**Figure 4.1** Skeleton of the perch in left lateral view.
forms much of the skull roof, and the lacrimal, which forms the anteroventral margin of the orbit. The maxilla is the slender, edentulous bone articulating with the lacrimal. Its widened posterior end extends laterally and is embedded in soft tissue. Note that it does not form part of the margin of the mouth. The premaxilla, which bears teeth on its anteroventral surface, is the most anterior bone of the upper jaw. It articulates with the premaxilla from the opposite side, and the nasal and maxilla posteriorly. A main feature of advanced actinopterygians is their ability to protrude the premaxilla during opening of the mouth. The maxilla acts as a lever for the jaw muscles in helping to protrude the premaxilla forward.

A series of three main bones, lying between the orbit and preoperculum, extend anteroventrally. These are, in dorsal to ventral order, the hyomandibular, metapterygoid, and quadrato. These bones contribute to the suspensorium, the apparatus that supports the jaws on the rest of the skull. The hyomandibular and metapterygoid support the quadrato, which forms the articulation with the lower jaw. The lower jaw is formed by three bones. The articular forms most of the posterior end of the lower jaw and articulates with the quadrato of the upper jaw. The dentary, which bears teeth, may be seen anterior to it. The angular is a small bone posterocentrally on the lower jaw.

**Key Terms: Skull**

- angular
- articular
- branchial arches
- dentary
- frontal
- head
- hyomandibular
- interoperculum
- lacrimal
- maxilla
- metapterygoid
- nasal
- operculum
- orbit
- premaxilla
- preoperculum
- quadrato
- tail
- trunk
- suboperculum
**Section II—External Anatomy**

The external anatomy of the perch (Figure 4.3) is similar in several aspects to that of the dogfish shark. The body, which may be subdivided into head, trunk, and tail regions, is generally streamlined, not surprising in a swimming fish, and there are several fins. The constricted region connecting the trunk and tail regions is the caudal peduncle. Several differences are immediately apparent, however. The skin, for example, has numerous scales. Also, there is only a single opening on each side of the body for the exit of water from the pharynx, and the positions of the paired fins are quite different.

Examine the head (Figure 4.3). On each side it bears a large eye, lacking lids. Posterior to it, the preopercular region, containing the bones that help support the jaws, and the opercular region, containing the opercular bones covering the gills, are easily recognizable. The large mouth is terminal in the perch but may be slightly dorsal or ventral in other teleosts. Note that the maxilla, a bone of the upper jaw, is free posteriorly, embedded in a fold of skin, and lacks teeth (see also Figure 4.1). The premaxilla is recognizable also, at the anterior end of the upper jaw, and can slide back and forth, thus allowing the perch (and most other teleosts) to protrude its jaws. Teeth are present on the premaxilla, as well as on the lower jaw or mandible. A naris can be found anterior to each eye. On each side of the head there are two nostrils, one anterior and the other posterior, opening into the nasal cavities. Water enters the nasal cavity through the anterior nostril and exits through the posterior nostril.

On the trunk and caudal peduncle, the prominent lateral line forms a distinct ridge along the scales. Other canals occur on the head but they are much less conspicuous. Using forceps, pull out one of the scales from the trunk (Figure 4.4). Most of the scale is embedded in the skin, and only a small posterior portion is exposed. This posterior end, termed the bony portion (though it is distinct from true bone), has numerous small tooth-like projections called cteni. This type of scale is termed ctenoid (comb-like), based on the structure of its posterior end (other teleosts may have circular or cycloid scales because they lack cteni; some lack scales). The embedded portion of the scale is made of fibrous connective tissue. Scales grow as the fish age. The concentric growth rings on the embedded portion of the scale can be used to age an individual.

There are four median fins, the anterior dorsal fin, posterior dorsal fin, anal fin, and caudal fin (Figure 4.3). Identify the anterior and posterior dorsal fins along the dorsal midline. The anterior dorsal fin is larger and is supported by ossified fin rays, as noted above. Most of the supporting fin rays in the posterior dorsal fin are unossified and flexible. The anal fin is on the ventral midline, just anterior to the tail, and is supported mainly by soft fin rays. The homocercal caudal fin is superficially symmetrical. Note the paired fins, the pectoral and
pelvic fins. Although some teleosts (for example, the catfish) have these fins in positions comparable to those in the shark, in the perch the pectoral fin is displaced dorsally and the pelvic is displaced anteriorly.

Lastly, examine the posterior openings of the urogenital and digestive tracts. Unlike the shark, the perch does not have a cloaca. Instead, the digestive tract has a separate opening, an anus, the large, circular opening anterior to the anal fin. The urogenital aperture is considerably smaller and less evident, and lies immediately posterior to the anus. In some females (see below), however, the urogenital opening may be as large as and even larger than the anus.

**KEY TERMS: EXTERNAL ANATOMY**

- anal fin
- anterior dorsal fin
- anus
- caudal fin
- caudal peduncle
- ctenoid
- eye
- head
- lateral line
- mandible
- maxilla
- mouth
- naris (nostril)
- pectoral fin
- pelvic fin
- posterior dorsal fin
- premaxilla
- scales
- teeth
- trunk
- urogenital aperture

**SECTION III—MOUTH, ORAL CAVITY, AND PHARYNX**

Examine the mouth, which forms the anterior opening of the digestive tract. It is terminal, a position common in fish that swim to overtake their prey. Note the posterior end of the maxilla. Embedded in soft tissue, it is free to move laterally, an important feature during expansion of the oral cavity during feeding. Note the marginal series of teeth in the upper and lower jaws. In addition to the marginal series, there are palatal teeth in the roof of the oral cavity, and pharyngeal teeth, both upper and lower, in the posterior part of the pharynx. Postpone identifying them until the pharynx is opened (see below).

Expose the oral cavity and pharynx by removing the opercular bones as follows. Lift the free, posterior end of the operculum. Insert one blade of a stout pair of scissors beneath the surface of the operculum, at approximately the midheight of the posterior margin. Keeping the blade close to the deep surface of the operculum, cut through the bones, heading toward and through the angle of the mouth. Spread the flaps to observe the gills, each composed of numerous gill filaments, which are involved with respiration (or gas exchange) with the water flowing over them. Then cut away, bit by bit, the opercular flaps covering the gill until you have exposed the region, as shown in Figure 4.5. The most anterior of the four branchial arches, and the gut it supports, should be plainly visible. Manipulate the arches and gills to identify the remaining three arches. Gill rakers should be plainly visible on the first arch. The rakers are projections that extend inward across the pharyngeal slit. They help in feeding, preventing prey (and other
kidney, lying immediately dorsal to the liver. Once you have exposed the head kidney, use a scalpel to cut a parasagittal section through the musculature dorsal to the swim bladder. This will allow you to expose the kidneys, which lie against the dorsal wall of the cavity, dorsal to the swim bladder. Be careful in using the scalpel. It is worth removing a row or two of scales along the path you intend to cut. If this method proves too awkward, find the kidneys by removing the swim bladder, but do so after you have examined the remaining structures described below.

The preparation described above is time-consuming, but it reveals the pattern, context, and arrangement of the various systems and their structures in a single view. Although you can begin with any of the structures, it is best to examine the gonads first, because in many specimens they will be so large that they will have to be removed.

The ovary of the female will vary considerably in size with the reproductive cycle of the fish, and may be massive, filled with eggs (Figure 4.6). The ovary of the perch is secondarily fused into a single structure (although this is not true of most teleosts, which retain paired ovaries) that is enveloped during embryonic development by bilateral peritoneal folds. This envelopment continues posteriorly and meets a funnel-like internal elongation of the urogenital aperture, lying just posterior to the anus. This combination (i.e., of the peritoneum and internal elongation of the aperture) forms an ovarian duct for passage of the eggs, although it is not comparable to that (usually considered a Mullerian duct) of other vertebrates. Gently tug the posterior end of the ovary will pull taut the funnel-shaped posterior end of the ovarian duct and make it easier to distinguish. In other teleosts the ovarian duct is formed differently. For example, a common pattern is that the ovary contains an internal cavity, formed by envelopment of a small part of the celomic cavity during embryonic development. The eggs are shed into this cavity, the lining of which extends posteriorly to form an ovarian duct. In most teleosts, therefore, the eggs are released directly into a tube, the ovarian duct, rather than into the pleuroperitoneal cavity, as occurs in almost all other vertebrates.

Cut transversely through the ovary, approximately 3 cm from its posterior margin, and carefully remove the anterior portion. This will leave a cone-shaped posterior end in place. Gently reflect it ventrally and delicately dissect between the ovary and swim bladder, now clearly visible, to expose the small, light-colored, elongated, and oval urinary bladder (Figure 4.7). The bladder continues posterointerally into the urinary opening of the urogenital pore, but postpone tracing it.

The paired testes of the male perch are lobulated, light-colored, and posteriorly tapered structures (Figure 4.8). Each testis has its own duct, the testicular duct, that carries only sperm. The testicular duct is a specializa-
tion of teleosts (although not all teleosts, such as salmonids, possess a duct for the testis; instead, sperm are released by the testes into the body cavity and leave the body through pores) and is not comparable to the archinephric duct observed in sharks. It is fairly small and thus difficult to find without a dissecting micro-
scope. Right and left testicular ducts unite near the posterior end of the testes into a single duct that leads out of the body through the urogenital pore just posterior to the anus. The opening of the duct can be distin-
guished from that of the archinephric duct (see below) with a magnifying glass. The urinary bladder lies dorsal to the posterior end of the testes.

Turn your attention to the anterior end of the animal (Figures 4.8 and 4.9). Identify the oral cavity—look now for the various teeth described above—and follow it posteriorly into the pharynx. The pharynx leads into the wide, short, and straight esophagus that passes posteri-
orly into the stomach. The stomach is “T”-shaped, with a broad horizontal portion and a short, vertical, pyloric portion forming the stem of the “T”. The coiled intestine follows the pyloric portion. Note the three finger-like projections, the pyloric ceca, at the anterior end of the intestine. These are typically present in teleosts, though their number varies. The anterior part of the intestine, the duodenum, is somewhat wider than the remaining distal portion. Although its terminal portion may be referred to as a rectum, it is not sharply damarcted from the rest of the intestine.

Note various structures associated with the digestive tract. The large, massive liver has already been noted. It may be necessary to remove part of it, as shown in Figures 4.8 and 4.9, in order for the stomach and other organs to be seen properly. The gall bladder is a small, elongated sac. The bile duct leads to the duodenum, but

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**Figure 4.7** Schematic illustration showing the urogenital structures of the female perch in right lateral view.

**Figure 4.8** Cutaway view of the male perch in right lateral view, to reveal structures of the pharynx and pleu-
roperitoneal cavity.
it is difficult to find. The pancreas cannot be seen grossly. Bits of pancreatic tissue are scattered throughout the mesentery, often embedded in the fatty tissue there (Figure 4.9). The spleen, not properly an organ of the digestive system but concerned with production of blood cells, is an elongated, dark-colored structure near the posterior end of the stomach.

The swim bladder is the large, hollow sac lying, as noted above, dorsally in the body cavity. It is not enclosed by the peritoneum, and so is retroperitoneal in position. It is a hydrostatic organ used to control buoyancy. Its inflation decreases the fish’s density, thus increasing buoyancy. Its deflation has the opposite effect. The bladder develops as an outgrowth of the anterior part of the digestive tract, and in many teleosts it retains an open duct connection to the esophagus, a condition termed physostomous. In the perch, however, the connection between the bladder and gut is lost, the physoclistous condition.

The kidneys lie dorsal to the swim bladder and are thus also retroperitoneal. They are long, narrow, ribbon-like structures with somewhat scalloped lateral margins lying on either side of the dorsal midline of the body cavity. Posteriorly, the kidneys curve ventrally, following the surface of the body cavity (Figure 4.7). Each kidney is drained by an archinephric duct (in the males of some species it may also receive sperm, but the more common condition is that represented by the perch, in which a separate testicular duct serves for sperm passage). The right and left ducts enter the urinary bladder. Urine exits the body through a single duct leading to the urinary opening of the urogenital aperture. Dissection of this region to reveal the ducts is difficult without a microscope and considerable patience. Figure 4.7 indicates the structures and their relationships.

Finally, examine the heart, which has already been exposed and noted. As in the shark, the heart is an S-shaped, four-chambered structure that receives venous blood posteriorly and pumps it anteriorly into the gills (Figures 4.8 and 4.9). The most posterior chamber is the sinus venosus, which directs blood into the atrium lying immediately anterior to it. From the atrium, blood enters the ventricle, which lies ventrally. The ventricle pumps blood through the fourth chamber, the bulbus arteriosus, which leads into the ventral aorta. Afferent branchial arteries branch off the ventral aorta, leading blood through the gills. Efferent branchial arteries recollect the blood into the dorsal aorta, which distributes it to the various parts of the body. Unless you have an injected specimen, the vessels will be difficult to follow.