Lab: External Anatomy & Physiology of Fishes

Part One: Background Information

The essential elements of the fish framework include a skull, a backbone made up of a series of vertebrae, and two pairs of fins - the pectoral and the pelvic. The fish framework also has one or more dorsal fins on the back, and one or more anal fins on the underside. These fins are made of bone or cartilage and are attached to the rest of the skeleton. A caudal (tail) fin is firmly attached to the end of the backbone. The bony skeleton provides a rigid framework that allows great variety in movement and provides protection for the internal organs. In fish with the typical fish form, such as perch, each type of fin plays a particular and typical role in helping the fish move. The caudal fin provides power, the pectoral and pelvic fins are used to steer and brake and the anal and dorsal fins stabilize the fish. In addition to the bony skeleton that all of the true fish have, fish share some other common features. They breathe through gills and have an outer covering of scales. Unlike your skin, which is covered by several layers of dead and hardened cells, the fish's skin is alive to the very outermost covering. Because the outer cells of the fish are constantly exposed to water, they do not need the protection from drying that our dead cell layers provide. The scales grow from pockets in the skin. They overlap like shingles on a roof. It is interesting to note that when the fish first comes out of its egg, it has no scales. A few fish, like the catfish, remain "naked" throughout life. Once the scales begin to form, they grow with the fish. As the fish grows bigger, the scales grow bigger. The number of scales, though, always stays the same. As the scales grow, concentric rings form on them. These rings grow closer together in the winter than they do in the summer. By looking at the scale rings, one can determine the age of a fish.

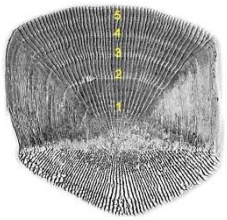
Fish skin contains cells that secrete mucus, or slime. The cells are scattered between the skin cells and release mucus as a layer over the surface of the skin. This is what makes a fish slippery. The slime serves several purposes. First, the slime acts as a lubricant that helps the body of the fish slide through the water. This can increase speed while reducing the energy required to move through the water. Second, the slime protects the fish from attack by fungus, bacteria, and parasitic protozoa. Damage to the slime layer by handling exposes living fish to parasites. The slime layer also plays an important role in protecting the fish from injury from abrasions.

Fish have a variety and brilliance of color unequaled by any other group in the animal world. Many fish also have the ability to change color. To accomplish these color changes, fish have specialized skin cells called chromatophores (*Greek, chromato (color) + phore (bearer) = color bearer*). Chromatophores are little sac-like cells, shaped like many armed stars, which are scattered through the skin in great numbers. Each contains colored pigments. Fish can make the pigment practically invisible by withdrawing the coloring into the center of the cell, or it can expose its color in varying degrees by spreading the color into the arms of a star. Many fish are countershaded. Countershading is a pattern of coloration in which the dorsal or back side of the fish is darker in color than the ventral or underside. It appears that the shading is a good example of protective coloration. The dark back is almost invisible to an enemy like a fish-hunting bird looking down from above into the dark water. To an enemy looking up from below, the light ventral or underside would be inconspicuous against the light coming from the surface.

Fish have evolved into an enormous variety of shapes and body styles. This variety has enabled fish to live successfully in almost all aquatic habitats. Dietary habits of fish also vary greatly. Some fish eat plants, others eat fish, and others eat a great variety of animal life.

Part One Analysis:

1. Based on the information above, how old was the fish from which this scale was removed? →



2. What are three roles the fish's mucus layer plays?

4. How would the ability to change colors be of survival value to a fish?

5. Some might think that countershading is due to the effect of light on the fish's skin. In other words, the top of the fish "gets tan" while the bottom doesn't. Briefly describe an experiment that would support or refute this hypothesis.

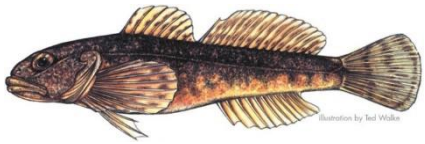
Part Two: Analysis of Body Shape

Much can be learned about a fish's way of life by simply looking at the fish. The shape of the body is an adaptation that helps the fish survive, and so the body shape often tells us where and how a fish lives. The shape and location of the mouth are adaptations for survival and can give us an insight into the way a fish lives. The color of a fish helps the fish survive. The color we observe can tell us something about the fish's way of life. Let's look at how different body shapes help fish live in different environments.

6. Compare the perch (left), a common inshore fish, with the tuna (right), a fish that cruises in the open ocean. How are the fins and body of the tuna different from the fins and body of the perch?

7. Now compare the perch with the butterfly fish below. Butterfly fish tend to live around coral reefs or in rocky habitats and their body shape allows for maneuverability. How do its fins, body and mouth compare with those of the perch?

8. Finally, compare this sculpin below with the perch. The sculpin is a fish that sits or hovers with very little movement and then ambushes their prey, lunging with startling swiftness. How do its fins, body and mouth compare with those of the perch?



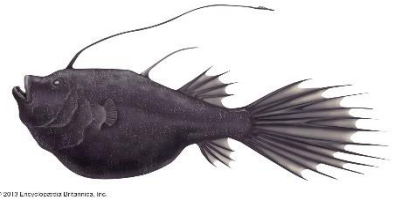
9. Based on what you have seen so far, where do you think the Jack Crevalle shown below lives? Is it a cruising, maneuvering or lunging fish? What evidence supports your answer?

10. Where do you think the sole below lives? Is it a cruising, lunging or maneuvering fish? What evidence supports your answer?

11. What about the oyster toadfish below? Is it a cruising, lunging or maneuvering fish? What evidence supports your answer?

12. Lastly, look at the sergeant major below. Is it a cruising, lunging or maneuvering fish? What evidence supports your answer?

Some fish have bodies and coloration that are so unusual, it is hard to believe they are real. Let's compare two very different fish. Consider the pipefish (left), which is related to seahorses. The pipefish is a pale olive green with narrow horizontal gray lines. The anglerfish (right) is dark red or black, and the projection from the fish's head produces light.



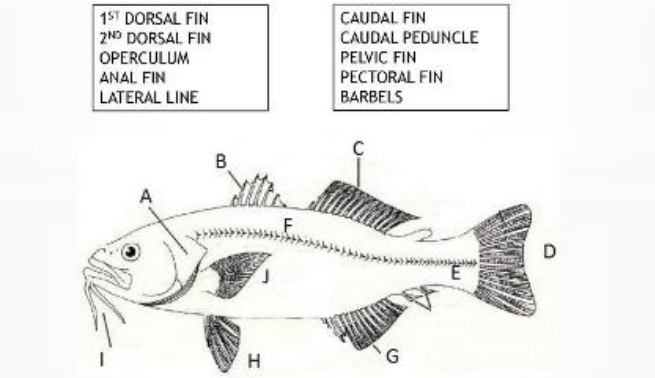
13. What do the color and shape tell us about the habitat in which we would most likely find the pipefish? The anglerfish?

14. What does the size of the mouth tell us about what the pipefish eats? The anglerfish?

15. Why do you think the anglerfish produces light? How do you think this production of light is achieved?

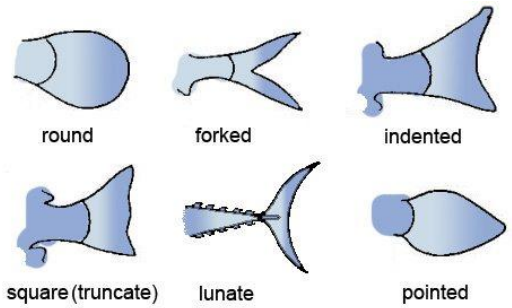
Part Three: Analysis of Fins and Other External Anatomy

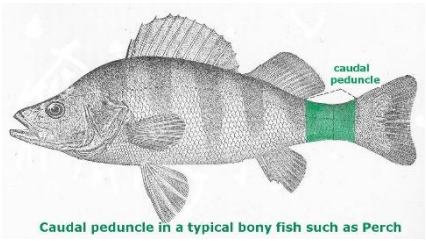
The fins of a fish are obviously important to help it move through the water. Two types of fins are found in most of the fish: median and paired fins. Median fins are single in number which runs down the mid-line of the body. In fishes, median fins are dorsal, caudal and anal fins while paired fins are pectoral and pelvic which are arranged in pairs homologous to human arms and legs. Fins help to swim and maintain the balance of the body. The lateral line is a visible line along the side of a fish consisting of a series of sense organs which detect pressure and vibration. The operculum is the gill cover and barbels are whisker-like appendages near the mouth that some fish have as sensory organs in the search for food. Using this information, match the term to the appropriate letter in the image below.



16. *A.*
B.
C.
D.
E.
F.
G.
H.
I.
J.

Fish have specialized caudal fins that also give us clues to how that fish lives. The caudal peduncle is the region that attacheds the caudal fin to the body. Fast-swimming fishes typically have a narrow, strong caudal peduncle with narrow and strong caudal fin lobes. Slow-swimming fishes typically have a wider, weaker caudal peduncle with a more rounded caudal fin.





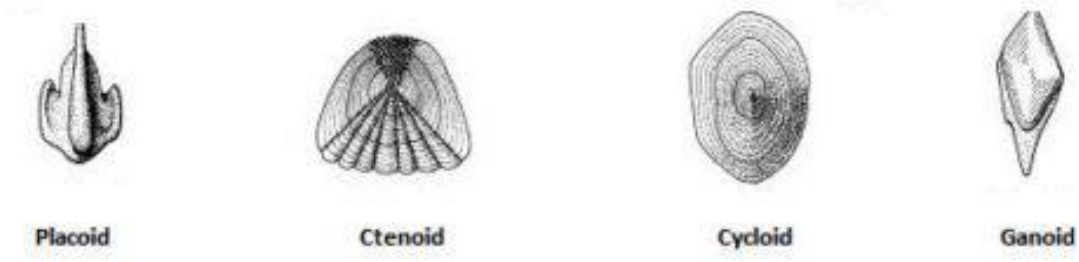
17. Based on the information above, list the caudal fin types in order from fastest swimmer to slowest swimmer.

18. How would a fish with a lunate tail create propulsion through the water?

19. How would a fish with a round tail create propulsion through the water?

Part Four: Analysis of Scales

As you learned in the first section, fish scales can be used to determine the age of a fish. Scales, however, can tell us much more about a fish than just their age. Fish scales are formed of bone from the deeper, or dermal, skin layer and are found in four major forms; placoid, ctenoid, cycloid and ganoid.



Placoid scales are bony, spiny projections with an enamel-like covering found in elasmobranchs (the group including sharks, rays, skates and sawfish). Unlike the scales of bony fishes, placoid scales do not increase in size as the fish grows, instead new scales are added between older scales. Placoid scales are often referred to as dermal denticles. It is thought that true teeth developed from placoid scales.

Ctenoid scales overlap each other with spines or comb-like teeth along their free edges. These scales are characteristic of the higher bony fishes.

Cycloid scales are large, thin and round or oval in shape. They are similar to ctenoid in that they overlap, except that they do not have the comb-like teeth.

Ganoid scales, which are found in more evolutionarily older fish species such as gar, are similar to placoid scales but are covered with a peculiar enamel-like substance called ganoin. Ganoid scales are usually rhomboid in shape and have articulating peg and socket joints between them.

20. Identify the correct scale type with each fish listed below.

A. Sockeye Salmon
B. Longnose Gar
C. Atlantic Stingray
D. Great White Shark
E. Bluefin Tuna
F. Yellow Perch