different species; a 10-pound steelhead, for example, provides far better sport than a 10-pound walleye, and a 10-pound bonefish is much more challenging than a 10-pound barracuda. Growing season and geographic location may be a factor as well. A 10-pound largemouth bass in Florida, where a favorable growing season can allow a bass to grow large fast, is akin to perhaps a 6-pound largemouth bass in Minnesota in terms of age and availability within the bass population, meaning that they are catches of similar accomplishment despite being of different size.