Pisces

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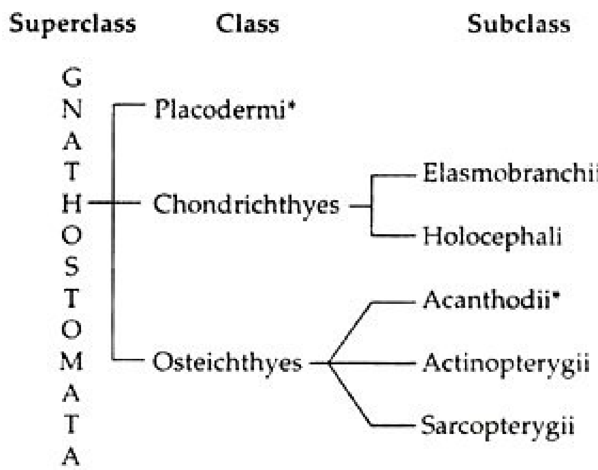
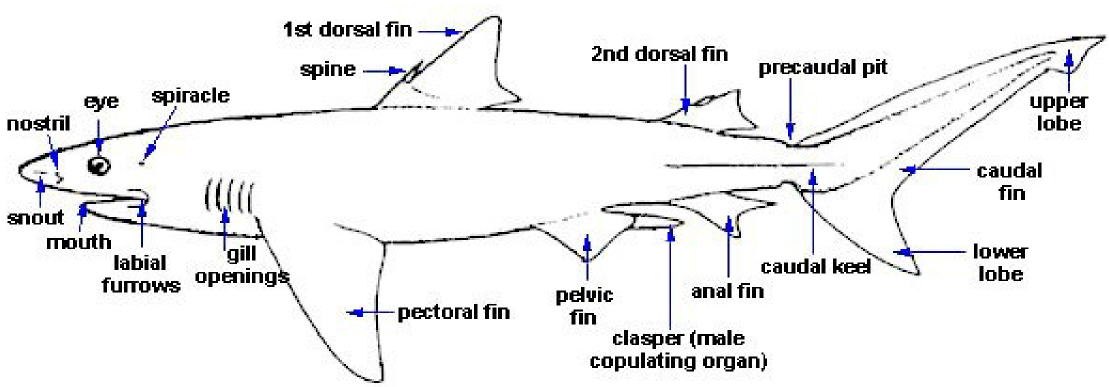
Fishes :

Living fishes with jaws mostly fall into two well marked classes, the cartilaginous fishes (Chondrichthyes) and the bony fishes (Osteichthyes) including the familiar ray- finned fishes and the lung fishes. These two groups arose in the late Devonian period of geological time scale. Before that time various other types of fish dominated the waters. Classification scheme of fishes by J. Z. Young (1981) is shown:

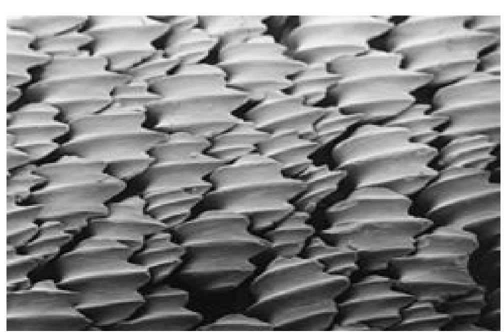


Class — Chondrichthyes:
General characters:

1. Most of the members are marine and are carnivorous.



2. Epidermis is covered by closely set placoid scales.

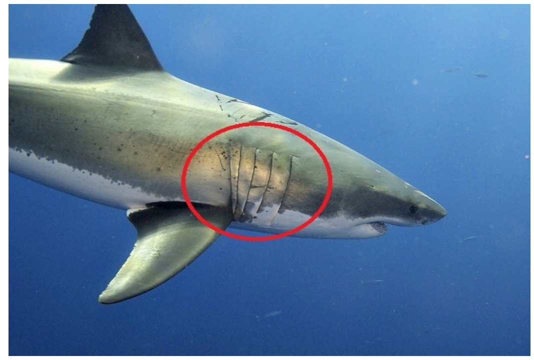


3. Endoskeleton is cartilaginous.

4. Median and paired fins are present. Fins are supported by cartilaginous fin rays.

5. Generally operculum is absent in these fishes, instead, gill slits are present.

Gill with operculum

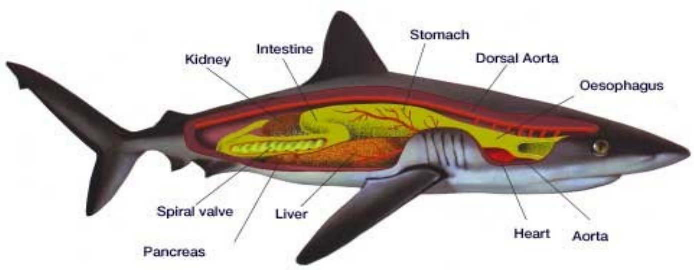


Gill slits

6. Mouth is sub-terminal in position.

7. Jaws are armoured with rows of sharp teeth. These teeth are modified placoid scales.

8. A spiral valve is present in the intestine.



Spiral valve

9. Swim bladder is absent.

Swim bladder

10. Caudal fin is of heterocercal type, i.e. two lobes of the fin are unequal.

11. Unisexual fish, males having clasper for reproduction. Clasper is the modified organ from pelvic fins.

Clasper

12. Internal fertilisation is the characteristic of these fishes.

Subclass — Elasmobranchii:

General characters:

1. At the anterior end of the body 5 to 7 gill slits are present in each side.

2. Mouth is sub-terminal in position.

3. These fishes can swim with high speed.

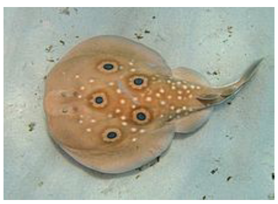
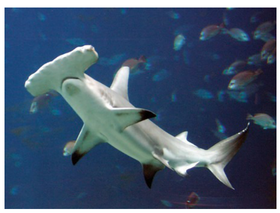
4. Firm and hard jaws are provided with numerous sharp teeth.

5. Brain is developed. Powerful olfactory system helps in detection of food.

6. There are some ribs in the thoracic cavity.

Examples: ***Scoliodon sp***

Torpedo sp, *Sphyrna sp* (Hammer headed Shark). Sting ray *Pristis sp* (Saw fish),

Subclass — Holocephali:

General characters:

1. Small mouth aperture is guarded by jaws and lips.

2. Plate like teeth firmly attached with the jaws. Holostylic upper jaw, i.e. rigidly attached to the skull.

3. Gill slit partially covered by operculum.

4. Cloaca absent, i.e., anus and urinogenital aperture separate.

5. Skin is naked in adults.

6. In addition to pelvic clasper males possess another clasper on the head.

7. Spiracle absent.

Examples:

Chimaera (Rat fish) , Harriotta.


General features of class Osteichthyes :

1. The mouth is apical in position.

2. The body is covered with cycloid or ctenoid or ganoid scales. The skin is soft. Complete absence of scales in cat fish group.

3. Claspers are absent.

4. The tail is homocercal, heterocercal or diphycercal.

5. The head may be dorsoventrally or laterally flattened.

6. Gill slits, usually four pairs, open in a gill chamber, remain covered by operculum.

8. The endoskeleton is bony with amphicoelous vertebrae.

9. A spiral valve in the intestine is absent.

10. Generally omnivorous, with a short or long intestine.

11. Cloaca absent.

12. An air bladder is usually present.

Sub class : Actinopterygii: (Ray fins**)**

1. Body of Actinopterygii is covered by ganoid, cycloid or ctenoid scales. In some cases scales are absent.

2. Fins supported by bony or cartilagenous fin rays.

3. Generally spiracle is absent in Actinopterygii.

4. External nare is on the top of the head.

5. Caudal fins are either homocercal or heterocercal.

6. Endoskeleton is either bony or cartilaginous in Actinopterygi.

Examples:

acipenser

Acipenser : with Ganoid scale, heterocercal tail, cartilagenous endoskeliton.

Labeo, Hilsa, Lates, : With cycloid scale, homocercal tail

Anabas : With Ctenoid scale

Cat fish: Clarius (Magur), heteropneutes (Singi) are naked fish without any type of scale.

Subclass — Sarcopterygii: (Fleshy fins)

1. Paired fins are scaly with a lobed appearance.

3. The body is covered by thick, pitted rhomboidal scales. These scales have a characteristic cosmoid layer.

4. These fishes possess internal nares, which opens into the buccal cavity through a pore called choanae.

5. Swim bladder transforms into lungs.

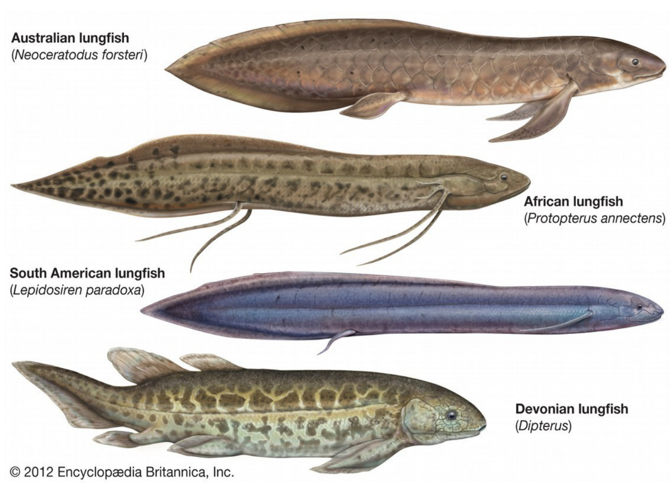
6. Primitive species had heterocercal tail, but recent forms possess diphycercal tail.

7. Dorsal fin reduced in size.

8. Vertebral column extends up to the end of the tail, and divides the tail into upper and lowers equal halves.

Examples:

Latimeria, Neoceratodus, Lepidosiren, Protopterus.



Accessory Respiratory Organs in fishes:

Adult fishes depend chiefly on pharyngeal gills for aquatic respiration. However, other devices also occur to supplement or replace gill respiration. All such additional respiratory organs, other than gills, are known as **accessory respiratory organs.**

These are found mostly in fishes of tropical fresh waters and hill streams and develop as adaptation to the particular environmental condition. Accessory respiratory organs enable the fishes to live in oxygen-deficient water, to aestivate over prolonged droughts in dry summer, to take short excursions on land or simply to meet extra demand for oxygen.

1. Pharyngeal diverticula : These are a pair of simple sac-like outgrowths of pharynx, lined by thickened vascular epithelium and extending above the gills. These are very small in Periophthalmus, small and smooth in Amphipnous and somewhat folded in Channa. The fishes have poorly developed gill-filaments and the accessory respiratory sacs or chambers serve to breathe atmospheric air during aestivation or while coming out of water for sometime.

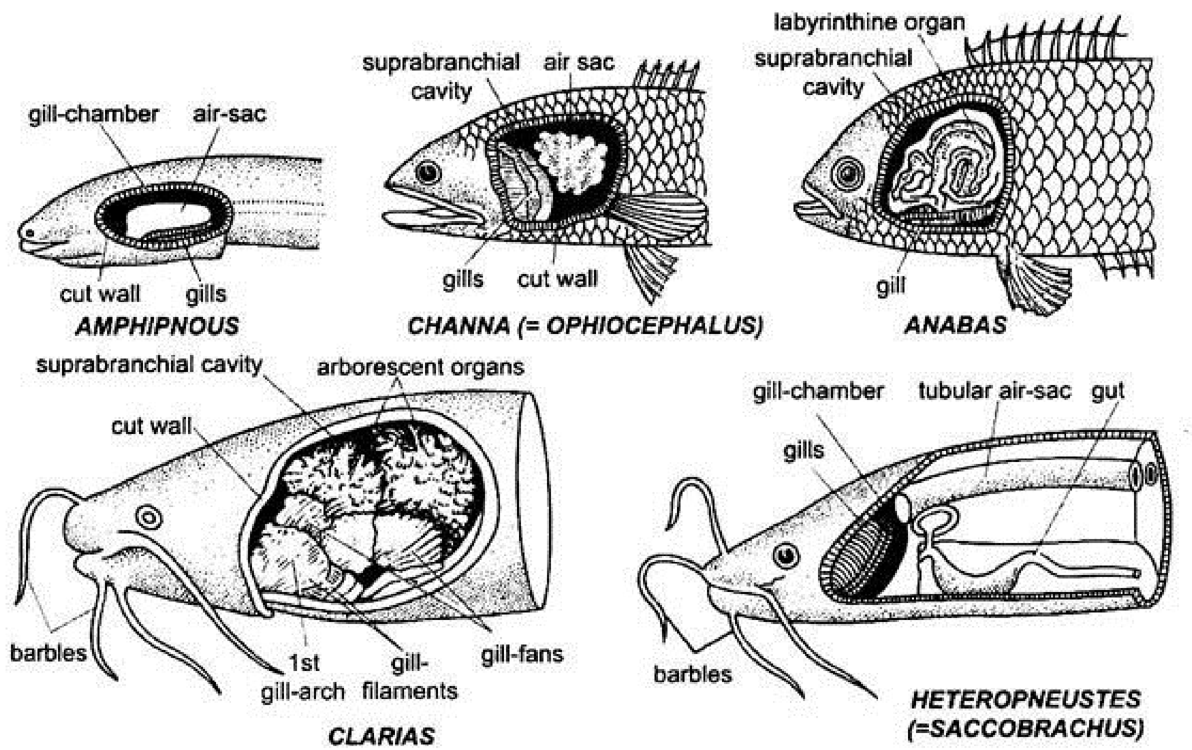


Fig. 17.8. Accessory respiratory organs dissected on the left side in some air-breathing teleost fishes.

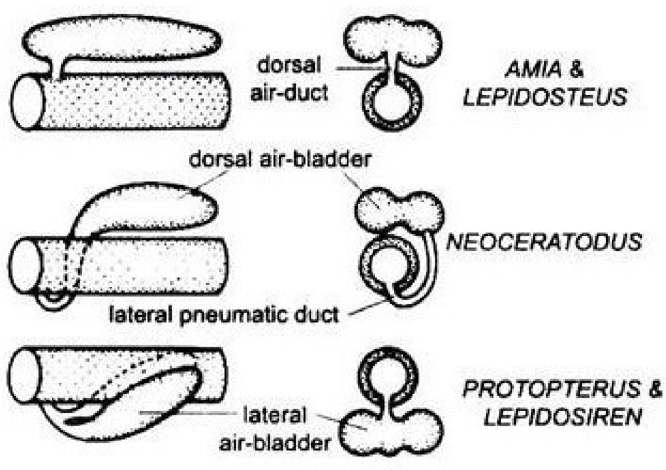
2. Branchial diverticula : The outgrowths from gill chambers form more complicated aerial accessory respiratory organs than the simpler pharyngeal outgrowths in other fishes. Three well known examples are :

(a) Heieropneustes(Singi) : This Indian catfish has a pair of long, tubular and dorsally situated air sacs, arising posteriorly from gill chambers and extending almost upto the tail. They are highly vascular. The air is drawn in and expelled out through pharynx.

(b) Anabas (Koi) : This Indian climbing perch has two, spacious, suprabranchial cavities as dorsal outgrowths of the two gill chambers. Each cavity contains a special labyrinthinie organ formed by much folded, concentric bony plates developed from the first epibranchial bone and covered with thin vascular mucous membrane. Margins of these plates are wavy and the plates are covered with vascular gill-like epithelium. Each branchial outgrowth communicates freely not only with the opercular cavity but also with buccopharyngeal cavity. Air is drawn through mouth into suprabranchial cavities and expelled through opercular opening.

(c) Clarius (Magur) : The Indian catfish, Clarias batrachus has the most complicated accessory respiratory organs. These are in the form of two much branched tree-like dendritic or arborescent organs developed inside suprabranchial cavities one on either side above gill chambers. The cavities and the organs are covered by vascular, mucous epithelium and function as lungs. The fish periodically reaches water surface to renew air.

3. Air bladders : Swim bladder of higher bony fishes (teleosts) is essentially a hydrostatic organ. But, in lower bony fishes (dipnoans and ganoids), the air bladder acts like a lung to breathe air and is truly an accessory respiratory organ. The wall of bladder is vascular and sacculated with alveoli. In Amia and Lepidosteus bladder is single, dorsal, and opens dorsally into pharynx. In Neoceratodus also it is single and dorsal but opens ventrally into pharynx. However, in Lepidosiren and Protopterus, it is bilobed, ventral and opens ventrally into pharynx.



4. Bucco-pharyngeal epithelium : In most of the fishes, the epithelial lining of buccal cavity and pharynx is usually highly vascular and permeable to gases in water. But, the South American fish, Symbranchus and the mud skippers (Periophthalmus), can fill their oral and pharyngeal cavities with air and thus take oxygen directlyfrom atmosphere.

5. Gut epithelium : In several fishes epithelial lining of certain parts of alimentary canal becomes vascular and modified to serve as a respiratory organ. It may be just behind stomach (Misgurus fossilis), or intestine (Lepidocephalus guntea, Gobitus) or rectum (Callichthyes). Fresh air is drawn through mouth or anus and after gaseous exchange voided through anus. In these fishes the wall of gut is modified to perform the respiratory function. The walls of the gut in these areas become thin, due to reduction of muscular layer.

6. Skin or integument : Some fishes can respire cutaneously both in air and in water through thin, moist and permeable skin. Ex : Common eels (Anguilla anguilla), Mudskippers (Periophthalmus) respire through their skin. Fish larvae and embryos can also subserve cutaneous respiration before the emergence of gills. Median fin folds of many fishes are supplied with numerous blood vessels that help in cutaneous respiration.

7. Pelvic fins : In American lung fish, Lepidosiren. during breeding time, the pelvic fins of male become enlarged and grow filamentous vascular outgrowths which provide fresh oxygen to the guarded eggs.

Parental Care in Fishes :

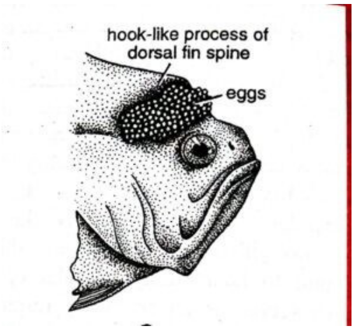
Fish as a group pay little parental care to their eggs and young, rather they ensure fertilization of their eggs. This lack of parental behaviour is correlated with production of great numbers of eggs and sperm. There are, however, some notable exceptions in which the eggs and young are guarded with great solicitude mostly by the male parent.

1. Nest building : Most interesting example is provided by the male stickleback (Gastrosteus aculeatus), a small freshwater fish of North American lakes and ponds. The male fish actually builds a nest of dead aquatic plants making use of a sticky secretion from his kidneys. When the nest assumes a considerable size, the male makes asmall tunnel. By an elaborate courtship ritual, he induces several females to lay eggs in a tunnel in the nest. Then he guards over the fertilized eggs, keeping away all intruders in a fierce manner, till they are hatched. The bowfin (Amia calva) of the great lakes of North America, builds a crude circular nest among aquatic plants. The male keeps guard until the eggs hatch and then keeps the young fish with him for some time afterwards. The male of African lung fish (Protopterus), digs oval pits or holes at the base of tall swamp grasses. As many as 5000 eggs may be laid in a single hole or nest by several females. The male vigorously guards them and even thrashes surface to aerate water around the eggs.

2. Shelter in mouth : There are several species of mouth-brooding fishes. The fertilized eggs are carried in the mouth cavity by males in the catfish Arius and by females in the Cichlid, Tilapia. The very small young also take refuge in the parental buccal cavity in times of danger.

2. Coiling round eggs: In Pholis, one of the parents possibly the male guards by coiling round the eggs, rolled into a ball or sphere until they hatch.

3. Attachment to body : The male of the New- Guinea fish, **Kurtus** entangles the egg mass on a hook like process on head until they are hatched.



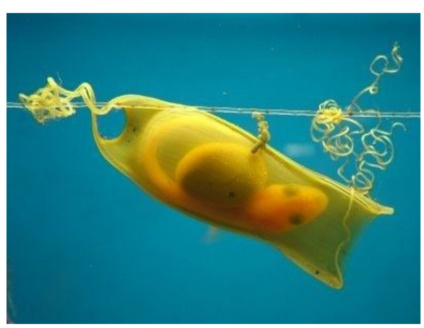
4. Integumentary cups : In the siluroids, Aspredo and Platystacus, the fertilized eggs are pressed into the soft spongy skin of belly of the female. Each egg becomes attached by a stalk into a cup like depression of integument and carried until hatching.

Integumentary cup

Brood pouch

6. Brood pouches : In the sea horse, Hippocampus and pipe fish Syngnathus, the female transfers eggs into a brood pouch on the belly of male to be kept until hatching takes place.

7. Mermaid's purses : Ovipaious sharks (e.g. Scyllium) lay fertilized eggs inside protective horny egg capsules or mermaid's purses, which remain anchored to see weeds by their long tendrils. The young hatch out after rupturing the egg case.



8. Viviparity : A few species of fishes are viviparous such as dog fish, Scoliodon and the surf fish (Cyamatogaster aggregatus).Both fertilization and development are internal. Developing embryos are nourished mostly by a yolk sac placenta and the young are born with the characteristics of the adult. Viviparity provides maximum protection and represents the highest degree of parental care.

Air Bladder or Swim Bladder :

A characteristic organ of bony fishes. is a gas-filled pneumatic sac, called air bladder or swim bladder, lying dorsal to the digestive tract, directly beneath the vertebral column and mesonephric kidneys but outside coelom. The air bladder arises as an outgrowth from the oesophageal region of the alimentary canal.

Swim bladder does not occur in elasmobranchs. However, it is found in all bony fishes except a few bottom dwellers (Lophius, Pleuronectes, etc.). It is vestigial in Latimeria (the only living crossopteygian).

Variation or Types :

1. Swim bladder of ganoids and dipnoi : In most primitive fishes, the air bladder serves as an accessory respiratory organ or lung, which seems to have been its original function.

In Polypterus (Chondrostei), one of the most primitive bony fishes living today, it is a smooth-walled bilobed sac, with a short left and long right lobe, opening ventrally into oesophagus by a single duct. In the lung fishes Protopterus and Lepidosiren, the condition is similar but the two lobes are equal in size and have thick, vascular walls with alveoli and septa.

In the Australian lung fish Neoceratodus, air bladder consists of a single lobe lying dorsal to gut, but still connected ventrally to oesophagus by a narrow pneumatic duct, passing down along the right side of gut.

In the holosteans Amia and Lepidosteus, air bladder is a single large and highly . vascular lobe, lying dorsal to oesophagus and its pneumatic duct also opening dorsally into oesophagus. Thus, in Amia and Lepidosteus, the air bladder serves as both a respiratory organ (lung) and a hydrostatic organ.

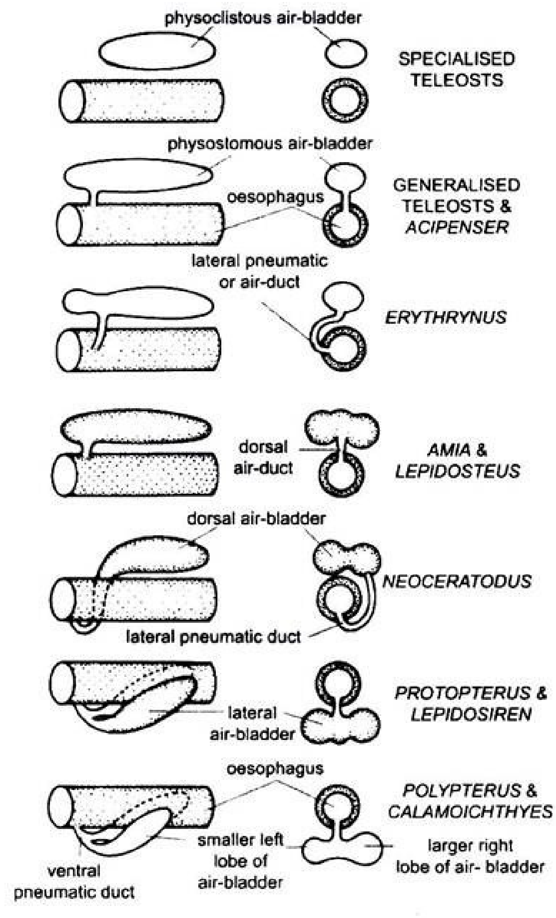


Fig. 17.6. Various types of air-bladders and lungs in fishes shown in L.S. (left side) and T.S. (right side).

2. Swim blader of teleosts : Air bladder in higher bony fishes or teleosts is the most specialized, playing little or no part in respiration, and primarily serving as a hydrostatic organ. Two types of air bladders are known.

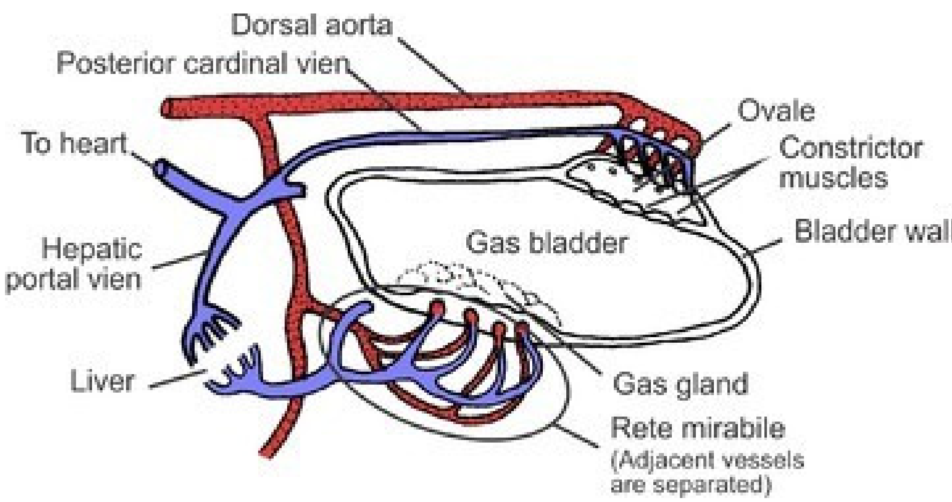
In the more generalized groups of teleosts, (salmon, eel) the air bladder retains connection with the gut via a pneumatic duct, just as in a ganoids and dipnoi. In the teleost Erythrinus the air bladder has a lateral attachment to gut. Such an open air bladder is called physostomous.

In the more specialized teleosts (perch, cod), the duct becomes atrophied or lost. Such a closed or ductless air bladder is called physoclistous.

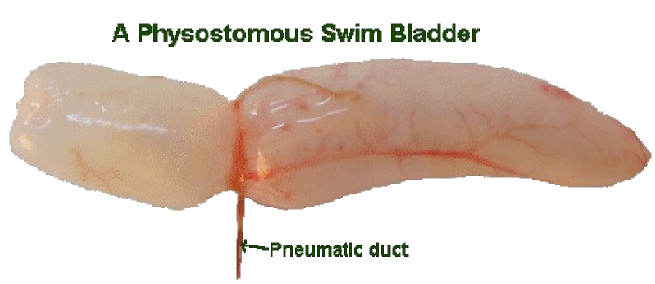
Structure of teleostean air bladder :

A typical teleostean air bladder is a thin-walled gas-filled sac lying dorsal to alimentary canal extending the entire length of body cavity, The gases are similar to those dissolved in water (0_2 ,$C0_2$, N_2).

In higher physoclistic teleosts, the air bladder tends to be divided into two chambers, demarcated by a constriction with a sphincter. Essentially air bladder is tough sac-like structure with an overlying capillary network. Just beneath the capillary protocercal there is a layer of connective tissue called tunica externa. Below this layer lies the tunica interna, made up of chiefly smooth muscle fibers. The wall of anterior chamber has a remarkable red body or red gland so called because of its colour. It contains a compact mass of interlacing fine capillaries called rete mirabile . The red gland receives blood from coeliaco-mesenteric artery and empties into the hepatic portal vein. Gases in the bladder come from blood secreted by the red gland. The posterior chamber is thin-walled and forms the oval gland which permits reabsorption of gases by the blood. Secretion and resorption are under the control of autonomic nervous system.



In physostome fishes with air bladder connected to pharynx by a duct, air can also be gulped or bubbled through the mouth.



Functions of air bladder : Air bladders or swim bladders in fishes are associated with several functions-

(a) Respiration : In lower or intermediate fishes, such as ganoids and lung fishes, the air bladder serves as a lung. These fishes come to water surface regularly to gulp air. In physostomous (with duct) teleosts, which also gulp air, the bladder serves as an accessory respiratory organ. Even in physoclistous (ductless) teleosts, the bladder is said to store oxygen to be utilized during deficiency.

(b) Hydrostasis : Air bladder in teleosts functions chiefly as a hydrostatic organ and helps to keep the weight of piscine body equal to the volume of water displaced by fish. Secretion of more gases means lower specific gravity so that fish rises in water. Resorption of gases means increased specific gravity and the fish sinks.

(c) Sound production : Some fishes are able to produce sounds with the gases inside air bladder by the use of special muscles attached to the air bladder. But the actual mechanism is not understood. Some fishes (Doras, Platy stoma, and Malapterurus) can produce grunting, hissing or drumming sound. The sound production is meant to startle the enemies or to attract mates.

(d) Audition : In Cypriniformes, a series of small bones, the weberian ossicles, connects the air bladder and perilymph cavity containing internal ear. Low-frequency vibrations of the contained gas, induced by noises in water, are transmitted by the ossicles to the membranous labyrinth. Thus, these fish can hear.

Related questions:

1. Write the important features of class Osteichthyes.
2. Describe the different types of accessory respiratory organs found in fishes.
3. What are the types of swim bladder. State their function.
4. Describe briefly the parental care strategies of fishes.

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