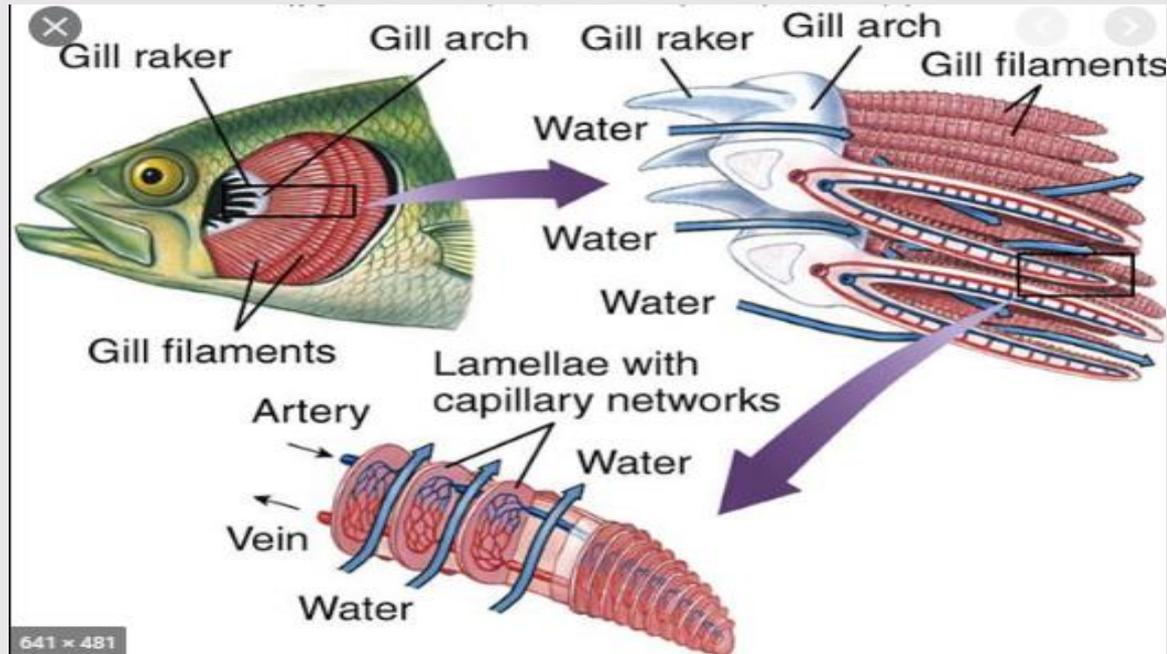




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# Respiratory system in fishes



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# GILL

## Gaseous Respiration in Fish

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Just like you and me fish need a constant supply oxygen in the form of  $O_2$  in order to run their metabolism.

Without oxygen they can't turn their food into energy or make any new fish body

So fish live in the water and they breathe the water, to do this they have special organs called gills.

Gills are wonderfully well designed, and they have to be because although the water does hold some oxygen it never holds anywhere near as much as the air, and to make things more difficult the amount of oxygen a body of water can hold decreases the warmer it becomes, and also, salt water holds less oxygen than fresh water.

gills need to be a lot more efficient at extracting  $O_2$  from the water than our lungs need to be at extracting it from the air.



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A fish's gills are situated one set on either side of the body and near the back of the head

They are open to the gullet at the front, and open to the external environment behind.

They are designed so that water can flow continually passed them, coming in through the mouth, and/or the spiracle in sharks and their allies, and passing out through the single external gill opening in fish or through one of the 5 to 7 gill clefts in sharks and rays.

In fish there is a bony plate protecting the gills, this is called the **operculum**, and it is hinged and has muscles attached to it so it can be regularly opened and closed.



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In sharks and rays the number of gills is usually **5**, but there are some species with **6 or 7 sets**, in fish the number of gills is **4** on either side of the body.

Each gill is supported by a gill arch and protected by gill rakers. Each gill arch supports one set of paired gill filaments.

The gill rakers help make sure that no extraneous material gets into the gill filaments to clog them up.

Each paired gill filament in turn supports numerous lamellae, extending out from both sides of the filament body.



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It's here in the lamellae that the uptake of  $O_2$  actually occurs.

The lamellae are very fine structures, however their exact dimensions depend on the normal activity levels of the fish in question.

The more active the fish the thinner they are and the less distance there is between them.

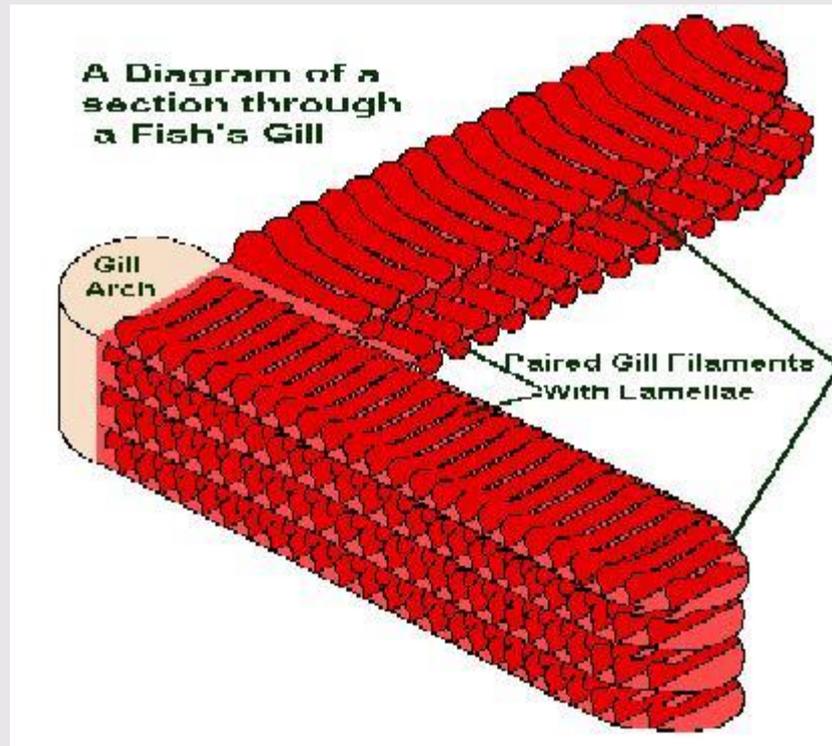
Also the absolute thickness of the individual lamellae walls varies, this is important in considering to facility with which  $O_2$  can diffuse from the water to the fish's blood, the thinner the membrane the more quickly and easily the  $O_2$  can pass across it.



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The presence of all these lamellae greatly increases the surface area of the gills, meaning that a large amount of water is available for gaseous exchange at any particular moment of time.





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# Counter current Mechanism

The gill lamellae are remarkable in that the blood inside the channels flows in a direction opposite to that of the water current flowing out side.

This is called Counter current Mechanism.

And helps in maximum exchange of gases ie intake of O<sub>2</sub> and release of CO<sub>2</sub>.

In active and fast swimming fishes such as mackerel the total surface area of the lamellae exposed to water current may be upto 1000sq mm/g wt and 80% of the O<sub>2</sub> dissolved in the water diffuses in to the blood, as a result of counter current mechanism, considered as the most efficient method.



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# Fig 11.9

## Structure and Function of Gills

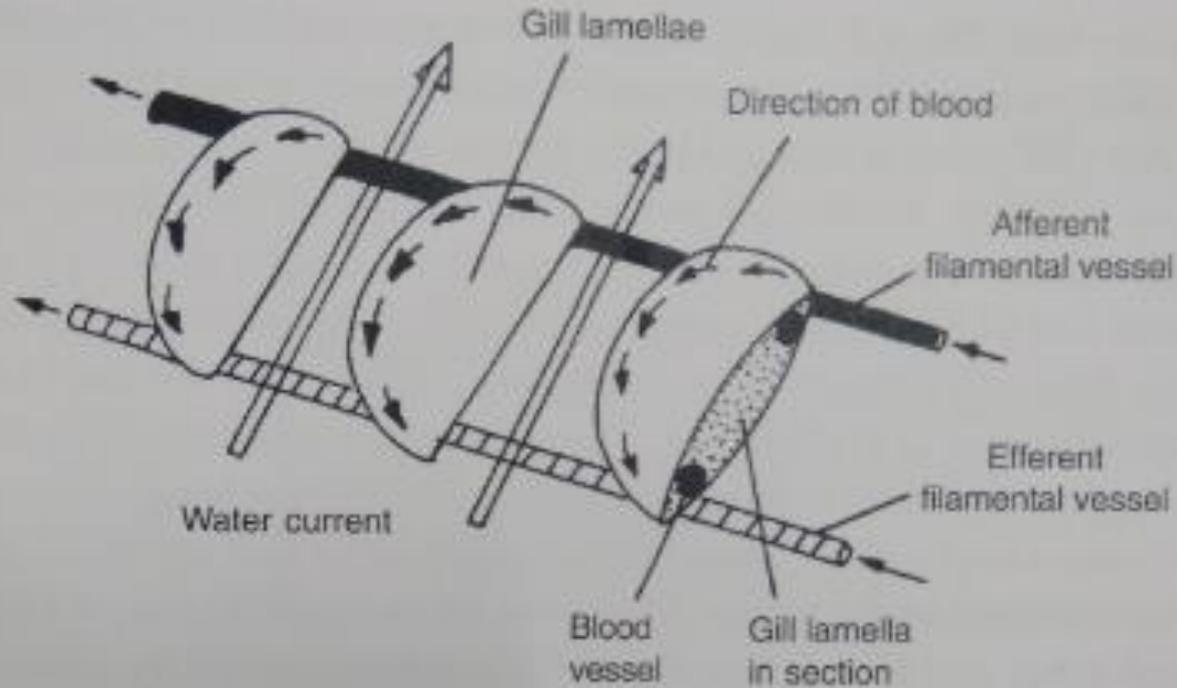


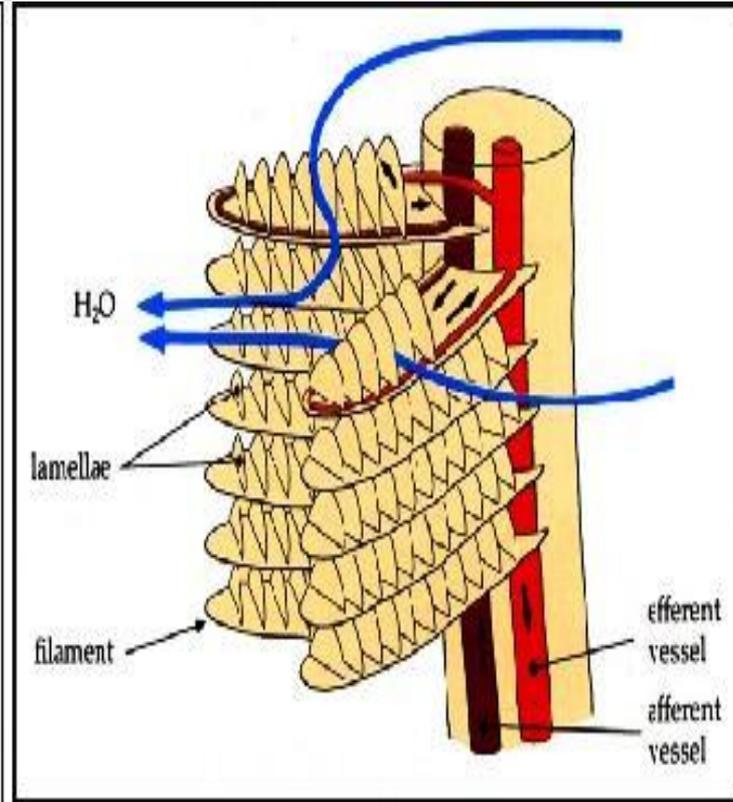
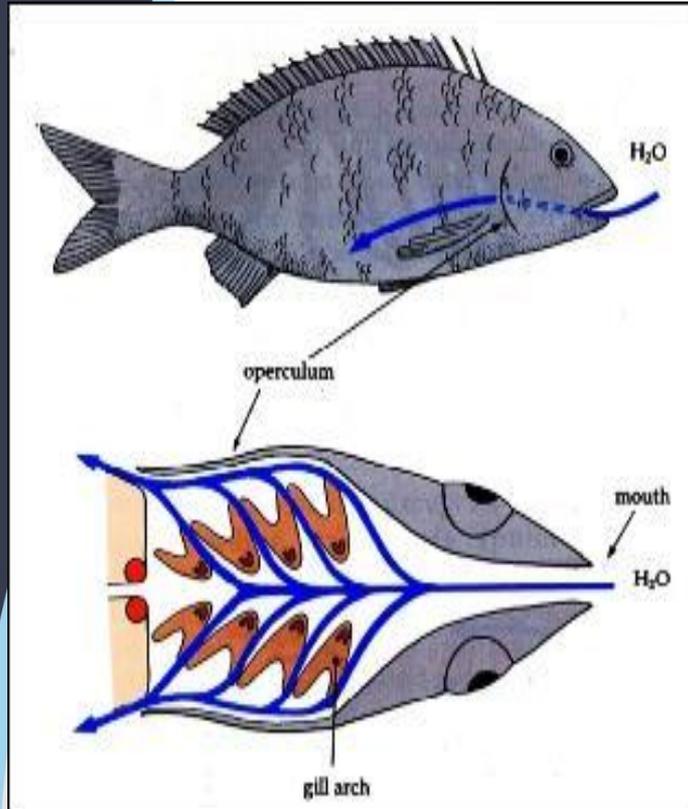
Fig. 11.9. Diagram of gill filaments showing counter current flow.



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# Structure of gills





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# Gill slits

There are six or seven pairs of gills in cartilaginous fishes while four pairs in bony fishes due to the loss of spiracle.

Gill slits of bony fishes are covered by operculum while operculum is absent in cartilaginous fishes. In sharks gill slits are situated while in rays they are ventrally placed.

A pair of spiracle is present in Elasmobranchii anterior to first gill which corresponds to a vestigial primitive first gill slit.

Although spiracle is absent in bony fishes, in Actinopterygii it is replaced by a pseudobranch which is free in some fishes but skin covered in others.



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# holobranch

A complete gill is known as holobranch. It consists of a bony or cartilaginous arch. The anterior and posterior part of each gill arch possesses plate like gill filaments. Each holobranch consists of an anterior (oral) and a posterior (aboral) hemibranch.

The architectural plan of teleostean gills shows heterogeneity in their functional unit which is due to varied osmoregulatory, feeding and respiratory behaviour and to the physicochemical status of their environment.

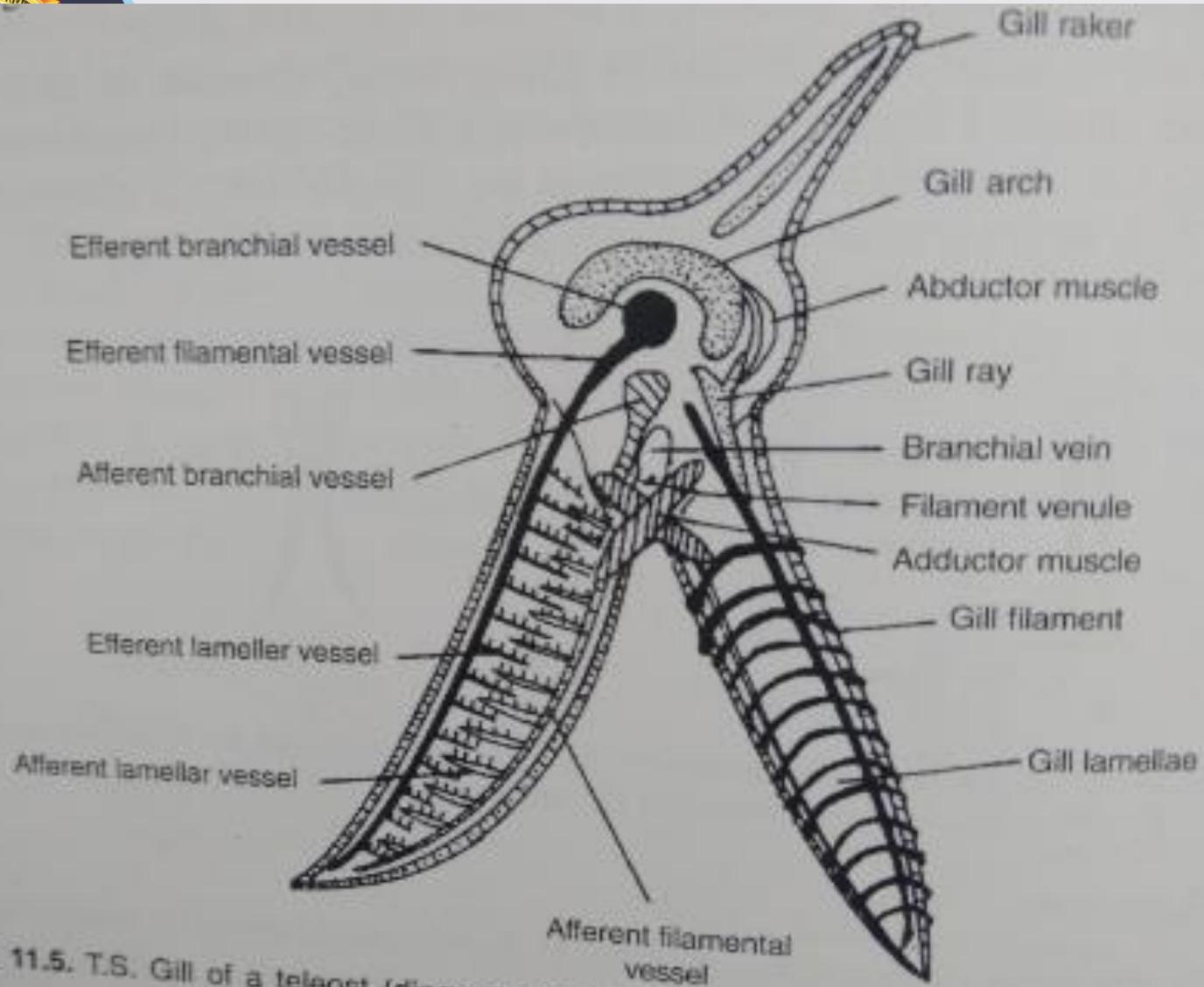


Fig. 11.5. T.S. Gill of a teleost (diagrammatic).



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The epibranchial and the ceratobranchial elements of each branchial arch bears two rows of gill filaments of the two hemibranchs of the holobranch., which are the seat gaseous exchange.

It encloses afferent and efferent branchialarteries and veins.

It is also provided by nerves.

It also contains abductor and abductor muscles. Inside it contains gill rakers, taste buds, mucous gland cells and sensory papillae.



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# Gill raker

It occurs in two rows on the inner margin of each gill arch.

Each gill arch is short stumpy structure supported by bony elements (fig3, a & b). The gill arch projects across the pharyngeal opening. They are modified in relation to food and feeding habits. The mucous cells of the epithelium help to remove sediments from the covering epithelium in order to enable the taste buds to function effectively and to sense the chemical nature of food passing through the gill sieve.



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# Gill Filaments (Primary gill lamellae)

Each hemibranch consists of both primary and secondary lamellae. The primary gill filaments remain separated from the branchial septum at their distal end making two hemibranch in opposition which direct the water flow between the gill filaments.

The gill filaments are blade-like structures supported by gill rays. The heads of the gill rays of both the hemibranchs are connected by ligaments

They provided with two types of adductor muscle units in teleosts. The gill filaments are also lined by epithelium referred to as primary epithelium. The epithelium has glandular and non glandular part.



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# Lamellae (secondary lamellae)

The each gill filaments is made up of secondary lamellae which are actual seat of exchange of gases.

They are generally semicircular and lined up along both sides of the gill filaments.

The lamellae frequency is directly proportional to the dimension and resistance of the gill sieve. The secondary lamellae are having two sheets of epithelium which are separated by space and through these spaces blood circulates.

The epithelial sheets are separated by a series of pillar cells. Each cell consists of a central body and is provided with extension at each end.



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*Thank you*