Swim Bladder and Scales in fishes

Zoology (Hons.) 2nd SEM DC3 Unit 5

Swim Bladder:

The **swim bladder**, **gas bladder**, **fish maw**, or **air bladder** is an internal gas-filled organ that contributes to the ability of many bony fish to control their buoyancy, and thus to stay at their current water depth without having to waste energy in swimming. The swim bladder functions as a resonating chamber, to produce or receive sound.

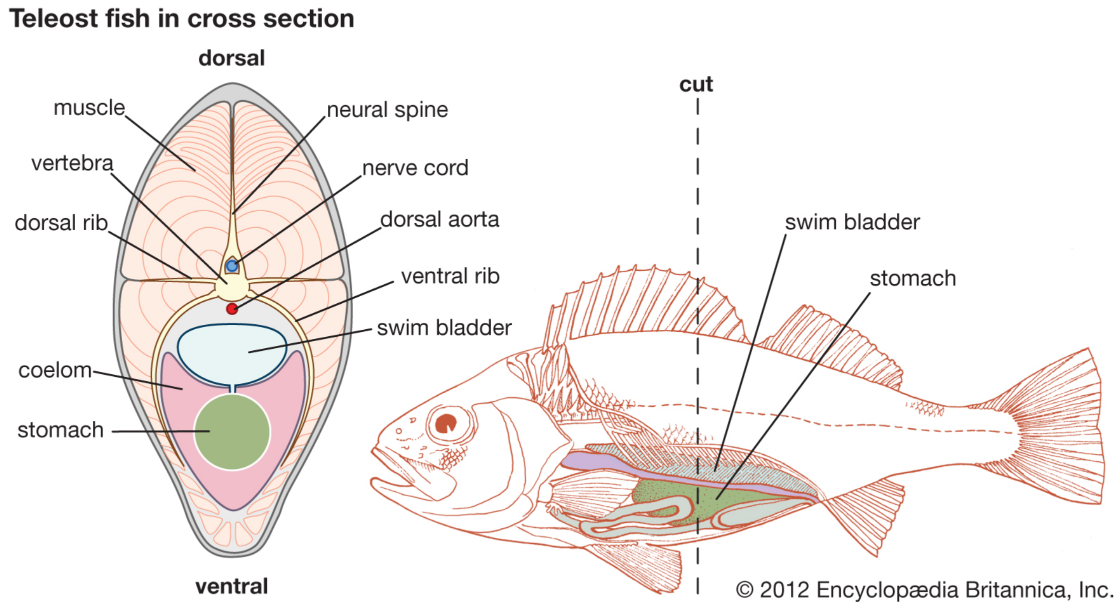
The swim bladder is evolutionarily homologous to the lungs. Darwin reasoned that the lung in air-breathing vertebrates had derived from a more primitive swim bladder.

The gas/tissue interface at the swim bladder produces a strong reflection of sound, which is used in sonar equipment to find fish.

Depending on the presence of the duct (ductus pneumaticus) between the swim bladder and the oesophagus the swim bladder can be divided into 2 broad categories: 1) Physostomous and 2) Physoclistous type.

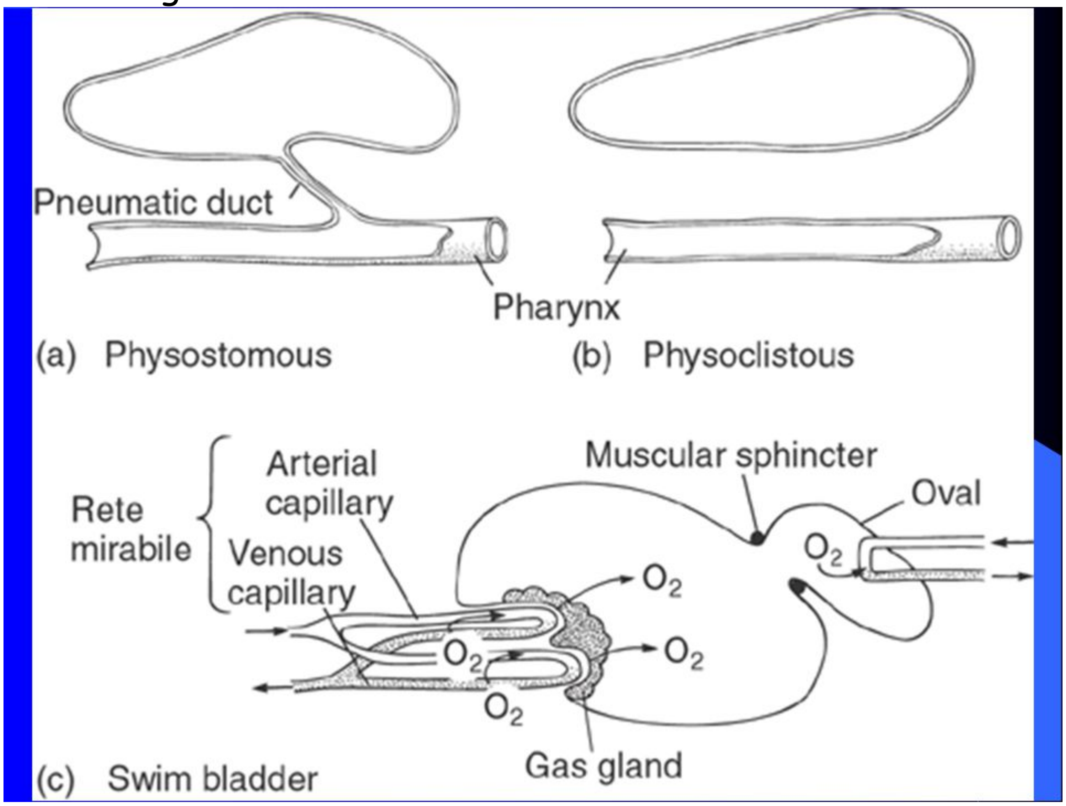
Structure and function

The swim bladder normally consists of two gas-filled sacs located in the dorsal portion of the fish, although in a few primitive species, there is only a single sac. It has flexible walls that contract or expand according to the ambient pressure. The walls of the bladder contain very few blood vessels and are lined with guanine crystals, which make them impermeable to gases. By adjusting the gas pressurising organ using the gas gland or oval window the fish can obtain neutral buoyancy and ascend and descend to a large range of depths. Due to the dorsal position it gives the fish lateral stability.



In physostomous swim bladders, a connection is retained between the swim bladder and the gut, the pneumatic duct, allowing the fish to fill up the swim bladder by "gulping" air.

In more derived varieties of fish the connection to the digestive tract is lost. In early life stages, these fish must rise to the surface to fill up their swim bladders; in later stages, the pneumatic duct disappears, and the gas gland has to introduce gas (usually oxygen) to the bladder to increase its volume and thus increase buoyancy. In order to introduce gas into the bladder, the gas gland excretes lactic acid and produces carbon dioxide. The resulting acidity causes the hemoglobin of the blood to lose its oxygen (Root effect) which then diffuses partly into the swim bladder. The blood flowing back to the body first enters a rete mirabile where virtually all the excess carbon dioxide and oxygen produced in the gas gland diffuses back to the arteries supplying the gas gland. Thus a very high gas pressure of oxygen can be obtained, which can even account for the presence of gas in the swim bladders of deep sea fish like the eel, requiring a pressure of hundreds of bars. Elsewhere, at a similar structure known as the *oval window*, the bladder is in contact with blood and the oxygen can diffuse back out again. Together with oxygen, other gases are salted out in the swim bladder which accounts for the high pressures of other gases as well.



Physoclistous swim bladders have one important disadvantage: they prohibit fast rising, as the bladder would burst. Physostomes can "burp" out gas, though this complicates the process of re-submergence.

The swim bladder in some species, mainly fresh water fishes (common carp, catfish, bowfin) is interconnected with the inner ear of the fish. They are connected by four bones called the Weberian ossicles from the Weberian apparatus. These bones can carry the vibrations to the saccule and the lagena (anatomy). They are suited for detecting sound and vibrations due to its low density in comparison to the density of the fish's body tissues. This increases the ability of sound detection. The swim bladder can radiate the pressure of sound which help increase its sensitivity and expand its hearing.

Teleosts are thought to lack a sense of absolute hydrostatic pressure, which could be used to determine absolute depth. However, it has been suggested that teleosts may be able to determine their depth by sensing the rate of change of swim-bladder volume.

Scales:

A **fish scale** is a small rigid plate that grows out of the skin of a fish. The skin of most fishes is covered with these protective scales, which can also provide effective camouflage through the use of reflection and colouration, as well as possible hydrodynamic advantages. The term *scale* derives from the Old French "escale", meaning a shell pod or husk.

Most bony fishes are covered with the cycloid scales of salmon and carp, or the ctenoid scales of perch, or the ganoid scales of sturgeons and gars. Cartilaginous fishes (sharks and rays) are covered with placoid scales. Some species are covered instead by scutes, and others have no outer covering on part or all of the skin.

Fish scales are part of the fish's integumentary system, and are produced from the mesoderm layer of the dermis, which distinguishes them from reptile scales. The same genes involved in tooth and hair development in mammals are also involved in scale development. The placoid scales of cartilaginous fishes are also called dermal denticles and are structurally homologous with vertebrate teeth. It has been suggested that the scales of bony fishes are similar in structure to teeth, but they probably originate from different tissue. Most fish are also covered in a layer of mucus or slime which can protect against pathogens such as bacteria, fungi, and viruses, and reduce surface resistance when the fish swims.

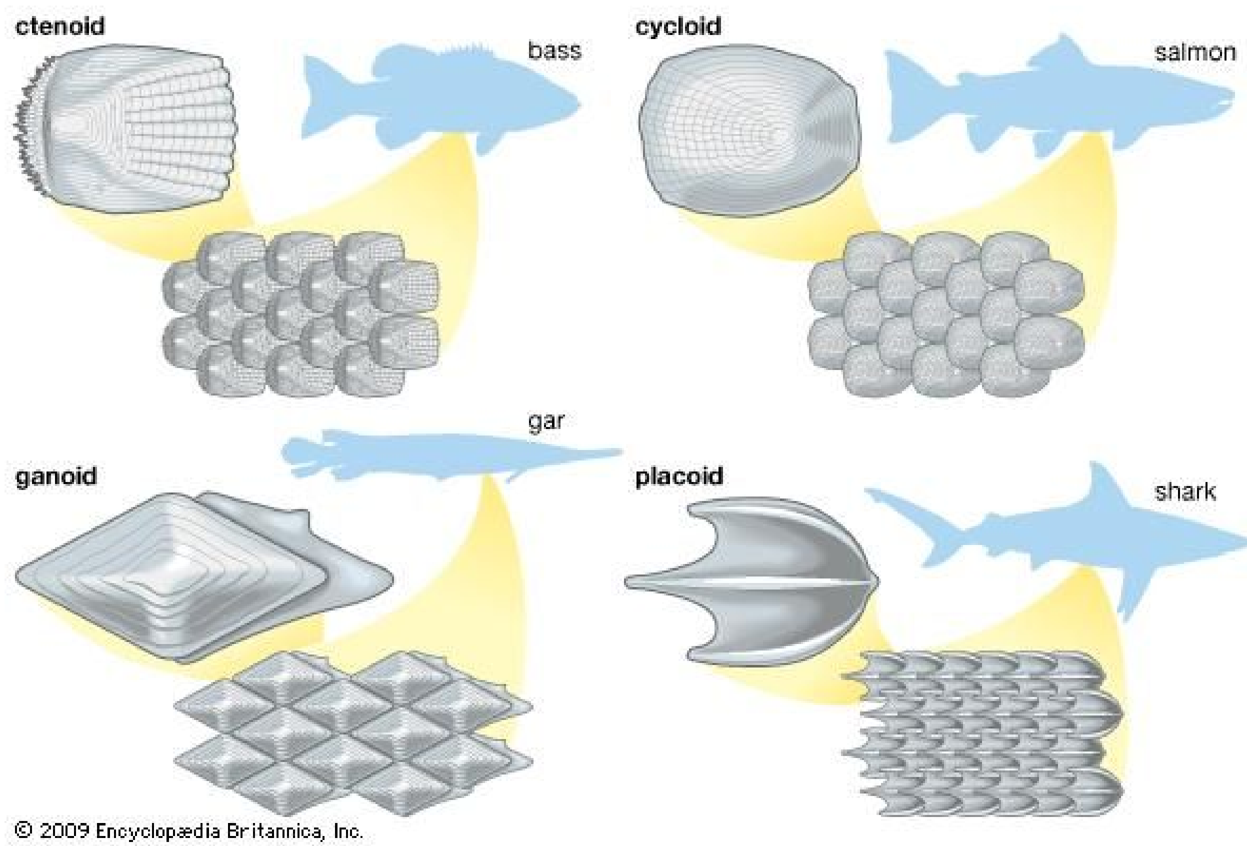


Fig. Different types of Scales in fishes

Ganoid scales

Ganoid scales are found in the sturgeons, paddlefishes, gars, bowfin, and bichirs. They are derived from cosmoid scales and often have serrated edges. They are covered with a layer of hard enamel-like dentine in the place of cosmine, and a layer of inorganic bone salt called *ganoine* in place of vitrodentine.

Ganoine is a characteristic component of ganoid scales. It is a glassy, often multi-layered mineralized tissue that covers the scales, as well as the cranial bones and fin rays in some non-teleost ray-finned fishes

Leptoid scales

Leptoid (bony-ridge) scales are found on higher-order bony fish, the teleosts (the more derived clade of ray-finned fishes). The outer part of these scales fan out with bony ridges while the inner part is criss-crossed with fibrous connective tissue. Leptoid scales are thinner and more translucent than other types of scales, and lack the hardened enamel-like or dentine layers.

Leptoid scales come in two forms: cycloid and ctenoid.

Cycloid scales

Cycloid (circular) scales have a smooth texture and are uniform, with a smooth outer edge or margin. They are most common on fish with soft fin rays, such as salmon and carp.

Ctenoid scales

Ctenoid (toothed) scales are like cycloid scales, except they have small teeth or spinules called **ctenii** along their outer or posterior edges. Because of these teeth, the scales have a rough texture. They are usually found on fishes with spiny fin rays, such as the perch-like fishes. These scales contain almost no bone, being composed of a surface layer containing hydroxyapatite and calcium carbonate and a deeper layer composed mostly of collagen.

Placoid scales

Placoid (pointed, tooth-shaped) scales are found in the cartilaginous fishes: sharks, rays. They are also called *dermal denticles*. Placoid scales are structurally homologous with vertebrate teeth ("denticle" translates to "small tooth"), having a central pulp cavity supplied with blood vessels, surrounded by a conical layer of dentine, all of which sits on top of a rectangular basal plate that rests on the dermis. The outermost layer is composed of vitrodentine, a largely inorganic enamel-like substance.