RESPIRATION IN SHELLFISHES

Respiratory system of prawn

Consist of three main organs

1. Lining of branchiostegites or gill covers:

It is thin membranous and highly vascular containing minute blood lacunae or vessels. This organ form large surface area for absorption of o_2 and release co_2 in water.

2. Epipodites:

These are three pairs of simple ,foliaceous and highly vascular outgrowth of integument , arises from coxal segments of three paires of maxiliipedes. Epipodites occupy the anterior part of gill chamber and 1st pair are bilobed and larger than others.

3. Gills:

There are eight gills inside the each gill chamber.

TYPES OF GILLS

There are three types of gill present according to their place of origin and attachment

1. Podobranch or foot gill:

it is attached to the coxa of each second maxillipede

2. Anthrobranch or joint gill:

it attached to the arthrodial membrane joining a limb with the body.Each third maxillipede bears two arthrobranch.

3. Pleurobranch or side gill:

it is attached to the lateral wall of the thorasic segments bearing the 5 walking legs

STRUCTURE OF GILL

Gills are more or less crescentic or semilunar in shape. They gradually increase in size backward, so that each gill is larger than its front one.

Each gill is attached to its middle to the wall of thorax by a small connection called gill root. Through the gill root nerves and blood channels passes to the gill.

Gills are phyllobranch and each of them consist of two rows of leaf like gill plate. Gill plates arranged like leaves of a book.

Gill plates are largest in the middle but become gradually smaller towards the two end.

A deep median longitudinal groove runs between the two rows of gill plates.

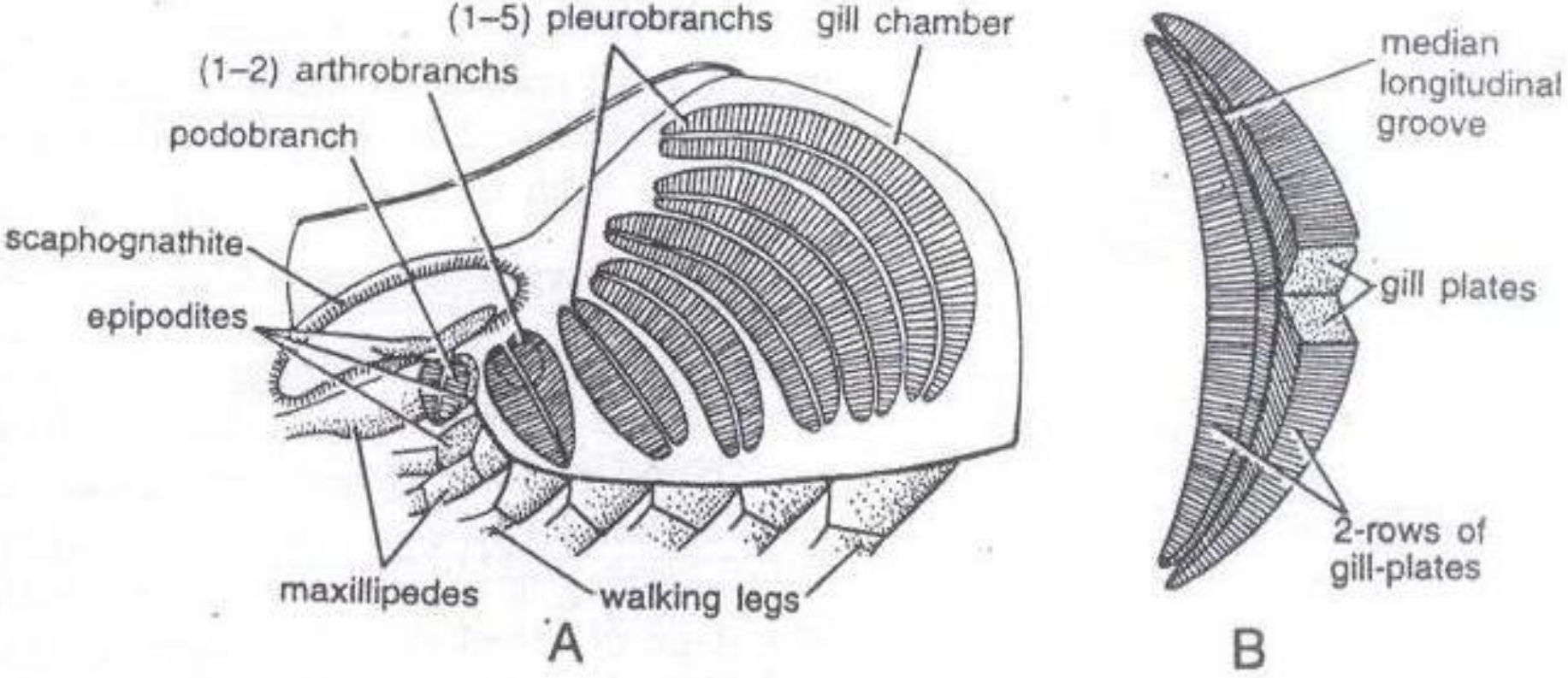


Fig. 19. *Palaemon.* A-Left gill-chamber exposed to show the gills. B-A phyllobranch.

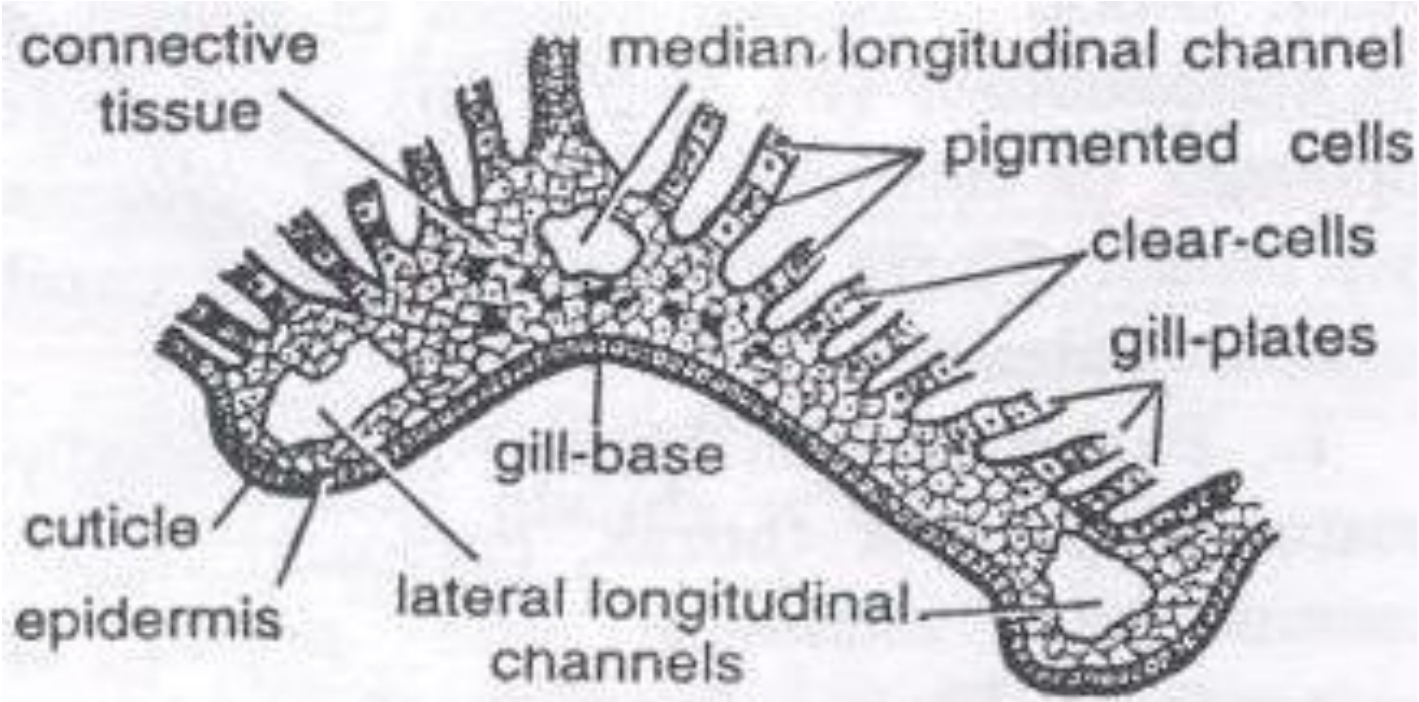


Fig. 20. *Palaemon.* Gill in oblique T.S.

Histologically gill plate is composed of single layer of cells.

Two types of cells are present –pigmented and transparent or clear cells.

Cells are covered by an epidermis which is externally protected by thin cuticle layer

BLOOD SUPPLY IN GILL

- **Three longitudinal blood chennels run through the gill base from one end to the other.**

- **Two are lateral longitudinal and third is median longitudinal channel running through gill base, beneath the median group of gills.**

- **In each gill plate the lateral channel gives off a slender marginal channel which finally join the median longitudinal channel**

Blood circulation in gill

- Deoxygenated blood from body is brought to the gill by an afferent branchial channel.
- It enters through gill root, flowing first through the lateral longitudinal channels then marginal channels and finally reaches the median longitudinal channels. During this path, blood gets oxygenated.
- From median channel blood is carried by efferent branchial channel to the heart.

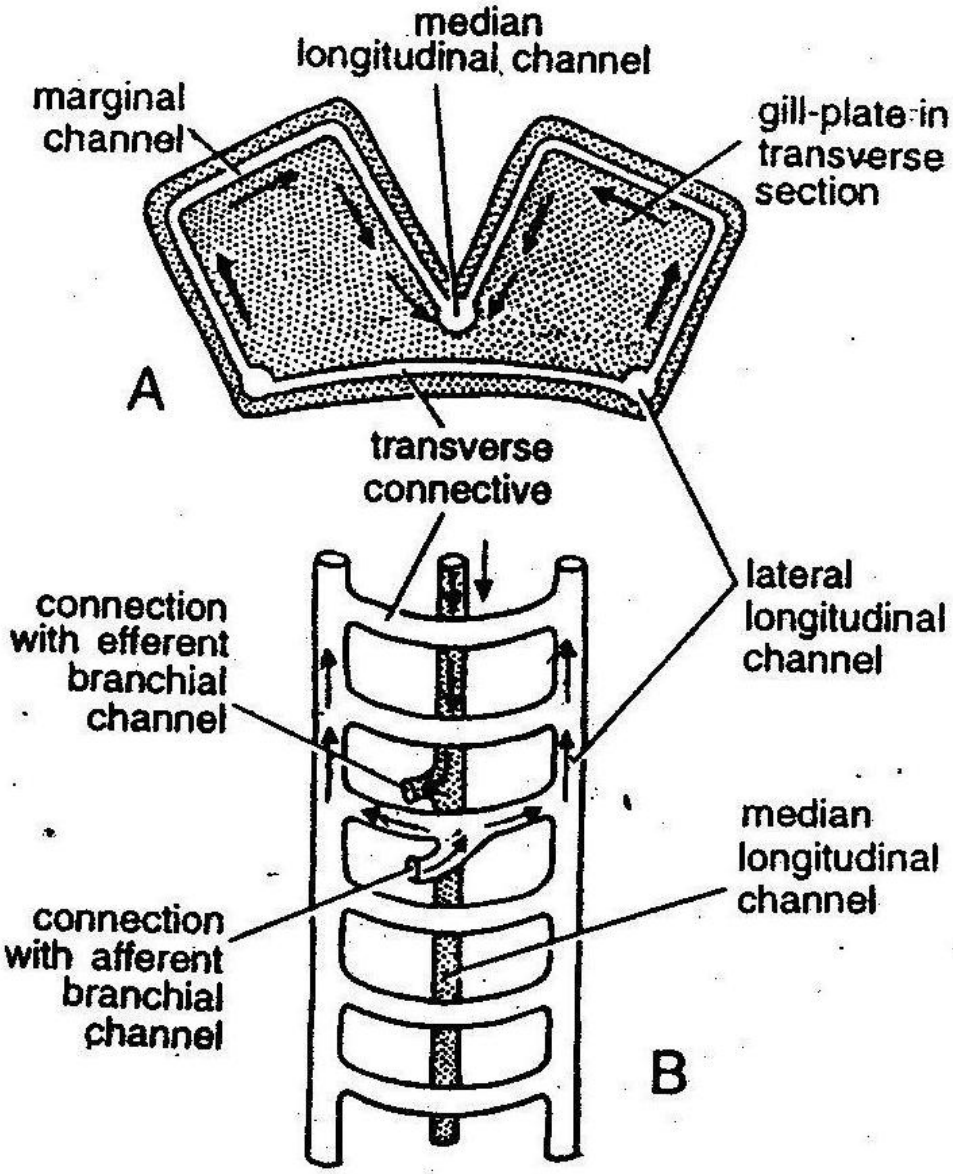


Fig. 21. *Palaemon.* A-Blood supply in gill plates. B- Diagrammatic representation of the ladder of blood channels in a gill.

Mechanism of Respiration

- The scaphognathite of each maxilla lies anteriorly inside the gill chamber.

- Due to the constant vibration of scaphognathite, it bales out water from the anterior opening of the gill chamber.

- Fresh water enters the gill chamber from behind in the form of the current. During the water flow exchange of gases takes place.

- The delicate and thin gill plates which are supplied with blood capillaries act as an excellent permeable membranes for the gaseous exchange.

Respiratory System of Lobster

- Gills of lobsters are known as **trichobranch** (TRIK-o-brank; from the Greek, thrix, hair; branchia, gills)

- They are composed of numerous filaments arranged, plume-like, around a central axis.

- On any given thoracic segment there may be as many as four pairs of gills, one pair on the basal segment of the limbs, two pairs arising from the soft membrane linking the limbs to the body, and one pair on the side of the body just above the limbs.

- In the American lobster, the full complement of gills occurs at the base of the second, third, and fourth thoracic legs, with fewer pairs on the remaining thoracic segments except the first, which lacks gills. **There are 20 pairs of gills in the American lobster.**

Respiratory System of Lobster

- On each side the gills lie within the branchial chamber, which is formed by a deep lateral fold of the carapace.

- Access to the brachial chamber is through very small openings between the appendages and two larger Openings, both ventral, one at the posterior end of the branchial chamber and the other at its anterior end.

- At the anterior opening, there is the leaf-like flap known as the gill bailer, or scaphognathite, which performs rapid beating and drives water forward in the channel and out of the branchial chamber.

Respiratory System of True Crab

- The primary respiratory organs of true crab are called gills, which are arranged like pyramid within the two gill-chambers. Each gill-chamber is present on the side of the thoracic chamber and is completely separated from it by pleuron. Externally the gill chamber is cov-ered by the branchiostegite.
- Gill of crabs known as **phyllobranchs**, after the Greek words phylion, meaning leaf, and branch, meaning gill.

Gaseous Exchange in Gills

- Water enters the branchial chambers of crabs primarily through an anterior opening above the base of each claw, or cheliped, and to a much less extent through openings at the base of the other thoracic legs.
- In the blue crab, when the chelipeds are raised and held forward, the opening at the base of the chelipeds is very large and nearly circular. When the chelipeds are folded against the body, the opening is a wide slit.
- Bristle-like setae arising from the basal portion of the cheliped filter some of the water entering the slit.
- The current of water through the branchial chambers of crabs is maintained by the beating of the gill bailer, which lies in the channel at the anterior exhalant opening of each branchial chamber.
- The water passes under the gills, up between the gills, over the gills, and out through the exhalant aperture.

Respiration in Mollusca (Pila)

The respiratory organs consist of a (1) single gill or ctenidium, (2) a pulmonary sac or lung and (3) a pair of nuchal lobes

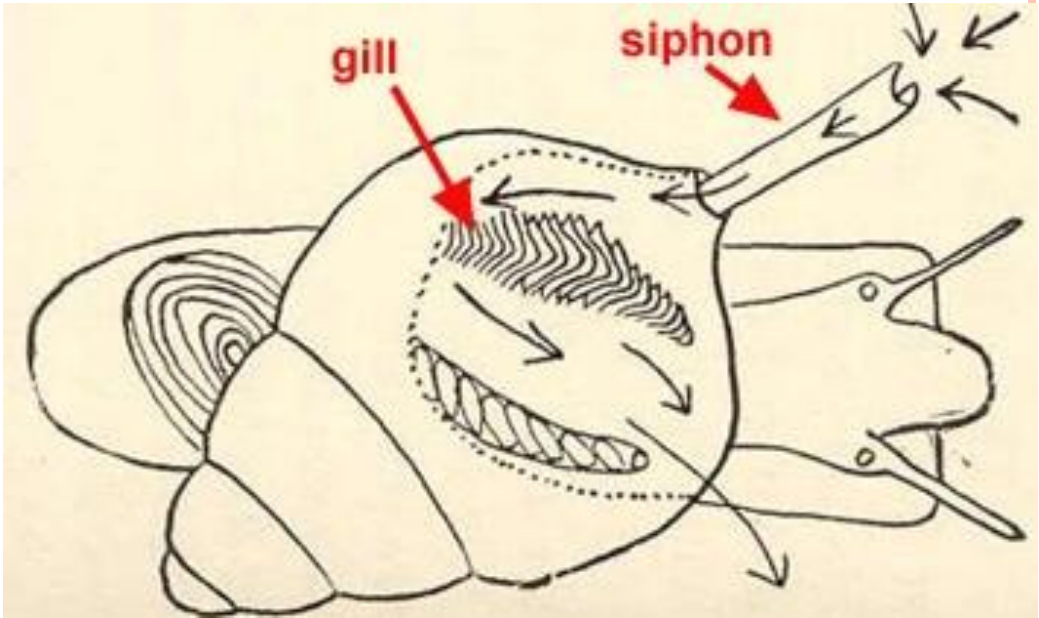
Ctenidium: consist of numerous thin lamellae attached to the mantle wall by their broad base and their apices free in the branchial chamber

✓A ctenidium with a single row of lamellae that is attached to an axis is called monopectinate gills

✓The lamellae present in the middle of the ctenidium are largest and they gradually become smaller towards the ends

✓Epithelial layer of lamellae consist of three kind of cells

1 Non ciliated columnar cells
2 Ciliated columnar cells
3 Glandular cells



Pulmonary Sac

It is a sac like structure hanging from the roof of the mantle cavity

It is developed from the mantle and consist of densely pigmented dorsal wall and a creamy white ventral wall

the flap on two sides of the opening are of unequal size, the left being larger than the right and help in the controlling the opening of pulmonary sac

Nuchal Lobes

Mantle have two fleshy and contractile nuchal lobes on the two sides of head

The left nuchal is well developed whereas the right is less developed

They form respiratory tubular funnels longer and smaller during respiration

Mechanism of respiration

Aquatic respiration

The animal is fully expanded and left nuchal lobe increase in size and takes the form of gutter

The respiratory current of water enters through the gutter like left lobe and reach the posterior part of pulmonary chamber and finally enters the branchial chamber where is baths the entire length of gills

Aerial or pulmonary Respiration

Pila moves towards surface of water and thrusts out its left nuchal lobe which becomes elongated and tubular to form the respiratory siphon

Pulmonary chamber become greatly emlarge and cut off from the branchial chamber

Air enters the pulmonary sac through respiratory siphon and respiratory movements produced by the alternate contraction and expansion of pulmonary sac help in respiration

On land the respiratory siphon is not formed and the air enters pulmonary chamber directly through the expanded nuchal lobe

Respiratory System of Unio

- Respiration is aquatic and carried on simultaneously with the feeding process. The respiratory organs are the gills or ctenidium and the mantle.
- The freshwater muscle respires the oxygen dissolved in water by a pair of gills or ctenidia or branchiae. On each side of the foot is a single gill, hanging the mantle cavity between the mantle and the visceral mass like a flattened, plate-like structure.

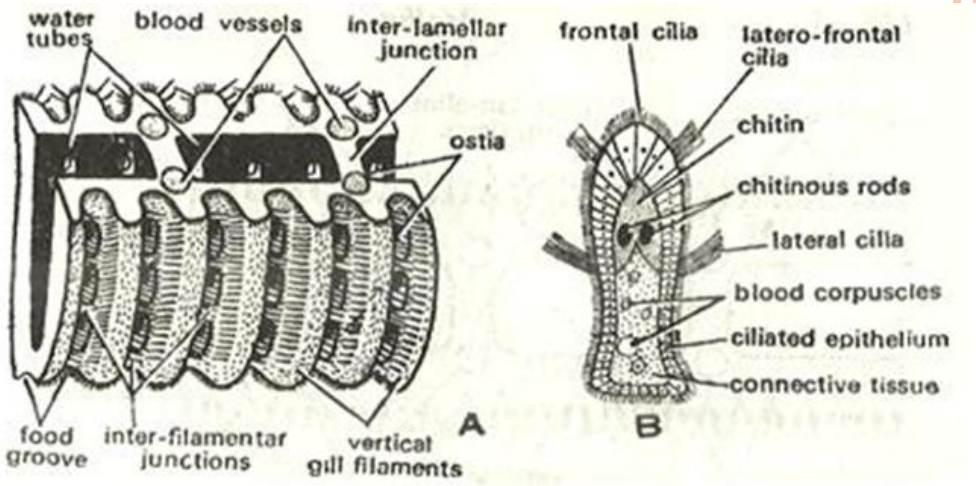


Fig. 9. Unio. A—Diagrammatic magnified view of a small part of gill lamina B—One gill

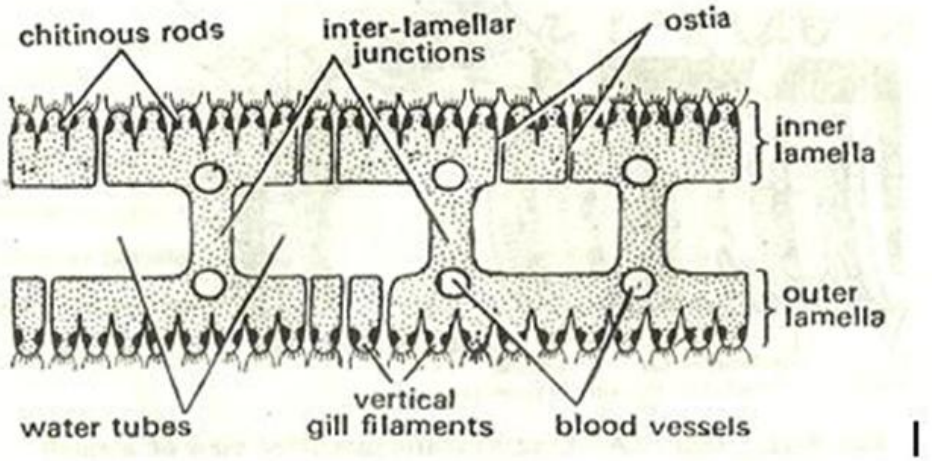
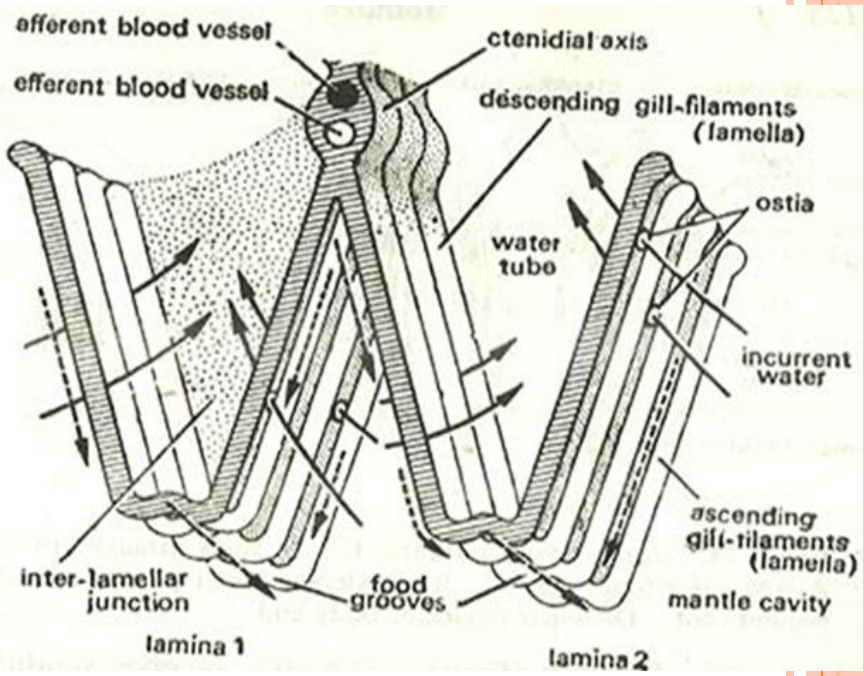


Fig. 10. Unio. Gill lamina in section

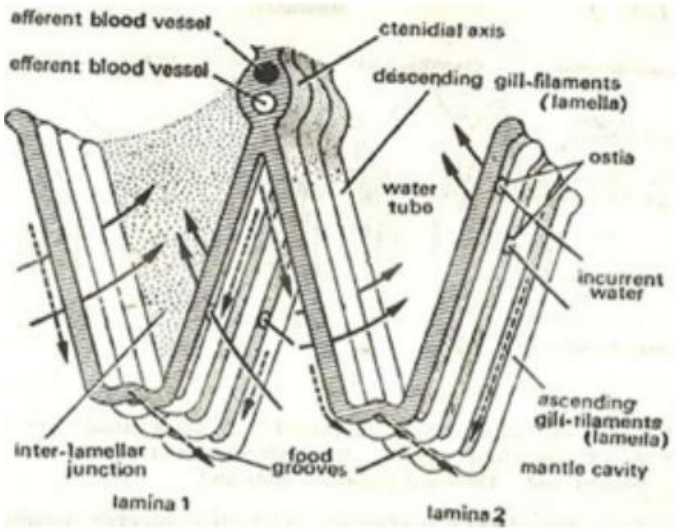
Structure of ctenidia

- The is a single pair of elongated ctenidia or gills, one on each side of the foot and are of eulamellibranch type.
- Each ctenidium appears double but it is made of two gill plates or demibranchs or laminae, an outer and an inner gill plate which have been derived by the folding of a single ctenidium.
- Each ctenidium is bipectinate, with a central ctenidial axis, from which filaments arise in two rows, one on either side.
- The filaments of each row are folded in the middle to appear V-shaped in section. Of the two arms of V, one is descending, the other ascending.
- At the angle of the fold, each filament is notched. The notches of all filaments form a continuous food groove, that extends the whole length of the underside of each lamina of the ctenidium.



Structure of ctenidia

- The adjacent gill filaments are joined by the fusion of tissue forming interfilamentar junction. Thus gill filament and interfilamentar junctions form the two lamellae of a gill plate.
- In the interfilamentar junctions are holes known as ostia which connects connect infrabranchial chamber of the mantle cavity with water tubes in the laminae.
- The gill filaments are covered with various kinds of cilia and each gill filament is supported by two chitinous rods.
- On the sides of filaments are lateral cilia, on the distal surface are frontal cilia and on lateral side are latero-frontal cilia.



ATTACHMENT OF CTENIDIA

- Outer lamella of the outer gill plate is attached to the mantle.
- The inner lamella of outer gill plate and the outer lamella of inner gill plate are joined together to the visceral mass.
- The inner lamella of inner gill plates is attached to the visceral mass anteriorly, but further back it is free and behind the foot it is joined to its fellow of the other side, so that the inner lamellae of inner gill plates are united with one another.

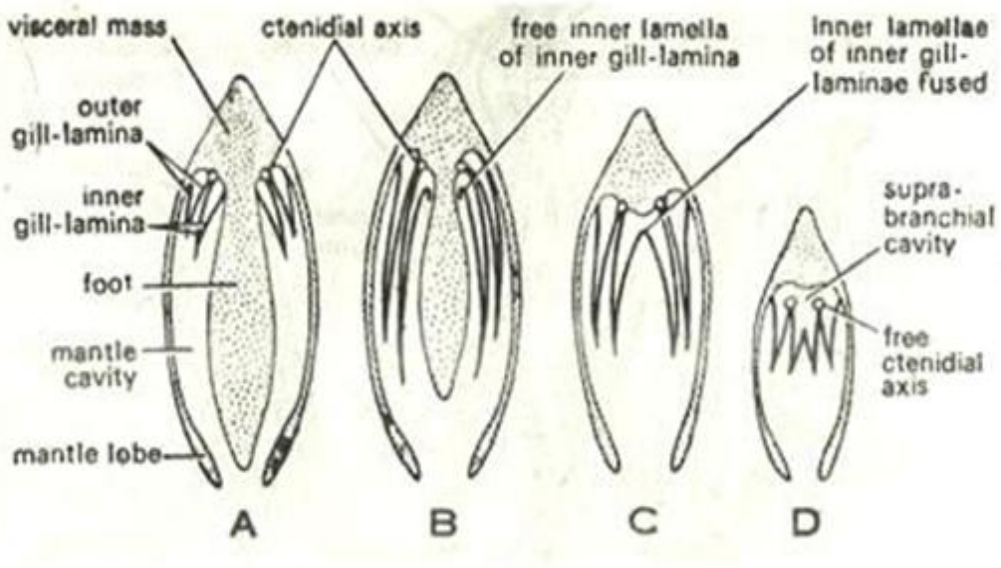


Fig. 12. Unio. Diagrammatic T.S. to show attachment of gills. —

A- Anterior foot region. B—Posterior foot region. C—A little behind foot. D—Near posterior body end.

Blood supply of gills

- The ctenidia are supplied by afferent branchial vessel carrying deoxygenated blood from the kidneys and divides to give rise branches into the interlamellar junctions.

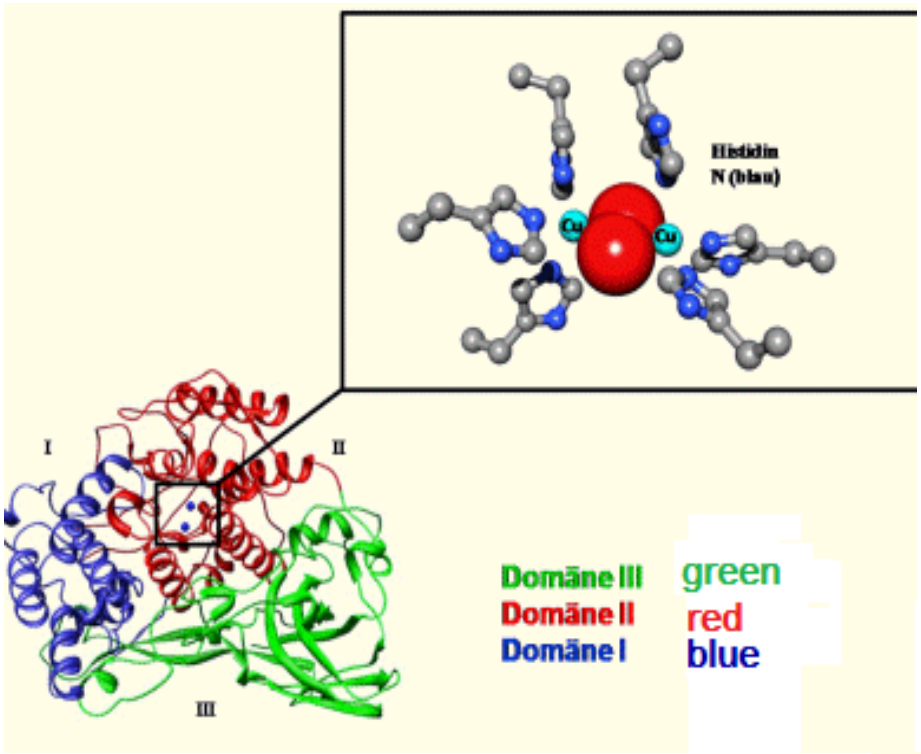
- These branches unite to open into efferent branchial vessel which carries away oxygenated blood to the heart.

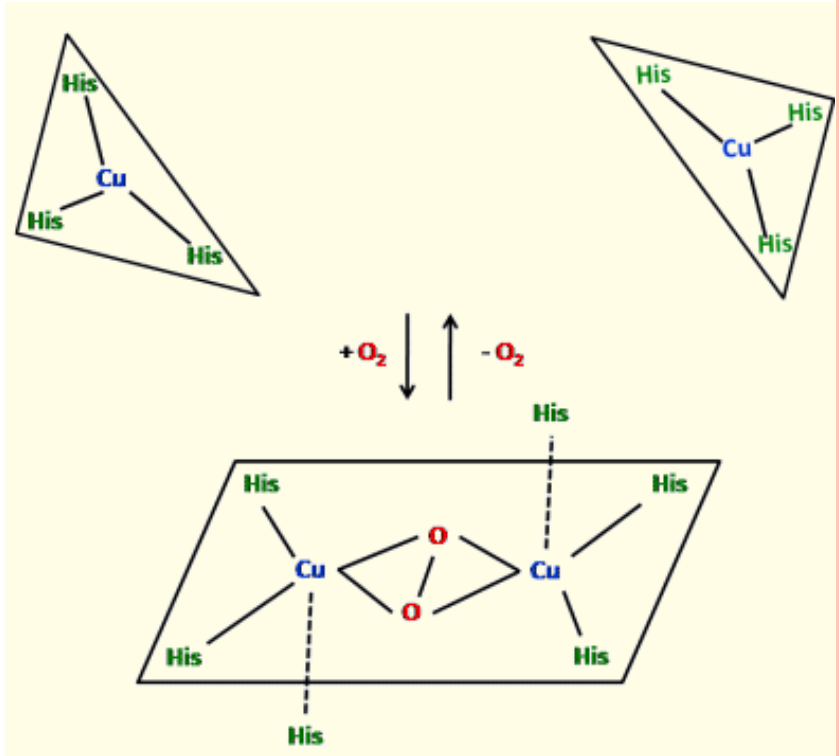
Course of Water current

- Constant beating of the cilia of gill filaments causes a continuous current of water to enter the inhalant siphon lying posteriorly and ventrally from where it goes to the mantle cavity.
- The lateral cilia pass water current to water tubes of gill plates through ostia, then it goes to supra-branchial chamber and passes out through exhalant siphon.
- Water current not only transport oxygen it also brings food and the outgoing current carries away products of excretion and faeces in addition to CO2.
- Mantle also helps in respiration. It is richly supplied with the blood vessels and gaseous exchange takes place through its thin wall.

Respiratory pigment in shellfish

Haemocyanin: **Respiratory pigments in most of the arthopods and mullasc. It is high molecular weight protein (75 kD) containing two copper (Cu) atoms. It is dissolved in blood plasma. Deoxygenated blood is white while oxygenated blood is blue in colour. Normal stability of oxygen binding is achieved only when the unit contain 8 copper atoms (tetramer). Oxygen carrying capacity is low compared to haemoglobin**





The oxygen binding at the active site of hemocyanin